12-1990

# Distribution of the Fishes of The Great Smoky Mountains National Park

Damien J. Simbeck
*University of Tennessee - Knoxville*

To the Graduate Council:

I am submitting herewith a thesis written by Damien J. Simbeck entitled "Distribution of the Fishes of The Great Smoky Mountains National Park." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Animal Science.

David A. Etnier, Major Professor

We have read this thesis and recommend its acceptance:

Stephen E. Moore, Dewey Bunting

Accepted for the Council:
Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

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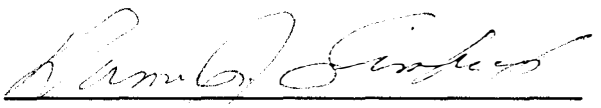
Signature 

Date 11-27-90

# DISTRIBUTION OF THE FISHES OF THE GREAT SMOKY MOUNTAINS NATIONAL PARK

A Thesis

Presented for the

Master of Science

Degree

The University of Tennessee

Damien J. Simbeck

December 1990

## DEDICATION

I would like to dedicate this thesis to my father, Don K. Simbeck, for instilling in me an appreciation for all of nature, and for teaching an inquisitive boy as much as he could along the way. His love and constant support throughout my life will never be forgotten.

## ACKNOWLEDGMENTS

Throughout the course of my research and studies, a number of people greatly assisted me. I am particularly indebted to Dr. David Etnier, my major professor, for his help and guidance during this project. I am also indebted to my commitee members, Mr. Steve Moore and Dr. Dewey Bunting, for their assistance throughout this study. Their help was invaluable to the completion of this thesis.

I would also like to thank my wife, Regina, for her understanding and constant support during the course of this project. Without her constant encouragement, I would have been unable to complete this project.

**ABSTRACT**

Over 200 collections of fishes have been made within the boundaries of the Great Smoky Mountains National Park, revealing a Park ichthyofauna of 74 native and 5 introduced fish species. Abrams Creek, containing the most diverse ichthyofauna in the park, currently contains only 35 of its historical 67 fish species. This loss of species resulted from intentional poisoning of the creek to improve habitat for rainbow trout and impoundment of the lowest 2.6 miles by Chilhowee Reservoir.

Abrams Creek also contains a very unusual ichthyofauna in its upper portion. Several species found above its 25-foot waterfall have not been found below it, and some are rare elsewhere in the Little Tennessee River system. A possible drainage history, supported both by ichthyological and geological data is theorized. Outlets for some of the streams now in the upper Abrams Creek system may have existed toward Little River and Parsons Branch or Tabcat Creek.

Possible environmental problems which might be faced by the Park's fishes are discussed. Although the streams in the Park are not subjected to problems such as waste water treatment or agricultural runoff, they are effected by such problems as acid rain and the possibility of global warming.

TABLE OF CONTENTS

# INTRODUCTION

The Great Smoky Mountains National Park was officially opened in 1934. It was formed by purchasing over 400,000 acres of privately owned land. Over 85% of the land was owned by timber industries, and only 1/3 of the land was still virgin forest. Numberous settlements and farms were scattered throughout the area, with concentrations along the Little Pigeon River, Cataloochee and Hazel creeks, and in Cades Cove. With the exception of Cades Cove, these lands were allowed to return to their natural state after the formation of the Park. Today, the Park totals approximately 508,000 acres, most of which is managed as a natural area, free of human changes and controls. (Campbell, 1960)

Although there have been many fish collections made within the boundaries of the Great Smoky Mountains National Park, there has never been a complete summary of all historical collections or an annotated list of the species found. The objectives of this project are: 1) to compile all past fish collections from within the Park's boundaries, 2) to develop a complete list of the Park's fishes and to document their distributions, 3) to discuss possible drainage histories of the Park's streams which might have affected the fishes' distributions, and 4) to discuss environmental problems already facing the Park's fishes and to theorize possible

problems to be faced in the future.

Carl Hubbs made numberous surveys in the Park in the fall of 1937 and again in the summer of 1940. Robert Lennon surveyed the Park's fishes in 1957, including a reclamation attempt of the lower portion of Abrams Creek. Since the late 1980's, the Park Service has been conducting regular stream surveys throughout the park to study changes in the populations of the Park's fishes. From 1988 to 1990, members of the Zoology Department at the University of Tennessee, with the National Park Service, conducted surveys within the park to attempt to fully understand the distribution and abundance of the fishes of the Smokies.

Although the Park is visited each year by millions of people, its streams are virtually free of major human impact. Only Abrams Creek is subject to pasture runoff, and there are no major effluents from waste disposal processes in any stream. Silt levels are very low, except for Abrams Creek, and are primarily due to natural erosion. The only major made-made problems which may be imposed on the Park's fishes are: 1) the introduction of exotic species, 2) impoundments of the Park's rivers and streams, 3) possible changes in pH due to acid rain, 4) possible changes in temperature due to the atmospheric warming caused by the greenhouse gases, and 5) possible change in the terrestial environment due to the above problems, causing changes in the aquatic system.

Documentation of the current and past distributions and abundances of the Park's fishes is necessary to allow detection of potential changes through time caused by the above.

# I. HISTORY

## Geological and Geographical

The Great Smoky Mountains National Park lies within the Blue Ridge province of east Tennessee and western North Carolina. The Blue Ridge was formed between 200 and 700 million years ago by an upthrusting as Laurentia (ancient North America) collided with Gondwana (ancient Africa). (Cook, et al., 1980) This lifting left behind a range of mountains from Newfoundland to Alabama and Georgia. They are made of highly metamorphic rocks with some igneous rock layers which overlie a younger strata of sedimentary rock. Throughout the range, though primarily on the west side, are "windows" that expose the younger sedimentary rock. (Wilson, 1935; Cook, et al. 1980)

Streams within the study area are primarily of high gradient, 1-5%, and low temperature, usually less than 20°C year-round. Substrates are primarily boulder, rubble, and cobble, with some areas of gravel, sand, and bedrock outcroppings. Waterfalls are numberous and sometimes quite large, acting as barriers to upstream migration of fishes.

Within the study area, Abrams Creek flows through one of the "windows" of the Blue Ridge, Cades Cove. The upper portion of the creek, as it flows through the Cove, is very low gradient with gravel and cobble substrate. There are

several springs within the cove, arising from the under-ground waterways which may have helped to form this window.

## II. STUDY AREA

The study area includes portions of four river systems, the Little River, Little Pigeon River, Pigeon River, and the Little Tennessee River. (Map 1) All of these are portions of the Tennessee River drainage.

For the porpose of this discussion, these systems have been divided into six systems, by treating Abrams Creek and Oconaluftee River, both tributaries to the Little Tennessee River, as separate systems due to their very different ichthyofaunas.

### Little River

The Little River drains the highest altitudes of the Park, Clingman's Dome, elevation 6643 ft. It drains the northern portions of the Park from Thunderhead Mountain to Newfound Gap. Thirty-one of the 79 fish species found in the Park are found in this system, though most are limited to the lowest portion just upstream of the Park boundary. Its headwater portions near Elkmont were heavily logged prior to the formation of the Park, and a small dam constructed in the mid-1920's may be preventing the reestablishment of species eliminated by run-off from the clear-cut. Many of the species present in the upstream portion, above "the sinks" (Map 1), cannot be found above this dam, though they are found at higher elevations elsewhere in the Park.

**Little Pigeon River**

This system is divided into three sections, West Prong, Middle Prong, and East Prong, the last represented in the Park only by the headwaters of Dunn Creek. Only 29 fish species have been found in this system. These streams drain the northern portions of the Park from Newfound Gap to Mount Guyot.

**Pigeon River**

This system consists of Cosby, Big, and Cataloochee creeks. These streams drain the eastern portions of the Park from Mount Guyot to Balsam Mountain. Only 13 fish species have been collected from these streams, limited primarilly by the sizes of Cosby and Big creeks and a 20-ft. waterfall outside the Park on Cataloochee Creek. Only introduced trout, and species which were able to negotiate the falls prior to or during their formation occur in Cataloochee Creek.

**Oconaluftee River**

Consisting of the Oconaluftee River and its tributaries, this major tributary to the Little Tennessee River drains the southern portions of the Park from Mount Guyot to Newfound Gap. Twenty-eight fish species have been collected in this river, one of which, Phenacobius crassilabrum, has been collected nowhere else in the Park.

**Little Tennessee River**

This system consists of the Tuckaseegee River, the Little Tennessee River, and all their tributaries which drain the southern side of the Park from Newfound Gap to Bunker Hill (Tabcat and Shop creeks). Like the Little River, it drains the highest elevations in the Park (Noland and Forney creeks). Forty-four fish species have been collected, two of which, Notropis rubellus and Percina squamata, have been collected nowhere else in the Park. This system contains portions of all four reservoirs which border the Park. Therefore, several species found in these reservoirs may also occur in this system in the lower portions upstream of the embayments.

**Abrams Creek**

This creek drains Cades Cove and the northwestern portions of the Park from Thunderhead Mountain to Bunker Hill. Draining into the Little Tennessee River at the lowest elevation in the Park, it has had about 2.6 miles of its lower end flooded by Chilhowee Lake. This stream was once the most diverse in the Park, at least near its mouth, containing 67 of the parks 79 fish species, 26 of which had not been collected anywhere else in the Park. Since the reclamation and impoundment of this stream, only 35 species have been found, 17 of which are found in the portion above the falls. The

portion of this stream above the falls is referred to as upper Abrams Creek, and the portion below the falls as lower Abrams Creek.

## III. SPECIES ACCOUNTS

The following is a list of the 79 fish species which have been collected within the Park's boundaries. Collection numbers refer to the collections listed in Appendix A. Table 1 also lists the Park's fishes, outlining their occurence prior to and since the 1957 reclamation of Abrams Creek. Map 2 shows the locations of all collections which have been made in the Park.

Table 1. Species found in Great Smoky Mountains National Park and Lower Abrams Creek before and after 1957

| | PARK | | LOWER ABRAMS | | |
|---|---|---|---|---|---|
| | before 1957 | after 1957 | before 1957 | after 1957 | COMMENTS |
| Ichthyomyzon greeleyi | X | X | X | | A |
| Lampetra appendix | X | X | X | | A |
| Lepisosteus osseus | X | | X | | A,B |
| Dorosoma cepedianum | X | X | X | X | A,E |
| Oncorhynchus mykiss | I | I | I | I | |
| Salmo trutta | | I | | | |
| Salvelinus fontinalis | X | X | X | | F |
| Campostoma anomalum | X | X | X | X | C |
| Carassius auratus | I | | I | | B |
| Clinostomus funduloides | X | X | | | |
| Cyprinella galactura | X | X | X | X | C |
| C. monacha | X | X | X | R | |
| C. spiloptera | X | | X | | A,D |
| Cyprinus carpio | I | | I | | B |
| Hemitremia flammea | | X | | | |
| Hybopsis amblops | X | X | X | X | |
| Luxilus chrysocephalus | X | X | X | X | |
| L. coccogenus | X | X | X | X | C |
| Nocomis micropogon | X | X | X | X | C |
| Notropis atherinoides | X | | X | | A,D |
| N. leuciodus | X | X | X | X | C |

Table 1. (cont.)

| | PARK | | LOWER ABRAMS | | |
|---|---|---|---|---|---|
| | before 1957 | after 1957 | before 1957 | after 1957 | COMMENTS |
| *N. photogenis* | X | X | X | | A |
| *N. rubellus* | X | | | | D |
| *N. rubricroceus* | X | X | | | |
| *N. spectrunculus* | X | X | | | |
| *N. telescopus* | X | X | X | X | C |
| *N. volucellus* | X | | X | | A,D |
| *Phenacobius crassilabrum* | X | X | | | |
| *P. uranops* | X | | X | | A,D |
| *Phoxinus tennesseensis* | X | X | | | |
| *Rhinichthys atratulus* | X | X | X | X | C |
| *R. cataractae* | X | X | | | |
| *Semotilus atromaculatus* | X | X | X | | |
| *Catostomus commersoni* | X | X | X | X | C,E |
| *Hypentelium nigricans* | X | X | X | X | C |
| *Moxostoma carinatum* | X | X | | X | |
| *M. duquesnei* | X | X | X | X | |
| *M. erythrurum* | X | X | X | X | |
| *M. macrolepidotum* | X | X | | | |
| *Ameiurus melas* | X | | X | | A,B |
| *A. natalis* | X | X | X | | A |
| *Ictalurus furcatus* | X | | X | | A,B |
| *I. punctatus* | X | | X | | A,B |
| *Noturus baileyi* | X | | X | R | |
| *N. flavipinnis* | ? | | ? | R | |
| *N. flavus* | X | | X | | A,D |
| *Pylodictus olivaris* | X | | X | | A,B |
| *Fundulus catenatus* | X | | X | | A,D |
| *Gambusia affinis* | | X | | | |
| *Labidesthes sicculus* | | X | | X | |
| *Morone chrysops* | | X | | X | E |
| *Ambloplites rupestris* | X | X | X | X | G |
| *Lepomis auritus* | | I | | I | G |
| *L. cyanellus* | | X | | | |
| *L. gulosus* | X | X | X | X | G |
| *L. macrochirus* | X | X | X | X | G |
| *L. megalotis* | X | X | X | X | G |
| *Micropterus dolomieu* | X | X | X | X | G |
| *M. salmoides* | X | | X | | B |
| *Etheostoma blenniodes* | X | X | X | | F |
| *E. chlorobranchium* | X | X | X | X | |
| *E. flabellare* | X | X | | | |
| *E. (Catonotus) sp.* | X | | X | | A,D,F |

Table 1 (cont.)

| | PARK before 1957 | PARK after 1957 | LOWER ABRAMS before 1957 | LOWER ABRAMS after 1957 | COMMENTS |
|---|---|---|---|---|---|
| E. rufilineatum | X | X | X | X | |
| E. simoterum | X | X | X | X | C |
| E. stigmaeum | X | | X | | A,D |
| E. swannanoa | X | X | | | |
| E. vulneratum | X | X | X | X | |
| E. zonale | X | X | X | X | |
| Percina aurantiaca | X | X | | | |
| P. burtoni | X | | X | | D,F |
| P. caprodes | X | X | X | X | G |
| P. evides | X | X | X | X | |
| P. squamata | | X | | | |
| Stizostedion canadense | X | | X | | A,B |
| S. vitreum | | X | | X | E |
| Aplodinotus grunniens | X | | X | | A,B |
| Cottus bairdi | X | X | X | | F |
| C. carolinae | X | X | X | | F |

A- In Abrams Creek, was found only in the lower portion now inundated by Chilhowee Reservoir
B- Probably still present in the reservoirs
C- Present in upper Abrams Creek, and can/has repopulated the lower portion from those populations
D- Probably extirpated from the Park
E- Recently collected in Abrams Creek only in the embayment
F- Could be reintroduced into lower Abrams Creek
G- Probably repopulated lower Abrams Creek through the reservoirs
I- Introduced species, not native to the Park
R- Currently being reintroduced into lower Abrams Creek

**Petromyzontidae**

1) Ichthyomyzon greeleyi Hubbs and Trautman, mountain brook lamprey

This species is uncommon to rare in the larger portions

of Little River and Oconaluftee River. It was collected in Abrams Creek prior to 1957. It is most common in Oconaluftee River from the lower portions of Raven Fork downstream. (Map 3)
Collection numbers: 34, 58, 59, 189, 217

2) Lampetra appendix (DeKay), American brook lamprey

This species is uncommon to rare in the larger portions Little River and Tabcat Creek. It was collected in Abrams Creek prior to 1957. (Map 4)
Collection numbers: 58, 73, 105, 194, 219

**Lepisostedae**

3) Lepisosteus osseus (Linnaeus), longnose gar

This primarily lentic species is uncommon in the impoundments of the Little Tennessee River. It was collected in Abrams Creek prior to 1957. It may enter the lower portions of the reservoir tributaries. (Map 5)
Collection number: 25

**Clupeidae**

4) Dorosoma cepedianum (Lesueur), gizzard shad

This species is common in the impoundments of the Little

Tennessee River. It was collected in Abrams Creek prior to 1957, and has subsequently been collected in the Abrams Creek embayment. (Map 6)

Collection numbers: 74, 135

**Salmonidae**

5) Oncorhynchus mykiss (Walbaum), rainbow trout

This introduced species is common in all streams of the Park to elevations of about 4000 ft. Introduced into the area around 1910, it has become the prominent game fish of the Smokies. (Map 7)

Collection numbers: 9, 13, 17, 19, 22, 23, 38, 39, 41, 42, 43, 44, 45, 47, 48, 49, 50, 54, 64, 65, 66, 67, 68, 69, 71, 72, 86, 99, 101, 103, 105, 106, 107, 109, 110, 113, 114, 116, 117, 118, 119, 120, 127, 131, 132, 133, 134, 137, 142, 144, 145, 146, 148, 149, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 176, 180, 182, 190, 192, 194, 196, 197, 199, 201, 202, 203, 204, 205, 207, 208, 210, 211, 212, 213, 214, 215, 218, 221, 223, 224.

6) Salmo trutta Linnaeus, brown trout

This introduced species is fairly common in the Little, Pigeon, Oconaluftee and Little Tennessee river systems. Its only official introduction was in Oconaluftee River in 1966. This species has also been unofficially introduced, primarily by local fishermen, in Little River, Abrams Creek, and the Pigeon River tributaries since that time, and has moved into the Park from peripheral stockings. (Map 8)

Collection numbers: 86, 101, 103, 105, 106, 107, 113, 117, 131, 132, 133, 134, 144, 145, 146, 148, 149, 157, 158, 159, 161, 162, 163, 164, 165, 166, 168, 169, 170, 171, 172, 180, 182, 190, 192, 194, 200, 201, 202, 210, 213, 218, 220, 223.

7) Salvelinus fontinalis (Mitchill), brook trout

This species was once widespread in the Park, but since the introduction of rainbow trout, it can be found uncommonly at elevations above those occupied by rainbow trout. It was probably eliminated from many streams due to run-off from logging areas. Efforts to reclaim streams for brook trout have had only moderate success, primarily due to insufficient funding. (Map 9)

Collection numbers: 5, 13, 15, 40, 44, 48, 49, 64, 74, 107, 109, 110, 150, 151, 152, 153, 162, 173, 174, 175, 176, 177, 218.

**Cyprinidae**

8) Campostoma anomalum (Rafinesque), central stoneroller

This species is, by far, the most widespread and abundant fish in the Park. It is found in all streams up to elevations of about 3200 ft. (Map 10)

Collection numbers: 1, 3, 4, 6, 7, 8, 9, 10, 12, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 27, 30, 31, 33, 34, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 47, 49, 50, 55, 56, 57, 60, 61, 64, 65, 66, 67, 68, 69, 70, 71, 72, 81, 82, 83, 86, 91, 92, 93, 94, 96, 97, 98, 99, 101, 102, 103, 105, 107, 111, 114, 116, 117, 118, 119, 123, 124, 125, 127, 131, 132, 133, 134, 137, 142, 144, 145, 146, 148, 149, 154, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 170, 171, 172, 178, 179, 180, 181, 182, 185, 186, 187, 188, 189, 190, 192,

194, 196, 197, 198, 199, 201, 202, 203, 204, 205, 207, 208, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224.

9) Carassius auratus (Linneaus), goldfish

This introduced species was uncommon in the lower portion of Abrams Creek prior to 1957. It is still present in the impoundments of the Little Tennessee River, but it has not been collected recently in the Park. (Map 11)

Collection numbers: 74

10) Clinostomus funduloides Girard, rosyside dace

This species is common in Oconaluftee River, Little Tennessee River tributaries downstream through Tabcat Creek, and the upper portion of Abrams Creek. The form present in the Park represents either an undescribed subspecies, or possibly a valid species. (Map 12)

Collection numbers: 19, 20, 21, 22, 24, 48, 50, 54, 66, 68, 69, 77, 86, 89, 90, 99, 100, 107, 111, 118, 128, 131, 132, 133, 136, 146, 161, 162, 165, 166, 168, 170, 172, 180, 181, 203, 205, 208, 209, 210, 211, 213, 215, 216, 217, 218, 219, 221, 223.

11) Cyprinella galactura (Cope), whitetail shiner

This species is fairly common in the lower elevation portions of all Park streams except the Pigeon River tributaries. This species persists in the lower portion of Abrams Creek. (Map 13)

Collection numbers: 8, 11, 16, 17, 18, 25, 29, 30, 31, 34, 36, 37, 51,52, 56, 57, 60, 67, 69, 70, 74, 91, 92, 94, 111, 123, 124, 125, 132, 137, 163, 167, 170, 171, 180, 188, 189, 194, 197, 199, 219, 220, 223.

12) Cyprinella monacha (Cope), spotfin chub

This species was common in lower Abrams Creek prior to 1957. It was also found in the Tuckaseegee River prior to the impoundment of Fontana Reservoir. Although extirpated from the Park, efforts are being made to reeastablish this species in Abrams Creek (see discussion). (Map 14)

Collecton numbers: 25, 52, 57, 58, 199

13) Cyprinella spiloptera (Cope), spotfin shiner

This species was rare, collected only near the mouth of Abrams Creek prior to 1957. It has apparently been extirpated from the Park. (Map 15)

Collection numbers: 25, 56, 74

14) Cyprinus carpio Linnaeus, common carp

This introduced species was fairly common throughout lower Abrams Creek prior to 1957. It has recently been found only in the impoundments of the Little Tennessee River, and its distribution in the Park appears to be limited to the embayments. It might be found in the lower portions of the reservoir tributaries. (Map 16)

Collection numbers: 70, 71

15) Hemitremia flammea (Jordan and Gilbert), flame chub

This species is uncommon, found only in spring pools along Abrams Creek just above the lowest crossing of the loop

road in Cades Cove. It is restricted to vegetated, spring type habitats, and its presence above Abrams Falls and nowhere else in the Little Tennessee River system is an enigma. (Map 17)

Collection numbers: 138, 139, 143, 209

16) Hybobsis amblops (Rafinesque), bigeye chub

This species is fairly common in the lower portions of Little River and Tabcat Creek. It is most widespread in Abrams Creek, persisting throughout the lower portion. It has been collected from Roaring Fork of West Prong Little Pigeon River, but there are no recent records. (Map 18)

Collection numbers: 25, 36, 56, 74, 91, 93, 94, 105, 115, 137, 167, 188, 189, 195, 199, 219.

17) Luxilus chrysocephalus (Rafinesque), striped shiner

This species is rare within the Park, being found only in the lowest portions of Abrams Creek. It also occurs in Little River just below the Park boundary, so records from this area are possible. (Map 19)

Collection numbers: 25, 56, 74, 137.

18) Luxilus coccogenus (Cope), warpaint shiner

This species is abundant throughout the Park, except in the Pigeon River system. It can be found up to elevation of about 2200 ft. It persists in the lower portion of Abrams Creek. (Map 20)

Collection numbers: 2, 3, 6, 7, 8, 10, 11, 12, 16, 17, 21, 23, 24, 25, 27, 28, 29, 30, 31, 32, 33, 34, 36, 37, 38, 50, 51, 52, 55, 60, 61, 65, 67, 68, 70, 71, 72, 81, 87, 91, 93, 95, 103, 104, 105, 106, 111, 121, 123, 124, 125, 132, 133, 135, 137, 148, 149, 156, 157, 159, 160, 163, 166, 167, 170, 171, 180, 181, 189, 190, 192, 194, 197, 199, 210, 213, 215, 216, 217, 218, 219, 220, 221, 222, 223.

19) Nocomis micropogon (Cope), river chub

This species is widespread and abundant in all systems except the Pigeon River, and can be found up to elevations of about 2800 ft. (Map 21)

Collection numbers: 2, 3, 7, 8, 10, 11, 12, 16, 17, 19, 20, 21, 23, 24, 25, 27, 29, 30, 31, 32, 33, 34, 36, 37, 38, 48, 49, 50, 51, 52, 54, 55, 57, 60, 61, 65, 66, 67, 68,,70, 71, 72, 86, 91, 92, 93, 94, 97, 101, 102, 103, 105, 106, 111, 114, 117, 118, 121, 123, 124, 125, 127, 132, 137, 145, 146, 149, 154, 156, 156, 158, 159, 160, 161, 162, 163, 164, 165, 167, 170, 171, 172, 180, 181, 188, 189, 190, 192, 194, 197, 199, 204, 211, 213, 215, 216, 217, 218, 219, 220, 221, 223, 224.

20) Notropis atherinoides Rafinesque, emerald shiner

This species was rare, collected only near the mouth of Abrams Creek prior to 1957. It has been extirpated from the Park. (Map 22)

Collection numbers: 56, 74

21) Notropis leuciodus (Cope), Tennessee shiner

This species is abundant in all systems except the Pigeon River, up to elevations of about 2200 ft. It persists in the lower portion of Abrams Creek. (Map 23)

Collection numbers: 8, 10, 11, 20, 21, 23, 24, 25, 30, 31, 32, 34, 36, 37, 38, 51, 52, 55, 57, 60, 61, 68, 71, 72, 88, 89,

91, 93, 94, 102, 103, 104, 105, 106, 111, 117, 123, 124, 125, 130, 132, 137, 148, 156, 159, 163, 165, 167, 170, 171, 180, 181, 188, 189, 190, 191, 192, 194, 199, 211, 213, 216, 217, 218, 219, 220, 221, 224.

22) Notropis photogenis (Cope), silver shiner

This species is uncommon to rare in the lower portions of the Little, Oconaluftee, and Little Tennessee river systems. It was collected near the mouth of Abrams Creek prior to 1957, but has not been collected there since. (Map 24)

Collection numbers: 25, 30, 31, 32, 52, 132, 170, 189, 194

23) Notropis rubellus (Agassiz), rosyface shiner

This species was collected from the mouth of Twenty-mile Creek (Little Tennessee River system) in 1937. It has probably been extirpated from the Park, since recent collections from the same area contain no additional specimens. (Map 25)

Collection numbers: 28

24) Notropis rubricroceus (Cope), saffron shiner

This species is common to abundant in the Little River, Little Pigeon River, and Cosby Creek. It is rare in Mill Creek of the upper Abrams Creek system, where it was only collected once, in 1977. (Map 26)

Collection numbers: 1, 4, 6, 8, 10, 11, 12, 16, 17, 37, 47, 55, 60, 64, 65, 67, 81, 82, 103, 112, 122, 130, 189, 190, 192, 196, 197, 198, 222, 224.

25) Notropis spectrunculus (Cope), mirror shiner

This species is common in the Oconaluftee and Little Tennessee river systems downstream through Forney Creek. A single specimen from lower Abrams Creek in 1988 surely represents an individual inadvertently released with Cyprinella monacha during its reintroduction. If additional specimens should be found there, they are probably also from this reintroduction, and do not represent a naturally occuring population. (Map 27)

Collection numbers: 30, 31, 32, 33, 34, 38, 51, 52, 68, 90, 111, 132, 170, 210, 216, 217, 223.

26) Notropis telescopus (Cope), telescope shiner

This species is common to abundant in the Abrams Creek, Little River, and Little Pigeon River systems. It is uncommon in the Oconaluftee and Little Tennessee systems and absent from the Pigeon River system. It persists in the lower portion of Abrams Creek. (Map 28)

Collection numbers: 8, 11, 16, 25, 31, 32, 33, 34, 36, 38, 47, 52, 56,57, 58, 70, 74, 81, 91, 92, 93, 94, 104, 105, 111, 121, 123, 124, 125, 132, 137, 156, 167, 169, 188, 189, 194, 197, 199, 214, 216, 219, 220, 223.

27) Notropis volucellus (Cope), mimic shiner

This species was rare, collected only near the mouth of Abrams Creek prior to 1957. It has not been collected from the Park since 1940, though it occurs in the Tuckaseegee River

near the Park boundary. (Map 29)

Collection numbers: 25, 56, 90.

