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SERIES III BIOLOGY VOL. 2, NO. 4
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AN ECOLOGICAL STUDY OF THE FAUNA AND FLORA OF THE SAVANNAH RIVER PLANT AREA

VIII. Comparison sites

5. Comparison of the Flora of Four State Parks Within the Upper Coastal Plain

By

Clyde L. Porter, Jr., *and* Roy Yang Ming Yih
Department of Biology, University of South Carolina

The data reported in this paper were developed under Contract No. AT (07-2)-11 with the United States Atomic Energy Commission

This paper represents part of the contribution made by the University of South Carolina toward the development of the contract noted above. It supplies certain additional information to be employed in an outline of the phytoecology of the Upper Coastal Plain of South Carolina. Outside of the Savannah River Plant area three major studies have been completed in this geographical part of the state, namely, the flora of the Barnwell State Park (Porter, unpublished University of South Carolina thesis), the ecology of the Congaree River Swamp and Bottomlands, (Hoy, 1955, 1957; Huggins, 1955, 1958; Swails, Anderson and Batson, 1957), and the flora of Poinsett State Park (Porter, Welbourne, Yih and Hoy, 1958). The emphasis on the study of the plants of the Upper Coastal Plain lies in the fact that the Savannah River Plant area is an integral part of this Plain, forming as it does its southwestern end along the Savannah River.

The four state parks which form the basis of the present study are:

The Aiken State Park,
The Sesquicentennial State Park,
The Lee State Park, and
The Cheraw State Park.

The employment of state park acreage for ecological studies is explained in an earlier publication (Porter, Welbourne, Yih and Hoy, 1958). Briefly, such areas

permit one to work undisturbed, and return visits are made more readily.

It is a pleasure to express our thanks to the several park superintendents for their help in carrying out the work. We have met with unfailing courtesy and cooperation from these gentlemen. They are as follows:

Mr. Carl Foxworth, Superintendent of Aiken State Park; Mr. Marshall D. Holder, Superintendent of Sesquicentennial State Park; Mr. Van W. Pressley, Superintendent of Lee State Park and Mr. George T. Holder, Superintendent of Cheraw State Park.

Finally, we extend our thanks to Mr. C. West Jacocks, Director of State Parks, who has been willing to meet Department of Biology members more than halfway in arranging for opportunities to carry on these studies.

Aiken State Park is located on the South Fork of the Edisto River just seven miles north of Windsor on county road No. 54. About 200 of the 1,067 acres in this park are in swamp land bordering the river. South of the river the elevation increases and one passes from the swamp through a transitional zone into the Sand Hills which make up a significant part of the remaining acreage. A number of streams, mostly spring-fed, pass through the park and empty into the Edisto River. Several small ponds are also found within the boundary of the park.

The second park is northeast of Aiken State Park and is called Sesquicentennial State Park. It lies 12 miles north of Columbia on the eastern side of Highway No. 1. Most of the 1,500 acres in this park are true Sand Hills on the highest elevations of which "sand barrens" are found. One creek, probably spring-fed, has been dammed to form a lake beyond which it continues its course with the typical accompanying swampy regions.

The third park is Lee State Park which is located on County Road S-31-22, 7 miles southeast of its junction with Highway No. 15, which is three miles northeast of Bishopville. It lies along the Lynches River and a considerable portion of the park area lies within the Lynches River Swamp. Thus, the size of the sand-hill areas is somewhat restricted. There are 2,839 acres in Lee Park.

The fourth and last of the state parks considered in this paper is Cheraw State Park which encloses 7,361 acres within its boundaries. Except for the very large lake most of the acreage is in the Sand Hills. Drainage from the lake is into the Great Pee Dee River.

Both transects and quadrats were employed in the study. In all, 14 transects and 15 quadrats were made. The former averaged 150 meters in length except for at least one "roaming" survey of varying length in each park. The 15 quadrats furnished quantitative information of the flora within the 10m. x 10m. plots. In order to arrive more easily at a comparison of the flora, the different species from all four parks have been arranged alphabetically and their presence in one or more of the parks indicated by an X in the appropriate column of the list which follows.

COMBINED TRANSECT LIST

	State Parks			
	Aiken	Sesqui.	Lee	Cheraw
Acalypha gracilens		X		X
Acer negundo	X			
Acer rubrum	X	X	X	X
Acer saccharinum			X	
Agrimonia pubescens		X		
Aletris farinosa	X			
Alnus rugosa			X	
Alnus serrulata	X	X	X	X
Ambrosia artemisiifolia	X	X	X	X
Amelanchier canadensis		X		
Amorpha herbacea	X			X
Ampelopsis arborea			X	
Andropogon gerardii				X
Andropogon scoparius		X	X	X
Andropogon ternarius	X	X	X	X
Andropogon virginicus	X	X	X	X
Antennaria plantaginifolia	X			
Apios americana			X	
Aralia spinosa		X	X	
Arenaria caroliniana	X	X		X
Arisaema triphyllum			X	
Aristida sp.	X	X		
Aristolochia Serpentaria	X			
Aronia arbutifolia	X	X	X	X
Arundinaria tecta	X	X	X	X
Asclepias amplexicaulis				X
Asclepias humistrata	X		X	
Asclepias tuberosa	X			
Ascyrum hypericoides	X	X	X	X
Ascyrum stans		X	X	
Aster ericoides		X		X
Aureolaria pedicularia	X	X	X	X
Axonopus compressus		X	X	X

	State Parks			
	Aiken	Sesqui.	Lee	Cheraw
Baccharis halimifolia		X	X	X
Baptisia perfoliata	X			
Batisia tinctoria	X	X		X
Berchemia scandens	X		X	X
Berlandiera pumila	X			X
Bignonia capreolata	X		X	X
Boehmeria cylindrica		X	X	
Brasenia Schreberi	X	X		X
Breweria humistrata	X	X		
Bulbostylis capillaris	X	X	X	X
Bulbostylis ciliatifolia				X
Callicarpa americana	X	X	X	X
Calycanthus floridus	X			
Campsis radicans	X	X	X	X
Carex glaucescens			X	
Carex intumescens	X			
Carex spp.	X	X	X	
Carpinus caroliniana	X		X	
Carya ovalis	X	X	X	X
Carya pallida	X			
Carya tomentosa	X	X	X	X
Cassia fasciculata	X	X	X	
Cassia nictitans			X	
Catalpa Catalpa	X	X		
Celtis georgiana	X			X
Celtis occidentalis		X		X
Cenchrus pauciflorus		X		
Ceonothus americana		X	X	X
Cephalanthus occidentalis	X			
Ceratiola ericoides		X		
Cercis canadensis		X		X
Chenopodium ambrosioides			X	
Chimaphila maculata		X		X
Chionanthus virginicus	X			
Chrysopsis gossypina	X	X	X	X
Chrysopsis graminifolia	X	X	X	X
Chrysopsis mariana	X			
Cirsium repandum	X	X	X	X
Clethra alnifolia				X
Clethra tomentosa	X	X	X	X
Clitoria mariana	X	X	X	X
Cnidoscolus stimulosus	X	X	X	
Commelina virginica		X		X
Coreopsis delphinifolia	X	X		
Coreopsis lanceolata	X			
Coreopsis major	X	X	X	
Cornus florida	X	X	X	X
Cornus stricta			X	
Crataegus Marshallii		X	X	
Crataegus sp.	X	X	X	X
Crataegus uniflora	X	X		
Croton glandulosus	X			X
Cuscuta compacta			X	
Cynodon Dactylon				X
Cyperus ovularis	X			X
Cyperus retrofractus		X	X	X
Cyperus spp.	X	X	X	
Cyperus strigosus	X			
Cyrilla racemiflora		X		X

	State Parks			
	Aiken	Sesqui.	Lee	Cheraw
Decumaria barbara	X		X	X
Desmodium Fernaldii	X	X	X	X
Desmodium laevigatum				X
Desmodium nudiflorum		X	X	
Desmodium paniculatum	X	X	X	X
Desmodium rotundifolium			X	
Desmodium strictum	X			
Diodia teres	X	X	X	X
Diodia virginiana		X		X
Dioscorea quaternata		X	X	X
Diospyros virginiana	X	X	X	X
Dulichium arundinaceum	X	X		
Elephantopus caroliniana	X		X	
Elephantopus tomentosus		X	X	X
Epigaea repens	X	X	X	X
Eragrostis capillaris			X	X
Erianthus giganteus			X	
Erigeron sp.	X			
Erigeron strigosus	X	X	X	X
Eriogonum tomentosum	X	X		
Eupatorium album	X		X	
Euonymus americanus			X	
Eupatorium capillifolium		X	X	X
Eupatorium compositifolium	X	X	X	X
Eupatorium cuneifolium	X			X
Eupatorium dubium	X		X	
Eupatorium lecheaeafolium				X
Eupatorium rotundifolium		X		X
Euphorbia corollata	X	X	X	
Euphorbia Ipecacuanhae	X	X	X	X
Euphorbia marilandica	X			X
Euphorbia serpens				X
Fagus grandifolia			X	X
Festuca sp.	X			X
Fraxinus americana	X	X	X	
Fraxinus pennsylvanica			X	
Froelichia floridana			X	
Fuirena squarrosa	X			
Galactia volubilis	X	X	X	X
Galium hispidulum	X	X		
Galium sp.		X		X
Gaylusaccia baccata	X			
Gaylusaccia dumosa		X	X	X
Gelsemium sempervirens	X	X	X	X
Gerardia setacea		X	X	
Gila rubra	X			
Gnaphalium obtusifolium	X	X	X	X
Gymnopogon ambiguus	X	X		X
Habenaria ciliaris				X
Habenaria clavellata	X			
Hamamelis virginiana				X
Haplopappus divaricatus	X			X
Helenium tenuifolium		X		X
Helianthus atropurpurea				X
Helianthus hirta	X			
Heterotheca subaxillaris	X		X	
Hexastylis arifolia		X	X	X
Hieracium Gronovii		X		

	State Parks			
	Aiken	Sesqui.	Lee	Cheraw
Hydrocotyl umbellata	X	X		
Hydrolea quadrivalvis	X	X		
Hypericum gentianoides	X	X		X
Hypericum gerardi		X		
Hypericum mutilum		X		X
Ilex coriacea	X			X
Ilex decidua	X	X	X	X
Ilex glabra		X	X	X
Ilex opaca	X	X	X	X
Iris verna	X			
Itea virginiana	X		X	X
Juncus biflorus	X	X	X	
Juncus coriaceus	X	X		
Juncus dichotomus			X	X
Juncus effusus	X	X		X
Juncus scirpoides				X
Juncus tenuis		X	X	X
Juniperus virginiana	X			X
Jussiaea decurrens		X	X	
Kalmia latifolia	X	X		
Kuhnia eupatorioides		X	X	
Lactuca canadensis		X	X	
Lasiococcus dumosus			X	
Lechea minor				X
Lechea villosa	X		X	X
Leptilon canadensis	X		X	X
Leptoloma cognatum	X		X	X
Lespedeza cuneata	X	X		X
Lespedeza hirta	X	X	X	X
Lespedeza procumbens		X	X	
Lespedeza repens	X			X
Lespedeza striata	X	X	X	X
Leucothoe axillaris	X		X	
Liatris gaminifolia	X			X
Liatris secunda	X	X		X
Liquidambar Styraciflua	X	X	X	X
Liriodendron Tulipifera	X	X	X	X
Lobelia Boykinii				X
Lobelia cardinalis	X		X	
Lonicera japonica	X	X	X	X
Ludwigia alternifolia		X	X	X
Lupinus diffusus				X
Lycopus virginicus		X	X	
Lyonia lucida		X		X
Lyonia mariana	X	X		X
Magnolia virginiana	X	X	X	X
Malus angustifolia			X	
Marshallia obovata	X	X	X	X
Mayaca Aubleti		X	X	
Melia Azedarach	X			
Micranthemum umbrosum			X	
Mikania seandens			X	
Mitchella repens	X		X	
Morus rubra	X	X	X	X
Myrica cerifera	X	X	X	
Myriophyllum heterophyllum			X	
Nuphar sp.			X	
Nyssa biflora	X	X	X	X
Nyssa sylvatica	X		X	X

	State Parks			
	Aiken	Sesqui.	Lee	Cheraw
Opuntia compressa	X	X	X	X
Orontium aquaticum	X	X		
Ostrya virginiana			X	
Oxalis stricta		X		X
Oxydendrum arboreum		X	X	X
Panicum aciculare	X	X	X	X
Panicum anceps		X	X	X
Panicum angustifolium				X
Panicum Boscii	X	X		
Panicum chrysopsidifolium				X
Panicum halapense				X
Panicum hemitomum				X
Panicum lanuginose				X
Panicum leucothrix				X
Panicum lucidum				X
Panicum mutabile			X	
Panicum oligosanthes	X			
Panicum Ravenelli	X			
Panicum scoparium		X		X
Panicum spp.	X	X	X	
Panicum tennesseense				X
Panicum virgatum				X
Parthenium astericus				X
Parthenocissus quinquefolia	X			X
Paspalum dilatatum	X		X	X
Paspalum setacum	X			X
Paspalum sp.		X		
Paspalum Urvillei		X		
Passiflora incarnata		X	X	X
Peltandra virginica	X			X
Penstemon laevigatus	X			
Persea borbonia		X		X
Persea palustris	X			
Philadelphus hirsutus			X	
Physalis heterophylla			X	X
Physalis sp.	X			
Phytolacca americana	X	X	X	X
Pilea pumila	X	X	X	X
Pinus australis	X	X	X	X
Pinus echinata	X	X	X	
Pinus Taeda	X	X	X	X
Plantago lanceolata				X
Polycodium floridanum	X			
Polycodium sp.	X			
Polygala grandiflora				X
Polygonatum biflorum		X		X
Polygonella americana	X			
Polygonella Croomii		X	X	
Polygonum hydropiperoides	X		X	X
Polypremum procumbens		X		X
Populus heterophylla			X	
Potamogeton amplexifolius			X	
Potentilla simplex		X	X	X
Prenanthes altissima		X		
Prunella vulgaris	X			
Prunus angustifolia	X	X	X	X
Prunus caroliniana				X
Prunus serotina	X	X	X	X
Psoralea sp.		X		

	State Parks			
	Aiken	Sesqui.	Lee	Cheraw
Ptilimnium capillaceum		X		
Quercus alba			X	
Quercus cinerea	X	X	X	X
Quercus coccinea	X		X	
Quercus falcata	X	X	X	X
Quercus margaretta	X			
Quercus hemisphaerica				X
Quercus laevis	X	X	X	X
Quercus laurifolia			X	X
Quercus lyrata	X		X	
Quercus marilandica	X	X	X	X
Quercus Michauxii			X	
Quercus nigra	X		X	X
Quercus phellos	X	X		X
Quercus stellata	X	X	X	X
Quercus velutina			X	
Quercus virginiana				X
Rhexia aristosa			X	
Rhexia lanceolata				X
Rhexia mariana			X	
Rhexia sp.		X		
Rhododendron nudiflorum	X	X	X	
Rhododendron viscosum		X		X
Rhus copallina	X	X	X	X
Rhus glabra		X		
Rhus radicans	X	X	X	X
Rhus Toxicodendron	X	X	X	X
Rhus vernix	X			X
Rhynchosia diffomis	X	X		X
Rhynchosia erecta				X
Rhynchospora corniculata				X
Rhynchospora filifolia	X	X		
Rhynchospora Grayii				X
Rhynchospora sp.			X	
Robinia Pseudoacacia		X		
Rubus cuneifolius	X			
Rubus sp.	X	X	X	X
Sagittaria sp.		X		
Salix nigra	X	X	X	X
Sambucus canadensis	X	X	X	
Sanicula canadensis	X			
Sassafras albidum	X	X	X	X
Saururus cernuus	X	X	X	
Schrankia angustata	X	X	X	X
Scirpus cyperinus	X			X
Scirpus sp.		X		
Scleria triglomerata	X	X	X	X
Senecio Smallii			X	X
Sericocarpus asteroides	X	X		X
Sericocarpus sp.			X	
Sida rhombifolia			X	
Sida spinosa			X	
Silphium astericus	X			X
Silphium compositum	X	X		X
Silphium integrifolium				X
Silphium laciniatum	X			
Smilax Bona-nox		X	X	X
Smilax glauca	X	X	X	
Smilax laurifolia	X		X	X

	State Parks			
	Aiken	Sesqui.	Lee	Cheraw
Smilax rotundifolia	X	X	X	X
Smilax Smallii	X	X	X	
Solanum carolinense		X	X	X
Solanum nigrum			X	
Solidago altissima			X	
Solidago odora	X	X	X	X
Sorghum halapense			X	
Spiraca tomentosa		X		X
Sporobolus junceus	X	X	X	X
Sporobolus Poiretti				X
Stillingia sylvatica	X		X	X
Stipa avenacea	X			
Stipulicida setacea	X	X	X	X
Stylosanthes biflora	X	X		X
Styrax americana		X	X	X
Styrax grandifolia		X	X	X
Symplocos tinctoria				X
Taxodium distichum	X			
Tephrosia spicata		X	X	X
Tephrosia virginiana	X	X	X	X
Tradescantia rosea	X	X	X	
Tragia linearifolia		X	X	X
Tragia urens	X	X	X	X
Triadenum Walteri	X	X	X	
Trilsia odoratissima				X
Trioda flava			X	
Typha latifolia	X	X		X
Ulmus alata	X		X	
Ulmus americana			X	
Uniola latifolia			X	
Uniola sessilifolia		X	X	X
Vaccinium arboreum	X	X	X	X
Vaccinium corymbosum	X			
Vaccinium stamineum		X	X	X
Vaccinium tenellum	X	X	X	X
Viburnum cassinoides			X	
Viburnum nudum				X
Viola primulifolia	X	X	X	
Vitis aestivalis	X	X	X	X
Vitis rotundifolia	X	X	X	X
Wisteria frutescens			X	
Xyris caroliniana		X		X
Yucca filamentosa	X	X		
Zornia bracteolata	X			

This list represents sand-hill species in all parks, deep-swamp species in Aiken and Lee State Parks, and lesser-swamp, or creek-swamp species in Cheraw and Sesquicentennial State Parks. The variation in species type is as previously noted, due to variations in the physiography of the different parks.