28) Phenacobius crassilabrum Minckley and Craddock, fatlips minnow

This species is uncommon, collected in the Park only in the Oconaluftee River near the Park boundary. (Map 30)

Collection numbers: 33, 59, 216.

29) Phenacobius uranops Cope, stargazing minnow

This species was uncommon, collected only near the mouth of Abrams Creek prior to 1957. Its presence in Little River and Little Pigeon River just outside the Park makes collections from these streams possible in the future. (Map 31)

Collection numbers: 25, 56, 74.

30) Phoxinus tennesseensis Starnes and Jenkins, Tennessee dace

This species was rare, collected only in lower Tabcat Creek prior to 1957, and in a small tributary to Cosby Creek .3 km above the Park boundary. Recent collections in the unimpounded portions of Tabcat Creek have found no specimens, but the Cosby Creek location has not been recently sampled. It may still persist there. (Map 32)

Collection numbers: 69, 76

31) Rhinichthys atratulus (Hermann), blacknose dace

This species is fairly common throughout the Park, though more common in the upper Abrams Creek, Little River (lower portion), and Little Pigeon River systems. This headwater species has been found to elevations of 4000 ft. (Map 33)

Collection numbers: 2, 4, 7, 9, 12, 13, 17, 18, 19, 20, 21, 22, 23, 37, 39, 40, 41, 42, 43, 46, 47, 61, 64, 67, 69, 71, 92, 95, 96, 97, 98, 101, 102, 103, 106, 109, 114, 120, 129, 130, 132, 142, 148, 149, 155, 161, 166, 168, 170, 171, 172, 178, 179, 184, 186, 187, 189, 192, 196, 198, 201, 203, 204, 205, 206, 207, 208, 210, 214, 216, 219, 220, 222, 223.

32) Rhinichthys cataractae (Valenciennes), longnose dace

This species is fairly common throughout the Park, though more common in the Little River (upper portions), Little Tennessee River, and Oconaluftee River systems. It has been collected up to elevations of about 3200 ft. (Map 34)

Collection numbers: 2, 4, 6, 9, 12, 17, 18, 19, 20, 21, 24, 38, 39, 41, 42, 43, 44, 47, 48, 49, 50, 54, 61, 62, 63, 64, 65, 66, 67, 68, 84, 86, 88, 98, 99, 101, 102, 103, 105, 106, 107, 111, 113, 116, 117, 118, 119, 120, 131, 132, 134, 136, 142, 144, 145, 146, 156, 157, 158, 159, 162, 163, 164, 165, 168, 169, 170, 176, 178, 179, 180, 181, 182, 185, 186, 187, 189, 190, 196, 197, 198, 201, 202, 208, 210, 211, 212, 213, 214, 215, 216, 217, 218, 221, 223, 224.

33) Semotilus atromaculatus (Mitchill), creek chub

This species is uncommon in the Little Pigeon, Little, and Oconaluftee river systems, and common in Tabcat Creek (Little Tennessee River drainage) and upper Abrams Creek. It has been collected in lower Abrams Creek only during the 1957 reclamation. It apparently has not repopulated that area. (Map 35)

Collection numbers: 19, 20, 21, 31, 37, 51, 69, 74, 92, 95, 96, 133, 161, 166, 170, 171, 172, 198, 203, 204, 205, 207, 208, 209, 216, 217, 219, 223.

**Catostomidae**

34) Catostomus commersoni (Lacepede), white sucker

This species is rare in Little River, absent from the Little Pigeon River, and uncommon in the lower portions of Cataloochee Creek (Pigeon River system), Oconaluftee River, and Deep and Twenty-mile creeks of the Little Tennessee River system. It is often common in the upper portion of Abrams Creek. It has been collected in the lower portion only during the 1957 reclamation, and in the embayment. (Map 36)

Collection numbers: 19, 21, 31, 39, 40, 42, 43, 74, 87, 103, 114, 132, 135, 145, 148, 149, 161, 166, 170, 171, 172, 178, 190, 192, 203, 208, 209, 210, 212, 216, 223.

35) Hypentelium nigricans (Lesueur), northern hogsucker

This species is widespread and common in all streams of the Park, reaching elevations of up to about 2800 ft. (Map 37)

Collection numbers: 1, 2, 3, 6, 8, 10, 11, 12, 14, 16, 17, 18, 19, 20, 21, 23, 24, 25, 30, 31, 32, 33, 34, 36, 37, 38, 39, 42, 43, 47, 49, 51, 52, 55, 56, 57, 58, 60, 64, 67, 69, 70, 71, 88, 91, 92, 93, 94, 98, 101, 103, 105, 106, 107, 111, 114, 117, 119, 123, 124, 127, 131, 132, 133, 134, 137, 142, 145, 146, 148, 149, 154, 156, 157, 158, 159, 160, 161, 162, 163, 165, 166, 167, 168, 169, 170, 171, 172, 178, 180, 181, 186, 189, 190, 192, 194, 196, 197, 198, 199, 201, 202, 203, 204, 208, 210, 211, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224.

36) Moxostoma carinatum (Cope), river redhorse

This species is rare, collected only in the Little Tennessee River and Abrams Creek systems. All collections are represented by single individuals. (Map 38)

Collection numbers: 26, 28, 137, 168, 170

37) Moxostoma duquesnei (Lesueur), black redhorse

This species is the most common and widespread of the redhorses in the Park. It is found in all systems except the Pigeon River. The largest collections have been made in the Little River near the Park boundary. (Map 39)

Colection numbers: 14, 16, 25, 28, 30, 31, 32, 33, 34, 38, 51, 52, 74, 105, 132, 133, 135, 159, 160, 167, 170, 189, 194, 210, 213.

38) Moxostoma erythrurum (Rafinesque), golden redhorse

This, the second most common redhorse in the Park, is uncommon in the Little Tennessee River and Abrams Creek systems. It has been collected in the Little Pigeon River system, but not in recent years. (Map 40)

Collection numbers: 14, 25, 26, 28, 29, 31, 52, 56, 74, 145, 146, 167.

39) Moxostoma macrolepidotum (Lesueur), shorthead redhorse

This species is the rarest of the redhorses in the Park, collected only from the Little Tennessee River system. It was last collected in 1980 from Forney Creek. (Map 41)

Collection numbers: 26, 28, 126

**Ictaluridae**

40) Ameiurus melas (Rafinesue), black bullhead

This species was rare in the lowest portions of Abrams Creek prior to 1957. It may still persist in the reservoirs. (Map 42)

Collection numbers: 74

41) Ameiurus natalis (Lesueur), yellow bullhead

This species was uncommon in the lowest portions of Abrams Creek prior to 1957, but it has not been collected there since. It has been collected in Tabcat Creek (Little Tennessee River system) since the impoundment of Chilhowee Reservoir. (Map 43)

Collection numbers: 74, 77, 135

42) Ictalurus furcatus (Lesueur), blue catfish

This species was rare near the mouth of Abrams Creek prior to 1957, but it has not been collected in the Park since. It may still persist in the reservoirs. (Map 44)

Collection numbers: 74

43) Ictalurus punctatus (Rafinesque), channel catfish

This species is common in the reservoirs of the Little Tennessee River system and has been collected in the Park's embayments. It has not been collected from any of the larger

streams of the Park since 1957. (Map 45)

Collection numbers: 29, 74, 135

44) Noturus baileyi Taylor, smoky madtom

This species was rare, collected only in lower Abrams Creek prior to 1957. Exact locations of the past populations are unknown. It was extirpated, but is currently being reintroduced into this system from a population in Citico Cr. (Map 46)

Collection numbers: 74

45) Noturus flavipinnis Taylor, yellowfin madtom

Although there are no positive records from the Park, there exists confusion with the madtom specimens associated with the Abrams Creek reclamation in 1957 (Taylor, 1969). Lennon and Parker (1959) reported N. flavus and N. miurus from the reclamation, though Taylor (1969) found no specimens of a N. miurus type in the sample. Since N. flavipinnis was unknown at the time of the reclamation, and is very similar to N. miurus, it is possible that it was collected during this project, but all specimens have been lost. This species is being reintroduced into lower Abrams Creek. (Map 47)

Collection numbers: none

46) Noturus flavus Rafineque, stonecat

This species was uncommon, collected only in the lowest portion of Abrams Creek prior to 1957. It has been extirpated from the Park. (Map 48)

Collection numbers: 73

47) Pylodictus olivaris (Rafinesque), flathead catfish

This species is rare in the impoundments of the Little Tennessee River, and was collected from the main channel of the river prior to impoundment. Though it has not been collected in any of the Park's streams since 1940, it may be found in the lower portions of the reservoir tributaries. (Map 49)

Collection numbers: 52

**Cyprinodontidae**

48) Fundulus catenatus (Storer), northern studfish

This species was uncommon in the lower portion of Abrams Creek prior to 1957, but has not been collected since. It has apparently been extirpated from the Park. Its presence in Little River just outside the Park makes collections at the boundary likely. (Map 50)

Collection numbers: 25, 74

**Poeciliidae**

49) Gambusia affinis (Baird and Girard), mosquitofish

This species is rare, collected only in Tabcat Creek (Little Tennessee River system). Its presence in the impoundments of the Little Tennessee River is very likely, so records from any of its tributaries are possible. This species may have been stocked in the reservoirs for mosquito control. (Map 51)

Collection numbers: 77, 219

**Atherinidae**

50) Labidesthes sicculus (Cope), brook silverside

This species is rare, collected only in the lower portion of Abrams Creek. It is probably present in the Little Tennessee River reservoirs, and could be found near the mouth of the tributaries. (Map 52)

Collection numbers: 137

**Percichthyidae**

51) Morone chrysops (Rafinesque), white bass

This species is common in the reservoirs of the Little Tennessee River, and it has been collected within the Park only in the Abrams Creek embayment. Its occurence in other

embayments is likely. (Map 53)

Collection numbers: 135

**Centrarchidae**

52) Ambloplites rupestris (Rafinesque), rock bass

This species is fairly common at lower elevations of larger steams. This fish has been found in all the Park's river systems except the Pigeon River. It has not been collected above 2100 ft. (Map 54)

Collection numbers: 8, 10, 11, 14, 25, 30, 31, 32, 51, 56, 57, 58, 60, 68, 69, 74, 91, 92, 93, 105, 106, 111, 117, 123, 124, 127, 132, 133, 135, 137, 154, 159, 160, 162, 167, 170, 180, 194, 197, 199, 213, 216, 217, 219, 220, 223, 224.

53) Lepomis auritus (Linnaeus), redbreast sunfish

This introduced species continues to be uncommon in the Park, primarily in the impoundments of the Little Tennessee River. It has been collected in the Park's streams primarily just above the embayments. It was first collected in the Park in 1979. It is likely to increase, probably at the expence of L. megalotis. (Map 55)

Collection numbers: 91, 92, 135, 199, 219.

54) Lepomis cyanellus Rafinesque, green sunfish

This species has been collected only in Hazel Cr, though it is found in all the Little Tennessee reservoirs. It

undoubtably occurs in all the Park's embayments, and future records from the lower portions of these streams are possible. (Map 56)

Collecton numbers: 213

55) Lepomis gulosus (Cuvier), warmouth

This species is uncommon in the reservoirs of the Little Tennessee River. It was collected in the lower portion of Abrams Creek prior to 1957, and has subsequently been collected in the embayment of that creek. (Map 57)

Collection numbers: 74, 135

56) Lepomis macrochirus Rafinesque, bluegill

This species is common in the reservoirs and uncommon in lowest portions of the streams in the Little Tennessee River and Abrams Creek systems. Its presence in Little River and Little Pigeon River outside the Park makes collections from these systems possible. (Map 58)

Collection numbers: 25, 28, 29, 53, 56, 74, 123, 137, 163, 199, 213, 219, 221, 223.

57) Lepomis megalotis (Rafinesque), longear sunfish

This species was rare in lower Abrams Creek and the Little Pigeon River system. It has not been collected in the Park since 1958, so perhaps it has been extirpated, possibly in part due to competition with L. auritus. (Map 59)

Collection numbers: 14, 25, 74, 75.

58) Micropterus dolomieu Lacepede, smallmouth bass

This species is fairly common in the lower portions of all Park systems except the Pigeon River. It is also fairly common in the Little Tennessee River reservoirs. (Map 60)

Collection numbers: 3, 8, 10, 11, 12, 14, 16, 18, 23, 25, 29, 32, 33, 34, 35, 36, 38, 51, 52, 57, 58, 60, 71, 105, 106, 117, 123, 124, 133, 137, 154, 159, 160, 167, 180, 194, 199, 223.

59) Micropterus salmoides (Lacepede), largemouth bass

This species was rare in the Little Tennessee River system, and is probably still rare, except in its reservoirs. There have been no recent collections made in the Park's streams. (Map 61)

Collection numbers: 28, 31, 56.

**Percidae**

60) Etheostoma blennioides Rafinesque, greenside darter

This species is common in all Park systems except the Pigeon River and Abrams Creek. It was extirpated from lower Abrams Creek during the 1957 reclamation. It is represented in the Little Tennessee River and Oconaluftee River systems by the subspecies E. b. gutselli, and all other drainages by the subspecies E. b. newmani. (Map 62)

Collection numbers: 18, 23, 25, 31, 32, 34, 36, 38, 55, 57, 59, 60, 66, 68, 71, 72, 73, 88, 104, 105, 107, 111, 117, 118, 130, 131, 132, 133, 145, 146, 156, 159, 163, 168, 170, 178, 181, 184, 189, 191, 194, 210, 211, 212, 213, 214, 215, 216, 217, 218, 221, 223.

61) Etheostoma chlorobranchium Zorach, greenfin darter

This species is fairly common in the Little Pigeon River, Abrams Creek, Little Tennessee River, and Oconaluftee River systems. It persists in Abrams Creek. (Map 63)

Collection numbers: 11, 23, 25, 30, 33, 34, 36, 38, 50, 51, 52, 57, 59, 65, 68, 70, 71, 72, 78, 85, 123, 124, 125, 130, 140, 147, 167, 170, 181, 183, 188, 193, 197, 210, 211, 213, 214, 215, 216, 217, 218, 221, 222, 223, 224.

62) Etheostoma flabellare Rafinesque, fantail darter

This species is uncommon in the Little Pigeon River system and rare, possibly extirpated, from the upper portion of Abrams Creek. Its presence in Little River just outside the Park makes Park collections in this system possible. It is represented in the Park by an undescribed subspecies. (Map 64)

Collection numbers: 6, 10, 12, 16, 19, 20, 60, 65, 80, 130, 142, 197, 198, 224.

63) Etheostoma (Catonotus) sp. , duskytail darter

This species was rare, collected only in the lower portion of Abrams Creek prior to 1957. It has not been collected in the Park since 1957, and appears to be extirpated. (Map 65)

Collection numbers: 25, 56, 74.

64) Etheostoma rufilineatum (Cope), redline darter

This species is fairly common in the Little Pigeon

River, Little River, Abrams Creek, and Little Tennessee River (Tabcat Creek only) systems. It persists in lower Abrams Creek. (Map 66)

Collection numbers: 8, 11, 14, 25, 36, 57, 70, 71, 73, 85, 91, 92, 93, 94, 105, 106, 121, 123, 124, 125, 137, 156, 167, 188, 189, 191, 194, 199, 219, 220.

65) Etheostoma simoterum (Cope), Tennessee snubnose darter

This species is fairly common in the Pigeon River (Cosby Creek only), Little Pigeon River, Little River, Abrams Creek, and Little Tennessee River (Tabcat Creek only) systems. It is the only darter which has recently been collected in upper Abrams Creek. It persists in lower Abrams Creek. (Map 67)

Collection numbers: 11, 18, 21, 25, 36, 57, 64, 69, 71, 72, 87, 91, 92, 93, 97, 105, 106, 115, 123, 124, 149, 159, 161, 166, 167, 171, 172, 189, 191, 194, 197, 203, 209, 219, 224.

66) Etheostoma stigmaeum (Jordan), speckled darter

This species was rare, collected only near the mouth of Abrams Creek prior to 1957. It has been extirpated from the Park. It was represented in the Park by E. s. jessiae, which may be a valid species. (Map 68)

Collection numbers: 25, 56

67) Etheostoma swannanoa Jordan and Evermann, Swannanoa darter

This species is uncommon in the Little Pigeon River system, and has been rarely collected in the Pigeon River (Cosby and Big creeks) system. (Map 69)

Collection numbers: 6, 11, 36, 60, 64, 65, 108, 119, 130, 197, 222, 224.

68) Etheostoma vulneratum (Cope), wounded darter

This species, recently elevated from synonymy of E. maculatum by Etnier and Williams (1989), is uncommon near the Park boundary in Little River. It was rare near the mouth of Abrams Creek prior to 1957. It has also been collected in the past from Middle Prong Little Pigeon River and Oconaluftee River. It has been collected in Abrams Creek once since 1957. (Map 70)

Collection numbers: 14, 25, 34, 58, 105, 124, 189, 191, 194

69) Etheostoma zonale (Cope), banded darter

This species is uncommon in the Park, where it occurs only in the lower portion of Abrams Creek. It persists in the lower portion since the 1957 reclamation. Its presence in Little River outside the Park makes collections at the boundary possible. (Map 71)

Collection numbers: 23, 25, 52, 72, 123, 124, 125, 147, 167, 188, 199.

70) Percina aurantiaca (Cope), tangerine darter

This species is uncommon to rare in the Little River and Little Tennessee River systems. It was collected in the past in Middle Prong Little Pigeon River, but has not been collected within the Park in this stream recently. (Map 72)

Collection numbers: 14, 121, 133, 165, 191, 211, 213, 221.

71) Percina burtoni Fowler, blotchside logperch

This rare darter was collected only during the 1957 reclamation of Abrams Creek. It has not been collected since, and is extirpated from the Park. (Map 73)

Collection number: 74.

72) Percina caprodes (Rafinesque), logperch

This species is rare in lower Abrams Creek, Tabcat Creek (Little Tennessee River system), and has been collected in the past from West Prong Little Pigeon River. It is probably an inhabitant of the Little Tennessee River impoundments, so records from the lower portions of its tributaries are likely. Its presence in Little River outside the Park make collections at the boundary possible. (Map 74)

Collection numbers: 36, 70, 74, 75, 79, 135, 199, 219

73) Percina evides (Jordan and Copeland), gilt darter

This species is uncommon in the Little River, Abrams Creek, and the Little Tennessee and Oconaluftee river systems, though limited to the lower elevations. It persists in the lower portion of Abrams Creek. (Map 75)

Collection numbers: 25, 30, 31, 33, 34, 50, 52, 68, 105, 111, 132, 147, 167, 170, 188, 189, 193, 194, 210, 211, 216, 217, 221, 223.

74) Percina squamata (Gilbert and Swain), olive darter

This species is rare, restricted in the Park to the lowest portions of the Fontana tributaries from Deep Creek to Eagle Creek. It is most common in Noland Creek, just above the embayment. (Map 76)

Collection numbers: 126, 131, 165, 180, 181, 184, 211, 214, 221.

75) Stizostedion canadense (Smith), sauger

This species is uncommon in the impoundments of the Little Tennessee River. It was collected in Abrams Creek near the mouth prior to 1957. (Map 77)

Collection numbers: 25

76) Stizostedion vitreum (Mitchill), walleye

This species has been collected only in the Abrams Creek embayment, and occurs throughout the Little Tennessee reservoirs. Future collections from the lower portions of the reservoir tributaries are possible. (Map 78)

Collecton numbers: 135

**Sciaenidae**

77) Aplodinotus grunniens Rafinesque, freshwater drum

This species was collected in the Park only during the Abrams Creek reclamation. It probably still exists in the

reservoirs of the Little Tennessee River, though it has not been recently collected within the Park's boundaries. (Map 79)

Collection numbers: 74

**Cottidae**

78) Cottus bairdi Girard, mottled sculpin

This species is the most widespread of the sculpins in the Park. It is common in all the systems, though it has not been collected in Middle Prong Little Pigeon River and Cataloochee Creek. It is highly variable throughout the Park, possibly represented by more than one species. (Map 80)

Collection numbers: 2, 3, 7, 11, 12, 17, 23, 33, 34, 36, 38, 39, 48, 49, 50, 51, 52, 53, 56, 65, 66, 68, 69, 70, 72, 73, 74, 75, 84, 86, 90, 99, 101, 103, 104, 105, 107, 111, 113, 117, 118, 119, 131, 132, 134, 136, 144, 145, 146, 157, 158, 162, 163, 165, 168, 169, 170, 180, 181, 189, 190, 192, 194, 195, 196, 198, 201, 210, 211, 212, 213, 214, 215, 216, 217, 218, 221, 223, 224.

79) Cottus carolinae (Gill), banded sculpin

This species is common in the lowest portions of Little River and throughout Middle Prong Little Pigeon River. It is currently sympatric with C. bairdi only in lower Little River where collections of the latter may represent dispersal rather than breeding populations. It was collected once from lower Abrams Creek. (Map 81)

Collection numbers: 6, 57, 60, 65, 81, 104, 104, 120, 121, 133, 142, 156, 159, 197, 222.

Hybrids

In addition, three different hybrid combinations have been collected in the Park. Notropis leuciodus X N. rubricroceus hybrids have been collected in West Prong Little Pigeon River, collection numbers 10, 11, and 130. Etheostoma rufilineatum X E. chlorobranchium hybrids were collected in Tabcat Creek, collection number 91. A single E. rufilineatum X E. vulneratum hybrid was collected in lower Abrams Creek, collection number 25.

Possible additions to the Park's ichtyofauna

Several species have been collected near the Park's boundaries, but no records exist from within the boundaries. Others have been collected or reported from the Little Tennessee River reservoirs, but have not yet been collected within the Park. A discussion of these species is included, to acknowledge the possibility of future additions to the Park's ichtyofauana.

Three species occuring near the Park's boundaries are the blotched chub (Erimystax insignis) in Little River and Little Pigeon River, the mountain shiner (Lythrurus lirus) in Little River, and the sand shiner (Notropis stramineus) in West Prong Little Pigeon River. These species might be collected within the Park in these systems.

The following ten species have been reported from the

Little Tennessee River reservoirs: the paddlefish, (Polyodon spatula), the skipjack herring (Alosa chrysochloris), the threadfin shad (Dorosoma petenense), the golden shiner (Notemigonus crysoleucas), the silver redhorse (Moxostoma anisurum), the muskellunge (Esox masquinongy), the redear sunfish (Lepomis microlophus), the spotted bass (Micropterus punctulatus), the white crappie (Pomoxis annularis), and the black crappie (P. nigromaculatus). These species probably occur within the Park's boundaries in the Abrams and Tabcat creek embayments, and might be collected in the lowest portions of the tributaries to the reservoirs.

**Deletions from past Park fish lists**

The following species have been reported from the Park in past literature, but have been omitted from the species list for various reasons.

Ichthyomyzon bdellium, the Ohio lamprey, was reported by Hubbs in his 1937 collection from Oconaluftee River. These probably represent misidentifications of the similar I. greeleyi.

Ichthyomyzon castaneus, the chestnut lamprey, was reported from the reclamation of Abrams Creek, but these probably represent misidentifications of I. greeleyi.

Ichthyomyzon hubbsi, the mountain brook lamprey, was reported by Lennon and Parker (1959), but this species is now

considered a synonym of I. greeleyi (Etnier and Starnes, in press).

Notropis ariommus, the popeye shiner, was reported from many collections before N. telescopus was upgraded to species (Gilbert, 1969). All Park records of N. ariommus represent N. telescopus.

Notropis cornutus, the common shiner, was reported from collections before Luxilus chrysocephalus was upgraded to species (Gilbert, 1961). All Park reports of N. cornutus represent L. chrysocephalus.

Notropis stigmaturus (=Cyprinella venusta), the blacktail shiner, was reported from Abrams Creek during the reclamation, but this is surely a misidentification of either C. monacha or C. spiloptera.

Phenacobius catostomus, the riffle minnow, was reported from collections before P. crassilabrum was described (Minckley and Craddock, 1962). All Park reports of P. catostomus represent P. crassilabrum.

Noturus miurus, the brindled madtom, was reported from old collections of Abrams Creek before N. baileyi and N. flavipinnis were described. All Park reports of N. miurus probably represent N. baileyi or N. flavipinnis (Taylor, 1969).

Lepomis humilis, the orangespotted sunfish, was reported during the reclamation of Abrams Creek and on some collections since. This species is certainly not native to the Park, and

all reports probably represent misidentifications of either L. auritus or L. megalotis.

Etheostoma camurum, the bluebreast darter, was reported from many old collections, before E. chlorobranchium was described (Zorach, 1972). All Park records of E. camurum represent E. chlorobranchium.

Etheostoma maculatum, the spotted darter, was reported from many old collections, before E. vulneratum was upgraded to species (Etnier and Williams, 1989). All Park records of E. maculatum represent E. vulneratum.

# IV. DISCUSSION

## Abrams Creek

By far the most intriguing and perplexing stream within the Park is Abrams Creek. The upper portion, flowing through Cades Cove, is a low gradient stream with primarily rubble and cobble substrate. This area was of high value to the early settlers of the mountains because of the flat terrain and deep, fertile soil. Most of the cove consisted of farmland and settlements prior to the formation of the Park. At present, some cattle farming continues in the Cove. For this reason, Abrams Creek is the only creek in the Park with substantial silt and elevated nutrient levels due to pasture run-off. Silt levels are moderate throughout the stream, though highest in the Cove and lowest near the mouth. Since species diversity was very high prior to the 1957 reclamation, it is doubtful that the run-off had any major adverse effect on the stream, particularly the lower portion.

Most intriguing about the stream is the species make-up of the lower and upper portions. Of the 79 species found in the Park, 67 have been found in Abrams Creek. However, only 17 species have been found above the 25-foot waterfall where the creek enters the Blue Ridge substrate. Of these 17, five have not been found below the falls, and one is found nowhere

else in the Park.

Hemitremia flammea, the flame chub, is found only in the springs of the Cove (see species account). Since this species requires the vegetated spring pool habitats found only in Cades Cove, there is no acceptable habitat for this species in the lower portion of the creek.

Salmo trutta, the brown trout, was stocked into Abrams Creek, probably by local fishermen, in the mid 1970's (Steve Moore, pers. comm., 1990) in Cades Cove and has not yet expanded its range into the lower portion of the creek.

The other three species, however, leave one with the question of how they got into the upper portion without being in the lower portion. All three species, Clinostomus funduloides, Notropis rubricroceus, and Etheostoma flabellare, are found in other streams of the Park, including streams of Blue Ridge substrate similar to that of lower Abrams Creek. All are also present in streams which drain adjacent portions of the mountains surrounding the cove. It seems likely that these, and perhaps other fish species found in upper Abrams gained access to that area through stream capture during the formation of Cades Cove.

**Geological Evidence**

A cove in the Blue Ridge mountains is formed when the overlying sandstones are washed away by surface run-off and

undermined by undergound streams in the basement strata of sedimentary rock (Wilson, 1935, Cook et al., 1980). Perhaps, before Cades Cove "fell in", the streams draining the surrounding mountians had different outlets (Fig. 1). Thus, as Cades Cove was formed, streams from surrounding drainages were trapped in Cades Cove, and now are part of the upper Abrams Creek system.

Since the caves and underground streams of Cades Cove flow toward the Tuckaleechee Cove area, it is likely that the undermining worked its way toward Little River. Also, if a ridge extension, in line with Wear Mountain and Bunker Hill, were intact, it would cover most of Cades Cove, draining toward the Little River to the north and east and toward the Little Tennessee River in the vicinity of Parsons Branch to the southwest. This ridge would also parallel Chilhowee Mountain and the state line ridge. (Fig. 1) Parallel ridges are typical of the western edge of the Blue Ridge Mountains. The entire Cades Cove area is surrounded by Elkmont (south) and Cades (north) sandstones which are both precambrian sandstones of the Great Smoky Group. Underlying these formations is the Great Smoky Fault. Around the perimeter of the Cove is an outcropping of Metcalf Phylite, which overlies the fault. To the south, the Elkmont Sandstone is found above the phylite; however, to the north, the phylite overlies the sandstone. (Moore, 1988) (Fig. 2) The proposed ridge

extension would match these geological features. (Fig. 2)

**Ichthyological evidence**

Etheostoma flabellare is present in several tributaries to the Little River in Tuckaleechee Cove, and is present in the Tennessee River system from Little River upstream. There is only one record of this fish in the Little Tennessee River system outside of Cades Cove, that of a single individual taken from the upper portion of the Tellico River (UT 91.3698).

Notropis rubricroceus is also present in the Little River in Tuckaleechee Cove, and is found from the Little River upstream in the Tennessee River system. It has also been taken in the upper portion of the Tellico River. (Etnier and Starnes, in press) It seems very unlikely that these two species would migrate through the Little Tennessee River, up Abrams Creek, and into the Cove, without establishing populations in other areas of the system, particularly lower Abrams Creek.

Clinostomus funduloides is present throughout the Little Tennessee River system downstream to Tabcat Cr., with additional populations in upper Citico Cr. and upper Tellico River. This species can obviously survive in the Blue Ridge substrate, even at elevations as low as 880 ft. at the mouth of Tabcat Cr. They could easily deal with the Blue Ridge

substrate at elevations between 870 and 1560 ft in the lower portions of Abrams Creek if they had used this creek to gain access to upper Abrams Creek.

The presence of these three species, common in neighboring drainages, but absent from lower Abrams Creek, as well as the presence of a 25-ft waterfall separating the upper and lower portions, leaves it doubtful that access to the upper portion was made through the lower portion. Headwater captures during the formation of the Cove would, however, explain their presence in only the upper portions of this system.

**Reclamation Attempt of 1957**

By far, the most devastating event to occur to fishes in the Great Smoky Mountains National Park was the reclamation of the lower 14.6 miles of Abrams Creek. On 8 and 9 June 1957, representatives from the Tennessee Game and Fish Commission, with members of the Tennessee Valley Authority, the National Park Service, and the U.S. Fish and Wildlife Service treated the lower section of this creek with a toxicant, rotenone, in an attempt to eliminate all fish species from that section, so that rainbow trout could be the only fish species in the newly formed Chilhowee Reservoir and its tributaries. As the gates to this reservoir were being closed, all fishes from that section of the Little Tennessee River and the lower section of

Abrams Creek were to be eliminated, and the reservoir and tributaries were to be stocked with only rainbow trout. A total of 47 species was collected in lower Abrams; many have not been collected since (see Table 1). (Lennon and Parker, 1959)

Of the 58 species collected in the lower portion of Abrams Creek prior to 1957, only 27 have been collected since. Of these, 10 are found in the untreated upper portion. Four of those 27 have been collected recently only in the embayment portion of Chilhowee Reservoir. Ten of these species have not been collected in the Park since, and are considered extirpated, although three are being reintroduced. Five additional species have been collected since 1957 that were not collected prior to the reclamation. Therefore, of the 63 species which have ever been collected from lower Abrams Creek, only 32 have been collected since 1957.

Of the 31 species eliminated from this stream during the reclamation, 20 had been previously collected only from the lowest 2 miles of the creek, downstream of Panther Creek. It is very probable that these species will not be able to locate suitable habitat above the embayment, and therefore have been eliminated from this system. (see table 1). Two species are not native to the Park.

Nine native species, however, might be reintroduced into the portion of the stream unaffected by the reservoir. These

are: Salvelinus fontinalis, Cyprinella monacha, Semotilus atromaculatus, Noturus baileyi, Etheostoma blenniodes, Etheostoma (Catonotus) sp., Percina burtoni, Cottus bairdi, and C. carolinae. Cyprinella monacha and Noturus baileyi are currently being reintroduced. Noturus flavipinnis is being reintroduced, although there are no positive records from the Park (see species account). Semotilus atromaculatus is very common in the upper portion of the creek, and could easily reestablish itself without help. Since it was only collected from the lower portion during the reclamaton attempt, it is likely that this species was previously rare in that portion, perhaps present only as dispersing individuals and having no established population. Attempts to reestablish the other six species should be made in order to return the lower portion to as near its past condition as possible.

The 27 species which have become naturally reestablished have probably done so by four different methods- repopulating from the upper portion, gaining access through the reservoir, being introduced by man, or surviving the reclamation attempt.

Ten species (see table 1) could have easily invaded the lower portion of the creek from populations in the upper portion. Many of the species could have gained access through the reservoir, as the reclamation attempt was not at all successful in eliminating all other fish species from the

reservoir. Rainbow trout were intentionally released into the lower portion by man, the original purpose of the reclamation.

Some species must have survived within the creek itself or its tributaries, though Lennon felt that the reclamation was a success and "that there is no doubt that (all other species) migrated into Abrams and tributaries from the new lake." (Lennon and Parker, 1959) Probably the best examples of species surviving the onslaught are Etheostoma chlorobranchium and E. zonale. Prior to 1957, both species had been collected from all portions of lower Abrams Creek. Since 1957, E. chlorobranchium has only been collected from the area near the campground. Numberous collections near the embayment and near Bell Hole have contained no specimens. E. zonale is found in no other tributary to Chilhowee reservoir, so it would have difficulty gaining access to Abrams Creek from an outside population. These species, as well as others, likely survived the reclamation attempt, either in the stream itself or in an untreated tributary.

**Taxonomic Considerations**

Since several of the species found within the Park's boundaries are still of uncertain taxonomic status or are easily recognizable subspecies, further discussion of these forms is necessary to clarify their present status.

The rosy side dace, Clinostomus funduloides, found in the Park is an undescribed subspecies found throughout the Little Tennessee River and Hiwassee river systems in Tennessee and North Carolina. It differs from C. f. estor of the lower portions of the Tennessee and Cumberland Rivers in having smaller scales, more melanism, and a much shorter jaw (Etnier and Starnes, in press). Although this form may be a valid species, Deubler (1955) considered specimens from the Hiwassee River to be intergrades between this form and C. f. estor.

The greenside darter, Etheostoma blenniodes, is represented in the Park by two distinct subspecies, E. b. newmani and E. b. gutselli. The later was once considered a valid species, the Tuckaseegee darter. The two subspecies differ in that E. b. gutselli is mottled brown with bluegreen nuptial colors, has naked opercles and large naked areas on the belly, lacks a median projection on its upper lip, and has a well developed frenum. Both differ from the nominal subspecies in the development of the projection of the upper lip. (Etnier and Starnes, in press). Etheostoma b. gutselli is present in the streams on the south side of the Park from Oconaluftee River to Twenty-mile Creek, while E. b. newmani is present in the Little Pigeon and Little River systems and was present in lower Abrams Creek prior to 1957.

The greenfin darter, Etheostoma chlorobrancium, was considered part of the E. camurum complex until Zorach (1972)

recognized it as a valid species. It differs from E. camurum in having higher scale, fin ray, and vertebral counts, and in having a larger maximum size. It is most different in nuptial coloration of males, which have dark green bands in the median fins and green coloration on the body. (Zorach, 1972; Etnier and Starnes, in press) The two species are not sympatric, and E. camurum is not found in the Park. Etheostoma chlorobranchium is restricted to the upper portions of the Blue Ridge streams in the upper Tennessee River system.

The duskytail darter, Etheostoma (Catonotus) sp., was present in the lower portion of Abrams Creek prior to 1957. This is the only member of its subgenus to inhabit larger streams and rivers. It differs from the closely related E. flabellare in having less broadly connected gill membranes and from E. kennicotti in having extensive naked areas on its belly and in having indistinct banding on its caudal fin (Etnier and Starnes, in press). This species was extirpated from the Park during the 1957 reclamation of Abrams Creek. All records of E. flabellare from lower Abrams Creek were based on misidentifications of this species.

The speckled darter, Etheostoma stigmaeum, was present in lower Abrams Creek prior to the 1957 reclamation. It is known from the Park from two collections, in 1937 and 1940. This species, or species complex, varies throughout its range, and is represented by five subspecies, possibly all of which

should be considered as valid species. The E. s. jessiae form was present in Abrams Creek. It differs from the nominal subspecies, found through the southern coastal plain and into Tennessee in the lower Tennessee and Cumberland rivers, in having a longer snout, a frenum, a more complete lateral line, and differences in fin ray counts. It also differs from the E. s. meadiae form, present in the Clinch and Powell river systems of Tennessee and Virginia, in having a longer snout, fewer lateral scales, a more complete lateral line, often lacking a frenum, and differences in fin ray counts. (Etnier and Starnes, in press) Further study is needed to determine whether these forms represent true species or only subspecies.

The wounded darter, Etheostoma vulneratum, was long considered a subspecies of E. maculatum until Etnier and Williams (1989) elevated it to species status.

The mottled sculpin, Cottus bairdi, is highly variable throughout the Park. Most individuals have complete lateral lines. Dorsal saddles vary from indistinct and mottled to very distinct, and similar to those of C. carolinae. Chin pigmentation is usually uniform, made up of small spots, though Cosby Creek populations have some larger, irregular patches. This species, or perhaps a species complex, needs much additional work before one can clearly say how many sculpin species inhabit the Park's streams, and where each is found.

## Environmental Problems

### Impoundments

The four impoundments of the Little Tennessee River, Chilhowee (1957), Calderwood (1930), Cheoah (1918) and Fontana (1944) have eliminated or greatly restricted several species in the Park. Many of the species eliminated by the reclamation of Abrams Creek were found only in the lower two miles of the creek. The impoundment of that area might have eliminated those species if they were unable to locate suitable habitat above the embayment.

Species such as Moxostoma carinatum require larger rivers, which, along the Park's boundary, have been converted into a series of reservoirs. These species may soon be lost to the Park, since no large, flowing rivers persist. Species such as Percina squamata, restricted to the lowest portions of the Fontana tributaries, have been isolated from other populations by the reservoirs. If some disaster, natural or man-made, were to eliminate them from these tributaries, they might not be able to naturally reestablish themselves.

The impoundments do, however, offer habitat to several species which do not occur naturally in the Park's streams (see species accounts). The reservoirs may also provide a low elevation, cold-weather refuge for species in the tributaries. This theory is supported the low numbers of cyprinids

collected from Deep, Hazel and Noland Creeks from spring as apposed to fall collections (see table 2). Additional work in these tributaries is necessary to verify this.

**Acid Rain**

A major problem which aquatic life may have to deal with may be the decrease in pH due to acidic rainfall. Since the Smokies is concidered by some to be a temperate rainforest, the fishes of the Park may be highly affected by increased acidity. Future studies of fish distributions are necessary to detect possible problems. Some species are very sensitive to increasing acidity. These species might be eliminated if streams were to become more and more acidic.

Another possible indication of acid rain problems could be a change in elevation for numberous species. If acidity were to increase, fishes might have to move further downstream, where the increased flow and buffering capacity would dilute the acid. This could have a devastating effect on species resticted to higher elevations because of water temperature and habitat preferences, i.e. Notropis rubricroceus and Etheostoma chlorobranchium. These species may not be able to find refuge from the increased acidity in an area of suitable habitat. Species found only at the Park boundaries might have to move out of the Park to find areas which could be tolerated, thus being eliminated from the

Park's ichtyofauna. Species such as Percina squamata would have no refuge, since the reservoirs have blocked or flooded possible refuges.

**Global Warming**

Although it has yet to be proven that the overall climate of the world is becoming warmer due to entrapment of the suns warmth by "greenhouse" gases, a water temperature increase of only a few degrees might eliminate numerous fish species from the Park. Increases in water temperatures would allow such species to persist only in colder waters upstream. They would most likely meet insurmountable obstacles such as waterfalls, drastically changing habitats, or limited stream size, thus preventing there reestablishment in suitable waters.

Few fishes have overcome the waterfalls of the Smokies. The brook trout, stonerollers, daces, hogsuckers, and white suckers above the Cataloochee Creek falls surely gained access to that area when the falls were smaller, during their formation. Even such obstacles as the sinks in Little River would probably act as barriers to all but the most streamlined fish species. Other species, however, would not be able to move above these barriers into cooler waters.

Species requiring the larger stream, cobble habitats such as in lower Little River and Oconaluftee River may not be able to adapt to the smaller, bedrock-boulder portions of

these streams. Unable to find suitable habitat, they could be eliminated from the Park.

A warming of the waters could, however, bring a few species present just outside the Park (see species accounts) into the Park at the boundaries, thus increasing the Park's ichthyofauna. Continuous stream surveys are needed to document changes in fish populations, possibly providing evidence for the global warming theory.

**Changes in the Terrestrial Environment**

Global warming, acid rain, and invasions of exotic species (particularly the Adelis sp.) could alter the vegetation of the mountain tops, exposing bare ground and rock. This would alter the run-off from rains, changing its physical (rate) and chemical (leaching) makup, as well as increase silt levels due to the erosion of exposed soils. Such changes in run-off could easily eliminate sensitve species, particularly those with restricted ranges.

Unlike most streams and rivers outside the Park, the Park's streams are not exposed to waste treatment effluent, toxic waste disposals, or agricultural run-off (except Abrams Creek). It might be difficult to determine whether or not changes in fish populations in streams outside the Park are due to local or widespread problems. It would be much easier

to document problems due to more devastating and widespread problems by studying the fish distributions within the Park.

**Reintroduction Projects**

Since the reclamation of Abrams Creek, efforts have begun to reintroduce some of the species which were eliminated. Currently, two species, Cyprinella monacha and Noturus baileyi, have been released into different locations in the stream. Future plans are to reestablish as many of the eliminated species as possible. Some, such as Carassius auratus and Cyprinus carpio will not be reestablished intentionally, as they are exotic species.

Noturus baileyi was thought to be extinct after the reclamation, since it was unknown from anywhere else. On 23 July 1980, a single specimen was collected in Citico Creek (Bauer, et al., 1983) during a survey for Cyprinella monacha. Beginning in mid-1980's, members of the University of Tennessee Department of Zoology and the National Park Service, with help from Aquatic Specialists, an aquarium shop in Knoxville, TN, have been rearing this species in captivity and releasing the offspring into Abrams Creek near the Ranger's Station. Releases were made during the 1987-1990 seasons. Snorkeling at night, when they are most active, was done to search for adults. During the summer of 1990, one adult was seen, representing the only sighting since the reintroduction began. (J.R. Shute, pers. comm., 1990)

Noturus flavipinnis has also been reintroduced, though its past status in Abrams Creek is uncertain (see species account). Individuals from a Citico Creek population have been reared by Aquatic Specialists and released with Noturus baileyi. There have been no collections or sightings of this species in the creek since the reintroduction project began.

During the fall of 1988, members of the UT Department of Zoology, the National Park Service, and the North Carolina Game and Fish Commission captured 250 Cyprinella monacha from a portion of the Little Tennessee River above Fontana Reservoir and transplanted them into the lower two pools of Abrams Creek, just above the embayment. In the fall of 1989, they capture another 150 and released them into Abrams Creek near the Ranger's Station. In the fall of 1990, 340 additional individuals were released near the Ranger's Station. No collections have since been made at the upper site. However, a survey on 30 October 1988 of Abrams Creek above the embayment produced 13 individuals. A survey on 8 November 1989 failed to find any, but, high water due to heavy rains greatly hindered the effort.

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# APPENDICES

# APPENDIX A

| No. | LOCALITY<br>ELEVATION | DATE | COLLECTORS |
|---|---|---|---|
| 1 | Dudley Cr.<br>1500 ft | 30 Aug. 1932 | Hazard, King |
| 2 | Roaring Fork<br>1500 ft | 30 Aug. 1932 | Hazard, King |
| 3 | W. Prong Little Pigeon R. 1.5 mi. above Gatlinburg<br>1420 ft | 31 Aug. 1932 | Hazard, King |
| 4 | W. Prong Little Pigeon R. at mouth of Indian Gap Road<br>1700 ft | 31 Aug. 1932 | Hazard, King |
| 5 | W. Prong Little Pigeon R. at Indian Gap Road<br>4000 ft | 1 Sep. 1932 | Hazard, King |
| 6 | M. Prong Little Pigeon R. near Greenbriar<br>1700 ft | 2 Sep. 1932 | Hazard, King |
| 7 | Little R. at Elkmont<br>2150 ft | 2 Sep. 1932 | Hazard, King |
| 8 | M. Prong Little Pigeon R. at park boundary<br>1380 ft | 27 Aug. 1937 | Hubbs |
| 9 | M. Prong Little Pigeon R. at Porter's Creek<br>1620 ft | 27 Aug. 1937 | Hubbs |
| 10 | Dudley Cr. 1 mi. NE of Gatlinburg<br>1480 ft | 27 Aug. 1937 | Hubbs |
| 11 | W. Prong Little Pigeon R. 2 mi. above Gatlinburg<br>1700 ft | 28 Aug. 1937 | Hubbs |
| 12 | Fighting Cr. at 1600 ft<br>1600 ft | 28 Aug. 1937 | Hubbs |
| 13 | W. Prong Little Pigeon R. below "The Chimneys"<br>3400 ft | 28 Aug. 1937 | Hubbs |
| 14 | M. Prong Little Pigeon R. at Park boundary<br>1380 ft | 29 Aug. 1937 | Whaley |
| 15 | Walker Camp Prong at 4550 ft<br>4550 ft | 30 Aug. 1937 | Hubbs |

| No. | LOCALITY<br>ELEVATION | DATE | COLLECTORS |
|---|---|---|---|
| 16 | Webb Cr. .7 mi. above mouth<br>1350 ft | 30 Aug. 1937 | Hubbs |
| 17 | Little R. .5 mi. below Camp LeConte (Elkmont)<br>2050 ft | 31 Aug. 1937 | Hubbs |
| 18 | Laurel Cr. .5 mi. below lowest contact with Cove Road<br>1560 ft | 1 Sep. 1937 | Hubbs |
| 19 | Anthony Cr.<br>1800 ft | 2 Sep. 1937 | Hubbs |
| 20 | Mill Cr.<br>1710 ft | 2 Sep. 1937 | Hubbs |
| 21 | Abrams Cr. below mouth of Cove Creek<br>1690 ft | 2 Sep. 1937 | Hubbs |
| 22 | Anthony Cr.<br>1950 ft | 2 Sep. 1937 | Hubbs |
| 23 | Abrams Cr. below falls | 3 Sep. 1937 | Hubbs |
| 24 | Abrams Cr. above falls | 3 Sep. 1937 | Hubbs |
| 25 | Abrams Cr. 1 mi. above mouth, near mouth of Panther Creek | 6 Sep. 1937 | Hubbs |
| 26 | Little Tennessee R. at Calderwood | 6 Sep. 1937 | Hubbs |
| 27 | Twentymile Cr. above mouth<br>1280 ft | 7 Sep. 1937 | Hubbs |
| 28 | Twentymile Cr. embayment<br>1270 | 7 Sep. 1937 | Hubbs |
| 29 | Little Tennessee R.<br>1440 ft | 7 Sep. 1937 | Hubbs |
| 30 | Forney Cr. at mouth<br>1500 ft | 8 Sep. 1937 | Hubbs |

| No. | LOCALITY<br>ELEVATION | DATE | COLLECTORS |
|---|---|---|---|
| 31 | Deep Cr. near Bryson City, N.C.<br>1750 ft | 8 Sep. 1937 | Hubbs |
| 32 | Oconaluftee R. at Hwy. 19<br>1950 ft | 9 Sep. 1937 | Hubbs |
| 33 | Oconaluftee R. 1.5 mi. SW of Ravenford<br>1960 ft | 9 Sep. 1937 | Hubbs |
| 34 | Oconaluftee R. 1 mi. S of Ravenford<br>1980 ft | 10 Sep. 1937 | Hubbs |
| 35 | Raven Fork below mouth of Straight Fork<br>2440 ft | Summer, 1939 | Wilke |
| 36 | Roaring Fork 3 mi. NNE of Gatlinburg<br>2000 ft | 7 Sep. 1939 | collectors unknown |
| 37 | Little R. at mouth of small tributary at Metcalf Bottoms<br>1680 ft | 17 June 1940 | Hubbs |
| 38 | Raven Fork 1.5 mi. below Big Cove School<br>2250 ft | 18 June 1940 | Hubbs |
| 39 | Cataloochee Cr.<br>2575 ft | 19 June 1940 | Hubbs |
| 40 | Unnamed tributary to Cataloochee Creek<br>2575 ft | 19 June 1940 | Hubbs |
| 41 | Rough Fork of Cataloochee Cr. above Messer Fork<br>2980 ft | 20 June 1940 | Hubbs |
| 42 | Cataloochee Cr. .5 mi. below Little Cataloochee Cr.<br>2425 ft | 20 June 1940 | Hubbs |
| 43 | Unnamed tributary to Cataloochee Cr. .5 mi. below Little Cataloochee Cr.<br>2350 ft | 20 June 1940 | Hubbs |
| 44 | Big Cr. at and above Gunter Fork<br>3200 ft | 20 June 1940 | Hubbs |

| No. | LOCALITY<br>ELEVATION | DATE | COLLECTORS |
|---|---|---|---|
| 45 | Gunter Fork at mouth<br>3200 ft | 20 June 1940 | Hubbs |
| 46 | Dunn Cr. at Park boundary<br>1800 ft | 21 June 1940 | Hubbs |
| 47 | Cosby Cr. just inside Park boundary<br>1620 ft | 22 June 1940 | Hubbs |
| 48 | Kephart Prong at US fish hatchery<br>2850 ft | 27 June 1940 | Hubbs |
| 49 | Beech Flats Prong below US fish hatchery<br>2800 ft | 27 June 1940 | Hubbs |
| 50 | Deep Cr. just above Deep Cr. School<br>1760 ft | 29 June 1940 | Hubbs |
| 51 | Noland Cr. at mouth<br>1580 ft | 29 June 1940 | Hubbs |
| 52 | Tuckasegee R. at mouth of Noland Creek<br>1580 ft | 29 June 1940 | Hubbs |
| 53 | Oconaluftee R. at first bridge above mouth<br>1750 ft | 29 June 1940 | Wikle |
| 54 | Straight Fork 3 rd mi. above Raven Fork<br>2900 ft | 29 June 1940 | Hubbs |
| 55 | Webb Cr. E of Pittman Center<br>1280 ft | 2 Aug. 1940 | Tenn. Dept. of Cons. |
| 56 | Abrams Cr. Talassee-Calderwood | 29 Sep. 1940 | Tenn. Dept. of Cons. |
| 57 | Abrams Cr. at Happy Valley<br>1020 ft | 31 Mar. 1941 | Hubbs, Hubbs, Walker, Greene |
| 58 | Abrams Cr. at mouth of Panther Creek | 31 Mar. 1941 | Hubbs, Hubbs, Walker, Greene |
| 59 | Oconaluftee 1 mi. S of Ravenford<br>1980 ft | 1 Apr. 1941 | Hubbs, Hubbs, Walker |

| No. | LOCALITY<br>ELEVATION DATE | COLLECTORS |
|---|---|---|
| 60 | M. Prong Little Pigeon R. at Tn. 73 bridge<br>1380 ft 24 Sep. 1953 | Lennon, Parker |
| 61 | W. Prong Little Pigeon R. 2 mi. above headquaters<br>2000 ft 4 Nov. 1953 | Lennon, Bowman |
| 62 | Kephart Prong .8 miles above mouth<br>3200 ft 5 Nov. 1953 | Lennon, Bowman |
| 63 | Little R. 1.5 miles above Fish Camp Prong<br>3200 ft 6 Nov. 1953 | Lennon, Bowman |
| 64 | Cosby Cr. at mouth of Crying Cr., .25 mi. above Park boundary<br>1680 ft 9 Sep. 1954 | Lennon, Parker |
| 65 | Porter's Cr. at mouth<br>1640 ft 23 Sep. 1954 | Lennon, Parker |
| 66 | Bradley Fork .2 mi. above campground<br>2400 ft 10 Oct. 1954 | Lennon, Parker |
| 67 | Little R. at Elkmont<br>2150 ft 10 Oct. 1954 | Lennon, Parker |
| 68 | Oconaluftee R. 1.8 mi. below Cliff Branch<br>2300 ft 4 Dec. 1956 | Lennon, Parker |
| | *Not mapped due to probable location error | |
| 69 | Tabcat Cr. near Calderwood<br>7 June 1957 | Lennon, Surber |
| 70 | Abrams Cr. at campground<br>1120 ft 7 June 1957 | Lennon, Surber |
| 71 | Abrams Cr. below falls<br>8 June 1957 | Lennon, Surber |
| 72 | Abrams Cr. between falls and Hatcher Mountain Trail<br>1280 ft 8 June 1957 | Lennon, Surber |
| 73 | Abrams Cr. at and .5 mi. above mouth<br>9 June 1957 | Lennon, Surber |

| No. | LOCALITY<br>ELEVATION | DATE | COLLECTORS |
|---|---|---|---|
| 74 | Lower Abrams Creek (reclamation) | 8-9 June 1957 | Lennon et al. |
| | *not mapped due to lack of exact locations | | |
| 75 | Abrams Creek near Rabbit Creek | Sep. 1558 | Lennon |
| 76 | Tributary to Cosby Cr. .3 km above boundary<br>1640 ft | 1960 | unknown collectors |
| 77 | Tabcat Cr. at embayment<br>880 ft | 14 June 1968 | Etnier, Gilbert, Seaman |
| 78 | Abrams Cr. .25 mi. below campground<br>1100 ft | 9 Aug. 1971 | Etnier, Starnes, Stiles, Dickinson, Winfield |
| 79 | Abrams Cr. at mouth of Bell Br.<br>1020 ft | 9 Aug. 1971 | Etnier, Starnes, Stiles, Dickinson, Winfield |
| 80 | W. Prong Little Pigeon R. at headquarters<br>1420 ft | 25 Aug. 1973 | Stiles |
| 81 | Unnamed tributary to Webb Cr. 7.8 mi. ENE of Gatlinburg at Tn. 73<br>1280 ft | 25 July 1975 | Bauer, Higgins, Kornman, |
| 82 | Mill Cr. | 14 Apr. 1977 | Mathews, Baron |
| 83 | Forge Cr. | 2 Mar. 1978 | Dietrich |
| 84 | Noland Cr. Station 7 | 22 Mar. 1978 | Dietrich |
| 85 | Abrams Cr. Station 9 | 22 June 1978 | Dietrich |
| 86 | Straight Fork at Park boundary<br>2660 ft | 22 Aug. 1978 | Moore, et al. |
| 87 | Abrams Cr. upper shoe<br>1640 ft | 1978 | Dietrich |

| No. | LOCALITY<br>ELEVATION | DATE | COLLECTORS |
|---|---|---|---|
| 88 | Hazel Cr. at Granville Calhoun House<br>1337 ft | 18 Apr. 1979 | Crittenden, Moore, et al. |
| 89 | Deep Cr. at confluence<br>1750 ft | 26 Sep. 1979 | Lee, Smith, Delozier |
| 90 | Deep Cr. at mouth<br>1750 ft | 26 Sep. 1979 | Lee, Smith, Delozier |
| 91 | Tabcat Cr. above embayment<br>880 ft | 14 Nov. 1979 | Lee, Broadbent, Clossin, Delozier, Delozier |
| 92 | Shop Cr. above embayment<br>880 ft | 14 Nov. 1979 | Lee, Broadbent, Clossin, Delozier, Delozier |
| 93 | Abrams Cr. 200yd above campground<br>1120 ft | 15 Nov. 1979 | Smith, Lee, Delozier |
| 94 | Abrams Cr. 300yd below ranger's station<br>1110 ft | 15 Nov. 1979 | Smith, Lee, Delozier, |
| 95 | Parson's Br. at mouth<br>1400 ft | 19 Nov. 1979 | Lee, Clossin, Delozier, Delozier, Broadbent |
| 96 | Abrams Cr. at Hyatt Lane<br>1715 ft | 20 Nov. 1979 | Lee, Clossin, Delozier, Delozier, Broadbent |
| 97 | Abrams Cr. at Cove end of E. Oliver cabin Trail<br>1715 ft | 20 Nov. 1979 | Lee, Clossin, Delozier, Delozier, Broadbent |
| 98 | Abrams Cr. at Cove picnic area<br>1920 ft | 20 Nov. 1979 | Lee, Clossin, Delozier, Delozier, Broadbent |
| 99 | Straight Fork at Park boundary<br>2660 ft | 5 Dec. 1979 | Moore, et al. |
| 100 | Noland Cr. at bridge .5 mi. above confluence<br>1800 ft | 6 Dec. 1979 | Broadbent, Clossin, Lee, Delozier, Delozier |