The total number of species found in these various areas is 371. Each park had between 199 and 212 species. Of these, 73 species are common to all four parks, 72

are common to three, 88 are common to two, and 138 are found in only one park. The following figures represent the total list of species which do not occur in that particular park but which do occur in the other three: Aiken, 25; Sesquicentennial, 13; Lee, 15; and Cheraw, 19. Lee State Park has the largest number of species, 42, which occur in any one park and which do not occur in any of the others. Aiken State Park has the second highest figure, 41, and Sesquicentennial State Park has the least number, 18. The figures for Lee and Aiken might be attributed to the presence of swamps at these two places, which would naturally furnish species not found in the other two since they lack such ecological areas. The value for Cheraw, 39, is also significant and probably occurs as a result of Cheraw's higher latitude. Since Aiken and Cheraw Parks are separated by a distance of 140 miles, plants found at Aiken might possibly be replaced to some extent by other species at Cheraw, and conversely. Sesquicentennial, on the other hand, is approximately halfway between the two and has the lowest comparison figure. This may be explained to some extent by the fact that Sesquicentennial is located in a true sand-hill area having Sandhill Barrens at its highest elevation.

Other species, Sand Selaginella, *Selaginella acanthonota* Underw., and Sandwort, *Arenaria caroliniana* Walt., are further indications of these extreme conditions and they are not found in the other parks. *Selaginella* was not included in the listing because it is a spore producer, not a seed plant. Bracken Fern, *Pteridium aquilinum* (Michx.) Moore, is found in what might loosely be termed "Sandhills" in every park. It was not listed for the same reason stated above. Most of the floristic differences are in the dicotyledonous population. An unusually large number of Panic Grasses was found at Cheraw due to the fact that this area was surveyed during the period of greatest abundance for the genus.

SANDHILL QUADRATS

	Aiken		Sesqui.		Lee			Cheraw			
	1	2	1	2	1	2	3	1	2	3	4
Acer rubrum											1
Andropogon scoparius			221	51			31	17	54	13	11
Andropogon ternarius	11										
Arenaria caroliniana			29	1				2			
Aristida sp.	23										
Asclepias amplexicaulis											7
Ascyrum hypericoides	2	1						2			

	Aiken		Sesqui.		Lee			Cheraw			
	1	2	1	2	1	2	3	1	2	3	4
Aureolaria pedicularia	9		79	25				13	19	1	
Baptisia tinctoria	7	4							3	3	
Berlandiera pumila	8	1						12			
Breweria humistrata				2						2	
Chrysopsis gossypina	1										10
Chrysopsis graminifolia	21	71	52	12			2	113	29	11	44
Cirsium repandum								2		7	5
Clitoria mariana								5		3	
Cnidoscolus stimulosus		2		5							
Coreopsis delphinifolia	3	4									
Coreopsis major	2										
Crataegus meridiana			4								
Crataegus sp.	7	1									
Crataegus uniflora				2							
Cynodon Dactylon											2
Cyperus ovularis							29				
Desmodium paniculatum								7			
Diospyros virginiana	2		58	4			3	1	2		
Erigeron strigosus											2
Eriogonum tomentosum	11	3									
Euphorbia corollata									1		
Euphorbia ipecacuanhae	5	2	4	26	6	1				6	
Euphorbia marilandica										1	
Galactia volubilis	7	5		18	31						
Gaylusaccia dumosa					97						
Gelsemium sempervirens					19	6	5				2
Gnaphalium obtusifolium								7			
Gymnopogon ambiguus								2			1
Hypericum gerardi			12								
Kuhnia eupatorioides								2			
Lechea villosa							2				
Leptoloma cognatum							4				
Lespedeza hirta											13
Lespedeza repens	3							2			
Liatris graminifolia								3		1	
Lupinus diffusus											3
Lyonia mariana								3	17	7	3
Opuntia compressa		1		1			2				
Panicum Boscii	4										
Panicum chrysopsidifolium								19	14		14
Panicum leucothrix										1	3
Panicum mattamuskeetense			41								
Panicum spp.	13	3									
Parthenium integrifolium								6			
Pinus australis	3	2	4	4	7	2		11	21	14	42
Pinus echinata						1					
Pinus Taeda					18	3	227				
Polycodium floridanum	41										
Polycodium sp.		5									
Prunus serotina							9				
Quercus cinerea	29	14						2	4		
Quercus coccinea						1					
Quercus falcata						1	4				
Quercus laevis	38	31	51	51	51	31		7	28	99	
Quercus laurifolia					4		32				1
Quercus marilandica								16	35	2	
Quercus nigra							3				
Quercus stellata	14	5			5	10					

	Aiken		Sesqui.		Lee			Cheraw			
	1	2	1	2	1	2	3	1	2	3	4
Rhus copallina								7	9		
Rhus Toxicodendron	21	14	7		2			159	114	4	4
Rhynchosia erecta								1			
Rhynchospora			4	1				3	3		1
Sassafras albidum							21				
Scleria triglomerata									8		
Sericocarpus asteroides				34				13	101	9	
Silphium compositum		3	1								
Silphium integrifolium								2		9	
Smilax glauca	3										
Solanum carolinense											4
Solidago odora	37	22						205	83	26	
Sporobolus junceus	14	37	59	16			33	9	77	73	
Stipa avenacea								9			
Stipulicida setacea	17	4	26	6	52		41			6	12
Tephrosia virginiana	42	11		43	34	8		231	73	51	2
Tradescantia rosea	2		7	22							
Tragia urens							4			4	14
Vaccinium arboreum	51	9	1	1	1	34					
Vitis rotundifolia						5					

The quadrat study was divided, for convenience, into sandhill quadrats and swamp quadrats.

Only the two major swamps previously mentioned are considered here. Of the 43 species found in these quadrats, 26 were found at Aiken and 29 were found at Lee. The greatest number of species occurred in a quadrat study made at Lee but there is a difference of only four species between any two of the four quadrats. The total number of individuals found is 1942, averaging 749 for each Aiken quadrat and 222 for each quadrat made at Lee.

Considering the quadrats separately, the number of Sedges, *Carex spp.*, far exceeds any other species with 931 individuals being present in one. Poison Ivy, *Rhus radicans* L. was second with 135 individuals and is followed by *Sedge, Carex* spp., which also has the third highest figure, 102. Greenbrier, Smilax *rotundifolia* L., and Clearweed, *Pilea pumila* (L.) Gray, are next in order. Species with the least numbers present in any one quadrat are: American Holly, *Ilex opaca* Ait.; Swamp Black Gum, *Nyssa biflora* Walt.; Overcup Oak, *Quercus lyrata* Walt.; Water Oak, *Quercus nigra* L.; Elder, *Sambucus canadensis* L.; and Arrow-wood, *Viburnum dentatum* L., all of which were present only once. Fourteen species were found at Aiken which were not found at Lee, and 17 species were found at Lee which were not found at Aiken.

Of the composite list of 43 species, 17 are trees. White Ash, *Fraxinus americana* L., and Black Gum, *Nyssa sylvatica* Marsh., are the most common. The shrub layer consists of 19 species of which Poison Ivy, *Rhus radicans* L. and Greenbrier, *Smilax rotundifolia* L., are most common. *Carex* spp. represented the most common of the 7 herb species present.

SWAMP QUADRATS

	Aiken St. Pk.		Lee St. Pk.	
Quadrat number	1	2	1	2
Acer rubrum	4	5	5	3
Alnus serrulata		3		
Aristolochia Serpentaria	7			
Berchemia scandens			7	
Bignonia capreolata	11	19	17	3
Campsis radicans			10	
Carex spp.	931	102	13	4
Carpinus caroliniana			5	3
Crataegus sp.			1	1
Decumaria barbara	23	16		
Fraxinus americana	63	17	2	
Fraxinus pennsylvania				14
Hydiocotyl umbellata		13		
Ilex decidua			2	1
Ilex opaca			1	
Itea virginica	12	5		1
Liquidambar styraciflua			10	14
Lobelia cardinalis	7	2		1
Magnolia virginica	4	4		
Mitchella repens	29			
Nyssa biflora	1			
Nyssa sylvatica	34	27	5	13
Ostrya virginiana			1	5
Parthenocissus quinquefolia				1
Persea palustris	3	2		
Pilea pumila	49	14		
Populus heterophylla				2
Quercus lyrata			1	
Quercus nigra	1			
Rhodendron nudiflorum		3		
Rhus radicans	5	14	135	12
Rubus sp.		17		4
Sambucus canadensis	1			
Saururus cernuus			11	
Smilax pumila			4	
Smilax rotundifolia	8	22	94	17
Smilax Smallii			6	
Taxodium distichum	5	1		
Triadinum Walteri	2			
Viburnum dentatum			1	
Viola primulifolia		9		
Vitis aestivalis			8	2
Vitis rotundifolia			2	

Eighty-five species are noted in the composite list of the sand-hill quadrat portion of this study. Of this num-

ber 15 are trees, which are largely oak (8) and Pine (3). The most numerous species, considering the parks as a whole, are Turkey Oak, *Quercus laevis* Walt., and Loblolly Pine, *Pinus Taeda* L., but this figure for the pine represents the seedling count too. These same two plants also share the highest frequency figure which is 91%.

The shrub layer consists of 16 species of which Poison Oak, *Rhus Toxicodendron* L., is by far the most numerous. Dwarf Huckleberry, *Gaylussacia dumosa* (Andr.) A. Gray, and Farkleberry, *Vaccinium arboreum* Marsh., share second place with the same number of individuals. However, the highest shrub frequencies are shown by Poison Oak and Farkleberry, while Dwarf Huckleberry appears in only one quadrat.

The remaining species, 54, compose the herbaceous vegetation. Seventeen of this number are monocots of which 5 are Panic Grasses, and thirty-seven are dicots, 16 of which are composites. Little Bluestem, *Andropogon scoparius* Michx. and Goat's Rue, *Tephrosia Virginiana* (L.) Pers. have the greatest densities while Grass-leaved Golden Aster, *Chrysopsis graminifolia* (Michx.) Ell. and *Tephrosia virginiana* (L.) Pers. have the greatest frequencies.

AN ECOLOGICAL STUDY OF THE FAUNA AND FLORA OF THE SAVANNAH RIVER PLANT SITE

VIII. Comparison sites

6. The Present-Day Flora of Hartsville

By

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The data reported in this paper were developed under Contract No. AT (07-2)-11 with the United States Atomic Energy Commission

The purpose in making this listing of the flora of Hartsville is to present material to be used (Hoy, 1959) in comparing the present-day conditions with those recorded by W. C. Coker (1912), almost half a century ago, in his monograph on The Plant Life of Hartsville, S. C., (Coker, 1912).

Since Hartsville lies in the same geographical zone as the Savannah River Plant area there is reason for its inclusion in the group of comparison sites studied under the terms of the contract noted above. It is possible that these comparisons may throw some light on the phytoecological history of the Upper Coastal Plain in general.

University of South Carolina funds in support of the contract noted in the title of this paper made possible this present listing of the Hartsville flora.

Our thanks go to Mr. C. M. McKinnon who has so graciously made his extensive forest holdings available to us for this study.

The following list has been alphabetized for convenience. 358 species were identified on several trips to Hartsville. The list is unquestionably incomplete because the early spring flora is not recorded, and it is probable that some late fall composites could be included.

Acalypha ostryaefolia Riddell
Acer rubrum L.
Acer rubrum var. *tridens*
Achillea millefolium L.
Albizzia Julibrissin Durazz.
Aletris farinosa L.
Alnus serrulata (Ait.) Willd.
Amaranthus sp.
Ambrosia artemisiifolia L.
Amelanchier canadensis (L.) Medic.
Amorpha herbacea Walt.
Amsonia ciliata Walt.
Andropogon glomeratus (Walt.) BSP
Andropogon scoparius Michx.
Andropogon ternarius Michx.
Angelica venenosa (Greenway) Fern.
Antennaria sp.
Aristida sp.
Aristolochia Serpentaria L.
Aronia arbutifolia (L.) Ell.
Arundinaria gigantea (Walt.) Chapm.
Arundinaria tecta (Walt.) Muhl.
Asclepias amplexicaulis Sm.
Asclepias humistrata Walt.
Ascyrum hypericoides L.
Ascyrum stans Michx.
Aster ericoides L.
Aster paternus Cron.
Aster sp.
Aureolaria pedicularia (L) Raf.
Axonopus compressus (Sw.) Beauv.
Baccharis halimifolia L.
Baptisia leucantha T. & G.
Baptisia perfoliata (L.) R. Br.
Baptisia tinctoria (L.) R. Br.
Bidens spp.
Boehmeria cylindrica (L.) Sw.
Brasenia Schreberi Gmel.
Breweria humistrata (Walt.) Gray
Breweria sp.
Bulbostylis capillaris (L.) Clarke
Callicarpa americana L.
Campsis radicans (L.) Seem
Carex glaucescens Ell.
Carex Muhlenbergii Schk.
Carya pallida Ashe
Carya tomentosa (Poir.) Nutt.

Cassia fasciculata Michx.
Catalpa bignonioides Walt.
Catalpa Catalpa (L.) Karst
Ceanothus americanus L.
Celtis georgiana Small
Cenchrus pauciflorus Benth.
Cercis canadensis L.
Chenopodium album L.
Chenopodium ambrosioides L.
Chimaphila maculata (L.) Pursh.
Chionanthus virginicus L.
Chrysopsis gossypina (Michx.) Ell.
Chrysopsis graminifolia (Michx.) Ell.
Chrysopsis mariana (Michx.) Nutt.
Cirsium repandum Michx.
Clethra alnifolia L.
Clethra tomentosa Lam.
Clitoria mariana L.
Cnidoscolus stimulosus (Mich.) Engelm. and Gray
Commelina virginica L.
Conyza canadensis (L.) Cron.
Coreopsis delphinifolia Lam.
Coreopsis major Walt.
Cornus florida L.
Crataegus sp.
Crotalaria rotundifolia (Walt.) Poir.
Crotalaria sp.
Croton glandulosus L.
Cuscuta sp.
Cynodon Dactylon Pers.
Cyperus albomarginatus Mart. & Schrader
Cyperus compressus L.
Cyperus densicaespitosus Mattf. & Kukenth
Cyperus globulosus Aubl.
Cyperus ovularis (Michx.) Torr.
Cyperus retrofractus Chapm.
Cyrilla racemiflora L.
Decodon verticillatus (L.) Ell.
Decumaria barbara L.
Desmodium Fernaldii Schub.
Desmodium paniculatum (L.) DC.
Diodia teres Walt.
Diodia virginiana L.
Dioscorea quaternata (Walt.) Gmel.
Diospyros virginiana L.
Drosera intermedia Hayne
Duchesnea indica (Andr.) Focke

Eleocharis tuberculosa (Michx.) R. & S.
Eleocharis sp.
Elephantopus carolinianus Willd.
Elephantopus tomentosus L.
Eleusine indica (L.) Gaertn.
Epigaea repens L.
Eragrostis capillaris (L.) Nees
Eragrostis pilosa (L.) T. & G.
Eremochloa ophiuroides (Munro) Hack.
Erigeron sp.
Erigeron strigosus Muhl.
Erigeron vernus (L.) T. & G.
Eriocaulon septangulare With.
Eubotrys racemosa (L.) Nutt.
Euonymus americanus L.
Eupatorium album L.
Eupatorium capillifolium (Lam.) Small
Eupatorium compositifolium Walt.
Eupatorium rotundifolium L.
Eupatorium scabridum Ell.
Eupatorium sp.
Euphorbia corollata L.
Euphorbia Ipecacuanhae L.
Euphorbia maculata L.
Euphorbia marilandica Greene
Euphorbia sp.
Fimbristylis sp.
Fragaria sp.
Fragaria virginica Duchesne
Fraxinus americana L.
Galactia volubilis (L.) Britt
Galium hispidulum Michx.
Galium pilosum Ait.
Gaylussacia dumosa (Andr.) T. & G.
Gelsemium sempervirens (L.) Ait. f.
Gerardia sp.
Gnaphalium obtusifolium L.
Gnaphalium purpureum L.
Gymnopogon ambiguus (Michx.) BSP
Habenaria sp.
Hamamelis virginiana L.
Haplopappus divaricatus (Nutt.) Gray
Helenium tenuifolium Nutt.
Herpothamnus crassifolius Small
Heterotheca subaxillaris (Lam.) Britt. & Rusby.
Hexastylis arifolia (Michx.) Small
Hieracium sp.