| No. | LOCALITY<br>ELEVATION | DATE | COLLECTORS |
|---|---|---|---|
| 101 | Little R. at Elkmont<br>2150 | 10 Dec. 1979 | Moore, et al. |
| 102 | Little R. at Milsaps Picnic area<br>1960 ft | 10 Dec. 1979 | Lee, Broadbent, Smith Crittenden |
| 103 | Little R. at Metcalf Bottoms<br>1670 ft | 11 Dec. 1979 | Crittenden, Broadbent, Lee, Smith |
| 104 | Little R. at river mile 37.5<br>1200 ft | 12 Dec. 1979 | Crittenden, Broadbent, Lee, Smith |
| 105 | Little R. at boundary<br>1120 ft | 12 Dec. 1979 | Crittenden, Broadbent, Lee, Smith |
| 106 | M. Prong Little R. below Tremont<br>1320 ft | 14 Dec. 1979 | Lee, Broadbent |
| 107 | Straight Fork at confluence<br>2480 ft | 18 Dec. 1979 | Moore, et al. |
| 108 | M. Prong Little Pigeon R. .25 mi. above ranger's station<br>1450 ft | 18 Dec. 1979 | Moore, et al. |
| 109 | Lynn Camp Prong at Mark's Creek<br>2200 ft | 20 Dec. 1979 | Moore, et al. |
| 110 | Lynn Camp Prong at CCC camp<br>3800 ft | 21 Dec. 1979 | Moore, et al. |
| 111 | Deep Cr. at boundary<br>1780 ft | 1979 | Lee, et al. |
| 112 | Fighting Cr. at W. Prong Little Pigeon R.<br>1420 ft | 16 Jan. 1980 | Moore, Lee, Broadbent, Smith, Delozier, Delozier |
| 113 | Little R. at truck road above Elkmont<br>2320 ft | 8 Feb. 1980 | Moore, et al. |

| No. | LOCALITY<br>ELEVATION | DATE | COLLECTORS |
|---|---|---|---|
| 114 | Abrams Cr. at Mill Cr.<br>1710 ft | 11 Apr. 1980 | Moore, et al. |
| 115 | Abrams Cr. at camground<br>1120 ft | 24 Apr. 1980 | Clark, Dinkins, Swiney, Underwood |
| 116 | Hazel Cr. at Bone Valley Cr.<br>2270 ft | 6 May 1980 | Moore, et al. |
| 117 | Hazel Cr. at Procter House<br>1737 ft | 7 May 1980 | Lee, et al. |
| 118 | Hazel Cr. 2000 ft below Rowan Cr.<br>1950 ft | 7 May 1980 | Lee, et al. |
| 119 | Big Cr. at boundary<br>1550 ft | 15 May 1980 | Lee, Douglas, Swiney Brice, Clark, Underwood |
| 120 | Porter's Cr. 20 yds. below False Gap Prong | 19 May 1980 | Moore, et al. |
| 121 | Little R. at boundary<br>1120 ft | 29 May 1980 | Lee, Douglas, Swiney, Underwood, Clark, Brice |
| 122 | Fighting Cr. at W. Prong Little Pigeon R.<br>1420 ft | 16 June 1980 | Lee, Smith, Broadbent Moore, Delozier, Delozier |
| 123 | Abrams Cr. at embayment<br>880 ft | 22 July 1980 | Lee, Crittenden, Harsson, Underwood, Clark, Dinkins |
| 124 | Abrams Cr. 60-200 yds below Bell Br.<br>1010 ft | 29 July 1980 | collectors unknown |
| 125 | Abrams C 180 yds below Bell Br.<br>1010 | 30 July 1980 | Douglas, Smith, Swiney, Dinkins |
| 126 | Forney Cr. at confluence<br>1500 ft | 6 Aug. 1980 | USFWS E-79 |

| No. | LOCALITY<br>ELEVATION | DATE | COLLECTORS |
|---|---|---|---|
| 127 | Panther Creek above embayment<br>880 ft | 27 Aug. 1980 | Moore, et al. |
| 128 | Bunches Cr. at bridge in Big Cove Circle<br>2400 ft | 27 Oct. 1980 | Dinkins, Swiney |
| 129 | Mill Cr. in Cades Cove | 14 Apr. 1981 | collectors unknown |
| 130 | W. Prong Little Pigeon R. at headquarters<br>1420 ft | 25 Sep. 1981 | Moore et al. |
| 131 | Deep Cr. at turnaround<br>1975 ft | 2 Oct. 1981 | Moore, et al. |
| 132 | Deep Cr. at campground<br>1780 ft | 15 Oct. 1981 | Moore, et al. |
| 133 | Little R. at boundary<br>1120 ft | 16 Nov. 1981 | Moore, et al. |
| 134 | Bradley Fork at campground<br>2450 ft | 20 Nov. 1981 | Moore, et al. |
| 135 | Abrams Creek embayment (gill-net)<br>875 ft | 1981 | USFWS |
| 136 | Raven Fork at last bridge going to Big Cove<br>2040 ft | 9 Mar. 1982 | TVA |
| 137 | Abrams Cr. .5 mi. above embayment<br>920 ft | 11-12 June 1982 | Etnier, et al. |
| 138 | Abrams Cr. in Cades Cove<br>1715 ft | 14 July 1982 | Eddleman |
| 139 | Abrams Cr. in Cades Cove<br>1715 ft | 3 Aug. 1982 | Eddleman |
| 140 | Hazel Cr. at Proctor House<br>1737 ft | 5 Aug. 1982 | Dinkins, Layman |
| 141 | *Found to be outside the park boundary | | |

| No. | LOCALITY<br>ELEVATION | DATE | COLLECTORS |
|---|---|---|---|
| 142 | M. Prong Little Pigeon River above Greenbriar<br>2640 ft | 8 Sep. 1982 | Moore, et al. |
| 143 | Abrams Cr. in Cades Cove<br>1715 ft | 9 Sep. 1982 | Eddleman |
| 144 | Oconaluftee R. below Smokemont<br>2280 ft | 30 June 1983 | Moore, et al. |
| 145 | Oconaluftee R. .3 mi. below Smokemont Campground entrance<br>2190 ft | 6 July 1983 | Moore, et al. |
| 146 | Oconaluftee R. below Couches Cr.<br>2100 ft | 7 July 1983 | Moore, et al. |
| 147 | Abrams Cr. 200 m below ranger's station<br>1110 ft | 5 Aug. 1983 | Broadbent, Delozier |
| 148 | Abrams Cr. at horseshoe<br>1600 ft | 26 Sep. 1983 | Moore, et al. |
| 149 | Abrams Cr. at trail parking area<br>1710 ft | 29 Sep. 1983 | Moore, et al. |
| 150 | Indian Flats Cr. ca. 250m above Lynn Camp Prong<br>2840 ft | 15 Aug. 1984 | Habera |
| 151 | Indian Flats Cr. ca. 300m above uppermost bridge<br>3000 ft | 15 Aug. 1984 | Habera |
| 152 | Cosby Cr. ca. 500m above campground<br>2400 ft | 21 Aug. 1984 | Habera |
| 153 | Cosby Cr. ca. 300m above first foot bridge<br>2520 ft | 22 Aug. 1984 | Habera |
| 154 | Panther Cr. at embayment<br>880 ft | 29 Aug. 1984 | Moore, et al. |
| 155 | Panther Cr. at 2350 ft<br>2350 ft | 30 Aug. 1984 | Moore, et al. |
| 156 | M. Prong Little Pigeon R. section 1 | 17 Sep. 1984 | Moore, et al. |

| No. | LOCALITY<br>ELEVATION | DATE | COLLECTORS |
|---|---|---|---|
| 157 | Little R. at Metcalf Bottoms<br>1670 ft | 18 Sep. 1984 | Moore, et al. |
| 158 | Little R. at Elkmont<br>2150 ft | 18 Sep. 1984 | Moore, et al. |
| 159 | Little R. at boundary<br>1120 ft | 20 Sep. 1984 | Moore, et al. |
| 160 | Abrams Cr. above Buck Shank Cr.<br>1200 ft | 24 Sep. 1984 | Moore, et al. |
| 161 | Abrams Cr. at lower crossing Loop Road<br>1715 | 25 Sep. 1984 | Moore, et al. |
| 162 | Straight Fork 150 ft above park boundary<br>2670 ft | 14 Nov. 1984 | Moore, et al. |
| 163 | Hazel Cr. at Proctor House<br>1737 ft | 17 Oct. 1985 | Moore, et al. |
| 164 | Hazel Cr. at Bone Valley Creek<br>2270 ft | 18 Oct. 1985 | Moore, et al. |
| 165 | Hazel Cr. 2000 ft below Rowan Creek<br>1950 ft | 19 Oct. 1985 | Moore, et al. |
| 166 | Abrams Cr. at trail parking area<br>1710 ft | 25 Oct. 1985 | Moore, et al. |
| 167 | Abrams Cr. at Rabbit Trail crossing | 26 Oct. 1985 | Moore, et al. |
| 168 | Deep Cr. at turnaround<br>1975 ft | 1 Nov. 1985 | Moore, et al. |
| 169 | Deep Cr. below McCracken Branch<br>2200 ft | 2 Nov. 1985 | Moore, et al. |
| 170 | Deep Cr. at campground<br>1780 ft | 3 Nov. 1985 | Moore, et al. |
| 171 | Abrams Cr. at horseshoe<br>1600 ft | 16 Nov. 1985 | Moore, et al. |

| No. | LOCALITY<br>ELEVATION | DATE | COLLECTORS |
|---|---|---|---|
| 172 | Abrams Cr. at lower crossing Loop Road<br>1715 ft | 17 Nov. 1985 | Moore, et al. |
| 173 | Collins Cr. ca. 300m above Collins Creek Trail<br>2800 ft | 19 June 1986 | Habera |
| 174 | Indian Flats Cr. 250 m above Lynn Camp Prong<br>2840 ft | 12 Aug. 1986 | Habera |
| 175 | Indian Flats Cr. ca. 300m above uppermost bridge<br>3000 ft | 13 Aug. 1986 | Habera |
| 176 | Cosby Cr. ca. 500m above campground<br>2400 ft | 20 Aug. 1986 | Habera |
| 177 | Cosby Cr. 100 m above first footbridge<br>2500 ft | 21 Aug. 1986 | Habera |
| 178 | Cataloochee Cr. below Little Cataloochee Creek<br>2440 ft | 16 Sep. 1986 | Moore. et al. |
| 179 | Cataloochee Cr. at mouth of Winding Creek<br>2580 ft | 18 Sep. 1986 | Moore, et al. |
| 180 | Hazel Cr. at Proctor House<br>1737 ft | 15 Oct. 1986 | Moore, et al. |
| 181 | Hazel Cr. 2000 ft below Rowan Creek<br>1950 ft | 15 Oct. 1986 | Moore, et al. |
| 182 | Hazel Cr. at Bone Valley Creek<br>2270 ft | 15 Oct. 1986 | Moore, et al. |
| 183 | Abrams Cr. at campground<br>1120 ft | 15 Oct. 1986 | Habera |
| 184 | Hazel Cr. mi. above mouth<br>1750 ft | 25 Oct. 1986 | Habera |
| 185 | Cataloochee Cr. at Winding Creek<br>2580 ft | 29 Sep. 1987 | Moore, et al. |
| 186 | Cataloochee Cr. below Little Cataloochee Creek<br>2440 ft | 30 Sep. 1987 | Moore, et al. |

| No. | LOCALITY<br>ELEVATION | DATE | COLLECTORS |
|---|---|---|---|
| 187 | Cataloochee Cr. below Rough Fork<br>2900 ft | 1 Oct. 1987 | Moore, et al. |
| 188 | Abrams Cr. at ranger's station<br>1110 ft | 11 Oct. 1987 | Moore, Etnier, Ensign, Dickenson, et al. |
| 189 | Little R. at park boundary<br>1120 ft | 17 Oct. 1987 | Moore, et al. |
| 190 | Little R. at Metcalf Bottoms<br>1670 ft | 24 Oct. 1987 | Moore, et al. |
| 191 | Little R. 1.2 rd mi. above the "Y"<br>1200 ft | 24 June 1988 | Moore, et al. |
| 192 | Little River at Metcalf Bottoms<br>1670 ft | 1 Oct. 1988 | Moore, Simbeck, et al. |
| 193 | Abrams Cr. at ranger's station<br>1110 ft | 10 Sep. 1988 | Moore, et al. |
| 194 | Little R. at park boundary<br>1120 ft | 8 Oct. 1988 | Moore, et al. |
| 195 | Little R. .25 mi. below Elkmont<br>2100 ft | 9 Oct. 1988 | Moore, Ensign, et al. |
| 196 | Cosby Cr. at park boundary<br>1620 ft | 12 Oct. 1988 | Moore, Etnier, Ensign, Dickenson |
| 197 | M. Prong Little Pigeon R. from c.r. 321 upstream 200m<br>1380 ft | 12 Oct. 1988 | Moore, Etnier, Ensign, Dickenson |
| 198 | Dudley Cr. 3.7 mi. E of US 441 on Tn. 32<br>1500 ft | 12 Oct. 1988 | Moore, Etnier, Ensign, Dickenson |
| 199 | Abrams Cr. above embayment<br>880 ft | 30 Oct. 1988 | Etnier, Etnier, Dickenson, Simbeck, Russell, Pipes |

| No. | LOCALITY<br>ELEVATION | DATE | COLLECTORS |
|---|---|---|---|
| 200 | Little Cataloochee Cr. above mouth<br>2450 ft | 9 Nov. 1988 | Moore, Etnier, et al. |
| 201 | Big Cr. from boundary up 200m<br>1560 ft | 9 Nov. 1988 | Moore, Etnier, et al. |
| 202 | Cataloochee Cr. at mouth of Little Cataloochee Creek<br>2440 ft | 9 Nov. 1988 | Moore, Etnier, et al. |
| 203 | Abrams Cr. at lowest crossing of Loop Road<br>1715 ft | 13 Nov. 1988 | Moore, Etnier, et al. |
| 204 | Mill Cr. at lowest bridge<br>1780 ft | 13 Nov. 1988 | Moore, Etnier, et al. |
| 205 | Rowan's Cr. at Loop Road<br>1850 ft | 13 Nov. 1988 | Moore, Etnier, et al. |
| 206 | Cades Creek at Loop Road<br>1730 ft | 13 Nov. 1988 | Moore, Etnier, et al. |
| 207 | Rowan's Cr. at Sparks Lane<br>1780 ft | 13 Nov. 1988 | Moore, Etnier, et al. |
| 208 | Anthony's Cr. at Loop Road<br>1880 ft | 13 Nov. 1988 | Moore, Etnier, et al. |
| 209 | Abrams Cr. from lowest Loop Road to Hyatt Lane<br>1715 ft | 30 Jan. 1989 | Moore, Etnier, Simbeck, Sossamon, Russell, Petrie |
| 210 | Deep Cr. from boundary to bridge<br>1780 ft | 24 May 1989 | Moore, Etnier, Simbeck, et al. |
| 211 | Noland Cr. lower 150m above embayment<br>1720 ft | 24 May 1989 | Moore, Etnier, Simbeck, et al. |
| 212 | Twentymile Cr. from cabin upsteam<br>1280 ft | 25 May 1989 | Moore, Etnier, et al. |
| 213 | Hazel Cr. at and .5 mi. above embayment<br>1720 ft | 25 May 1989 | Moore, Etnier, et al. |

| No. | LOCALITY<br>ELEVATION | DATE | COLLECTORS |
|---|---|---|---|
| 214 | Forney Cr. from embayment up 400 m<br>1720 ft | 25 May 1989 | Moore, Etnier, et al. |
| 215 | Eagle Cr. lower 300m<br>1720 ft | 25 May 1989 | Moore, Etnier, et al. |
| 216 | Oconaluftee R. at Blue Ridge Parkway<br>2000 ft | 6 Sep. 1989 | Moore, Etnier, Simbeck, et al. |
| 217 | Raven Fork at first bridge above mouth<br>2010 ft | 6 Sep. 1989 | Moore, Etnier, Simbeck, et al. |
| 218 | Oconaluftee R. behind visitor's center<br>2010 ft | 6 Sep. 1989 | Moore, Etnier, Simbeck, et al. |
| 219 | Tabcat Cr. above embayment<br>880 ft | 8 Nov. 1989 | Moore, Etnier, Simbeck, Russell, McClain |
| 220 | Panther Cr. above embayment<br>880 ft | 8 Nov. 1989 | Moore, Etnier, Simbeck, Russell, McClain |
| 221 | Noland Cr. above embayment<br>1720 ft | 31 May 1990 | Moore, Etnier, Simbeck, Starnes, et al. |
| 222 | M. Prong Little Pigeon R. at park boundary<br>1380 ft | 31 May 1990 | Moore, Etnier, Simbeck, Starnes, et al. |
| 223 | Deep Creek at campground<br>1780 ft | 5 Oct. 1990 | Moore, Etnier, Hughes, Myer Eisenhour, Habera |
| 224 | West Prong Little Pigeon River at Sugerlands supply depot<br>1410 ft | 5 Oct. 1990 | Moore, Etnier, Hughes, Myer, Eisenhour, Habera |

# APPENDIX B

Table 2 Cyprinid Collections from Fontana Tributaries, Spring vs. Fall

| | FALL | | | | | SPRING | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 15 Oct 81 Dee | 17 Oct 85 Haz | 3 Nov 85 Dee | 15 Nov 86 Haz | 5 Oct 90 Dee | 7 May 80 Haz | 24 May 89 Dee | 25 May 89 Haz | 24 May 89 Nol | 31 May 90 Nol |
| C. anomalum | 115 | 20 | 143 | 67 | 51 | 8 | 26 | 84 | 40 | 33 |
| C. funduloides | 83 | -- | 67 | 5 | 203 | -- | 15 | 15 | 17 | 7 |
| C. galactura | 20 | 5 | 72 | 3 | 2 | -- | -- | -- | -- | -- |
| L. coccogenis | 138 | 42 | 53 | 110 | 3 | -- | 1 | 20 | -- | 2 |
| N. micropogon | 48 | 86 | 11 | 171 | 1 | 37 | -- | 21 | 6 | 2 |
| N. leuciodus | 11 | 46 | 2 | 173 | -- | 23 | -- | 77 | 3 | 1 |
| N. photogenis | 9 | -- | 15 | -- | -- | -- | -- | -- | -- | -- |
| N. spectrunculus | 31 | -- | 5 | -- | 3 | -- | 10 | -- | -- | -- |
| N. telescopus | 16 | -- | 2 | -- | 7 | -- | -- | -- | -- | -- |
| S. atromaculatus | -- | -- | 12 | -- | 5 | -- | -- | -- | -- | -- |
| R. atratulus | 27 | -- | 27 | -- | 36 | -- | 6 | -- | -- | -- |
| R. cataractae | 79 | 12 | 57 | 19 | 98 | 4 | 24 | 18 | 48 | 12 |
| Total species | 11 | 6 | 12 | 7 | 10 | 4 | 6 | 6 | 5 | 6 |
| Total indiv. | 577 | 211 | 466 | 548 | 409 | 72 | 82 | 235 | 114 | 57 |

Dee- Deep Creek at campground
Haz- Hazel Creek at Proctor House
Nol- Noland Creek at embayment

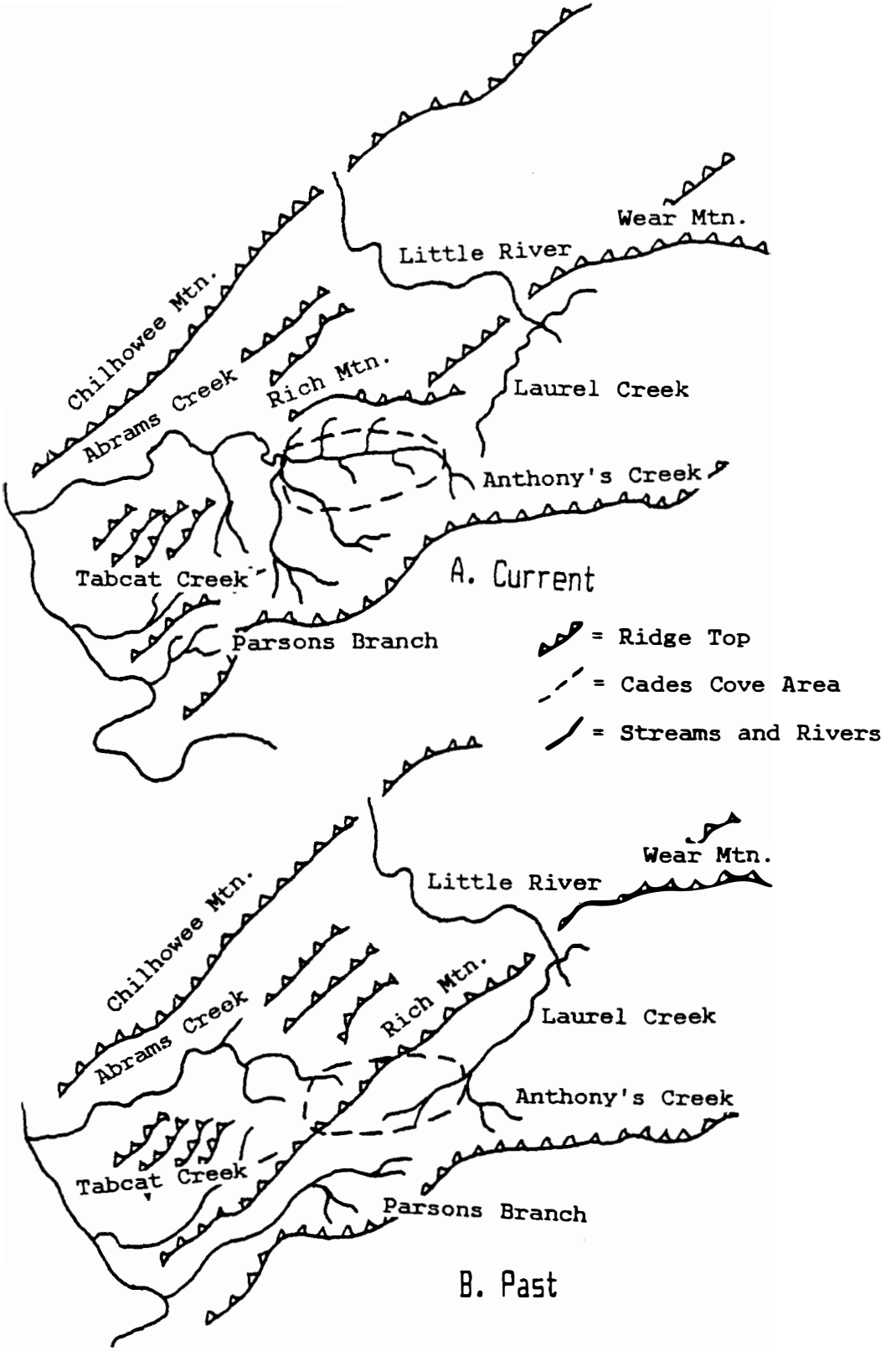
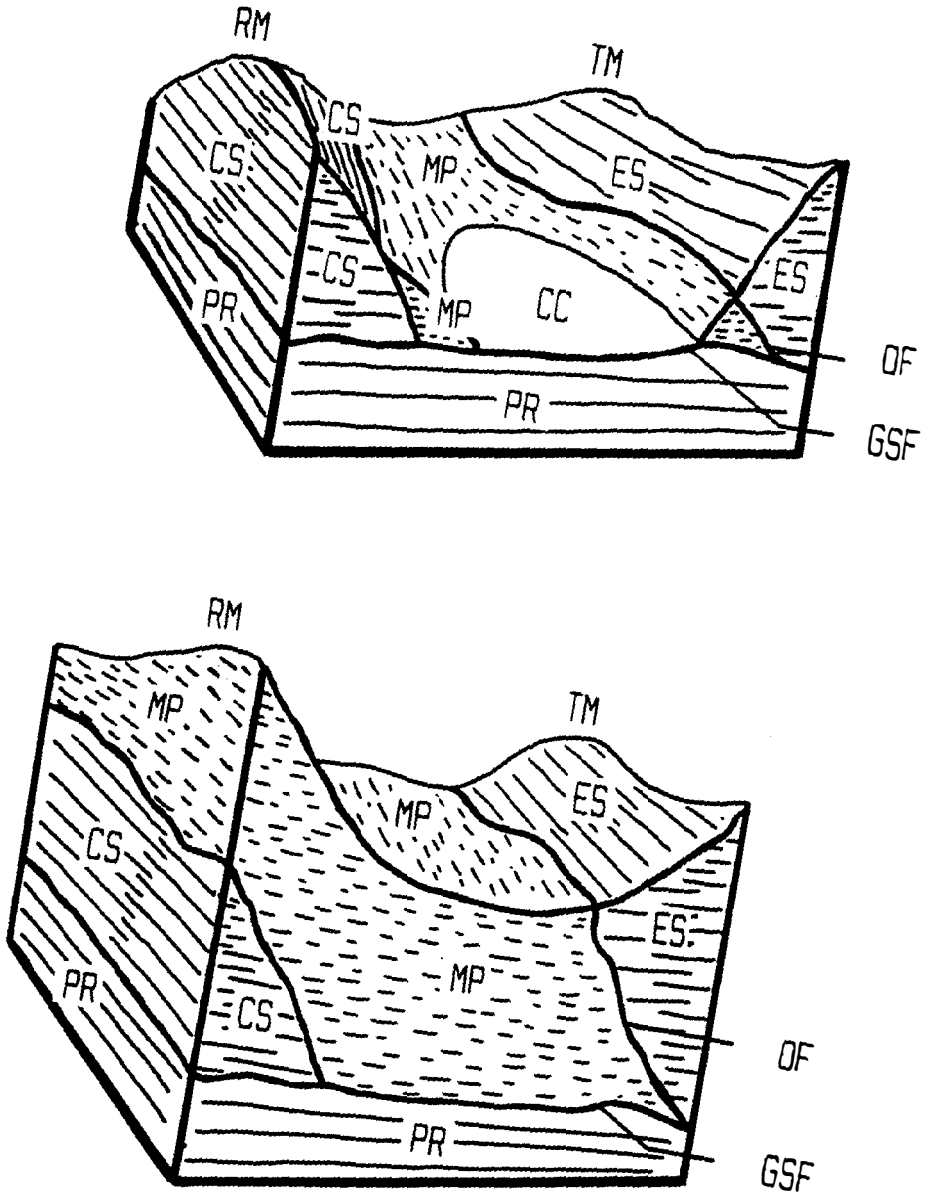



Figure 1. Possible Drainages of the Cades Cove Area

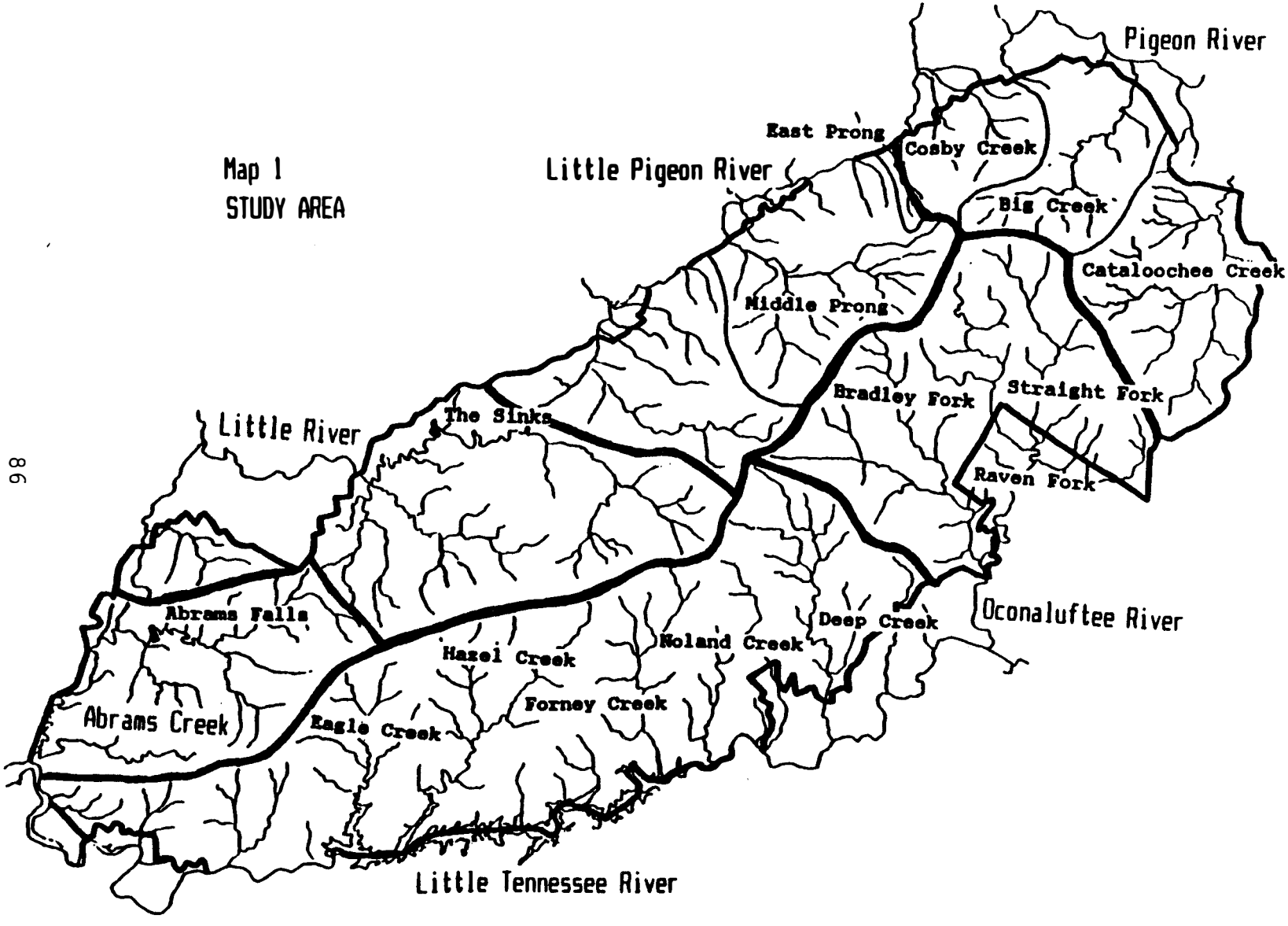



CC- Cades Cove
CS- Cades Sandstone
ES- Elkmont Sandstone
GSF- Great Smoky Fault
MP- Metcalf Phylite
OF- Ocanaluftee Fault
PR- Paleozoic Rock
RM- Rich Mountain
TM- Thunderhead Mountain

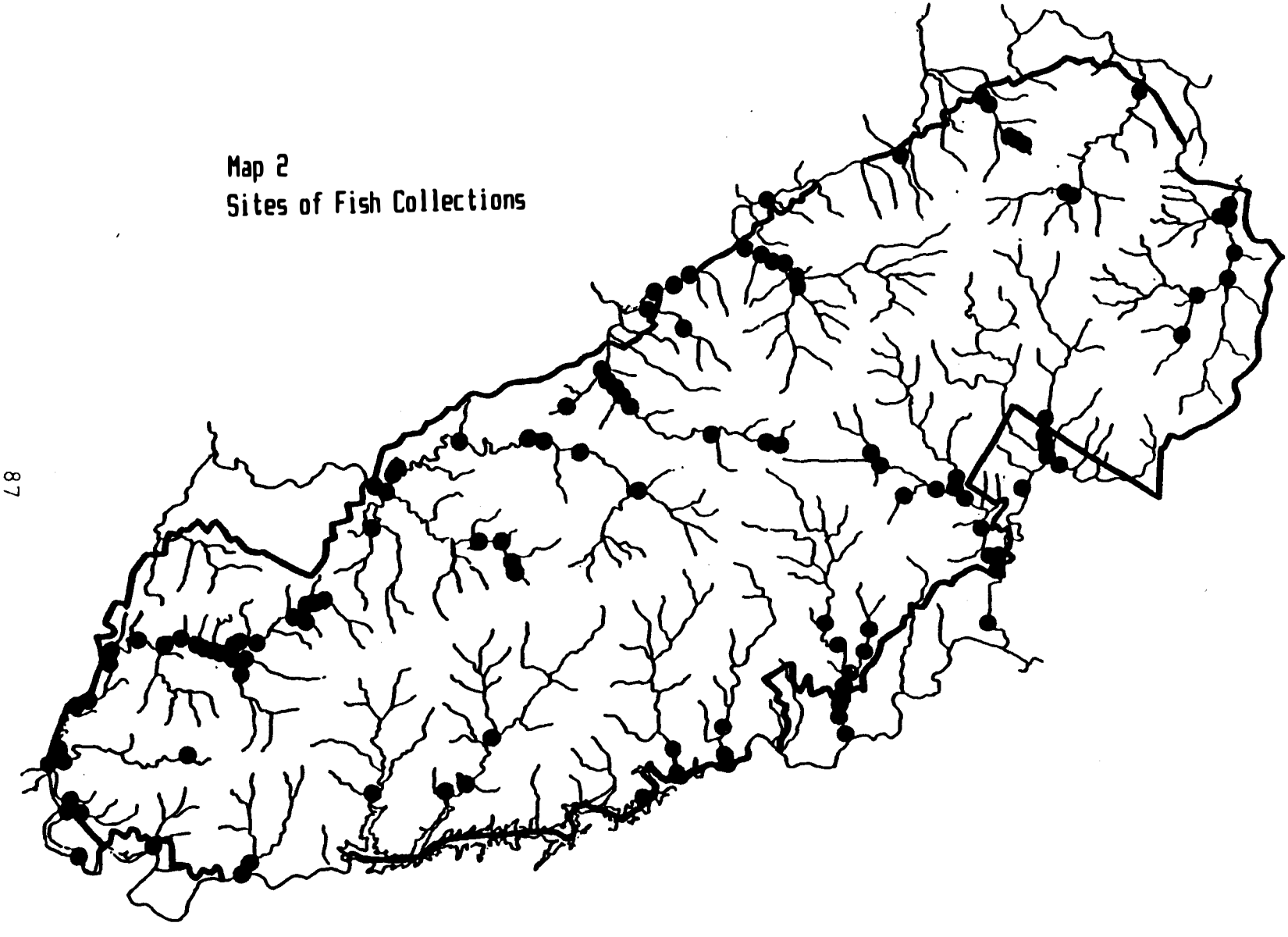
Source of A: Moore, 1988.

Figure 2. Possible Geology of the Cades Cove Area

# APPENDIX C

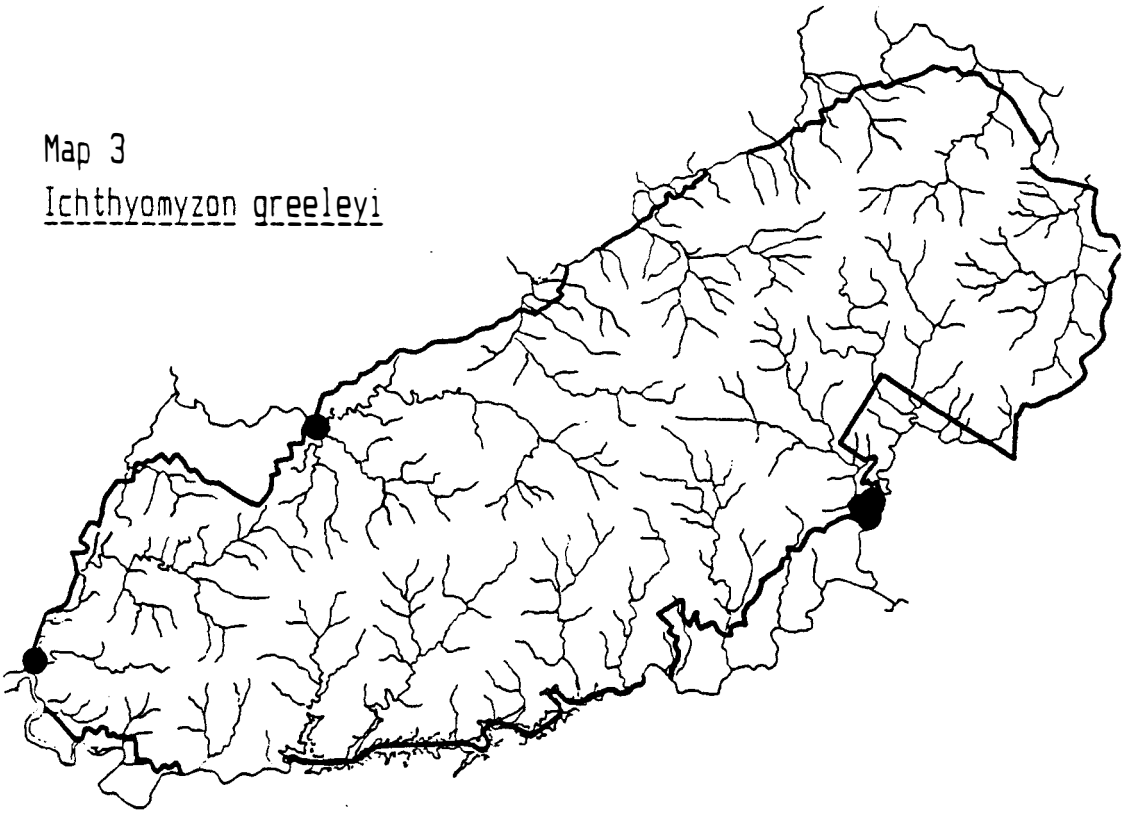

Map 1
STUDY AREA
Pigeon River
East Prong
Cosby Creek
Little Pigeon River
Big Creek
Cataloochee Creek
Middle Prong
Bradley Fork
Straight Fork
Little River
The Sinks
Raven Fork
Abrams Falls
Deep Creek
Oconaluftee River
Noland Creek
Hazel Creek
Forney Creek
Abrams Creek
Eagle Creek
Little Tennessee River