Hydrocotyle umbellata L.
Hypericum gentianoides (L.) BSP.
Hypericum mutilum L.
Ilex coriacea (Pursh.) Chapm.
Ilex decidua Walt.
Ilex opaca Ait.
Ipomoea pandurata (L.) G. F. W. Meyer
Iris cristata Ait.
Itea virginica L.
Juglans nigra L.
Juncus biflorus Ell.
Juncus coriaceus Mackenzie
Juncus dichotomus Ell.
Juncus scirpoides Lam.
Juncus tenuis Willd.
Jussiaea decurrens (Walt.) DC.
Kuhnia eupatoroides L.
Lachnocaulon anceps (Walt.) Morong
Lactuca canadensis L.
Lechea minor L.
Lechea racemulosa Michx.
Lechea villosa Ell.
Lepidium virginicum L.
Leptilon canadense (L.) Britton
Leptoloma cognatum (Schult.) Chase
Lespedeza cuneata (Dumont) G. Don
Lespedeza hirta (L.) Hornem.
Lespedeza procumbens Michx.
Lespedeza striata (Thumb.) H. and A.
Lespedeza violacea (L.) Pers.
Leucothoe axillaris (Lam.) D. Don
Liatris secunda (Ell.) Small
Liatris sp.
Ligustrum vulgare L.
Linum virginianum L.
Liquidambar Styraciflua L.
Liriodendron Tulipifera L.
Lithospermum carolinense (Walt.) MacMill.
Lobelia Boykinii T. and G.
Lonicera japonica Thunb.
Ludwigia alternifolia L.
Ludwigia hirtella Raf.
Ludwigia palustris (L.) Ell.
Lupinus diffusus Nutt.
Lycopus virginicus L.
Lyonia lucida (Lam.) K. Koch
Magnolia grandiflora L.

Magnolia virginiana L.
Melia Azedarach L.
Mikania scandens (L.) Willd.
Mimulus alatus Ait.
Mitchella repens L.
Moldavica thymiflora (L.) Rydb.
Mollugo verticillata L.
Monarda fistulosa L.
Morus nigra L.
Morus rubra L.
Muhlenbergia Schreberi Gmel.
Myrica cerifera L.
Myrica pensylvanica Loisel
Myrica pusilla Raf.
Nuphar advena Ait.
Nuphar sp.
Nyssa biflora Walt.
Nyssa sylvatica Marsh.
Opuntia compressa (Salisb.) Macbr.
Oxalis stricta L.
Oxydendrum arboreum (L.) DC.
Panicum aciculare Desv.
Panicum anceps Michx.
Panicum angustifolium Ell.
Panicum Bicknelli Nash
Panicum ciliatus Ell.
Panicum halophilum Nash
Panicum hemitomum Schult.
Panicum meridionale Ashe
Panicum oligosanthes Schult.
Panicum polyanthes Schult.
Panicum Ravenelii Scribn and Merr.
Panicum sphaerocarpon Ell.
Panicum trifolium Nash
Parthenocissus quinquefolia (L.) Planch
Paspalum dilatatum Poir.
Paspalum setaceum Michx.
Paspalum Urvillei Steud.
Passiflora incarnata L.
Perilla frutescens (L.) Britton
Persea Borbonia (L.) Spreng.
Persea palustris (Raf.) Sarg.
Pharbitis purpurea Small
Physalis heterophylla Nees
Phytolacca americana L.
Plantago aristata Michx.
Plantago Rugelii Dcne

Platanus occidentalis L.
Polygala lutea L.
Polygala sp.
Polygonella Croomii Chapm.
Polygonum hydropiperoides Michx.
Polygonum sp.
Polypremum procumbens L.
Populus alba L.
Portulaca oleracea L.
Prunus angustifolia Marsh.
Prunus caroliniana (Mill.) Ait.
Prunus serotina Ehrh.
Psoralea psoralioides (Walt.) Cory
Pyrrhopappus carolinianus (Walt.) DC.
Quamoclit sp.
Quercus alba L.
Quercus cinerea Michx.
Quercus coccinea L. Muench
Quercus falcata Michx.
Quercus georgiana M. A. Curtis.
Quercus laevis Walt.
Quercus Margaretta Ashe
Quercus marilandica Muenchh.
Quercus nigra L.
Quercus Phellos L.
Quercus stellata Wang.
Ranunculus sp.
Rhexia alifanus Walt.
Rhexia ciliosa Michx.
Rhexia lanceolata Walt.
Rhododendron canescens (Michx.) Sweet
Rhododendron nudiflorum (L.) Torr.
Rhododenron viscosum (L.) Torr.
Rhus copallina L.
Rhus radicans L.
Rhus Toxicodendron L.
Rhus Vernix L.
Rhynchosia difformis (Ell.) DC.
Rhynchospora fascicularis (Michx.) Vahl
Rhynchospora microcephala (Britt.) Britt.
Rhynchospora Rappiana Small
Richardia scabra L.
Robinia Pseudoacacia L.
Rubus sp.
Rumex crispus L.
Rumex Acetocella L.
Sabbatia difformis (L.) Druce

Sabbatia paniculata (Michx.) Pursh
Sagittaria Engelmanniana J. G. Smith
Salix nigra L.
Salvia lyrata L.
Sambucus canadensis L.
Sarracenia flava L.
Sassafras albidum (Nutt.) Nees
Satureja vulgaris (L.) Fritsch
Schrankia angustata Gray
Scirpus cyperinus (L.) Kunth
Scutellaria sp.
Senecio Smallii Britt.
Setaria lutescens (Weigel) F. T. Hubb.
Sida rhombifolia L.
Silphium astericus L.
Silphium compositum Michx.
Silphium sp.
Smilax glauca Walt.
Smilax laurifolia L.
Smilax rotundifolia L.
Sonchus sp.
Solanum nigrum L.
Solidago altissima L.
Solidago hispida Muhl.
Solidago microcephala (Greene) Bush
Solidago odora Ait.
Solidago sp.
Sorghastrum nutans (L.) Nash
Sorgum halapense (L.) Pers.
Sporobolus junceus Michx.
Stillingia sylvatica L.
Stipa avenacea L.
Stipulicida setacea Michx.
Stylosanthes biflora (L.) BSP.
Styrax americana Lam.
Styrax grandifolia Ait.
Symplocos tinctoria (L.) L'Her.
Tephrosia spicata (Walt.) T. and G.
Tephrosia virginiana (L.) Pers.
Tillandsia usneoides L.
Tradescantia rosea Vent.
Tradescantia sp.
Tragia urens L.
Tragia urticaefolia Michx.
Tragia linearifolia Ell.
Tragiola pilosa Small
Trianthema Portulacastrum L.

Trichostema dichotomum L.
Trichostema sp.
Trifolium repens L.
Ulmus americana L.
Uniola laxa (L.) BSP.
Vaccinium arboreum Marsh
Vaccinium tenellum Ait.
Verbascum Thapsis L.
Verbena urticifolia L.
Vernonia noveboracensis (L.) Michx.
Vernonia sp.
Viburnum cassinoides L.
Viburnum nudum L.
Viburnum sp.
Vinca major L.
Viola primulifolia L.
Viola sp.
Vitis aestivalis Michx.
Vitis rotundifolia Michx.
Xyris caroliniana Walt.
Xyris flexulosa Muhl.
Yucca filamentosa L.
Zizia aptera (Gray) Fern
Zornia bracteolata (Walt.) Gmel.

The following Pteridophytes were present:
Lycopodium alopecuroides L.
Osmunda regalis L.
Osmunda cinnamomea L.
Peridium aquilinum (L.) Kuhn
Polypodium polypodioides (L.) Watt
Onoclea sensibilis L.
Athyrium Filix-femina (L.) Roth
Polystichum acrostichoides (Michx.) Schott
Asplenium platyneuron (L.) Oakes

Gymnosperms identified include:
Pinus australis Michx.f.
Pinus Taeda L.
Pinus echinata Mill
Pinus palustris Mill.
Taxodium distichum (L.) Rich.
Chamaecyparis thyoides (L.) BSP
Juniperus virginiana L.

Additional notations were made on the flora of Hartsville include the following points:

(1) *Ilex coreacea* (Pursh.) Chapm., was particularly abundant in all low places around Prestwood Lake.

(2) *Acer rubrum* var. *tridens* Wood, a white-barked maple was noted in all moist areas, but was most abundant in the 5th transect.

(3) Sarracenia flava L., the pitcher plant occurred in the 5th transect.

(4) A sphagnum collected on transect 3 may prove to be an uncommon, if not new, species.

(5) The presence of white cedar, Chamaecyparis thyoides (L.) BSP, is noteworthy.

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AN ECOLOGICAL STUDY OF THE FAUNA AND FLORA OF THE SAVANNAH RIVER PLANT AREA

VIII. Comparison sites

7. The Flora of Hartsville, S. C., Then and Now — an Interval of Half a Century

By
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The data reported in this paper were developed under Contract No. AT(07-2)-11 with the United States Atomic Energy Commission

In 1912 W. C. Coker wrote a 129 page monograph on the Plant Life of Hartsville, S. C., (Coker, 1912). The first half of this monograph includes an account of the early botanical work in South Carolina, the climate, topography and geology of Hartsville, and a discussion of the vegetation in the six ecological areas recognized by him in the vicinity of the town. These areas are:

(1) The Sand Hills or Pine Barrens
(2) The well-drained Upland Forest
(3) The poorly-drained Flatwoods
(4) The Savannahs
(5) The Swamps
(6) The Streams and Ponds

A number of pages are devoted to the trees of Hartsville, native and imported, and this section includes a key for their identification. A systematic list of the Hartsville plants fills the second half of the monograph.

The present comparison study was made possible by the participation of the University of South Carolina at this point in conducting several surveys of plants in the Hartsville area (Porter, Welbourne and Batson, 1959). This was undertaken in order to see what, if any, changes could be noted in the phytoecology of an area over a period of time involving half a century. Hartsville is the point for this study for the reason that it was the site of the earlier report by Coker. Only one other listing of plants 50 years ago is known, and this was one made

in the Piedmont in 1913-15. Furthermore, Hartsville is an appropriate location for studies which may possibly supply data applicable to the Savannah River Plant area.

The following chart presents some of the major features of this comparison study. Included are data from the study made over the Savannah River Plant area (SRP area).

	Hartsville		
	1912	1957-58	SRP area
Angiosperm species	609	350	939
Monocot species	127	67	286
Monocot families	27	11	24
Dicot species	482	293	646
Dicot families	82	69	103

If one considers the area covered in each of the three botanical surveys — for Hartsville both in 1912 and in 1957-58 an area within a radius of two miles of the city — for the Savannah River Plant an area of 315 square miles — it is not difficult to see that in the larger area a greater number of both species and families might easily be expected, as is the case. Moreover, in the area of the Savannah River Plant the survey has been going on for seven years, and at all times of the year. Undoubtedly, the statement of Gilbert White (which is here quoted from Coker's monograph) applies to some degree:

"All nature is so full that that district produces the greatest variety which is the most examined."

The discrepancy between the figures for Hartsville in 1912 and in 1957-58 is because of the limited amount of time which could be given to the present study. In all, nine transects of about 150 yards each were made in the summer of 1957, and a long, continuous roving transect in the summer of 1958. All these transects were made along Prestwood Lake or northwest of the lake in the Sand Hills. Moreover, no study of ponds was possible in the limited time available, nor was it feasible to examine the marginal growth around the lake. Furthermore, the spring and the fall flora are not included in the recent listing. Incomplete as it is the study is nevertheless useful in that it establishes that:

(1) We know definitely that 218 of the 609 species identified by Coker are present today.

(2) 132 species occur today which were not present in Coker's time.

(3) Two species recorded in 1912 as recent additions to the flora of Hartsville have become quite numerous. These include *Tillandria usneoides* L., Spanish moss (Coker reported one spray on one tree) and *Helenius tennifolium* Nutt, known as bitterweed.

In recording the advent of new species it must be recognized that the specimens of 50 years ago were not available for examination. In a footnote Coker (1912) page 62, states that "A large proportion of the collections were taken to the New York Botanical Garden and there worked up. The majority of the plants were looked over by Dr. J. K. Small of the Garden staff, whose assistance in determining the species I gratefully acknowledge." Where the collection now resides I do not know. Our own studies involved identification in the field except in rare cases. However, it would not be impossible to obtain particular specimens, if this were desirable or necessary.

From the studies made in the summers of 1957 and 1958 (Porter, Welbourne and Batson, 1959) it would appear that the following species may have established themselves as part of the flora of Hartsville within the past 46 years:

Acalypha ostryaefolia Riddell
Alnus serrulata (Ait.) Wild.
Amelanchier canadensis (L.) Medic.
Andropogon ternarius Michx.
Angelica venenosa (Greenway) Fern.
Arundinaria gigantea (Walt.) Chapm.
Auerolaria pedicularia (L.) Raf.
Axonopus compressus (Sw.) Beauv.
Baptisia leucantha T. & G.
Baptisia perfoliata (L.) R. Br.
Breweria humistrata (Walt.) Gray
Bulbostylis capillaris (L.) Clarke
Campsis radicans (L.) Seem
Carex glaucescens Ell.
Carex Muhlenbergii Schk.

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Carya pallida Ashe
Carya tomentosa (Poir.) Nutt.
Cassia fasciculata Michx.
Catalpa Catalpa (L.) Karst
Celtis georgiana Small
Cenchrus pauciflorus Benth.
Chenopodium ambrosioides L.
Chrysopsis gossypina (Michx.) Ell.
Clethra tomentosa Lam.
Cnidoscolus stimulosus (Michx.) Engelm. and Gray
Commelina virginica L.
Conyza canadensis (L.) Cron.
Coreopsis major Walt.
Cyperus albomarginatus Mart & Schrader
Cyperus compressus L.
Cyperus densicaespitosus Mattf. & Du Kukenth
Cyperus globulosus Aubl.
Cyperus ovularis (Michx.) Torr.
Cyperus retrofractus Chapm.
Desmodium Fernaldii Schub.
Dioscorea quaternata (Walt.) Gmel.
Duchesnea indica (Andr.) Focke
Eleocharis tuberculosa (Michx.) R. & S.
Eragrostis pilosa (L.) T. & G.
Eremochloa ophiuroides (Munro) Hack.
Erigeron strigosus Muhl.
Eubotrys racemosa (L.) Nutt.
Euonymus americanus L.
Eupatorium album L.
Eupatorium scabridum Ell.
Euphorbia marilandica Greene
Fraxinus americana L.
Galium hispidulum Michx.
Galium pilosum Ait.
Gnaphalium obtusifolium L.
Haplopappus divaricatus (Nutt.) Gray
Herpothamnus crassifolius Small
Heterotheca subaxillaris (Lam.) Britt. & Rusby.
Hexastylis arifolia (Michx.) Small
Hydrocotyle umbellata L.
Ilex coriacea (Pursh.) Chapm.
Iris cristata Ait.
Juncus biflorus Ell.
Juncus coriaceus Mackenzie
Juncus dichotomus Ell.
Juncus tenuis Willd.
Kuhnia eupatoroides L.

Lactuca canadensis L.
Lechea minor L.
Lechea racemulosa Michx.
Leptilon canadense (L.) Britton
Lespedeza cuneata (Dumont) G. Don
Lespedeza procumbens Michx.
Lespedeza violacea (L.) Pers.
Liatris secunda (Ell.) Small
Ligustrum vulgare L.
Linum virginianum L.
Lithospermum carolinense (Walt.) MacMill.
Lobelia Boykinii T. & G.
Mimulus alatus Ait.
Moldavica thymiflora (L.) Rydb.
Monarda fistulosa L.
Morus nigra L.
Muhlenbergia Schreberi Gmel.
Myrica pensylvanica Loisel
Myrica pusilla Raf.
Nuphar advena Ait.
Nyssa sylvatica Marsh.
Opuntia compressa (Salisb.) Macbr.
Panicum angustifolium Ell.
Panicum Bicknelli Nash
Panicum ciliatus Ell.
Panicum halophilum Nash
Panicum meridionale Ashe
Panicum oligosanthes Schult.
Panicum polyanthes Schult.
Panicum Ravenelii Scribn. & Merr.
Panicum trifolium Nash
Paspalum dilatatum Poir.
Paspalum Urvillei Steud.
Perilla frutescens (L.) Britton
Persea Borbonia (L.) Spreng.
Persea palustris (Raf.) Sarg.
Pharbitis purpurea Small
Physalis heterophylla Nees
Phytolacca americana L.
Plantago Rugelii Dcne
Polygonella Croomii Chapm.
Populus alba L.
Psoralea psoralioides (Walt.) Cory
Quamoclit sp.
Quercus Margaretta Ashe
Ranunculus sp.
Rhexia alifanus Walt.

Rhododendron canescens (Michx.) Sweet
Rhododendron nudiflorum (L.) Torr.
Rhododendron viscosum (L.) Torr.
Rhus radicans L.
Rynchosia difformis (Ell.) DC.
Rhynchospora fascicularis (Michx.) Vahl
Rhynchospora microcephala (Britt.) Britt.
Rhynchospora Rappiana Small
Richardia scabra L.
Robinia Pseudocacia L.
Sabbatia difformis (L.) Druce
Sabbatia paniculata (Michx.) Pursh
Sagittaria Engelmanniana J. G. Smith
Satureja vulgaris (L.) Fritsch
Scirpus cyperinus (L.) Kunth
Setaria lutescens (Weigel) F. T. Hubb.
Silphium astericus L.
Sorgum halapense (L.) Pers.
Stipa avenacea L.
Tradescantia rosea Vent.
Uniola laxa (L.) BSP.
Xyris flexulosa Muhl.

Four ferns were found which were not mentioned in Coker's list (Coker, 1912). These were:

Athyrium Felix-femina (L.) Roth
Onoclea sensibilis L.
Pteridium aquilinum (L.) Kuhn
Polystichum acrostichoides (Michx.) Schott

The possibility that some species have disappeared from the Hartsville area could be answered in the affirmative only after a more prolonged study. Certainly, as more of the lake shore is taken over for building sites, a survey ten years from now would reveal the disappearance of a number of species.

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Five New Ostracods of the Genus Entocythere (Ostracoda, Cytheridae) From South Carolina

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In studying the ostracods of the genus *Entocythere* of Richland County, South Carolina, five new species were encountered and are described herein. The members of this genus are epizoic on crayfishes. Of the five species treated, three can be assigned to previously established groups including the Cambaria Group (Hoff, 1944), the Columbia Group (Roija, 1949), and the Heterodonta Group (Roija, 1944). A new group, the Runki Group, is here proposed to receive four closely allied species, two of which are described below.

Materials and Methods

The crayfishes, when caught, were placed in jars containing five percent formalin. They were brought into the laboratory where the ostracods that had fallen to the bottom of the jar were removed from the sediment, washed in water, and transferred to vials containing 70 percent ethyl alcohol. In some instances additional ostracods were obtained by agitating the preserved crayfish in a beaker of water. The ostracods were mounted directly in Hoyer's modified Berlese solution from the 70 percent alcohol. Many of the specimens were very satisfactorily mounted in Hoyer's solution directly from water or from formalin. For dissection, a small drop of Hoyer's solution was placed on a slide and allowed to thicken by exposure to air for about one minute. The ostracod was then transferred to the mounting medium and dissected. Specimens prepared in this manner were in no way inferior to those dehydrated in alcohol or acetic acid, cleared, and mounted in balsam.

Habitats and Habits of the Crayfishes and Ostracods

The areas of each species are indicated by: P-piedmont area; Sh-sand hills; C-coastal plain; S-swamp.

Crayfishes

I. SPECIES INHABITING LOTIC SITUATIONS.

A. Streams with rocky bottoms.

C. spicatus—P
C. latimanus—P-Sh
C. b. bartonii—P-Sh
P. b. blandingii—P-Sh
P. troglodytes—P-Sh
C. montanus acuminatus—P-Sh

B. Streams with sandy bottoms.

P. spicatus—P
P. enoplosternum—Sh-C-S
C. latimanus—P-Sh
P. b. blandingii—P-Sh-C-S
P. troglodytes—P-Sh-C-S
C. b. bartonii—P-Sh-C-S
C. montanus acuminatus—SH-C-S
P. sp. nov.—Sh-C-S
C. reduncus—Sh-C-S

II. SPECIES INHABITING PONDS AND DITCHES.

P. troglodytes—P-Sh-C-S
C. uhleri—C-S
P. sp. nov.—C
C. clypeatus—P
C. blandingii—P-Sh-C-S

III. SPECIES INHABITING SLUGGISH STREAMS AND SLOUGHS.

P. blandingii—Sh-C-S
P. enoplosternum—S
P. troglodytes—P-Sh-C-S
C. ulheri—C-S
P. sp. nov.—C
C. reduncus—S
C. montanus acuminatus—C

Ostracods

I. SPECIES INHABITING MODERATE TO RAPID LOTIC SITUATIONS.

E. internotalus—Sh-C-S
E. striophylax—P-Sh
E. suteri—P-Sh
E. telmoecea—C-S
E. hobbsi—Sh-C-S

II. SPECIES INHABITING SLUGGISH STREAMS.

E. telmoecea—P-S
E. internotalus—S
E. hobbsi—Sh-C-S
E. striophylax—P-Sh

III. SPECIES INHABITING PONDS AND DITCHES.

E. tiphophila—S
E. hobbsi—C-S
E. telmoecea—C-S

Crayfish Hosts

Among the approximately 2,000 crayfishes collected in Richland County during the past two years, eleven species and subspecies were encountered. These are assigned to three genera: Cambarus, Procambarus, and Orconectes. Ten of these species have been described previously and the eleventh is here designated as *Procambarus* sp. These crayfishes are listed in Table 1.

The determinations of the host species were made by Dr. Horton H. Hobbs, Jr., of the University of Virginia, and are deposited in his collections.

TABLE 1

Crayfish Hosts of the Ostracods of Richland County

1. *C. spicatus* Hobbs (1956)
2. *C. latimanus* (LeConte, 1855)
3. *C. b. bartoni* (Fabricius, 1817)
4. *C. montanus acuminatus* Faxon (1884)
5. *C. uhleri* Faxon (1884)
6. *C. reduncus* Hobbs (1956)
7. *P. b. blandingii* (Harlan, 1830)
8. *P. enoplosternum* Hobbs (1947)
9. *P. troglodytes* (LeConte, 1855)
10. *Procambarus sp.*
11. *O. clypeatus* (Hay, 1899)

Key to Ostracods of Richland County

(Based on characteristics of the clasping apparatus of the male)

1a. Clasping apparatus with talon on horizontal ramus 2

b. Clasping apparatus without talon 4

2a. Valve of male subelliptical. Heavy L-shaped clasping apparatus with conspicuous, toothed talon borne on mesial surface distal to angle ..... *E. internotalus*, sp. nov.

b. Horizontal ramus with talon on extensor margin 3

3a. Talon arising just distad of angle of clasping apparatus extending anteriorly for more than half the length of ramus. Talon divided into long dorsal and short ventral projections ..... *E. hobbsi* Hoff (1944)

b. Talon borne at midlength, or nearly so, on extensor surface of horizontal ramus ..... *E. tiphophila*, sp nov.

4a. Copulatory complex without a finger guard ..... *E. telmoecea*, sp. nov.

b. Copulatory complex with finger guard 5

5a. Angle of clasping apparatus about ninety degrees; length of horizontal ramus less than that of vertical ramus. Distal end of horizontal ramus with three light transverse ridges ..... *E. striophylax*, sp. nov.

b. Angle of clasping apparatus about sixty degrees; length of horizontal ramus as great as, or greater

than that of vertical ramus. Four prominent serrations borne on distal fourth of flexor margin _____ *E. suteri*, sp. nov.

The Cambaria Group (Hoff, 1944)

This subgeneric group is characterized by the large size of the valve, by the presence of an accessory structure at the base of the terminal claws of the 2nd antenna, and by the stout, L-shaped clasping apparatus of the male. Included in this group are *E. illinoisensus* Hoff (1942), *E. cambaria* Marshall (1903), *E. claytonhoffi* Rioja (1942), *E. mexicana* Rioja (1944), and *E. dorsorotunda* Hoff (1944).

The range of the group extends from Mexico to Wisconsin and southeastward to Florida. The new species described below occupies the northernmost limit of the range of the group along the Atlantic seaboard.

Entocythere internotalus, sp. nov.

The name is suggested by the toothed projection or talus located on the ventromesial surface at the junction of the horizontal and vertical rami of clasping apparatus.

Male. — *Valve* (Fig. 9) elliptical in lateral aspect, dorsal margin slightly more rounded than ventral. Anterior and posterior margins evenly rounded. Ventral margin with a slight concavity approximately one-third of length of valve from anterior end. Setae conspicious near free margins, being more numerous at posterior end than at anterior and sparsely scattered along ventral margin. Small eye located one-sixth of valve length from anterior end.

Valve relatively uniform in size as indicated by measurements (in mm.) of 10 specimens mounted in Hoyer's solution.

	Length	*Height*
	0.525	0.255
	0.510	0.285
	0.525	0.270
	0.555	0.285
	0.510	0.255
	0.510	0.240
	0.525	0.255
	0.615	0.330
	0.540	0.285
	0.525	0.300
Mean	0.536 mm.	0.276 mm.

Antenna I (Fig. 1) composed of six podomeres of which basal one is longest, the ultimate ranking second, and the second, third, fourth, and fifth subequal in length. Diameters of successive podomeres diminish regularly, distally.

Distal end of basal podomere with one seta which extends beyond distal end of second podomere. Distal end of second podomere with one seta which extends beyond distal end of third podomere. Two setae borne on distal end of third podomere extend beyond distal end of fourth podomere. Antepenultimate podomere with five setae which reach beyond midpoint of ultimate podomere. Penultimate podomere devoid of setae. Ultimate podomere with five long setae which extend distally twice the length of the podomere.

Antenna II (Fig. 2) consisting of four podomeres, of which the basal one is largest, thickest, and devoid of setae. Second podomere, about 1.5 times as long as thick. Extending distally from juncture of the two proximal podomeres is a long, heavy, spine-like structure, the flagellum, the length of which is equal to, or longer than, entire appendage. Arising on flexor apical margin of second podomere a spine-like plumose seta extends distally to mid-length of ultimate podomere. Penultimate podomere entire and little longer than wide, bearing two setae on flexor extremity; setae extend forward about one-half length of ultimate podomere. Midflexor margin of ultimate podomere with a seta which extends distally by one-half its length beyond distal end of ultimate podomere. Ventral claw slightly toothed, strongly arched, relatively slender and tapering, and about 1.2 times length of ultimate podomere. Dorsal claw with both stalked and distal portions arched, and extending distally to base of apical third of ventral claw; flattened surface of distal portion with 10-12 teeth. Medial claw, equipped with a row of 10-12 teeth, extending slightly distad of stalk of dorsal claw.

Mandible (Fig. 6) with distal end of protopodite having six relatively long teeth bearing one or two poorly developed cusps; those laterally situated thick and heavy and those more mesially situated becoming progressively slenderer. Convex surface of protopodite with a spine-like heavy seta located approximately equidistant between base of lateral teeth and juncture of mandibular palp; setae extending distally to point midway between its base

and base of lateral teeth. Respiratory plate represented by three setae, two of which are subequal in length and the third about three-fifths as long. Mandibular palp with four podomeres. Distal flexor margin of basal one with a long seta which extends beyond distal end of ultimate podomere. Antepenultimate podomere without setae. Penultimate podomere with thick seta borne on midextensor margin extending beyond apical end of terminal setae of same podomere. Ultimate podomere with three terminal setae; the heavier one longest and the slenderer two subequal in length.

Maxilla (Fig. 5) with an unsegmented palp bearing two long setae on its distal end; the longer, heavier, ventral one strongly bent and apparently denticulate distally; the dorsal one, only three-fourths as long as ventral one, gently curved and much slenderer. Seta borne on extensor margin of maxillary palp, proximal to base of terminal palpal setae, extends almost to mid-length of terminal setae. Protopodite with two long, gently curving setae of subequal length. Brachial plate with 18-20 plumose setae.

Copulatory Complex (Fig. 4) with the proximal portion of the base scapuloid in shape and small as compared with the distal portion. Attached to the proximal portion of the base are the dorsal and ventral fingers. The proximal portion of the dorsal finger is enlarged and together with the shaft is 1.7 times as long as its terminal bifurcate spine. The ventral finger is more attenuated than the dorsal finger and is more than twice as long; its distal spine is heavier and shorter than that of the dorsal finger. The vas deferens emerges from the area of the proximal portion of the base and undergoes a distinct convolution after which it narrows and progresses to the penis which opens in the lower midventral region of the distal portion of the base. The proximal end of the distal portion is strongly arched, and the distal end is truncate. The vertical and horizontal rami of the clasping apparatus are easily distinguishable. The vertical ramus tapers proximally, there being a distinct angle on both the anterior and posterior proximal margins. Toward the juncture of the rami, the vertical one is arched and thickened. In this area, the vertical ramus is produced to form a heavy sclerotized, mesial talon bearing two teeth. This structure is easily distinguishable and is characteristic of this

species. The horizontal ramus is about three-fourths the length of vertical ramus. The dorsal margin of the horizontal ramus bears several emarginations with a prominent tooth proximally; the emarginations are progressively shallower distally. There appear to be three rather indistinct teeth at the distal extremity. The ventral margin, except for the talon, is evenly contoured.

Female (Fig. 8). — The valve of the female is larger than that of the male but is similar in shape except that in the triunguis female the shell is generally more arched along the posterodorsal margin. A slight concavity occurs along the anteroventral margin in both forms. This concavity reaches its maximum depth near the anterior third of the shell.

The valve size is relatively constant as indicated by measurements (in mm.) of 10 specimens mounted in Hoyer's solution.

Length	*Height*
0.66	0.40
0.66	0.37
0.67	0.42
0.68	0.41
0.63	0.37
0.65	0.37
0.66	0.42
0.63	0.39
0.63	0.43
0.67	0.39
Mean 0.654 mm.	0.397 mm.

There appears to be nothing unusual about the female genitalia. An irregular deeply staining body is sometimes present in the triunguis forms. The ultimate podomere of Antenna II (Fig. 3) bears on its midflexor surface a spine-like seta which extends anteromesially for about the length of the podomere. At the base of the terminal claws is a structure that resembles a partially flexed hand. Around the "wrist" there is a single row of spines and the hand-like extremity bears finger-like spines. The ventral unstalked claw of the ultimate podomere is slightly longer than the podomere and is relatively heavy. The dorsal claw is slender and about two-thirds as long as the ventral claw. The medial claw is much reduced, being less than half the length of the

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dorsal one. The teeth borne on the dorsal claw are located on the distal half of the flexor surface. These teeth, while not so heavy and well developed as those on the ventral claw, are much more conspicuous than the sparse, fine teeth on the medial claw. Antenna I and mandibles are similar to those of the male, but the larger distal seta of the maxilla appears to be denticulate on the apical end.

Type Locality. — Colonel's Creek on S. C. Route 262 (Leesburg Road), 14.6 miles east of city limits of Columbia, Richland Co., S. C. The crayfish hosts are *P. enoplosternum* and *C. montanus acuminatus*. *E. hobbsi* was also found in the collections from the type locality.

Disposition of Types. — Holotype, allotypic (triunguis type female), and morphotypic (biunguis female) together with a dissected male paratype are deposited in the United States National Museum. Paratypes are in the collections of Drs. H. H. Hobbs, Jr., Enrique Rioja, Eugene N. Kozloff, C. Clayton Hoff, and the author.

Range. — This species, known only from Richland County, occurred in forty-two of the 124 collections. With four exceptions, this species was found in the coastal plain region of the County or in bordering areas. Twenty-six of these localities are in the Congaree River drainage system, thirteen in the Wateree, and three in the Broad. Table 2 lists the drainage systems, the collecting station numbers, and the crayfish hosts. The latter are listed numerically corresponding to Table 1 with the parenthetical numbers indicating the number of stations from which each species of crayfish was collected.

TABLE 2

Drainage	*Station Numbers*	*Crayfish Hosts*
Congaree River	38, 40, 43, 45-47, 49, 50, 51, 54-57, 72, 73, 79, 80, 87, 88, 89, 91, 94, 95, 98, 104, 107	8 (15), 2 (1), 4 (10), 10 (8), 6 (1), 7 (10), 9 (6), 5 (2)
Wateree River	30, 33-35, 66, 81, 82, 84, 85, 93, 96, 97, 100	8 (8), 2 (2), 4 (7), 10 (4), 6 (1), 7 (1), 9 (2)
Broad River	19, 42, 112	8 (1), 2 (2), 7 (1), 3 (1), 1 (1), 9 (1)

Variation. — General uniformity existed in all specimens examined. Very slight variations, however, such as the degree of concavity on the anteroventral margin of shell were noticed. The copulatory complex of male exhibits remarkable uniformity.