Map 2
Sites of Fish Collections



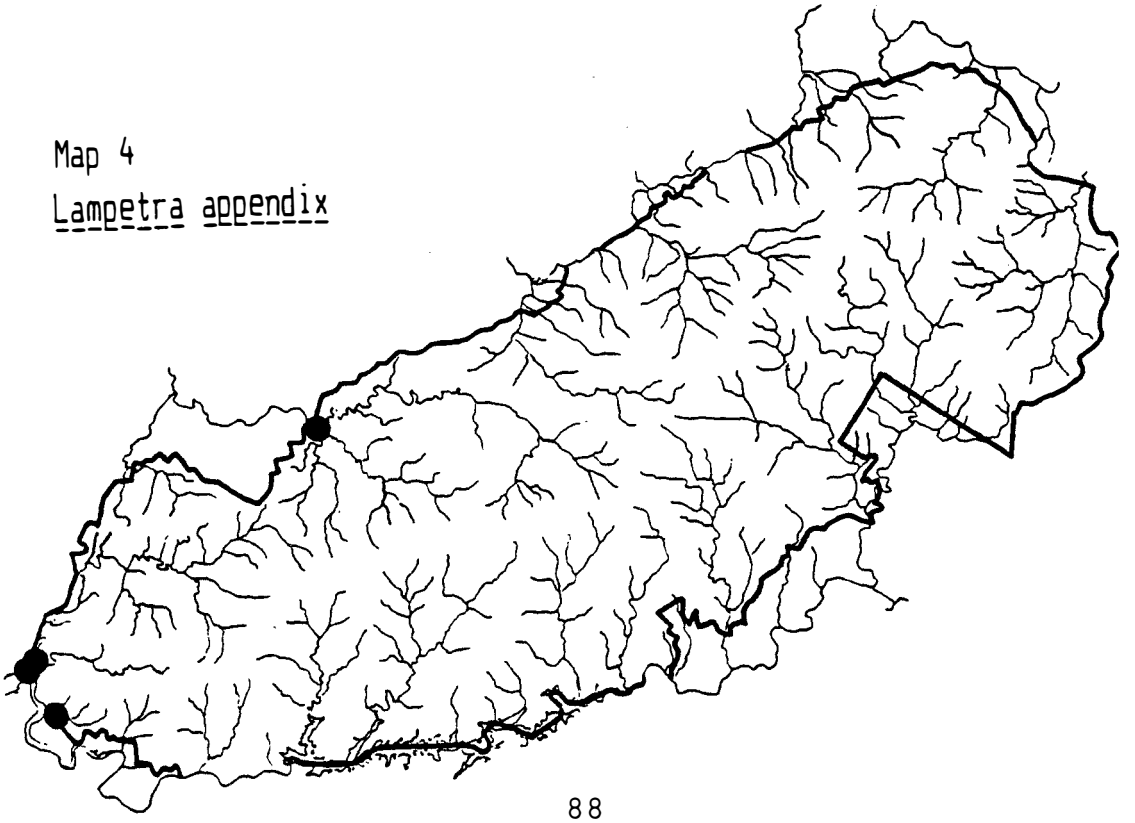
Map 3

Ichthyomyzon greeleyi



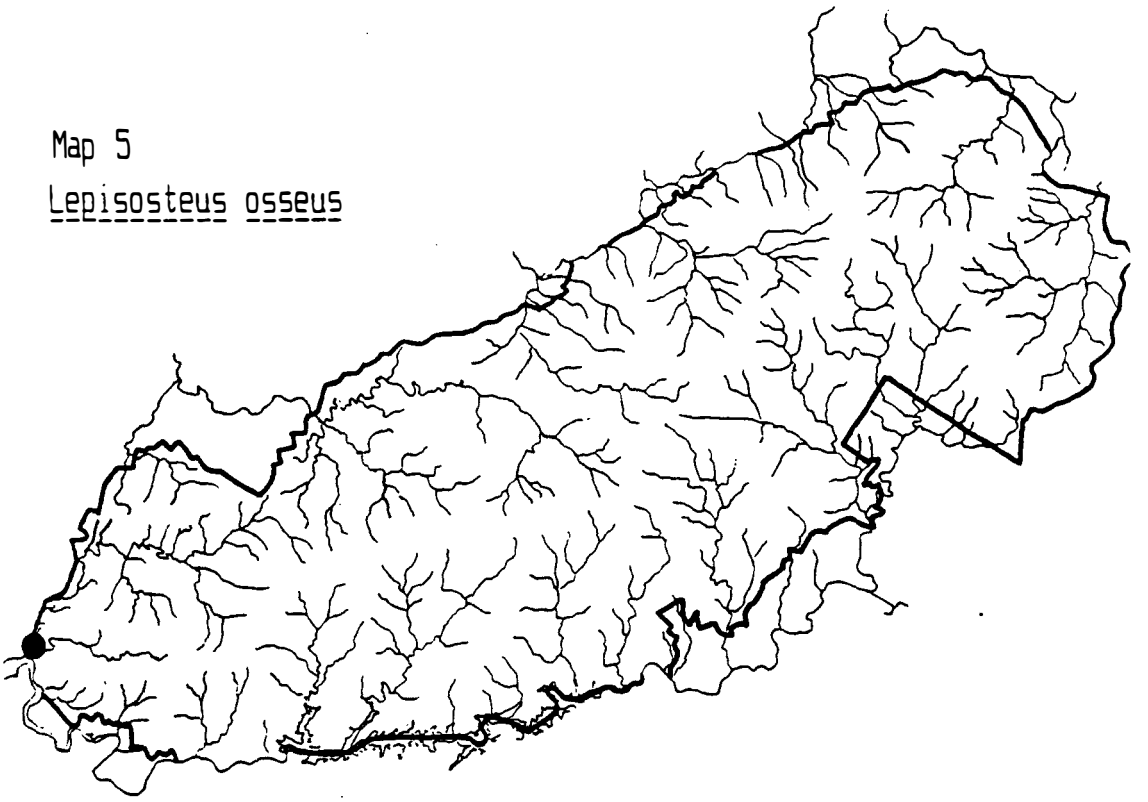
Map 4

Lampetra appendix



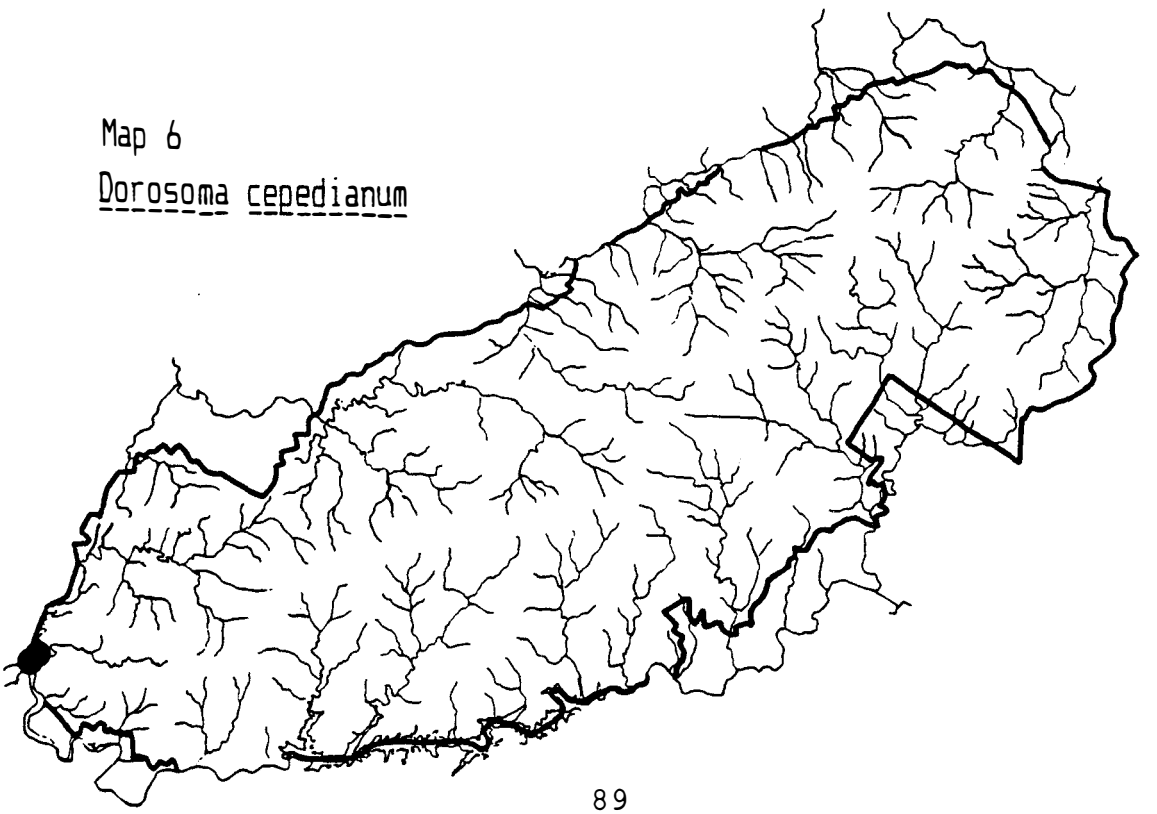
Map 5

Lepisosteus osseus



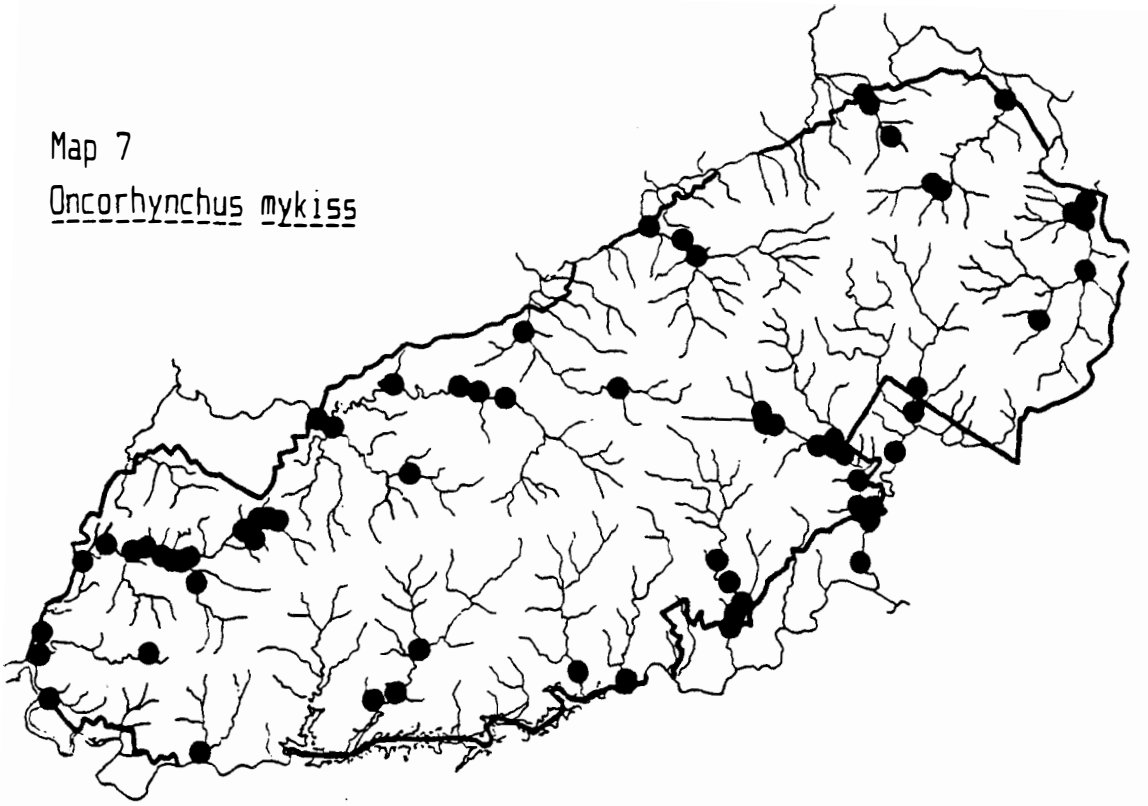
Map 6

Dorosoma cepedianum



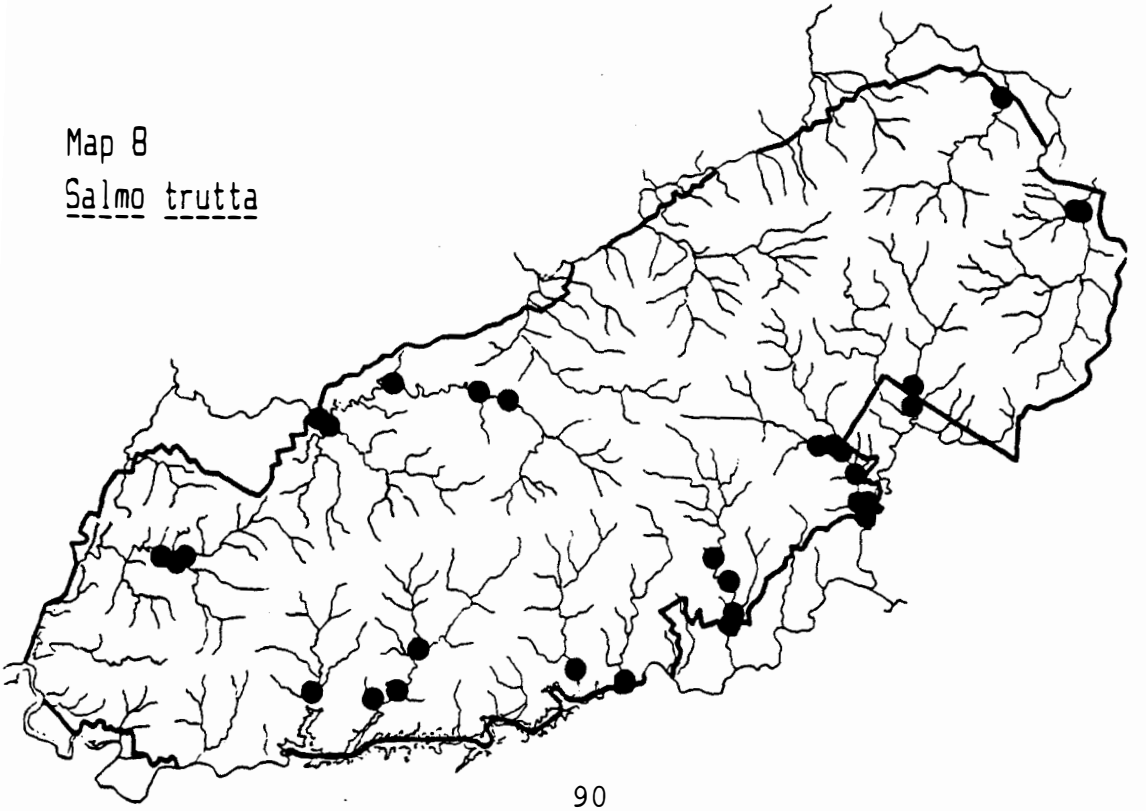
Map 7

Oncorhynchus mykiss



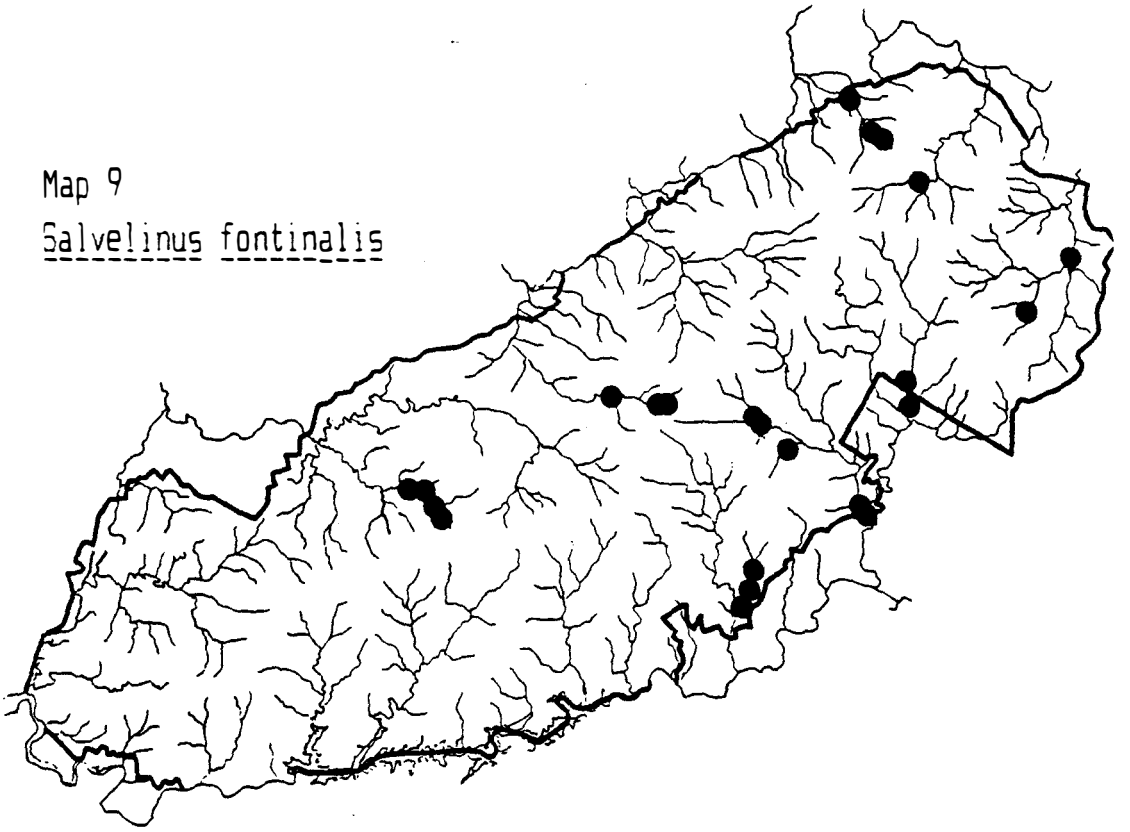
Map 8

Salmo trutta



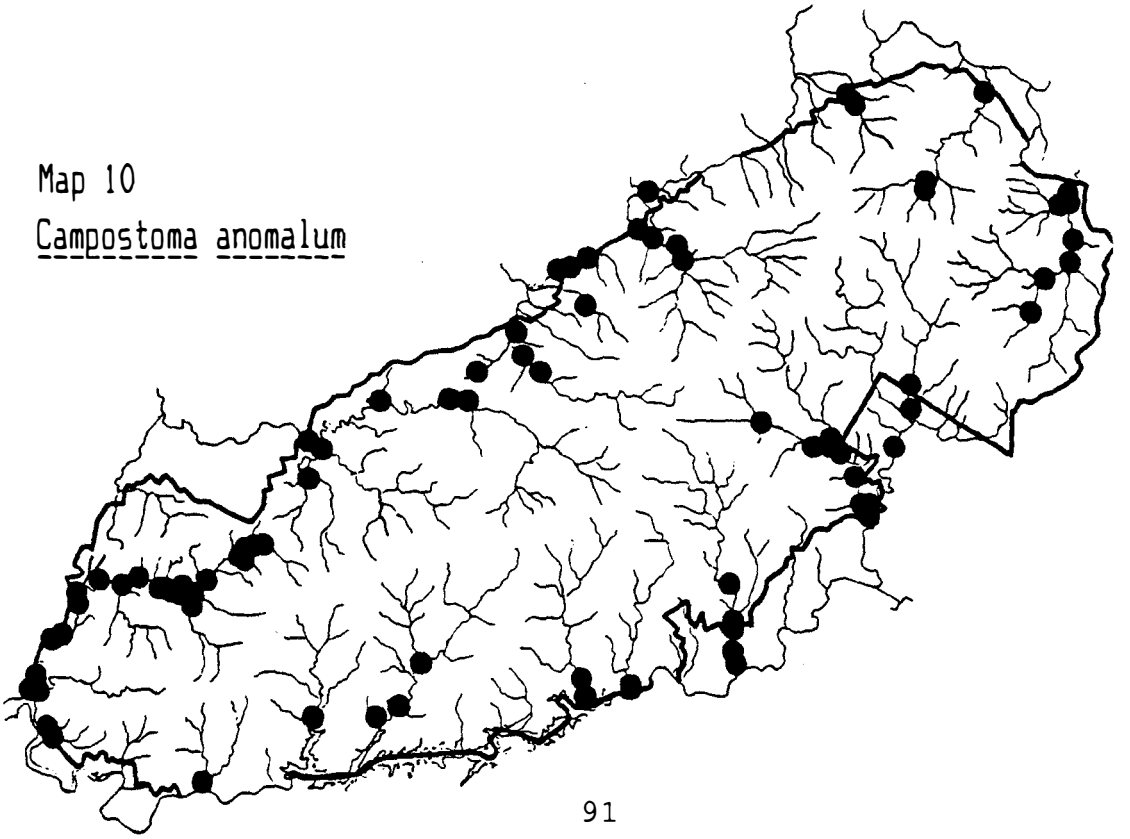
Map 9

Salvelinus fontinalis



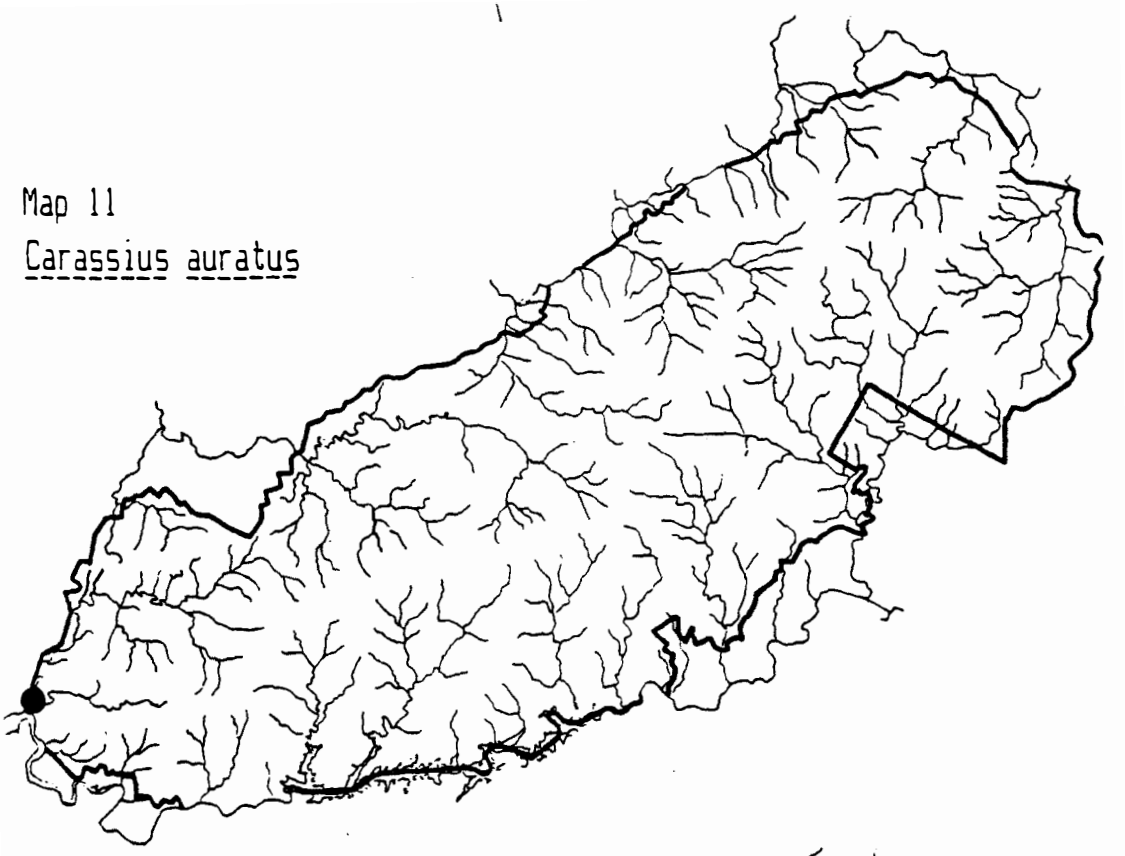
Map 10

Campostoma anomalum



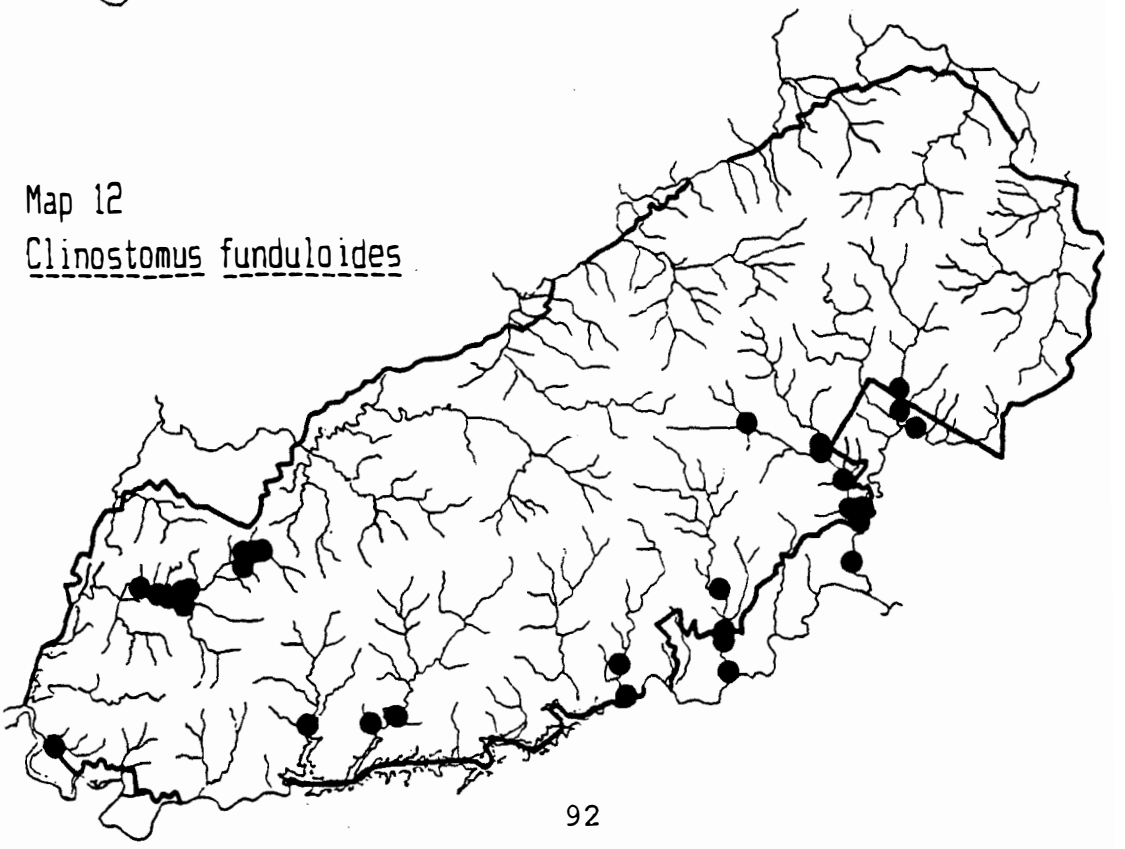
Map 11

Carassius auratus



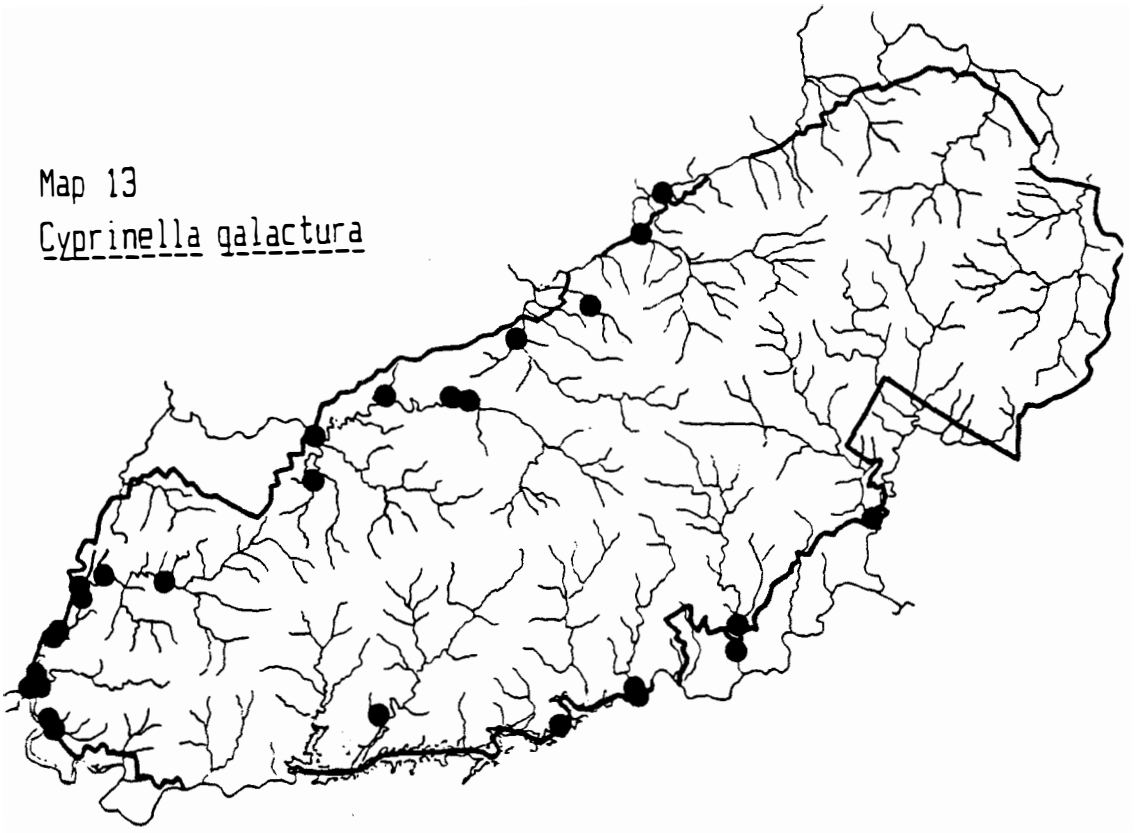
Map 12

Clinostomus funduloides



Map 13

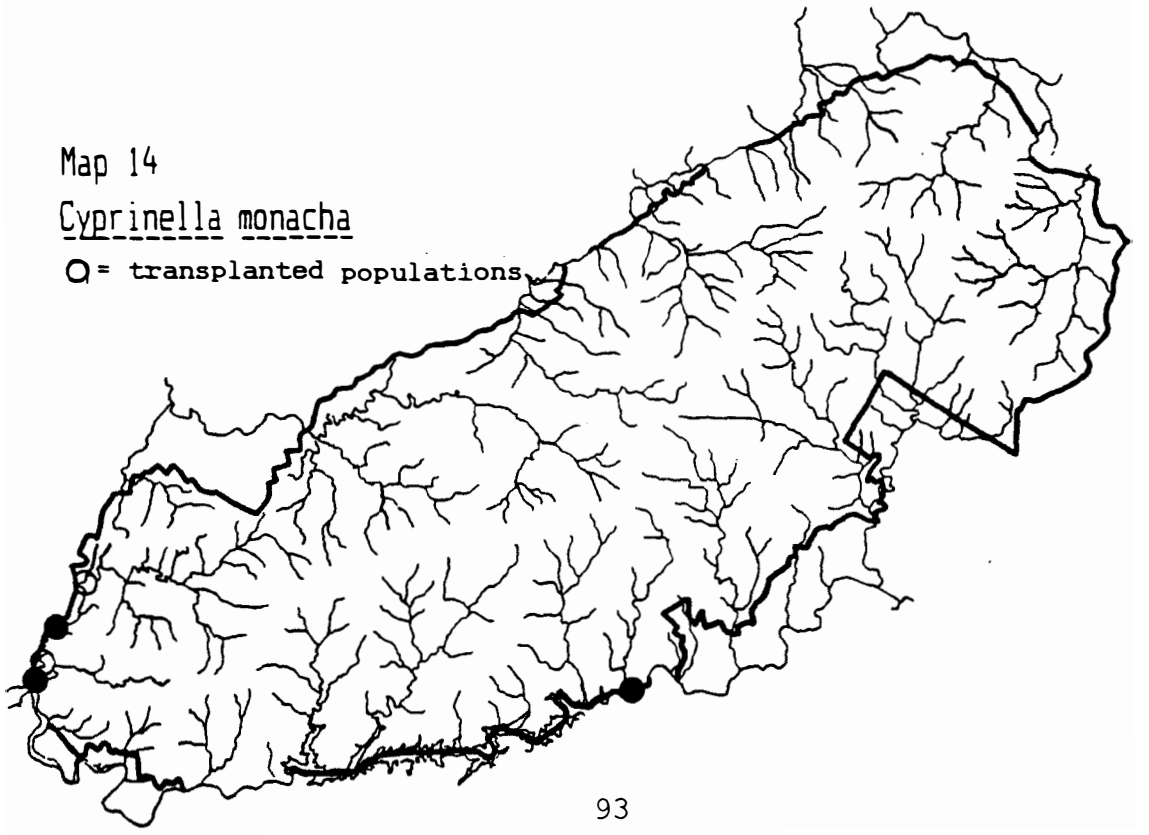
Cyprinella galactura