Remarks.—There seems to be little doubt that this species has its closest affinities with *E. elliptica* Hoff (1944). Whereas the latter species has not been considered to be allied with the talon bearing Entocytherids, the position of *E. internotalus* having definite affinities with *E. elliptica* and at the same time bearing a projection on the clasping apparatus analogous, if not homologous, to the talon on *E. illinoisensis* Hoff (1942) tends to link the Cambaria Group to the Heterodonta Group Rioja (1944) which is characterized by the presence of a talon or claw on the horizontal ramus of the clasping apparatus of the male.

The Runki Group (here proposed)

This new group is proposed to receive the two species recently described by Hobbs (1956) and the following two new species. These four share in common an accessory process of the male copulatory complex, which is termed by Hobbs (1956: 329), the finger guard and a heavy, well developed, prominently grooved, clasping apparatus. The genitalia of the triunguis female consists of the rod-like body ventral to which is the deeply staining structure termed by Hobbs, the "ruffled skirt". While Antennae II lacks the accessory structure on the distal end of the ultimate podomere which characterizes the Cambaria Group, two or three terminal claws are present. The valve of the triunguis female presents variations as shown by the posteroventral prominence of *E. daphnioides* and by the posterodorsal concavity of the two new species described below.

This group is known only from the mountains of North Carolina, Virginia, and West Virginia, and from the Santee Drainage System in Richland County, South Carolina.

Entocythere striophylax, sp. nov.

The name refers to the grooved finger guard of the copulatory complex.

Male. — *Valve* (Fig. 17) subelliptical (oblong-ovate) with anterior end markedly narrower than posterior end and ventral margin with slight concavity just anterior to mid-length. Dorsal margin slightly more rounded than ventral one. Setae sparsely scattered along free margin of valve with very few to none along dorsal margin. Lateral surfaces appear to bear no setae. Eye located about one-fourth of valve length from anterior margin.

Valve relatively uniform in size as indicated by measurements (mm.) of 10 specimens mounted in Hoyer's solution.

Length	*Height*
0.42	0.25
0.47	0.27
0.42	0.24
0.45	0.25
0.48	0.27
0.45	0.25
0.45	0.24
0.45	0.27
0.45	0.27
0.45	0.27
Mean 0.449 mm.	0.258 mm.

Antenna I (Fig. 12) composed of six podomeres of which basal one is longest and third from base shortest; distal three subequal in length. Diameter of basal podomere greater than that of second, and those of successive podomeres diminish regularly distally. Basal podomere with one subapical seta which extends distally beyond distal end of second podomere. Second podomere with one seta which extends distally beyond mid-length of antepenultimate podomere. Two setae borne on third podomere; one arising on flexor margin and extending distally to midpoint of penultimate podomere; the other arising on submesial margin and extending distally beyond distal end of ultimate podomere. Antepenultimate podomere with six setae; two arising on extensor margin and extending distally to mid-length of ultimate podomere and four, arising on and near flexor margin, extend distally beyond distal end of ultimate podomere. Penultimate podomere devoid of setae. Ultimate podomere with five long setae, the longest being three times as long as podomere and the other four about three-fifths as long as longest.

Antenna II (Fig. 10) consists of four podomeres, the basal one giving rise on distal end to characteristic antennal flagellum. Second podomere about as long as wide with a single, heavy, spine-like, feathered seta on distal extensor margin extending beyond distal end of penultimate podomere. Penultimate podomere entire, being longer than wide, and bearing two setae on distal flexor extremity; setae extend distally almost to base of terminal claws. Ultimate podomere appears divided toward distal end; proximal portion with seta on midflexor margin extending almost to distal end of shortest terminal claw. Distal portion of ultimate podomere with the three characteristic terminal claws; dorsal claw with heavy arched, stalked, basal portion and with flattened distal surface bearing 10-12 teeth. Ventral claw 1.2 times as long as dorsal claw, being arched distally and bearing cluster of light teeth on distal half of ventral margin. Short median claw, with 12-14 teeth, extending just distad of flattened portion of dorsal claw.

Mandible (Fig. 13) with protopodite bearing row of six multicuspid teeth; cusps vary in number from one or two on proximal tooth to five on prominent distal tooth, with the tricuspid condition prevailing on the intermediate ones. Convex surface of protopodite with spine-like setae at approximate level of proximal tooth. Respiratory plate of three setae of which the longer two are subequal in length and the third about three-fifths as long as longer pair. Palp consists of four podomeres with long seta on distal flexor margin of basal one extending beyond distal end of ultimate podomere. Penultimate podomere with a seta on midextensor margin extending to distal end of terminal setae; distal end of podomere with shorter seta which extends beyond mid-length of heavy terminal seta. Ultimate podomere with three terminal setae; the largest flattened and denticulate on distal margin; other two spine-like — one as long as heavy terminal seta and the other only two-thirds as long.

Maxilla (Fig. 14) with unsegmented palp which bears two long spine-like setae on distal end; the ventral one slightly longer and heavier than the dorsal one. Seta which often occurs on convex or dorsal side of maxillary palp, proximal to distal setae, absent; there is, however, a prominent notch in a comparable position. Protopodite with two terminal setae of subequal length extending to mid-length of palpal setae. Branchial plate with 18 to 20 plumose setae.

Copulatory Complex (Fig. 11). — The subrectangular portion of the base is small as compared with the distal portion which is clavate in shape. Attached to proximal portion of base are the typically short dorsal and longer ventral fingers; the latter extending beyond the distal end of the clasping apparatus and the former being heavier and about one-half the length of the latter. The finger guard is heavily sclerotized and is deeply grooved, with distal end shallowly emarginate. After emerging from the area of the proximal portion of the base, the vas deferens undergoes a distinct convolution, becomes narrower and progresses ventrally to the penis which opens into the deeply grooved ventral region of the distal portion of base. The dorsal end of the distal portion of the base is strongly arched and its ventrally projecting portion bears two concavities on its posterior margin: one at the same level as the penis and the other on the ventral surface. The clasping apparatus is clearly divisible into the vertical and horizontal rami; the former being straight while the latter is distinctly arched. The latter is four-fifths as long as former. The horizontal ramus bears three minute teeth like serrations on its distal end and three transverse ridges just proximad to the proximal tooth.

Female. — The valve of the triunguis (Fig. 16) female is larger than that of male and is conspicuously dissimilar. The entire dorsal margin is strongly arched and bears a prominent concavity on the posterodorsal margin. The concavity on anteroventral margin also appears more prominent than that in male. The anterior end of the valve is narrower than the posterior and is somewhat pointed. Setae are sparsely scattered on free margins of valve with few to none on the lateral surface and dorsal margin.

The valve size is relatively constant as indicated by measurements (in mm.) of 10 specimens mounted in Hoyer's solution.

Length	*Height*
0.45	0.30
0.47	0.30
0.48	0.29
0.45	0.29
0.47	0.29
0.47	0.29

	0.48	0.30
	0.48	0.30
	0.48	0.29
	0.45	0.29
Mean	0.468 mm.	0.294 mm.

The valve of biunguis forms (Fig. 15) is smaller and lacks the prominent concavity on the posterodorsal margin; also the sinuation on anteroventral margin is less prominent.

The genitalia of females are normal in appearance. The triunguis forms have the J-shaped, rod-like body ventral to which is the conspicuous, "ruffled skirt". The second antenna lacks the accessory process on the ultimate podomere, and bears two or three terminal claws. The dorsal claw bears a few inconspicuous teeth. The middle claw, when present, is about half as long as dorsal claw and is finely toothed on distal portion. The heavy ventral claw, which is 1.3 times as long as dorsal claw, bears prominent teeth on distal two-thirds of ventral surface.

Type Locality. — Cedar Creek at S. C. Route 215 about 9.6 miles north-northeast of city limits of Columbia, S. C. The hosts are *Procambarus b. blandingii, Cambarus b. bartonii, Cambarus latimanus,* and *Cambarus spicatus. E. suteri* was also found in the collections from the type locality.

Disposition of Types. — The holotype, the allotypic (triunguis) female, and the morphotypic (biunguis) female together with a dissected male paratype are deposited in the United States National Museum. Paratypes are in the collections of Drs. Enrique Rioja, Eugene N. Kozloff, C. Clayton Hoff, Horton H. Hobbs, Jr., and the author.

Range. — This species, known only from Richland County, occurred in forty-seven out of the 124 collections made in that county. All of the localities in which it was found are in the piedmont area, and the southeastern extremity of its range lies within the confines of the fall line. Thirty-seven of these localities are in the Broad River drainage system while five each are in the Wateree and Saluda River drainage areas. Table 3 lists the drainage system, the collecting station numbers and the

crayfish hosts. The latter are listed numerically corresponding to Table 1, with the parenthetical numbers indicating the number of stations from which each species of crayfish was collected.

TABLE 3

Drainage	*Station Numbers*	*Crayfish Hosts*
Broad River	1-22, 32, 42, 99, 102, 105, 109-112, 116-121	3 (36), 7 (8), 9 (7), 3 (6), 1 (3), 8 (2), 4 (1)
Saluda River	25-28, 101	2 (5), 4 (1)
Wateree River	113-115, 122, 123	2 (5), 9 (5)

Variations. — A slight difference in the length of the finger guard of the male copulatory complex is evident in some of the specimens. In many of them the distal end of the finger guard appears more lobate than emarginate. The "ruffled skirt" in the triunguis female is frequently obliterated by a deeply staining body; otherwise, a marked similarity exists in all of the females.

Remarks. — There seems to be little doubt that the closest affinities of *E. striophylax* are with *E. daphnioides* Hobbs (1955), *E. runki* Hobbs (1955) and *E. suteri,* described below. *E. striophylax* is easily separated from the other species of the Runki Group by the horizontal ramus of the clasping apparatus which lacks the serrated surface of the flexor margin found in the other three species. This species was found in several collections along with *E. suteri,* sp, nov., the former being far more widespread than the latter.

Entocythere suteri, sp. nov.

This species is named in honor of my good friend Professor Daniel B. Suter of Eastern Mennonite College, Harrisonburg, Virginia.

Male. — *Valve* (Fig. 22) oblong-ovate with anterior end narrower than posterior and ventral margin with a slight concavity just anterior to mid-length. Setae scattered on free margin, being numerous on anterior and posterior ends, and sparsely dispersed along ventral margin. Lateral surface with no setae. Eyes located about one-fifth of valve length from anterior end.

Valve relatively uniform in size as indicated by meas-

urements (in mm.) of 10 specimens from type locality mounted in Hoyer's solution.

Length	*Height*
0.45	0.27
0.47	0.27
0.45	0.27
0.44	0.26
0.47	0.28
0.47	0.26
0.47	0.27
0.47	0.27
0.44	0.26
0.46	0.27
Mean 0.459 mm.	0.268 mm.

Antenna I identical to that of *E. striophylax,* described above.

Antenna II (Fig. 19) with basal segment 1.5 times as long as wide, giving rise to characteristic antennal flagellum on distal end. Antepenultimate podomere slightly longer than wide with heavy, feathered seta arising on distal flexor margin and extending distomesially beyond mid-length of ultimate podomere. Penultimate podomere about 1.5 times as long as wide bearing on distal flexor margin two spine-like setae which extend past midpoint of ultimate podomere. Ultimate podomere divided toward apical end; proximal portion giving rise on distal flexor margin to a heavy spine-like seta which extends distally almost to distal end of shortest terminal claw. Distal portion of ultimate podomere with three terminal claws; heavy dorsal claw with strongly arched proximal portion and distinctly flattened distal surface with 10-12 teeth. Short middle claw, with 12-14 teeth, extends just distad of proximal end of flattened surface of dorsal claw. Ventral claw 1.4 times as long as dorsal claw, being arched distally and bearing a cluster of slender teeth on distal half of ventral margin.

Mandible (Fig. 21) with protopodite bearing a row of six or seven multicuspid teeth; cusps vary in number from one or two on proximal tooth to five on prominent distal tooth. Heavy spine-like seta borne on convex surface of protopodite at level slightly proximad of proximal tooth. Respiratory plate with three setae, of which the longer two are subequal in length and third about three-fifths

as long as other two. Mandibular palp consists of four podomeres. Distal flexor margin of basal podomere with a long seta which extends almost to base of terminal setae. Antepenultimate podomere without setae. Setae, borne on prominent concavity on midextensor margin of penultimate podomere extending beyond distal end of terminal setae; seta borne on distal end of same podomere extending almost to distal end of terminal setae. Ultimate podomere with three setae; one larger and flattened on distal end, other two spine-like and subequal in length.

Maxilla (Fig. 20) with unsegmented palp bearing two heavy setae which curve ventrally; ventral one heavier and more strongly arched with flattened, denticulate distal portion. Prominent notch present on dorsal side of maxillary palp proximal to base of terminal setae. Protopodite with two terminal setae of subequal length which curve ventrally and extend almost to distal end of palpal setae. Branchial plate with 20 or more plumose setae.

Copulatory Complex (Fig. 18). — The conspicuous proximal portion of the base is subtriangular in shape and is small as compared with the distal portion. Attached to the former are the short dorsal and long ventral fingers; the latter extends beyond the distal end of the clasping apparatus while the former is slightly heavier and a little more than half as long as the latter. The heavily sclerotized finger guard is grooved and the distal end prominently lobed. The vas deferens appears to arise in the area of the proximal portion of base; after a distinct convolution it progresses ventrally to the penis which opens into the deeply grooved ventral area of the distal portion of base. The large distal portion of the base bears a slight concavity on the posterior surface, and the ventral projection is deeply grooved; the latter extends beyond the angle of the clasping apparatus and is shallowly emarginate on the distal end. The clasping apparatus is easily divisible into the vertical and horizontal rami, the former being distinctly arched particularly on the flexor margin with the horizontal ramus being only slightly so. The vertical ramus lies at an angle of 60 degrees to the horizontal ramus. The latter bears four prominent serrations on the distal fourth of the flexor margin and the proximal extensions of them form very slight elevations along the lateral surface of distal

half of the ramus. A slight prominence is borne on the ventral edge of the distal end.

Female. — The valve (Fig. 23) of the female is more ovate than that of the male and is slightly larger. The dorsal margin of the valve is slightly arched and the anterior half higher than that of the male. The extreme anterior end is slightly pointed and the anteroventral margin bears a conspicuous concavity. A prominent concavity occurs on the posterior margin of valve in a corresponding position to that found on *E. striophylax,* but the concavity is more pronounced in the latter. The triunguis forms have the J-shaped, rod-like body ventral to which is the conspicuous "ruffled skirt." A deeply staining mass in this area often obliterates the details of the genital apparatus.

The valve size is relatively constant as indicated by measurements (in mm.) of 10 specimens from the type locality mounted in Hoyer's solution.

Length	*Height*
0.47	0.30
0.45	0.29
0.45	0.29
0.45	0.29
0.47	0.30
0.47	0.30
0.47	0.30
0.48	0.31
0.48	0.30
0.49	0.31
Mean 0.468 mm.	0.299 mm.

The second antenna of the triunguis forms, with a divided penultimate podomere, terminates with two terminal claws: the untoothed dorsal claw is about four-fifths as long as the toothed ventral one. The middle claw, when present is finely toothed and is slightly more than half as long as the dorsal claw. Accessory processes, often associated with terminal claws of the female, are lacking.

It is with extreme difficulty and uncertainty that the triunguis female of this species is separated from that of *E. striophylax* and the biunguis forms of the two species are indistinguishable.

Type Locality. — Twenty Five Mile Creek 4.5 miles east of Blythewood, Richland Co., S. C. on Secondary Route 60, 0.5 miles north-northeast of junction of Secondary Route 54 with Route 60 (Langford's Crossroads). The hosts here are *Cambarus latimanus* and *Cambarus montanus acuminatus*. *E. striophylax* is the only other species found in collections from the type locality.

Disposition of Types. — The holotype, the allotypic (triunguis) female together with a dissected male paratype are deposited in the United States National Museum. Paratypes are in the collections of Drs. Enrique Rioja, Horton H. Hobbs, Jr., C. Clayton Hoff, Eugene N. Kozloff, and the author.

Range. — This species occurred in only five out of the 124 collections. Three of the localities (stations 3, 14, and 42) are in the Broad River drainage system, one (station 102) at the junction of the Broad and Saluda rivers at Columbia, and the fifth locality (station 27) is in the Wateree River drainage area. This limited distribution indicates that this species is probably indigenous to the Piedmont area of Richland County but further collecting is needed to determine whether or not it is restricted to the Piedmont in other regions. The number of specimens which appeared in each collection was relatively small and only a few specimens are available. Table 4 lists the drainage systems, the collecting station numbers and the crayfish hosts. The latter are listed numerically corresponding to Table 1, with the parenthetical numbers indicating the number of stations from which each species was collected.

TABLE 4

Drainage	*Station Numbers*	*Crayfish Hosts*
Broad River	3, 14, 42	2 (3), 1 (1), 3 (3), 7 (1)
Wateree River	27	2 (1), 4 (1)
Junction of Broad and Saluda Rivers	102	3 (1), 1 (1), 2 (1)

Variations. — With one exception, a marked uniformity appears to exist in all of the male specimens examined. In a single specimen the serrated distal flexor margin of the horizontal ramus of the clasping apparatus is re-

duced and shows a distinct concavity and the serrations are less prominent than in typical specimens.