Map 14

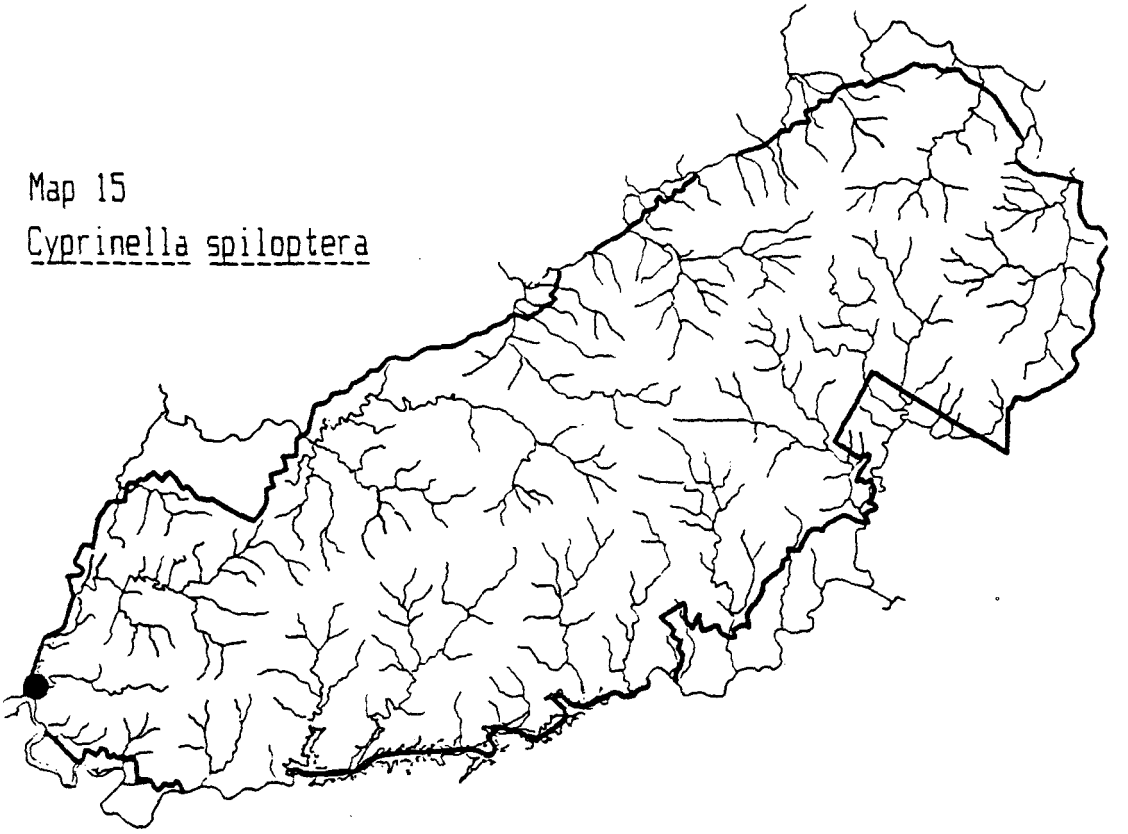
Cyprinella monacha

○ = transplanted populations



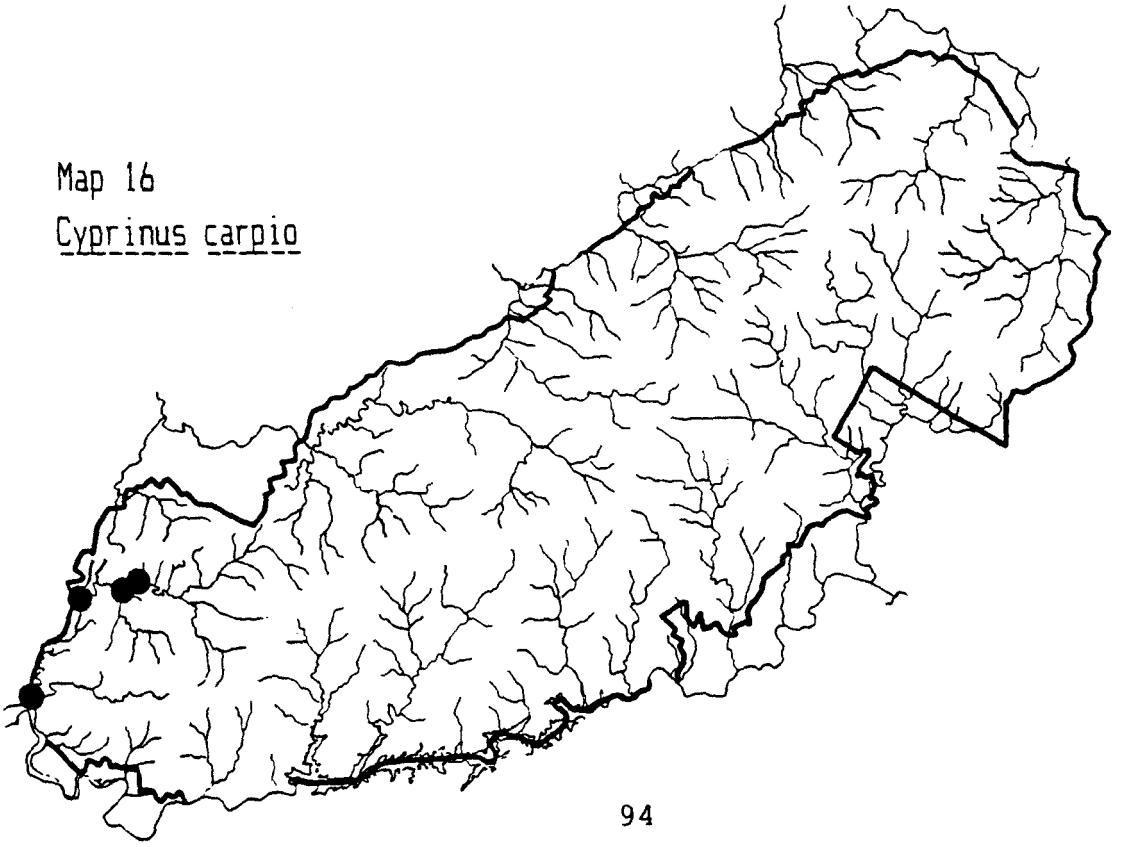
Map 15

Cyprinella spiloptera



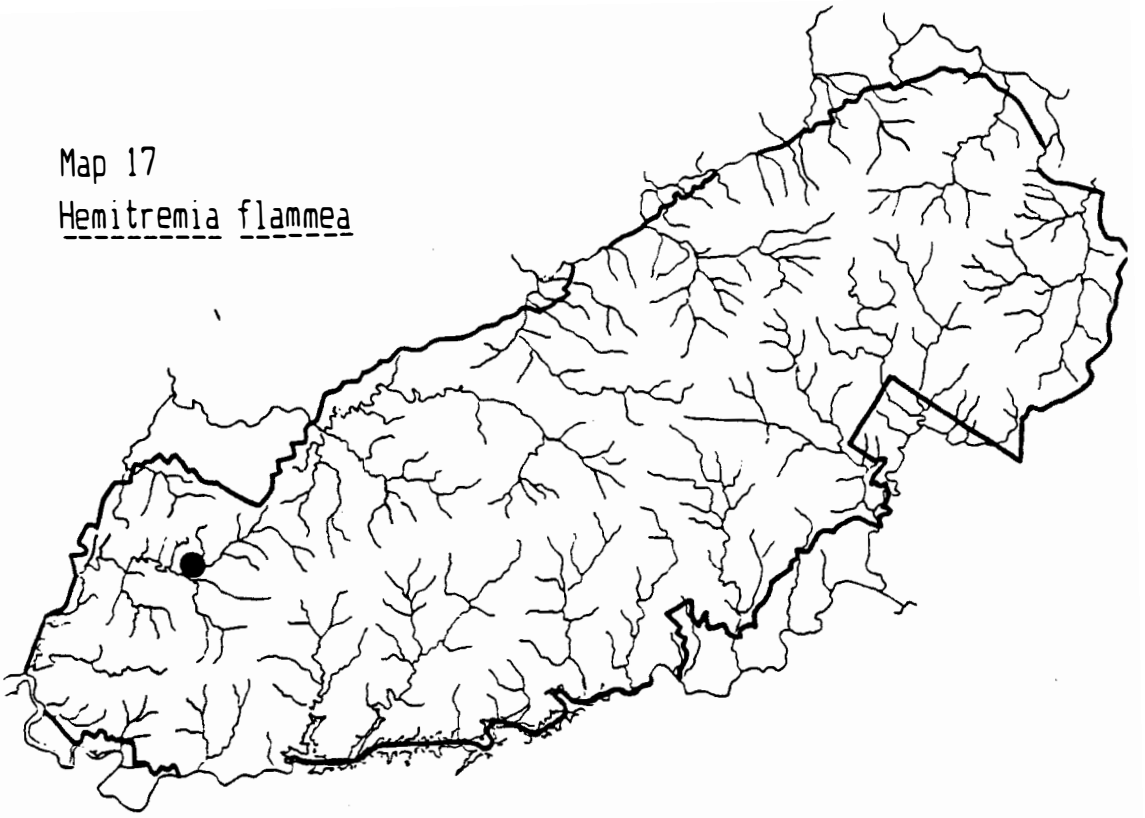
Map 16

Cyprinus carpio



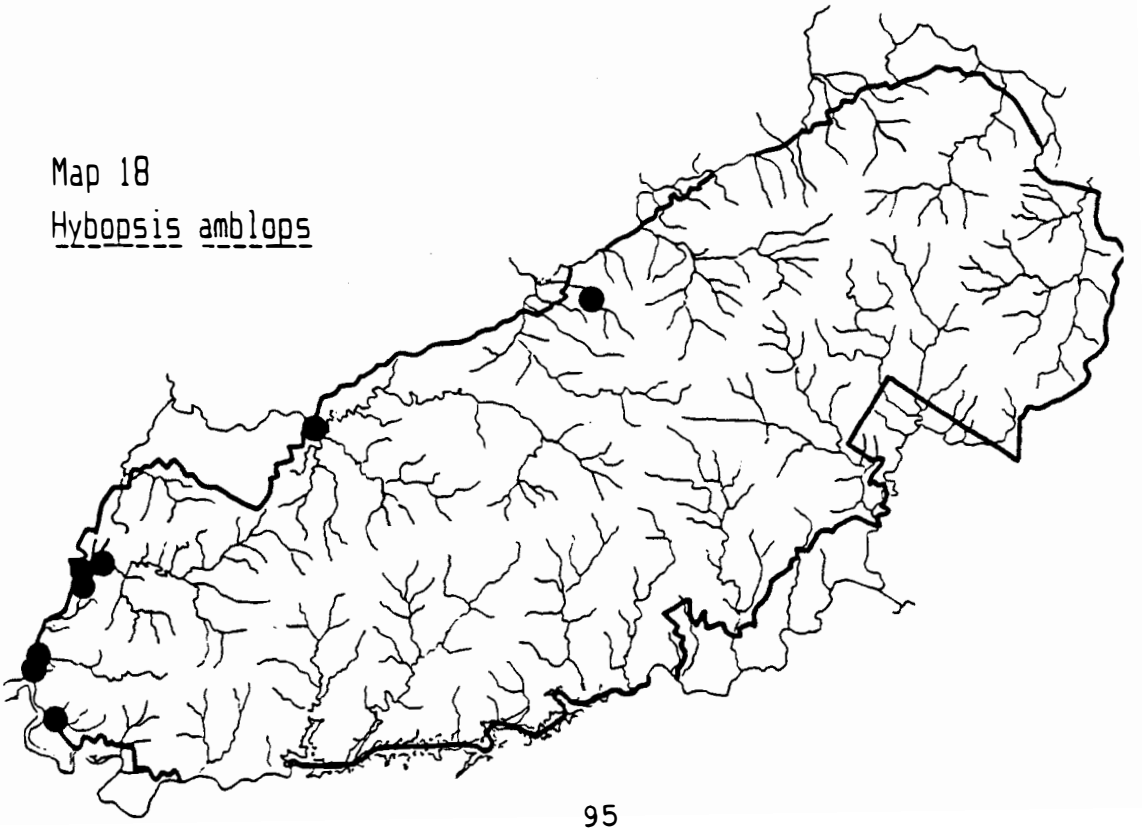
Map 17

Hemitremia flammea



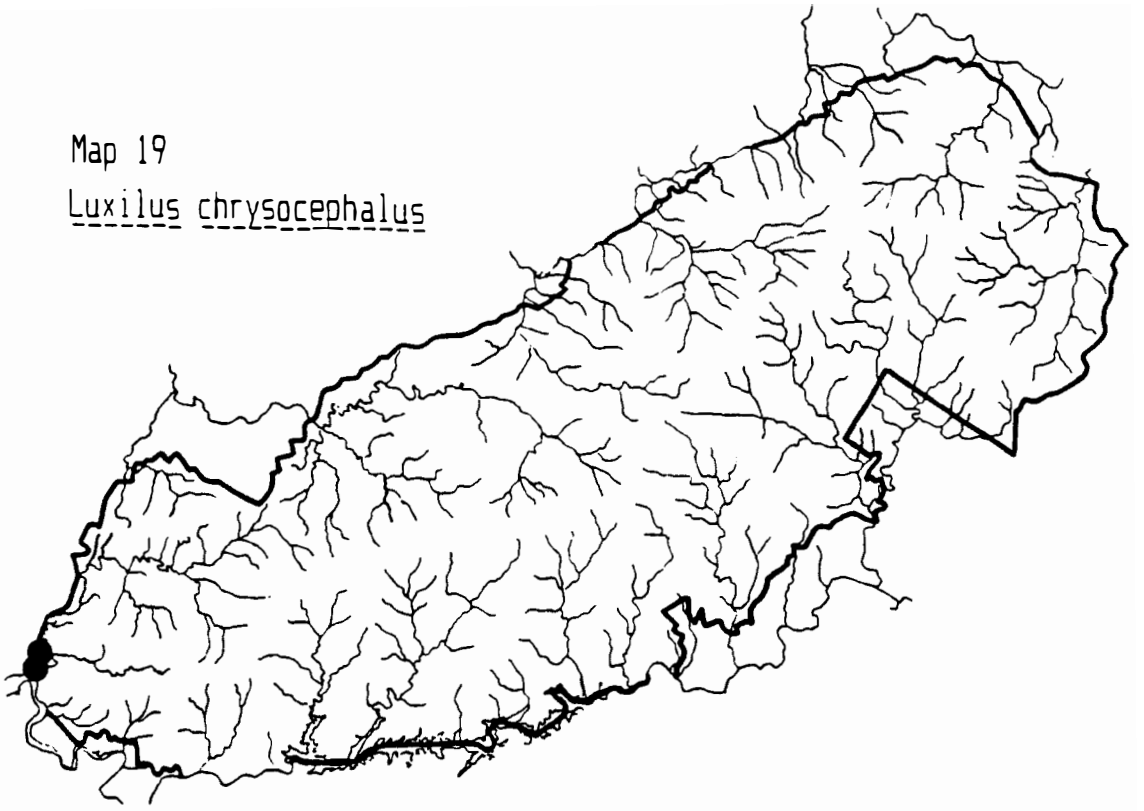
Map 18

Hybopsis amblops



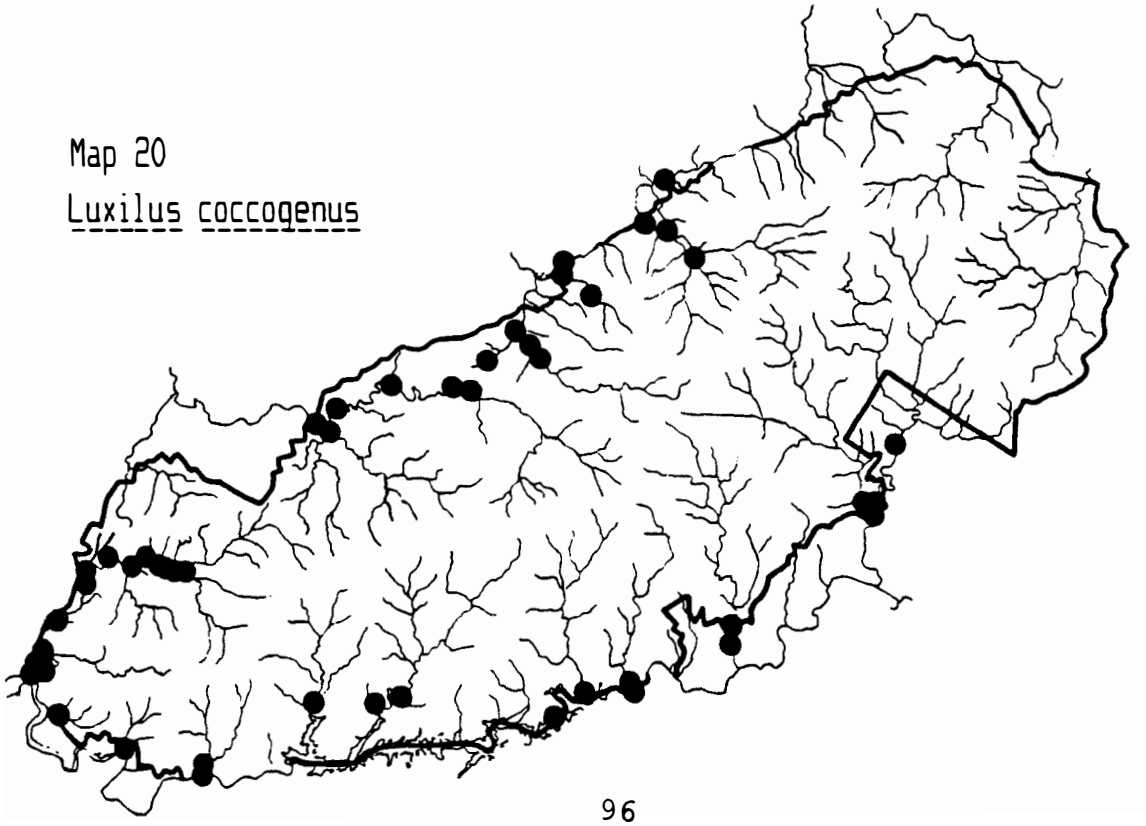
Map 19

Luxilus chrysocephalus



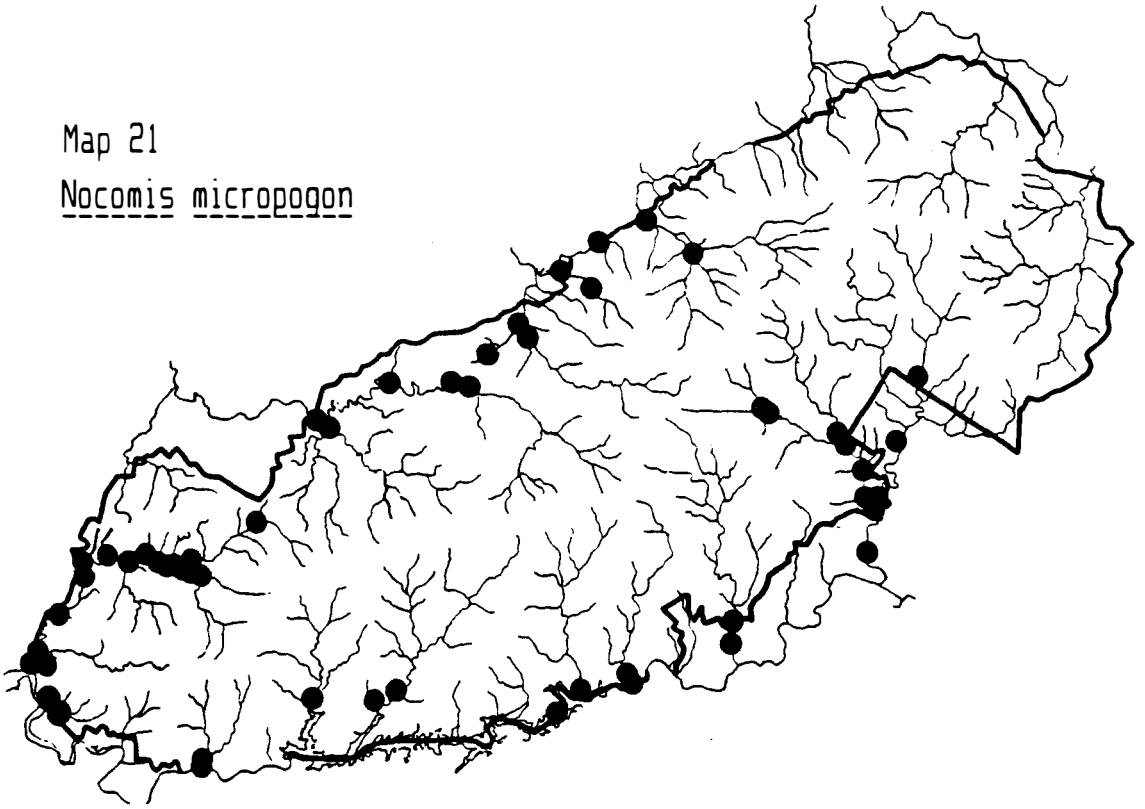
Map 20

Luxilus coccogenus



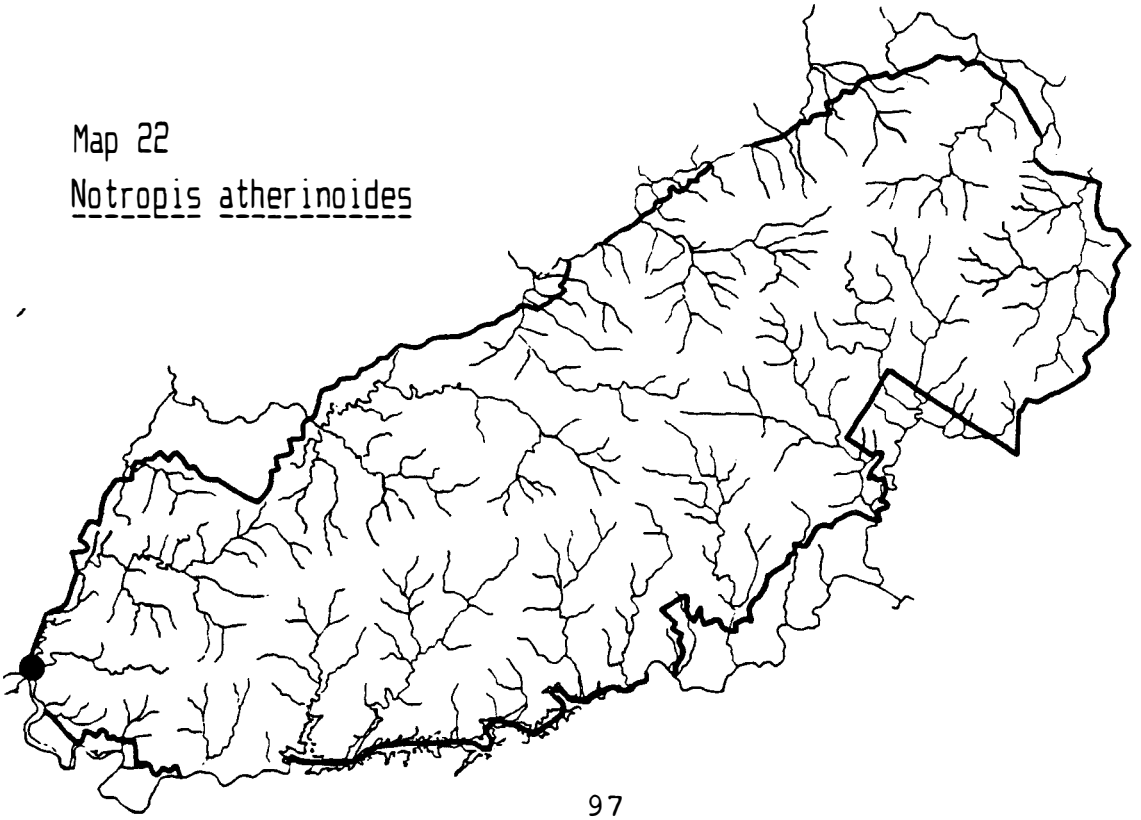
Map 21

Nocomis micropogon



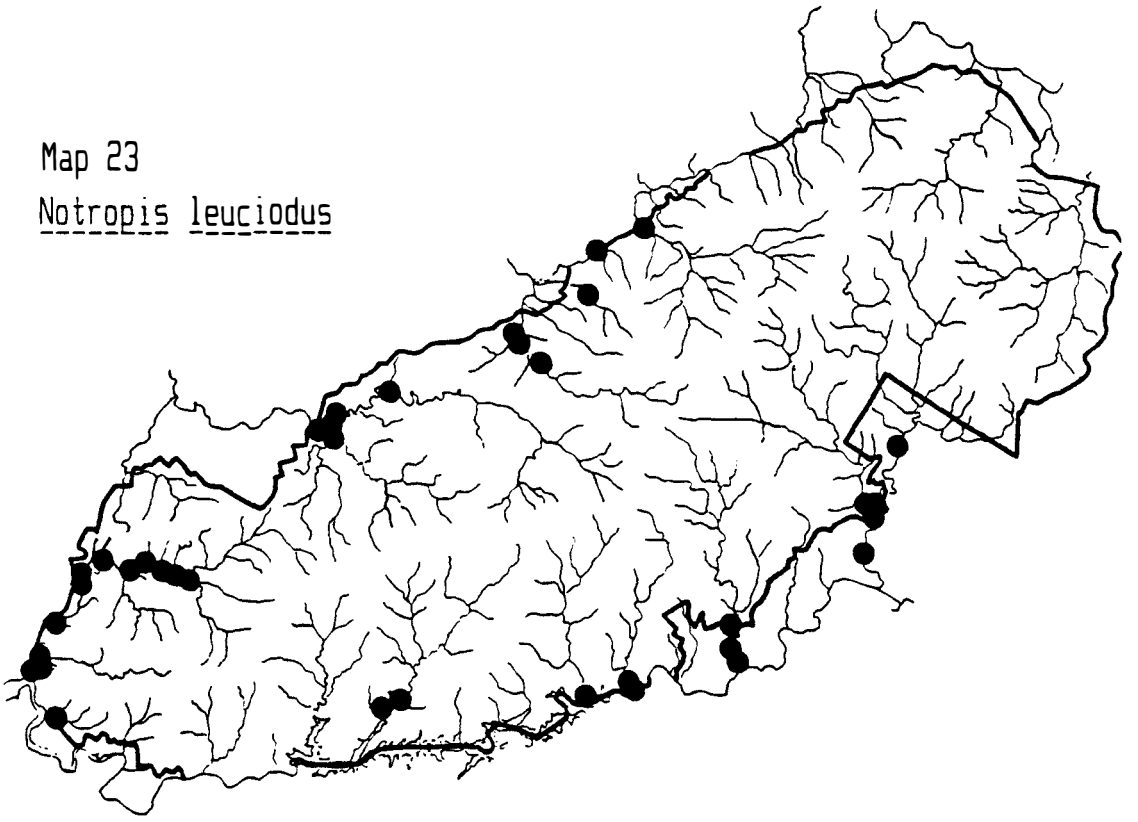
Map 22

Notropis atherinoides



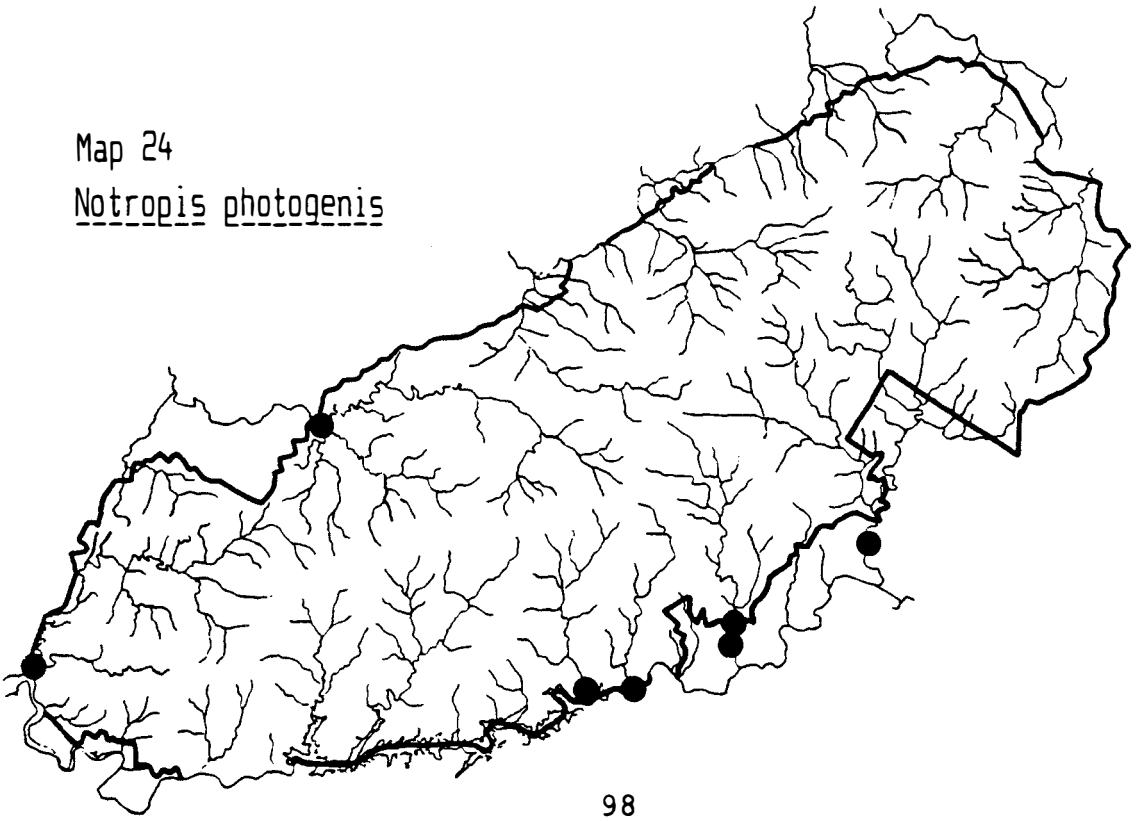
Map 23

Notropis leuciodus



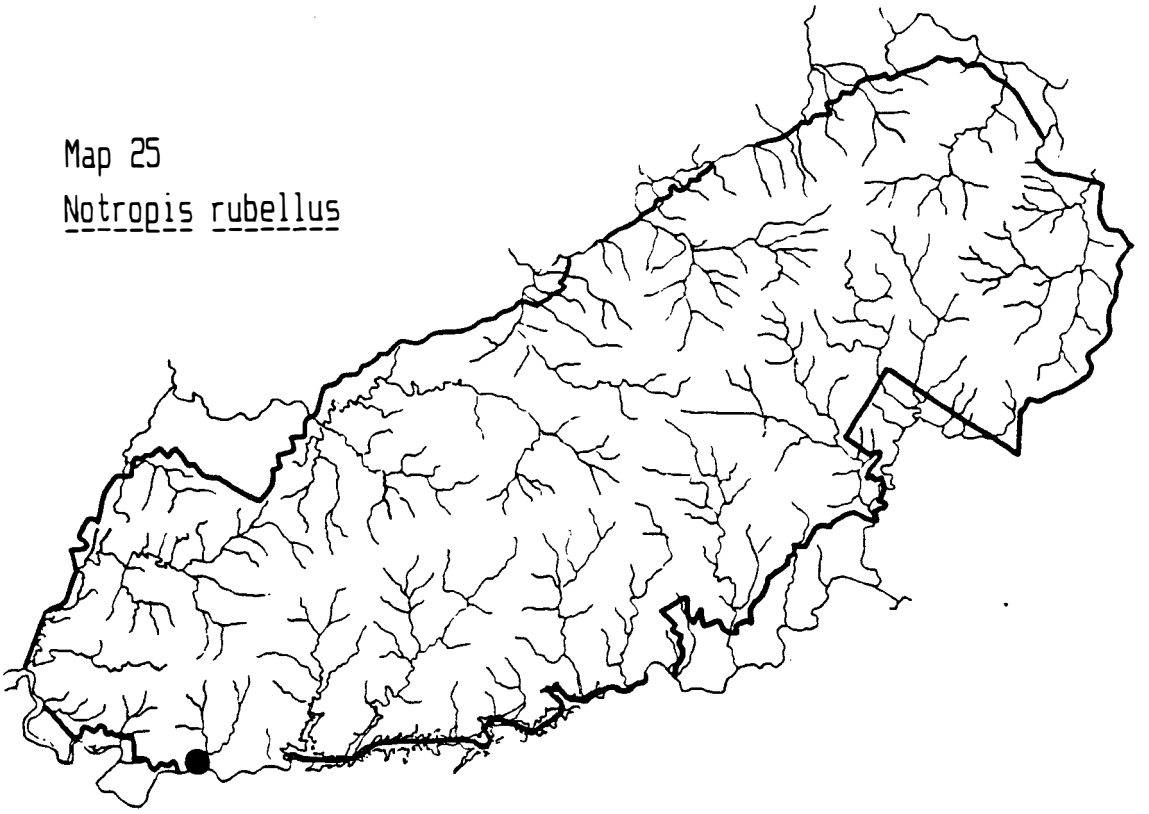
Map 24

Notropis photogenis