The triunguis female of this species shows considerable variation particularly with regard to the valve shape; the atypical forms exhibit a more prominent arch along the dorsal margin. A reduction of the "ruffled skirt" and the absence of the prominent concavity on the posterior margin were evident in some of the atypical specimens.

Remarks. — The closest relatives of *E. suteri* appear to be *E. daphnioides* Hobbs (1955), *E. runki* Hobbs (1955), and *E. striophylax,* described above. This species may be distinguished from *E. striophylax* by the presence of the serrated surface on the distal flexor margin of the horizontal ramus of the clasping apparatus. The horizontal ramus of the clasping apparatus of *E. suteri* is much narrower than that of *E. daphnioides* and *E. runki,* and the serrated area is restricted to the distal flexor margin. There is a striking similarity in the valves of the female of this species and those of *E. striophylax. E. striophylax* was present in every collection in which this species was found.

Columbia Group (Rioja, 1949)

This group is characterized by the absence of the talon on the extensor surface of the horizontal ramus of the C-shaped clasping apparatus. Included in this group are *E. equicurva* Hoff (1944), *E. dobbinae* Rioja (1943), *E. bicuspide* Rioja (1945), *E. caudricuspide* Rioja (1949), *E. riojai* Hoff (1943), *E. columbia* Dobbin (1941), *E. occidentalis* Kozloff and Whitman (1954), *E. caudata* Kozloff (1955) and *E. ericksoni* Kozloff (1955).

The range of the Columbia Group extends from the northwestern part of the United States to Mexico and from South Carolina to Florida with one species from Illinois.

Entocythere telmoecea, sp. nov.

This name is derived from Greek (*telma*—swamp, *oeceo*—to dwell) and was so chosen because this species was found to be largely indigenous to swamp areas.

Male. — *Valve* (Fig. 30) subreniform in lateral aspect with dorsal margin slightly arched. Ventral margin with very slight concavity just anterior to mid-length of

valve. Valve highest at mid-length. Both anterior and posterior margins of valve without angular prominences and setae sparsely scattered on lateral surfaces. Conspicuous submarginal row of setae along anterodorsal margin with a few irregularly scattered setae on ventral and posterior margins. Prominent eye located about one-sixth of valve length from anterior end.

Valve size is rather uniform as indicated by measurements (mm.) of 10 specimens from type locality mounted in Hoyer's solution.

	Length	*Height*
	0.36	0.19
	0.36	0.18
	0.38	0.21
	0.38	0.20
	0.36	0.19
	0.36	0.19
	0.35	0.19
	0.36	0.19
	0.38	0.21
	0.35	0.18
Mean	0.364 mm.	0.193 mm.

Antenna I composed of six podomeres that diminish regularly in diameter distally. Single seta arising from distal end of basal podomere extending to apical end of second podomere. Second podomere little longer than wide and bearing one subapical seta that extends to proximal end of antepenultimate podomere. Third podomere, with subequal diameter and length, bears two subapical setae which extend beyond distal end of antepenultimate podomere. Antepenultimate podomere, with length slightly greater than diameter, with six subapical setae, three of which, subequal in length, extend beyond distal end of ultimate podomere; other three setae about three-fifths as long as longest. Penultimate podomere 1.5 times as long as wide and devoid of setae. Ultimate podomere with five terminal setae, each about twice as long as podomere.

Antenna II (Fig. 25) with basal podomere 1.3 times as long as wide, bearing subapical antennal flagellum. Antepenultimate podomere little longer than wide, with distal flexor margin bearing a heavy, feathered, spine-like seta that extends just distad of distal end of penulti-

mate podomere. Undivided penultimate podomere about 1.5 times as long as wide with two setae borne on distal flexor margin; setae subequal in length, being slightly more than half as long as podomere on which borne. Ultimate podomere, which appears to be divided toward apical end, about 1.5. times as long as wide; heavy setae borne in prominent notch on proximal portion extends distomesially to apical end of distal portion. Characteristic terminal claws borne on distal portion; dorsal claw heavily stalked and arched proximally with flattened distal surface bearing 10-12 teeth. Short middle claw, with 10-12 teeth, extends just distad of proximal end of flattened distal surface of dorsal claw. Ventral claw slightly longer than dorsal, with heavy proximal portion tapering to narrow, arched, distal portion which bears a cluster of teeth on ventral surface.

Mandible (Fig. 27) with protopodite bearing row of six multicuspid teeth distally; the two proximal teeth with one or two cusps, the three middle ones with three, and the prominent distal tooth with five. Heavy seta borne on convex surface of protopodite at level slightly proximad of proximal tooth. Respiratory plate with three setae, two of which are subequal in length and the third about three-fifths as long as other two. Mandibular palp with four rather indistinct podomeres. Distal flexor margin of basal one with a long seta which extends to mid-length of terminal setae. Antepenultimate podomere devoid of setae. Midextensor margin of penultimate podomere with a long, gently curving seta which is 1.5 times as long as podomere on which borne; distal end of same podomere with an additional seta that extends almost to distal end of terminal setae. Three terminal setae borne on distal end of ultimate podomere; setae subequal in size and length and more than 1.5 times as long as ultimate podomere.

Maxilla (Fig. 24) with unsegmented palp bearing two long gently curving setae which are subequal in length; the ventral one being slightly heavier. There is no seta on extensor margin, but a prominent notch occurs in a comparable position. Protopodite terminates in two long, thin, ventrally curving setae of subequal size and length; setae extend just beyond distal end of palpal setae. Branchial plate with 20 or more plumose setae.

Copulatory Complex (Fig. 26). — The distinct proximal portion of base is subspatulate in shape and small

as compared with the distal portion. Attached to the proximal portion of the base are the dorsal and ventral fingers; the latter is more attenuated than the former and is about twice as long, extending well beyond the extensor margin of the horizontal ramus of the clasping apparatus. Both the dorsal and ventral fingers end with a terminal spine; that of the former being the longer of the two and apparently bifurcate. The vas deferens arises in the area of the proximal portion of the base and after a distinct convolution it proceeds ventrally to the penis which opens into a shallow groove in the ventral region of the distal portion of the base. The dorsal surface of the distal portion of the base is arched and bears a prominence along the superior margin. The posterior margin of the distal portion of the base bears a shallow sinuation at mid-length. The anterior and the posterior margins are rounded ventrally and join to form an acute point. The clasping apparatus is clearly divisible into the horizontal and vertical rami; the latter being slightly arched on the posterior margin and bearing a very slight emargination on the anterioproximal surface. The more attenuated arched horizontal ramus tapers gently toward the distal end but bears a prominent tooth on the mid-flexor surface and a conspicuous lobed structure on the flexor surface. The distal end of the horizontal ramus appears to bear two or three poorly developed teeth. The two rami are joined at an angle of about 50 degrees.

Female. — The valve of the triunguis female (Fig. 28) is subreniform in lateral aspect with an arched dorsal margin, the greatest height being at mid-length. The ventral margin has a prominent concavity which reaches a maximum depth at approximately one-third of the valve length from the anterior end. The valve is higher posteriorly with the posterior margin evenly rounded. The eye is located about one-fifth of the valve length from the anterior margin. The setae are irregularly dispersed along the anterior and posterior margins and are sparsely scattered along the ventral edge. The posterolateral surface has a few scattered setae with few to none on the anterolateral surface.

The valve size is relatively constant as indicated by measurements (in mm.) of 10 specimens mounted in Hoyer's solution.

Length	*Height*
0.41	0.24

0.41	0.24
0.40	0.23
0.39	0.22
0.41	0.24
0.39	0.24
0.40	0.24
0.40	0.24
0.41	0.22
0.39	0.21
Mean 0.401 mm.	0.232 mm.

The valve of the biunguis female (Fig. 29) is reniform in lateral aspect with both the anterior and posterior margins smoothly rounded and the dorsal margin evenly arched. The ventral margin bears a slight concavity which is just anterior to mid-length of the valve.

The second antenna of the triunguis female bears three terminal claws. The dorsal claw is about two-thirds as long as the ventral claw and is slenderer than the other two and bears a few inconspicuous teeth in the distal margin. The inconspicuous, thin, narrow, middle claw is about two-thirds as long as the dorsal claw and is without teeth. The heavy, distally arched, ventral claw has 10 to 12 prominent teeth.

The female (triunguis) genitalia are in the form of a short, thick, heavily sclerotized, hollow tube (*pieza quitinosa femenina*, Rioja 1943: 575) which is directed ventrad. This tubular process has been observed in a few copulating biunguis females; however, it is generally absent in the biunguis forms.

Type Locality. — Gill's Creek on S. C. Route 48, 2.7 miles south-southeast of The University of South Carolina stadium, Richland Co., S. C. The crayfish host is *P. troglodytes*.

Disposition of Types. — The holotype, the allotypic (triunguis) female, and the morphotypic (biunguis) female together with a dissected male paratype are deposited in the United States National Museum. Paratypes are in the collections of Drs. Horton H. Hobbs, Jr., Enrique Rioja, Eugene N. Kozloff, C. Clayton Hoff, and the author.

Range. — This species, known only from Richland

County, occurred in eighteen of the 124 collections. Fifteen of these collections were made in large swamp areas and of these thirteen were from the Congaree River Swamp. Table 5 lists the drainage systems, the collecting station numbers, and the crayfish hosts. The latter are listed numerically corresponding to Table 1, with the parenthetical number indicating the number of stations from which each species of crayfish was collected.

TABLE 5

Drainage	*Station Number*	*Crayfish Hosts*
Congaree River	23, 24, 31, 46, 52-55, 62-64, 78	2 (1), 7 (5), 9 (8), 8 (2), 5 (5)
Broad River	6, 111, 112	2 (3), 7 (1), 9 (2)
Wateree River	66, 83	7 (1), 9 (2), 8 (1), 6 (1)
Saluda River	122	2 (1), 9 (1)

Variations. — With the exception of the clasping apparatus of the male copulatory complex, the specimens which were examined showed relative uniformity. In many of them the prominent tooth on the midflexor margin of the horizontal ramus of the clasping apparatus was reduced in size and at the same time appeared to taper to a sharper point at its apical end. The lobe on the extensor margin which is opposite in position to the toothed structure is much reduced in some of the males, often to an extent that it is difficult to detect. In some specimens, that part of the horizontal ramus which is distal to the toothed prominence has a diameter the same as that just proximal to the prominence and shows little to no tapering on the distal half of the horizontal ramus. The angle between the vertical and horizontal rami appears to increase to as much as 80 to 90 degrees in a few of the males.

Remarks. — This species, no doubt, has its closest affinities with *E. equicurva* Hoff (1944). The former appears to be the larger of the two and even though the copulatory complex is strikingly similar to that of *E. equicurva,* the difference in the horizontal ramus distinctly separates these two species. Another difference is noted in that the setae borne on the extensor margin of th maxillary palp of *E. equicurva* is conspicuously absent on that of *E. telmoecea.* The C-shaped clasping apparatus

definitely places *E. telmoecea* in the Columbia Group Rioja (1949). The lobed structure on the flexor surface of the horizontal ramus of the clasping apparatus of *E. telmoecea* is suggestive of the talon borne in a comparable position on this structure of members of the Heterodonta Group.

Heterodonta Group (Rioja, 1944)

This group is characterized by the possession of a prominent talon on the convex border of the horizontal ramus of the clasping apparatus. Included in this group are *E. heterodonta* Rioja (1940), *E. copiosa* Hoff (1942), *E. sinuosa* Rioja (1942), *E. talulus* Hoff (1944), *E. hobbsi* Hoff (1944), *E. talirotunda* Rioja (1949) and *E. bidentata* Rioja (1949).

The range of this group extends from Illinois into Mexico and eastward into South Carolina, Georgia, and Florida.

Entocythere tiphophila, sp. nov.

The specific name chosen for this species refers to its apparent preference for living on crayfishes that frequent lentic or sluggish lotic situations in the area under consideration. It is derived from Greek (*tiphos* — standing water; *phil* — loving).

Male. — *Valve* (Fig. 30) subovate with posterior end slightly more angular than anterior and with maximum height just caudad of mid-length. Dorsal margin arched with ventral one slightly convex. Both anterior and posterior ends evenly rounded. Setae unevenly scattered along free margin of valve and sparsely dispersed on lateral surface. Eye located about one-fifth of valve length from anterior end.

Valve size is indicated by measurements (in mm.) of 10 specimens from the type locality mounted in Hoyer's solution.

Length	*Height*
0.35	0.20
0.34	0.20
0.35	0.20
0.35	0.21
0.35	0.21
0.35	0.19

0.35	0.20
0.33	0.18
0.34	0.19
0.35	0.20
Mean 0.346 mm.	0.198 mm.

Antenna I consists of six podomeres with diameter of basal one greatest and those of successive podomeres diminishing regularly distally. Basal podomere 1.25 times as long as wide with one subapical seta which extends to distal end of second podomere. Second podomere subequal in length to basal one, bears one seta on distal end which extends distad of apical end of third podomere. Third podomere about as wide as long with two subapical setae; the longer extending some distance beyond distal end of penultimate podomere and shorter seta about three-fifths as long as longer. Antepenultimate podomere 1.5 times as long as wide and bearing six setae on distal end; the longer three subequal in length and extend to proximity of distal end of ultimate podomere and the shorter three only about three-fifths as long. Penultimate podomere 1.5 times as long as wide and without setae. Ultimate podomere three times as long as wide with five terminal setae which are subequal in length, being more than twice as long as podomere.

Antenna II (Fig. 31) with basal segment more than 1.5 times as long as wide and with antennal flagellum arising on apical end. Antepenultimate podomere as wide as long with a heavy, spine-like, plumose seta borne on distal flexor margin extending to mid-length of ultimate podomere. Penultimate podomere 1.5 times as long as wide with two setae arising on distal flexor margin — the longer extending distad of mid-length of ultimate podomere, and the shorter seta about two-thirds as long as longer. Ultimate podomere divided toward apical end with proximal portion bearing long seta on distal flexor margin extending distad to mid-length of median terminal claw. Distal portion of ultimate podomere with three terminal claws; proximal portion of heavy dorsal claw arched and flattened distal portion bearing 10-12 teeth. Short median claw with 10-12 teeth, extends to proximal end of flattened surface of dorsal claw. Ventral claw slightly longer than dorsal claw with light cluster of teeth on distal third of ventral margin.

Mandible (Fig. 34) with protopodite bearing a row of six multicuspid teeth; cusps varying in number from

one to two on proximal tooth to five on prominent distal tooth; middle teeth apparently tricuspid. Heavy seta borne in notch on convex surface of protopodite at level slightly proximad of proximal tooth. Respiratory plate with three setae, of which the longer two are subequal in length and the third about three-fifths as long as other two. Mandibular palp appears to consist of four indistinct podomeres. Distal flexor margin of basal podomere with a long seta which extends to apical end of distal podomere. Antepenultimate podomere without setae. Penultimate podomere with a long seta borne on midextensor margin extending laterodistad for a length greater than that of podomere on which borne. Penultimate podomere also bears seta on distal end which extends beyond mid-length of terminal setae. Ultimate podomere with three setae of subequal length on distal end; two of which appear to be partially fused.

Maxilla (Fig. 32) with unsegmented palp bearing two ventrally evenly arched setae which are subequal in length. Prominent notch present on extensor surface of maxillary palp proximal to base of terminal setae. Maxillary protopodite with two terminal setae; dorsal one slightly shorter and more strongly arched than ventral seta, the latter extending distad of mid-length of palpal setae. Branchial plate with 22 setae.

Copulatory Complex (Fig. 33). — The proximal portion of the base is subtriangular in shape with the distal margin somewhat emarginate. Attached to the proximal portion of the base are the short dorsal and long ventral fingers; and the latter, which is more attenuated and distinctly arched, extends well beyond the ventrodistal edge of the horizontal ramus of the clasping apparatus. The dorsal finger is heavier than the ventral and is about half as long and bears a terminal spine which appears to be bifurcate. The vas deferens arises in the area of the proximal portion of the base and after a distinct convolution it extends ventrally to the penis which opens into a shallow vertical groove in the ventral area of the distal portion of the base. The large distal portion of the base is comparatively long and narrow. The posterior margin is relatively smooth and bears a conspicuous concavity on the ventral margin. The anterior and posterior margins join to form an acute point in the area just distad of the angle of the clasping apparatus. The clasping apparatus is easily divisible into the vertical and horizontal

rami; the former is only slightly arched, particularly on the flexor margin. The vertical ramus lies at an angle of slightly less than 90 degrees to the horizontal ramus. The latter, which is slightly more than half as long as the former, bears a prominent tooth on the flexor surface just proximal to the mid-length of the ramus. A very conspicuous talon is borne on the extensor surface opposite the tooth on the flexor surface. A sharp concavity is borne on the extensor surface of horizontal ramus just distad of the talon. The portion of the horizontal ramus distal to the talon and tooth tapers to the distal end. Three rather prominent teeth are borne on the distal end and are directed dorsad.

Female. — The valve of the triunguis female (Fig. 37) is subovate with the dorsal margin being more strongly arched than that of the male. The ventral margin bears a concavity which is anterior to mid-length. The postero-dorsal margin is gently sloping with the posteroventral edge evenly rounded. The anterior margin is smoothly rounded. Both the free margin of the valve and the lateral surface are sparsely and irregularly setiferous. The eye is located about one-fourth of the valve length from the anterior end.

The valve size is relatively constant as indicated by measurements (in mm.) of 10 specimens from the type locality mounted in Hoyer's solution.

Length	*Height*
0.39	0.24
0.36	0.24
0.38	0.23
0.37	0.24
0.36	0.23
0.38	0.24
0.39	0.24
0.39	0.24
0.36	0.24
0.38	0.24
Mean 0.373 mm.	0.238 mm.

The valve of the biunguis female (Fig. 35) is smaller than that of the triunguis form and the concavity on the anteroventral margin is slightly more pronounced. The dorsal margin is not so strongly arched as that of the triunguis form.

The genitalia of the triunguis females is similar to that of *E. telmoecea* described above. The short sclerotized tubular process, the "female chitinous papilla," is directed posteroventrad.

The second antenna of the triunguis female appears to bear two terminal claws. The slenderer dorsal claw is two-thirds as long as the heavier ventral claw and has a few inconspicuous teeth on the distal portion. The entire ventral surface of the thick ventral claw is flattened and bears a row of 10-12 prominent teeth on both mesial and lateral edges.

Type Locality. — In roadside ditch on S. C. Route 48, 9.1 miles southeast of the University of South Carolina stadium, Richland Co., S. C. The crayfish hosts are *Cambarus uhleri* and *Procambarus troglodytes*. *E. hobbsi* is the only other species of ostracod found in collections from the type locality.

Disposition of Types. — The holotype, the allotypic (triunguis) female, and the morphotypic (biunguis) female together with a dissected male paratype are deposited in the United States National Museum. Paratypes are in the collections of Drs. Horton H. Hobbs, Jr., Enrique Rioja, C. Clayton Hoff, Eugene N. Kozloff, and the author.

Range. — This species, which is known only from Richland County, South Carolina, was present in only four out of 124 collections. Three of these localities (stations 48, 57, and 61) from which it was taken are in the Congaree River swamp, while one (station 67) is in the Wateree River swamp. Each of these collections was made in stagnant water, containing considerable decaying organic matter, from which there was no drainage whatsoever. Table 6 lists the drainage systems, the collecting station numbers, and the crayfish hosts. The latter are listed numerically corresponding to Table 1, with the parenthetical numbers indicating the number of stations from which each species of crayfish was collected.

TABLE 6

Drainage	*Station Numbers*	*Crayfish Hosts*
Congaree	48, 57, 61	5 (1), 9 (2), 8 (1), 7 (2), 10 (1)
Wateree	67	5 (1)

Variations. — There is relative uniformity among all of the specimens examined except for the horizontal ramus of the clasping apparatus of the male copulatory complex. A slight difference in the length of this structure is evident in some of the specimens. The talon which is borne on the extensor margin is arched in some of the males while it is straight, or nearly so, in others. The length and thickness of the talon appears to vary slightly. The portion of the horizontal ramus distal to the talon is wider and with the ventral or extensor surface more even in some of the specimens. The angle of the clasping apparatus is more clearly defined in some of the males than in others.

Remarks. — The closest affinities of *E. tiphophila* are with *E. sinuosa* Rioja (1942) and *E. heterodonta* Rioja (1940). The clasping apparatus of the copulatory complex of this species is strikingly similar to that of *E. sinuosa,* differing from the latter in that the former has a larger talon and three tooth-like prominences on the distal end of the horizontal ramus, whereas only two are present on that of the latter. The proximal end of the vertical ramus of the latter appears more lobate than that of the former. The proximal teeth on the mandible of *E. tiphophila* are more well developed than those of *E. sinuosa.* The terminal setae on the maxillary palp of this species are subequal in length while those of *E. sinuosa* are markedly unequal. The number of setae borne on the antepenultimate and ultimate podomeres of the first antenna of the two species differs. There is considerable variation in the shape and contour of the valve of both male and female of the two species.

DISCUSSION

It may be noted in examining Table 8 that certain of the ostracods tend to occur together more frequently than do certain others. For example, among the 42 collections of *E. internotalus,* 31 of them contained *E. hobbsi.* It should also be noted that while there are only five collections in which *E. suteri* was represented, specimens of *E. striophylax* were also found to be present in all of them. While the table records only four collections of *E. tiphophila,* a larger series has been examined, but in only one instance was it found associated with another ostracod. In only three of the 124 collections made were three species of ostracods found together. Sixty-two of the collections contained only one species of ostracod, and 57

contained two. Five collections of crayfishes were not infested with ostracods. No explanation is offered to account for the absence of ostracods in these five collections. One of the localities in which there was no infestation of the crayfishes was visited one week later, and the crayfishes collected on this date were heavily infested. It is at least possible that were these five localities revisited the crayfishes would have ostracods associated with them.

Table 9 is presented to show the associations between the several species of crayfishes in Richland County, and no elaboration seems necessary.

It may be stated here that no data are available to indicate any degree of "host specificity" between the members of the genus *Entocythere* and their crayfish "hosts". Whereas the data presented in Table 10 do not alter this statement, there are at least suggestions of "host preference". For example, 98 per cent of the collections of *E. striophylax* were taken from *C. latimanus* and 80 per cent of the collections of this crayfish contained *E. striophylax*. This clearly indicates some type of association between these two species, but it is not clear what factors entered into bringing about their association. The factors which might contribute to this relationship are so numerous that any postulate on the basis of available data would amount to little more than conjecture. It seems probable that no valid conclusions can be drawn until data from experimental investigations are accumulated. Some valuable clues may be obtained when the ranges of both of these species are more accurately defined and when the ecological tolerances of the two are somewhat better understood.

That there is no "host specificity" in this instance is indicated when the frequency of associations between *E. striophylax* with *C. spicatus* and *C. b. bartonii* are considered. Every collection of these two crayfishes reveal that they were infested with *E. striophylax*. Indeed, if Table 10 is examined carefully it is apparent that there is no "host specificity" indicated for any of the entocytherids known to inhabit the Richland County area.

It should be made clear that the data presented in Table 10 were compiled from the aggregate collection of all the ostracods collected at a given locality. Con-

sequently, if three species of crayfishes were collected and two species of ostracods found in the collecting jar, all three crayfishes were credited with harboring the two ostracods. In spite of this limitation, this table is of value in suggesting a number of problems dealing with the ostracod-crayfish associations.

TABLE 8 — OSTRACOD ASSOCIATIONS

The numbers to the right indicate the total number of collections in which each species of ostracod was found. Those numbers within the blocks record the number of times that the species were found together.

E. internotalus	E. striophylax	E. suteri	E. telmoecea	E. tiphophila	E. hobbsi		
31	0	5	0	2	*	E. internotalus	(42)
5	0	4	5	*	2	E. striophylax	(47)
0	0	0	*	5	0	E. suteri	(5)
2	0	*	0	4	5	E. telmoecea	(18)
1	*	0	0	0	0	E. tiphophila	(4)
*	1	2	0	5	31	E. hobbsi	(56)

TABLE 9 — CRAYFISH ASSOCIATIONS

The numbers to the right indicate the total number of collections in which each species of crayfish was found. Those numbers within the blocks record the number of times that the species was found together.

O. clypeatus	P. sp.	P. troglodytes	P. enoplosternum	P. b. blandingii	C. reduncus	C. uhleri	C. m. acuminatus	C. b. bartonii	C. latimanus	C. spicatus		
0	0	0	0	1	0	0	0	2	2	*	C. spicatus	(3)
0	0	12	4	11	0	0	7	6	*	2	C. latimanus	(58)
0	0	1	0	1	0	0	1	*	6	2	C. b. bartonii	(6)
0	7	2	9	5	1	0	*	1	7	0	C. m. acuminatus	(25)
0	0	6	1	5	0	*	0	0	0	0	C. uhleri	(10)
0	0	1	0	0	*	0	1	0	0	0	C. reduncus	(3)
1	8	13	4	*	0	5	5	1	11	1	P. b. blandingii	(43)
0	9	2	*	4	0	1	9	0	4	0	P. enoplosternum	(26)
0	3	*	2	13	1	6	2	1	12	0	P. troglodytes	(33)
0	*	3	9	8	0	0	7	0	0	0	P. sp.	(17)
*	0	0	0	1	0	0	0	0	0	0	O. clypeatus	(1)

TABLE 10 — OSTRACOD — CRAYFISH ASSOCIATIONS

In each block the uppermost number indicates the number of times an association was found between the corresponding ostracod and crayfish. The middle number expresses the percentage of the collections containing the crayfish host that were infested by the ostracod indicated (i.e., total number of associations/total number of collections containing the crayfish host). The bottom number indicates the percentage of the number of collections containing the ostracods that were found associated with the crayfish indicated (i.e., total number of associations/total number of collections containing the ostracod).

E. internotalus (42)	E. striophylax (47)	E. suteri (5)	E. telmoecea (18)	E. tiphophila (4)	E. hobbsi (56)		
0 0% 0%	3 100% 6%	2 66% 40%	0 0% 0%	0 0% 0%	0 0% 0%	C. spicatus	(3)
5 9% 12%	46 80% 98%	5 9% 100%	6 10% 33%	0 0% 0%	14 25% 25%	C. latimanus	(58)
1 17% 2%	6 100% 13%	4 67% 80%	0 0% 0%	0 0% 0%	0 0% 0%	C. b. bartonii	(6)
17 68% 40%	2 8% 4%	1 4% 20%	0 0% 0%	0 0% 0%	19 76% 34%	C. m. acuminatus	(25)
2 20% 5%	0 0% 0%	0 0% 0%	5 50% 28%	2 20% 50%	4 40% 7%	C. uhleri	(10)
2 66% 5%	0 0% 0%	0 0% 0%	1 33% 6%	0 0% 0%	1 33% 2%	C. reduncus	(3)
12 27% 29%	8 18% 17%	1 2% 20%	1 2% 6%	2 5% 50%	27 62% 48%	P. b. blandingii	(43)
24 92% 57%	2 8% 4%	0 0% 0%	3 12% 17%	1 4% 25%	16 62% 29%	P. enoplosternum	(26)
9 27% 21%	12 36% 26%	0 0% 0%	13 39% 72%	2 6% 50%	12 36% 21%	P. troglodytes	(33)
12 71% 29%	0 0% 0%	0 0% 0%	0 0% 0%	1 6% 25%	15 88% 27%	P. sp.	(17)
0 0% 0%	0 0% 0%	0 0% 0%	0 0% 0%	0 0% 0%	0 0% 0%	O. clypeatus	(1)

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EXPLANATION OF PLATES

PLATE 1

Fig. 1. Antenna I of Male, *E. internotalus.*
Fig. 2. Antenna II of female, *E. internotalus.*
Fig. 3. Antenna II of female (Triunguis), *E. internotalus.*
Fig. 4. Copulatory complex of male, *E. internotalus.*
Fig. 5. Maxilla of male, *E. internotalus.*
Fig. 6. Mandible of male, *E. internotalus.*
Fig. 7. Lateral aspect of valve of female (Biunguis), *E. internotalus.*
Fig. 8. Lateral aspect of valve of female (Triunguis), *E. internotalus.*
Fig. 9. Lateral aspect of valve of male, *E. internotalus.*

PLATE 2

Fig. 10. Antenna II of male, *E. striophylax.*
Fig. 11. Copulatory complex of male, *E. striophylax.*
Fig. 12. Antenna I of male, *E. striophylax.*
Fig. 13. Mandible of male, *E. striophylax.*
Fig. 14. Maxilla of male, *E. striophylax.*
Fig. 15. Lateral aspect of valve of female (biunguis), *E. striophylax.*
Fig. 16. Lateral aspect of valve of female (triunguis), *E. striophylax.*
Fig. 17. Lateral aspect of valve of male, *E. striophylax.*

PLATE 3

Fig. 18. Copulatory complex of male, *E. suteri.*
Fig. 19. Antenna II of male, *E. suteri.*
Fig. 20. Maxilla of male, *E. suteri.*
Fig. 21. Mandible of male, *E. suteri.*
Fig. 22. Lateral aspect of valve of male, *E. suteri.*
Fig. 23. Lateral aspect of valve of female (triunguis), *E. suteri.*

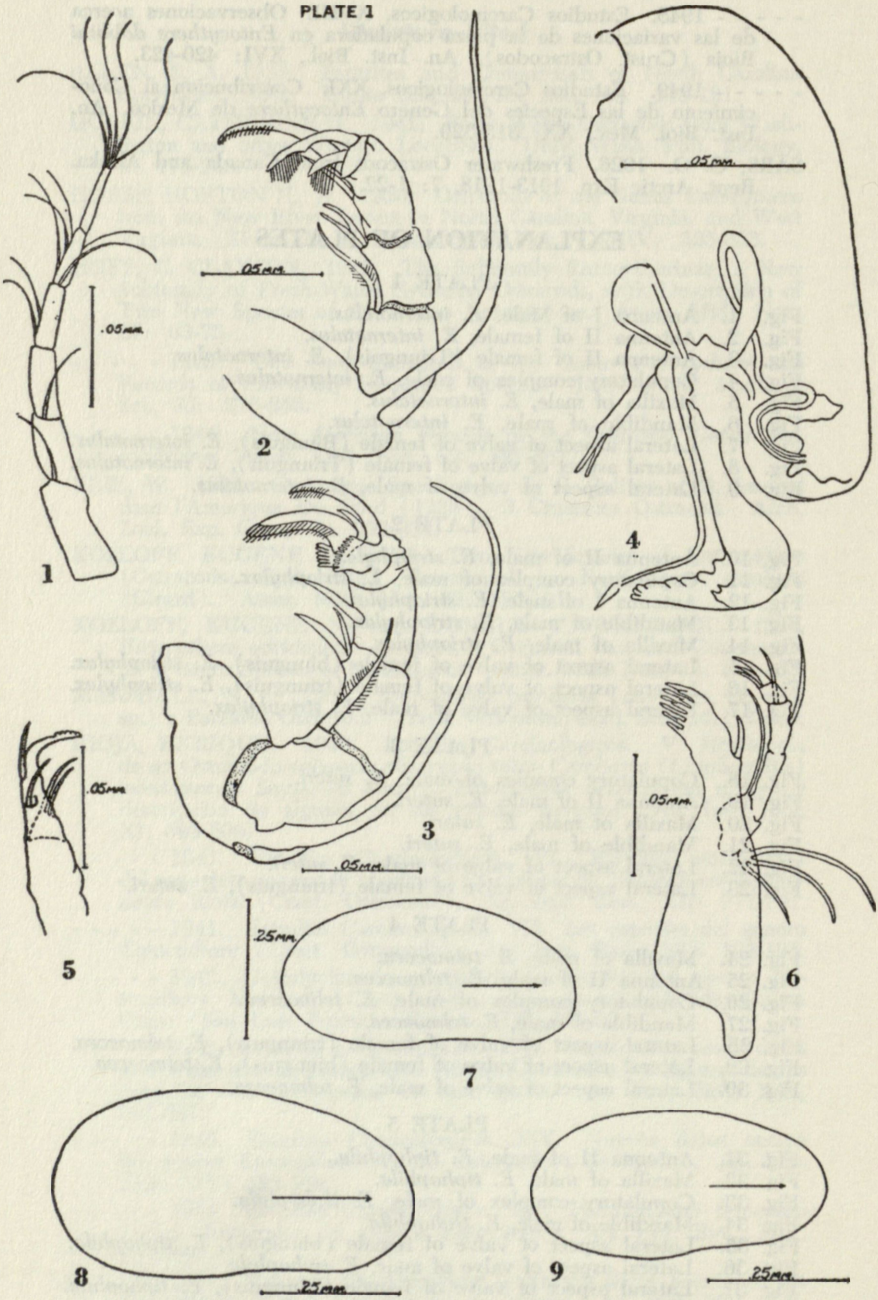
PLATE 4

Fig. 24. Maxilla of male, *E. telmoecea.*
Fig. 25 Antenna II of male, *E. telmoecea.*
Fig. 26. Copulatory complex of male, *E. telmoecea.*
Fig. 27. Mandible of male, *E. telmoecea.*
Fig. 28. Lateral aspect of valve of female (triunguis), *E. telmoecea.*
Fig. 29. Lateral aspect of valve of female (biunguis), *E. telmoecea.*
Fig. 30. Lateral aspect of valve of male, *E. telmoecea.*

PLATE 5

Fig. 31. Antenna II of male, *E. tiphophila.*
Fig. 32. Maxilla of male, *E. tiphophila.*
Fig. 33. Copulatory complex of male, *E. tiphophila.*
Fig. 34. Mandible of male, *E. tiphophila.*
Fig. 35. Lateral aspect of valve of female (biunguis), *E. tiphophila.*
Fig. 36. Lateral aspect of valve of male, *E. tiphophila.*
Fig. 37. Lateral aspect of valve of female (triunguis), *E. tiphophila.*

PLATE 1



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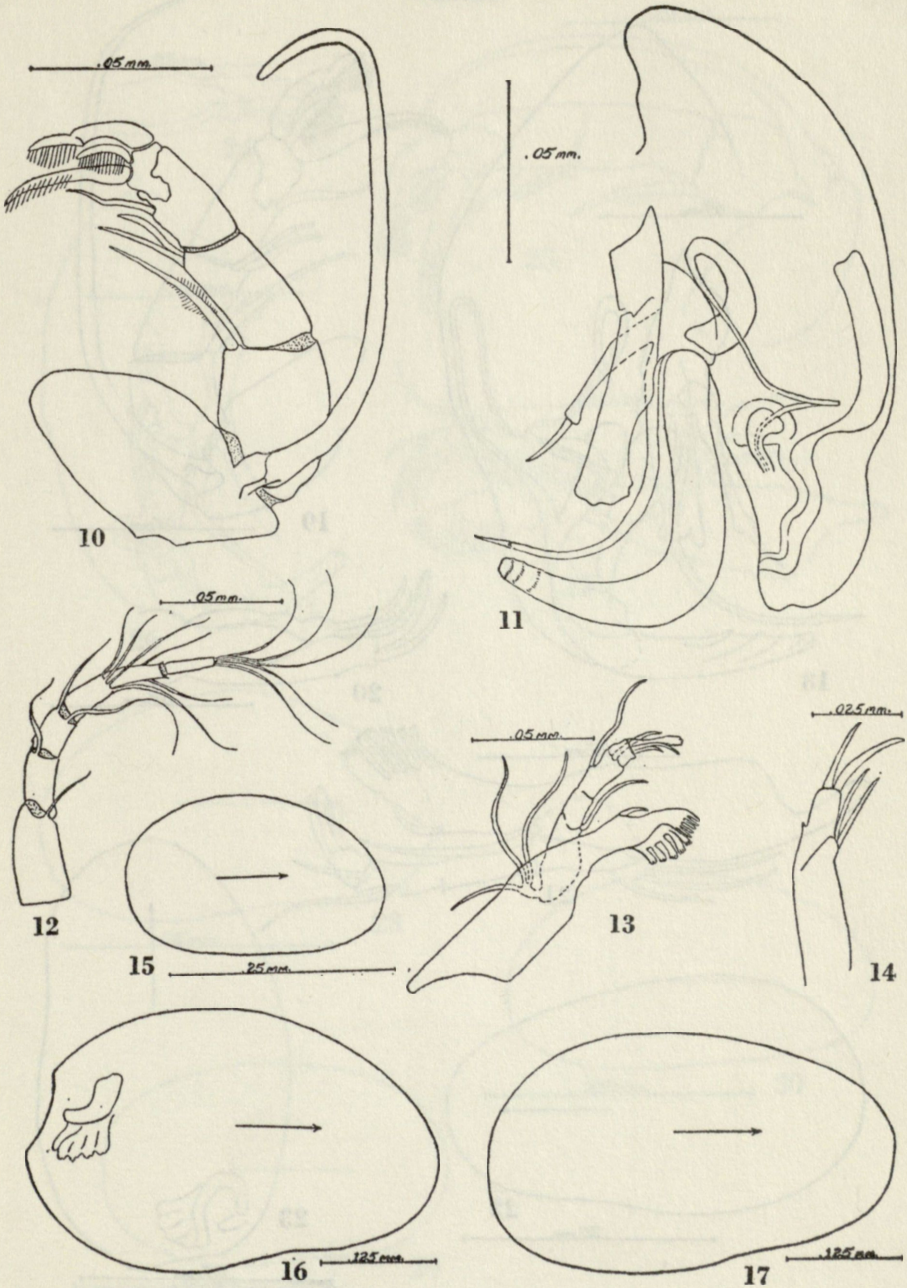
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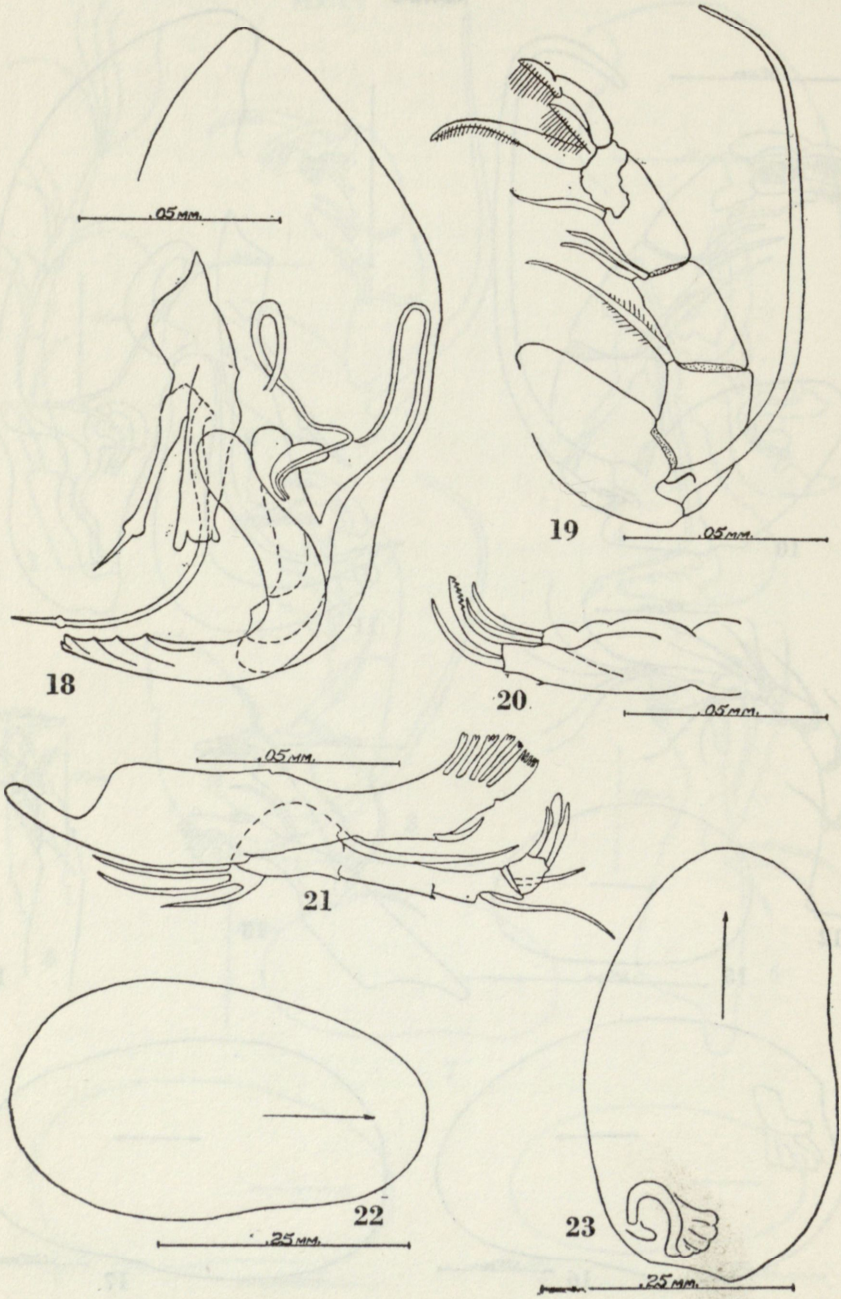
PLATE 3



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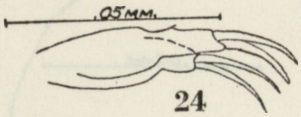

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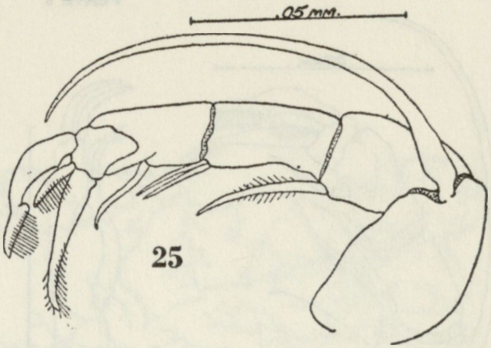

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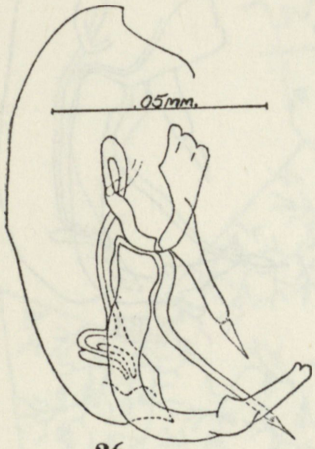

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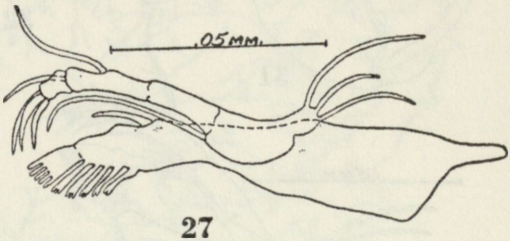

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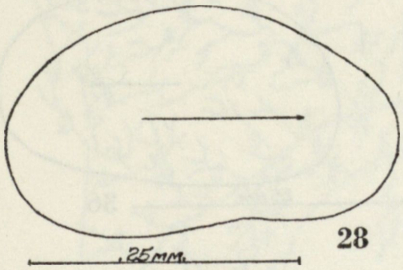

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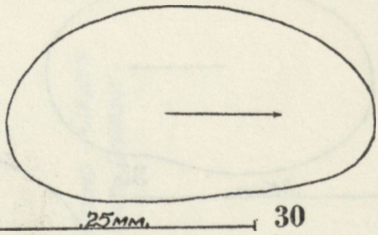

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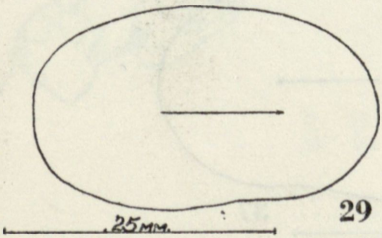

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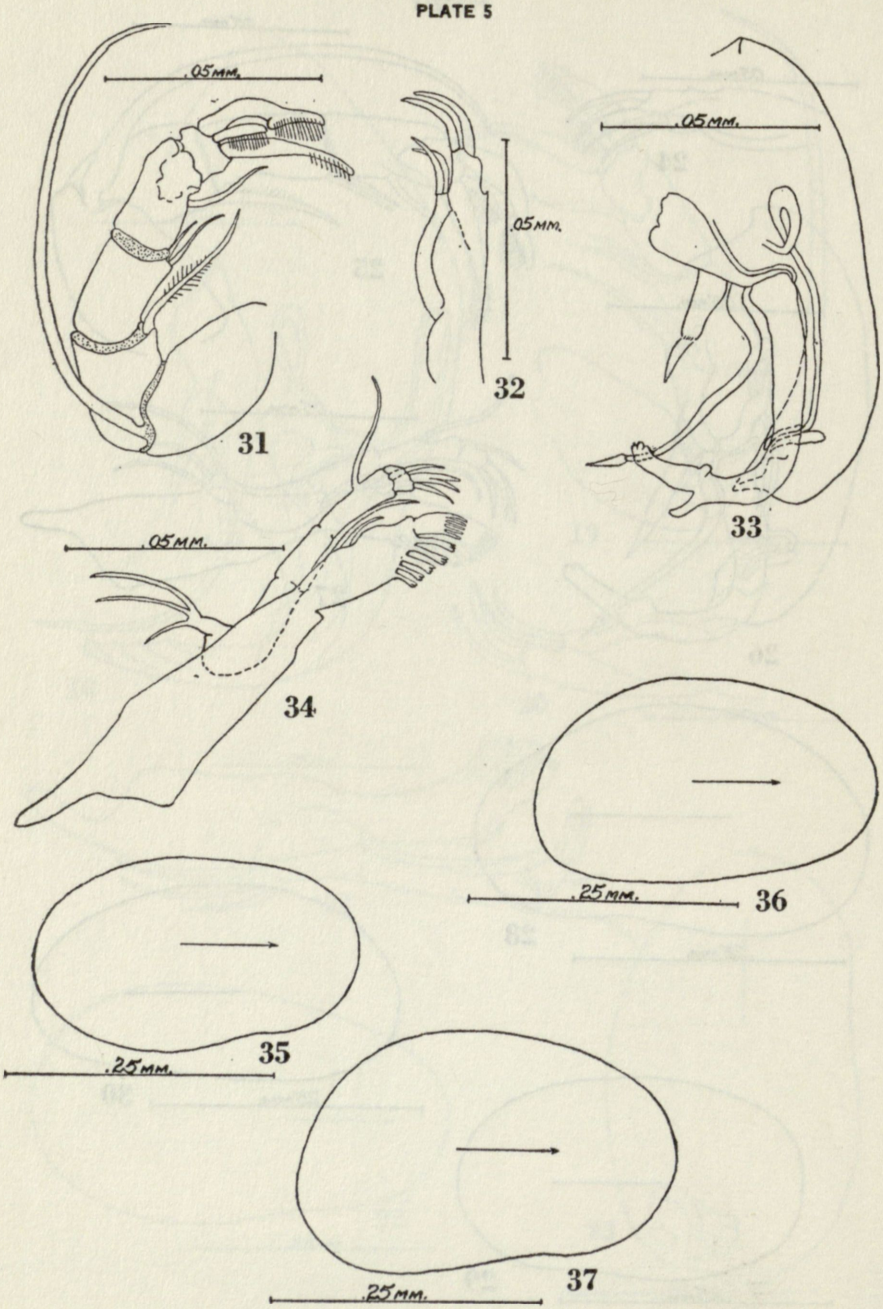
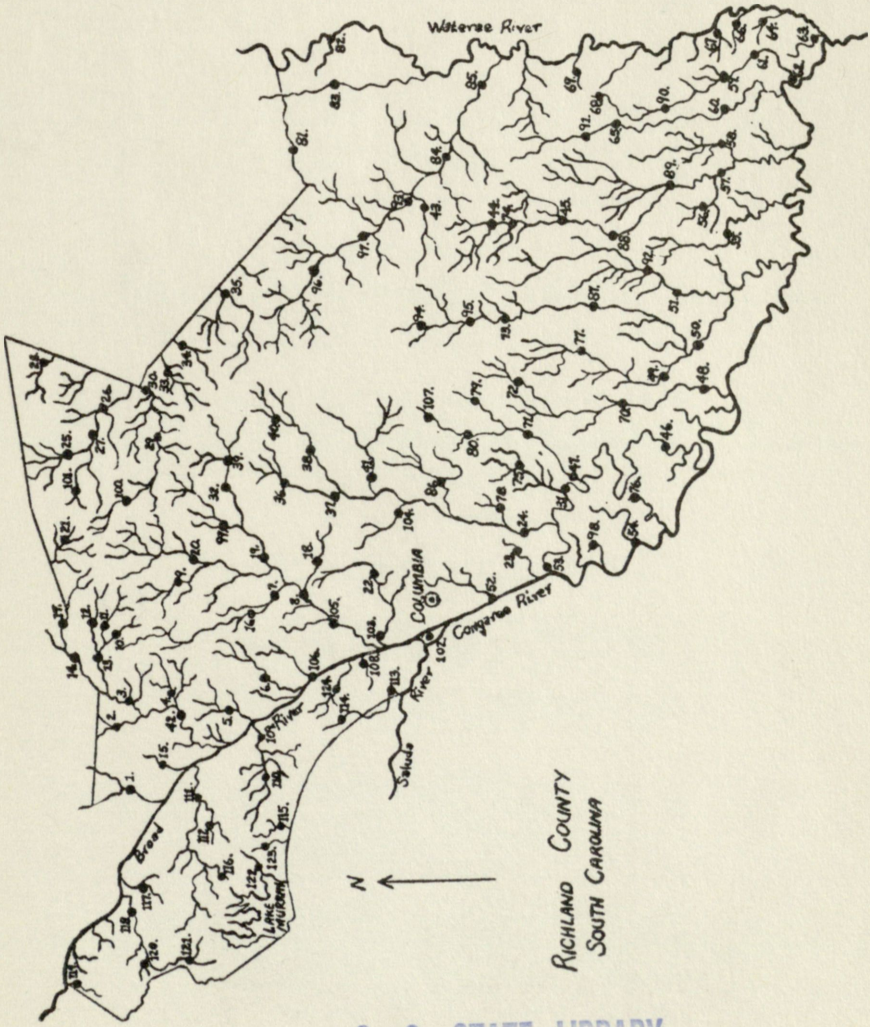
PLATE 5





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