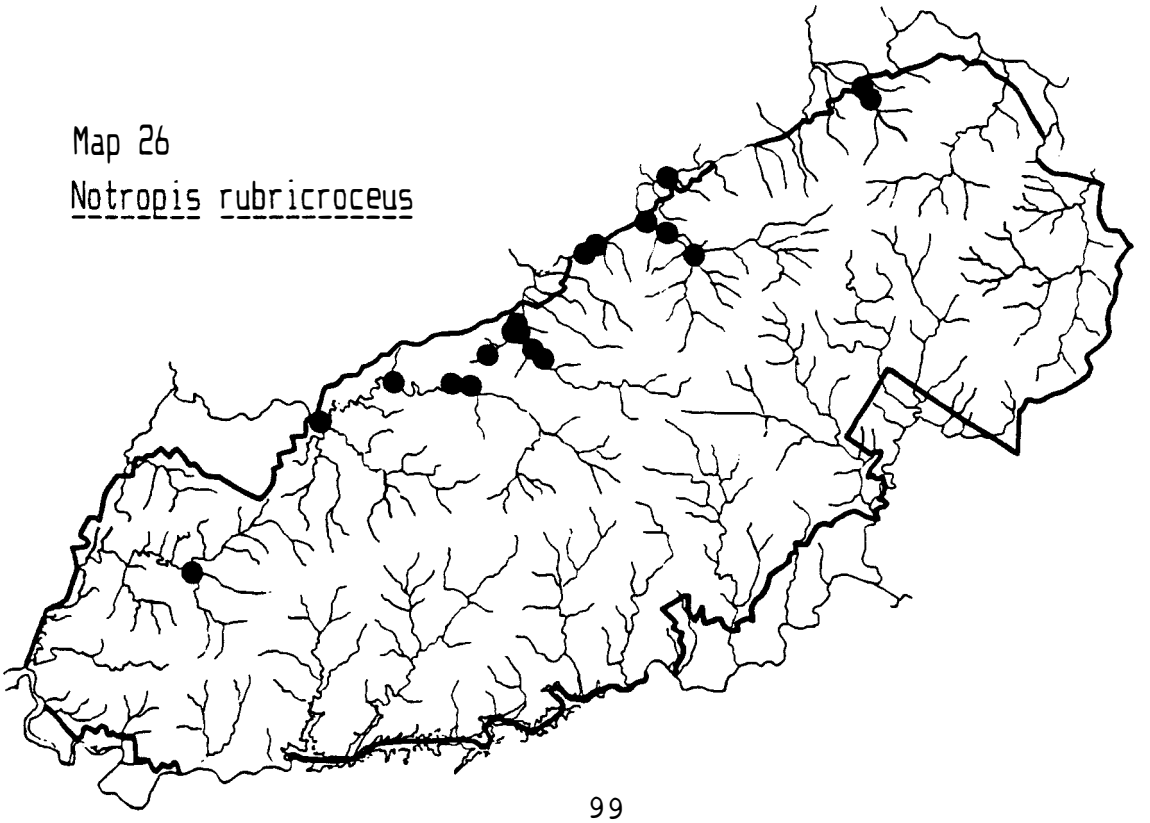
Map 25

Notropis rubellus



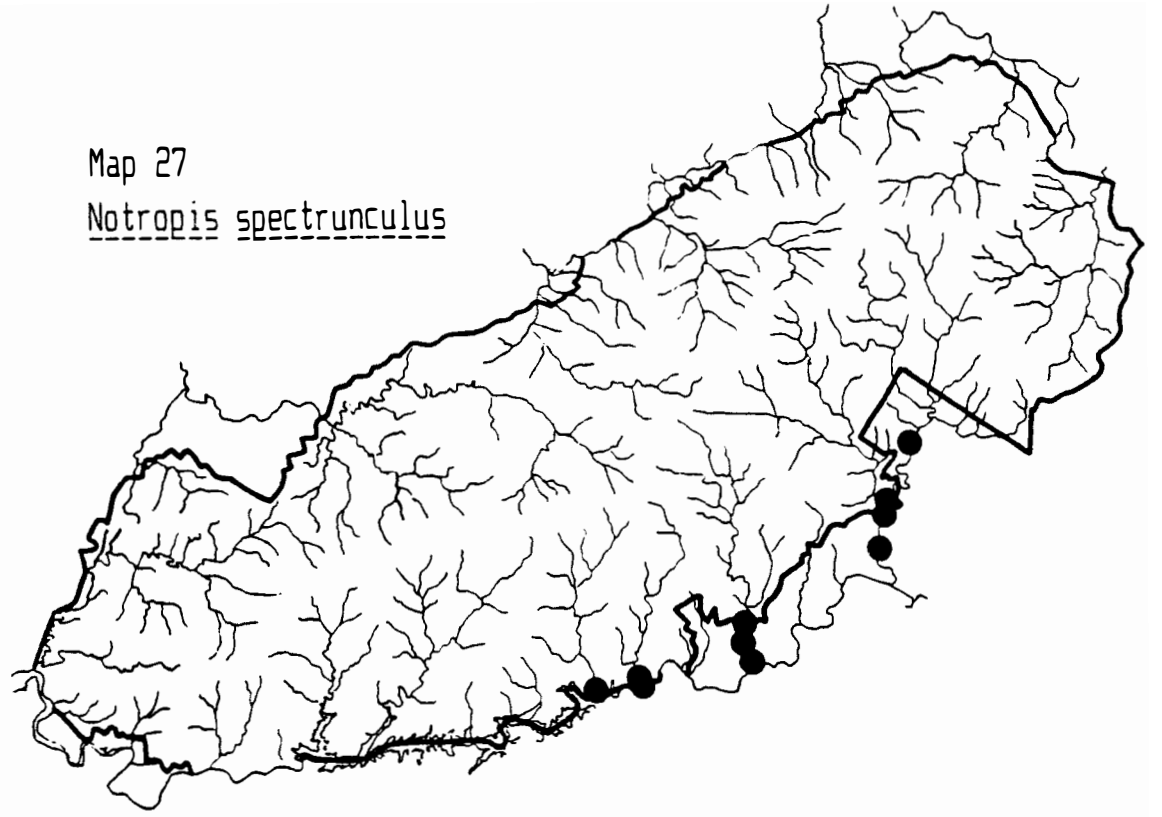
Map 26

Notropis rubricroceus



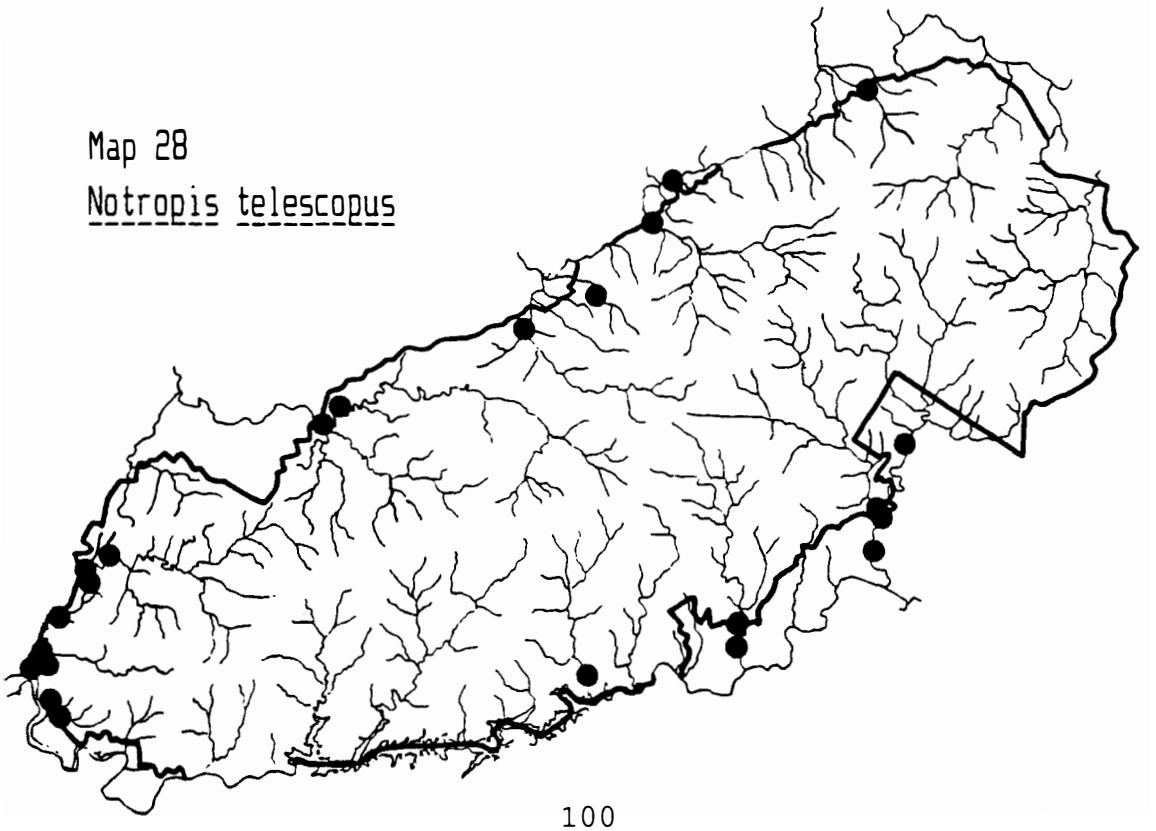
Map 27

Notropis spectrunculus



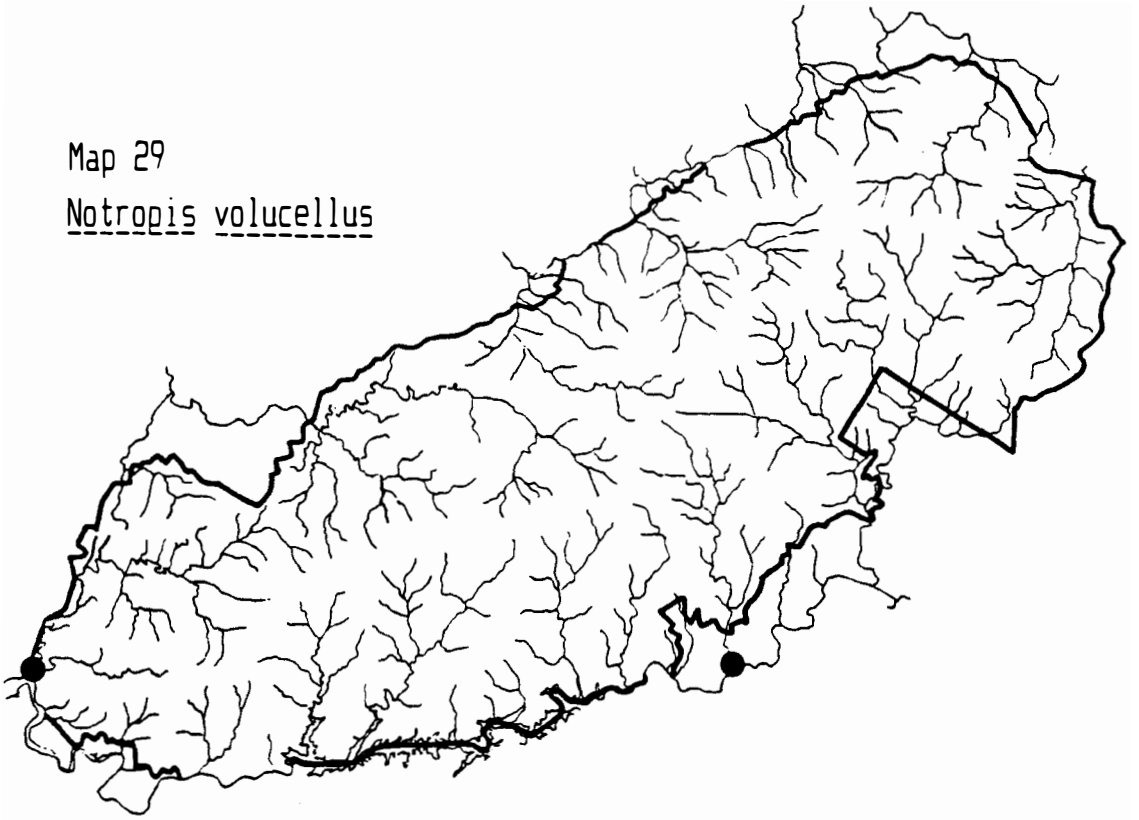
Map 28

Notropis telescopus



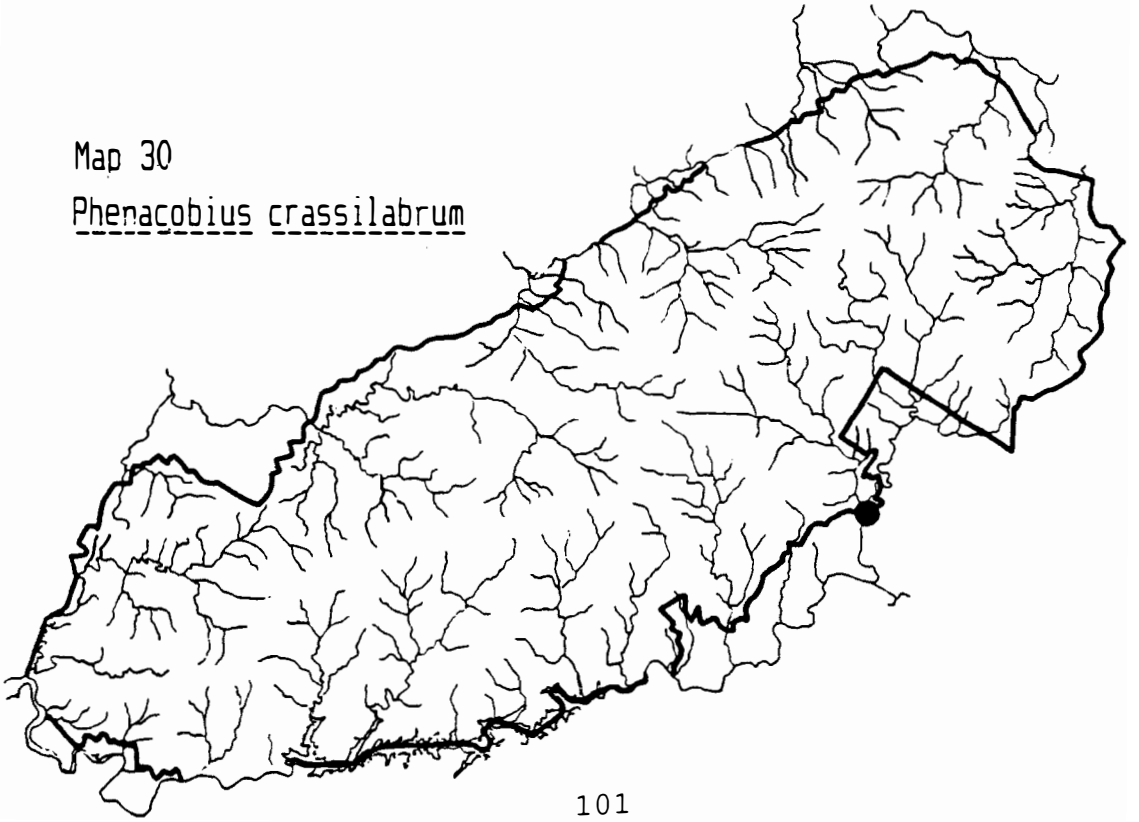
Map 29

Notropis volucellus



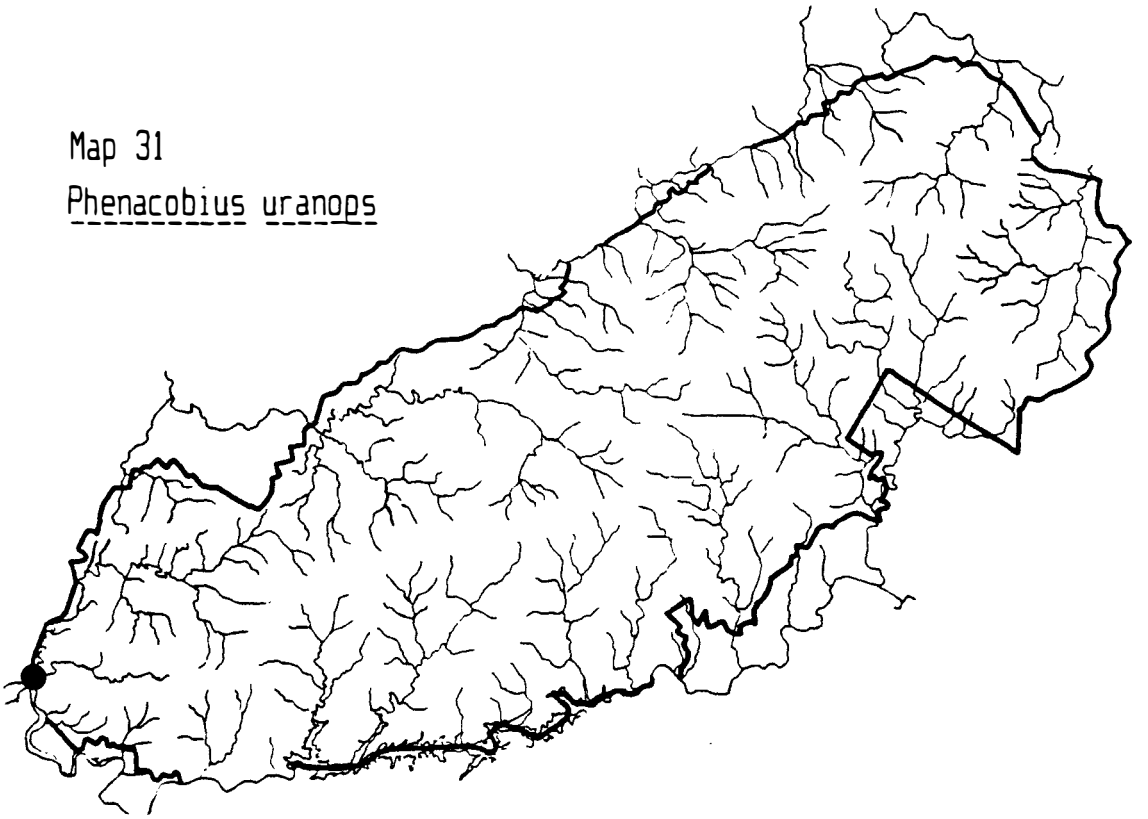
Map 30

Phenacobius crassilabrum



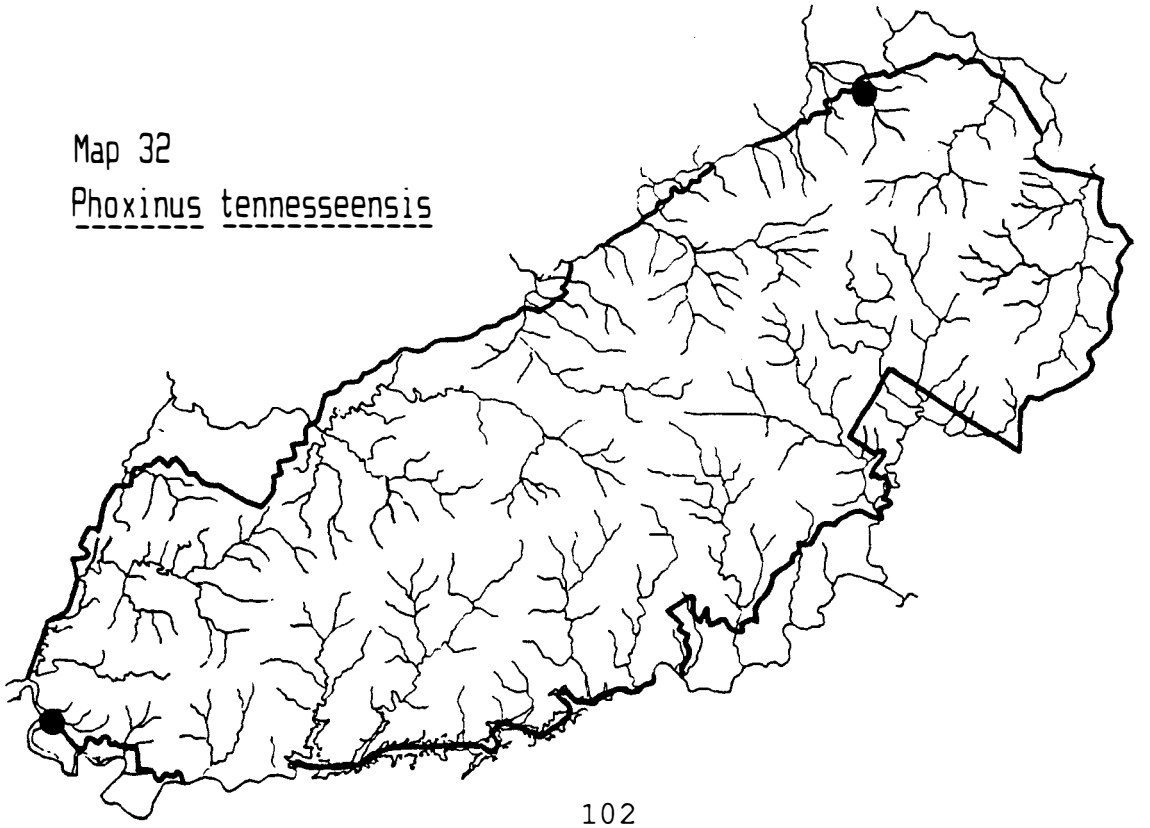
Map 31

Phenacobius uranops

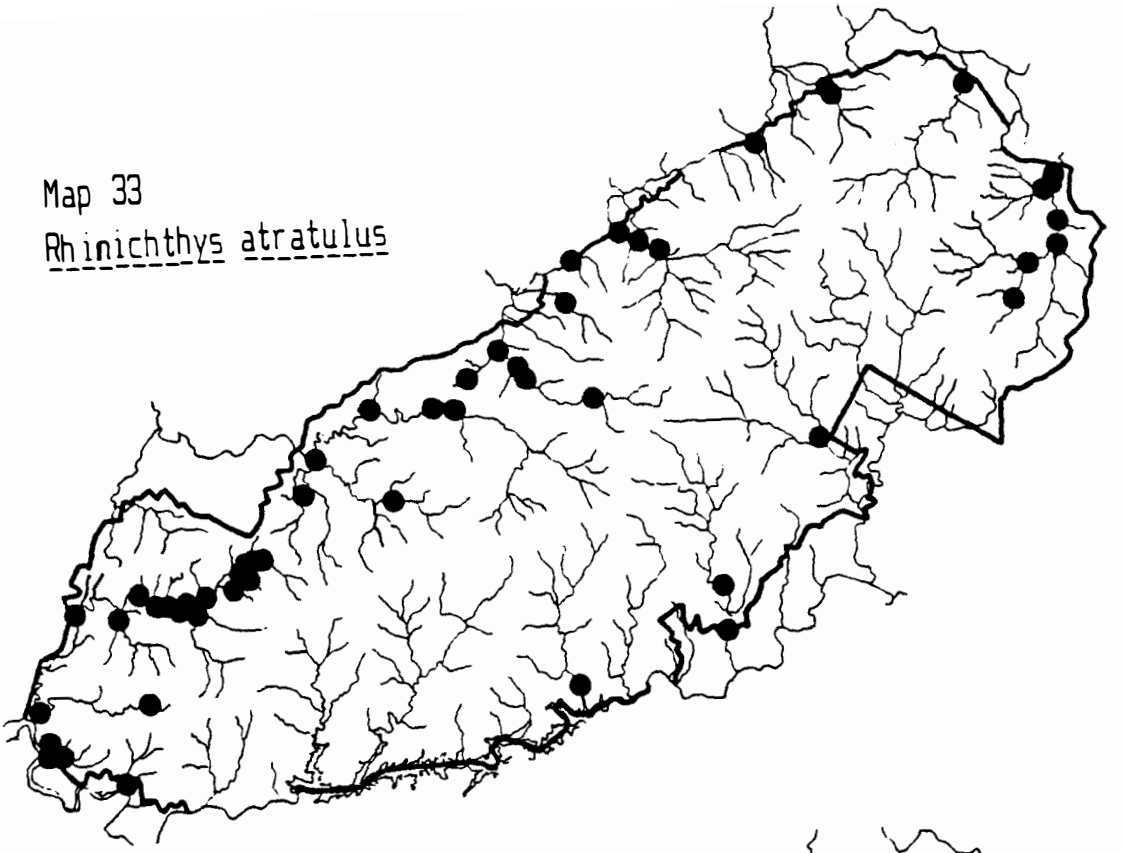


Map 32

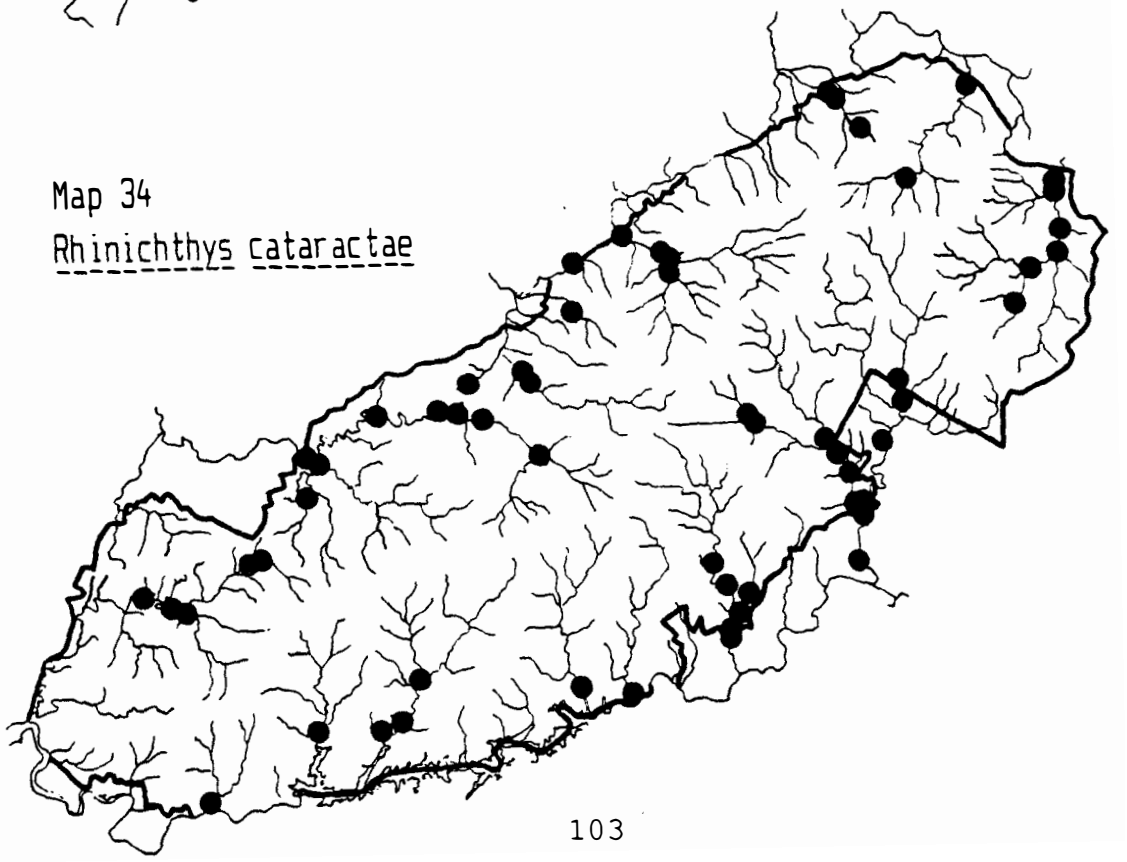
Phoxinus tennesseensis



Map 33
Rhinichthys atratulus

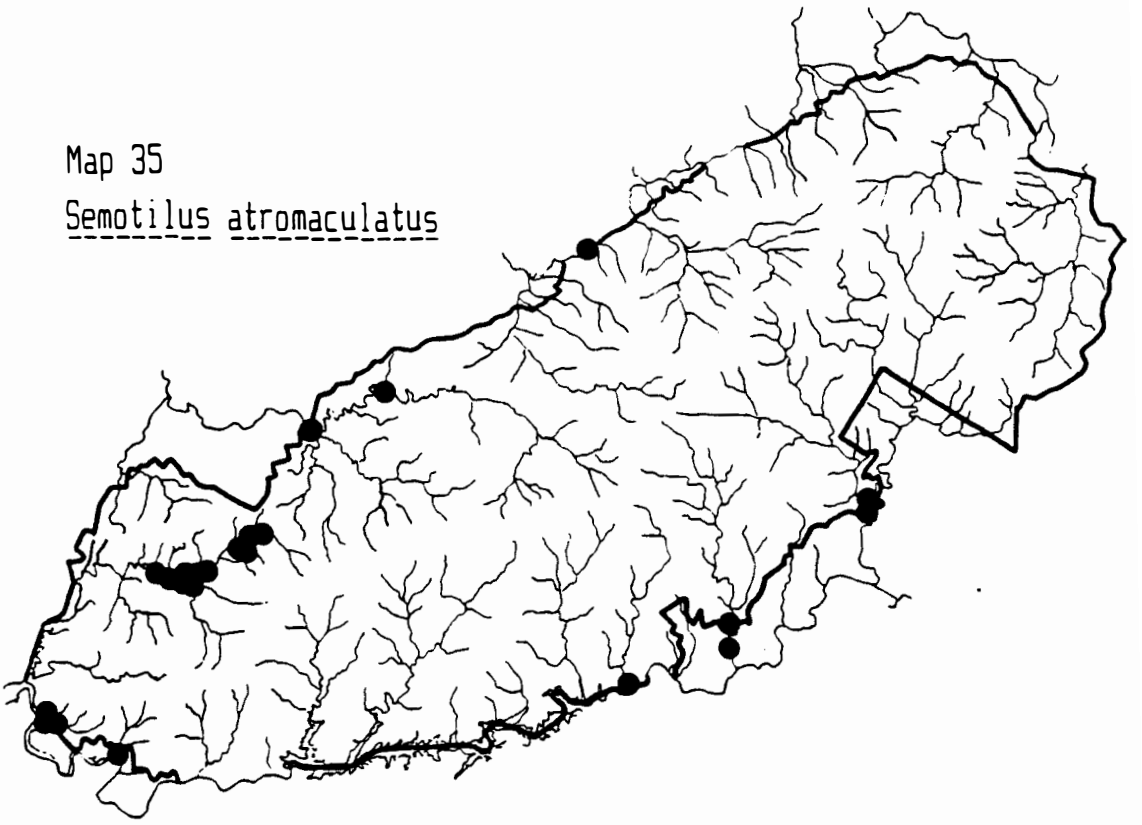


Map 34
Rhinichthys cataractae



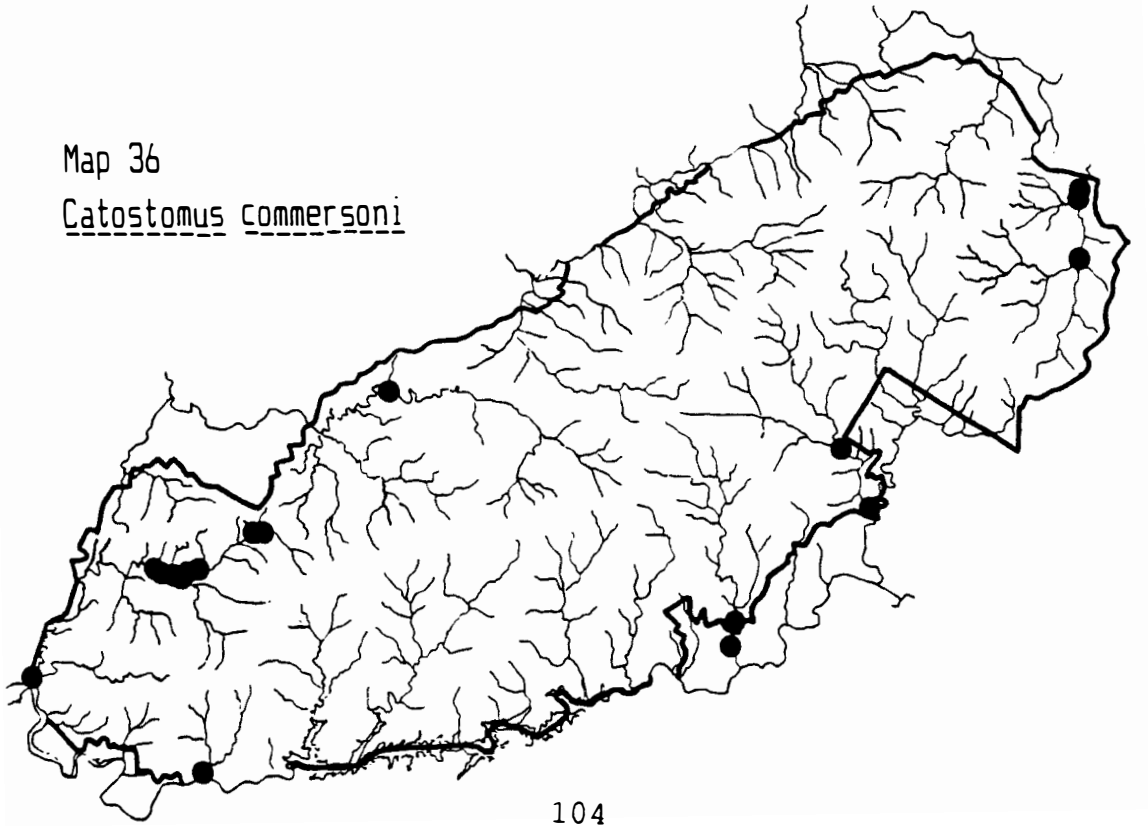
Map 35

Semotilus atromaculatus



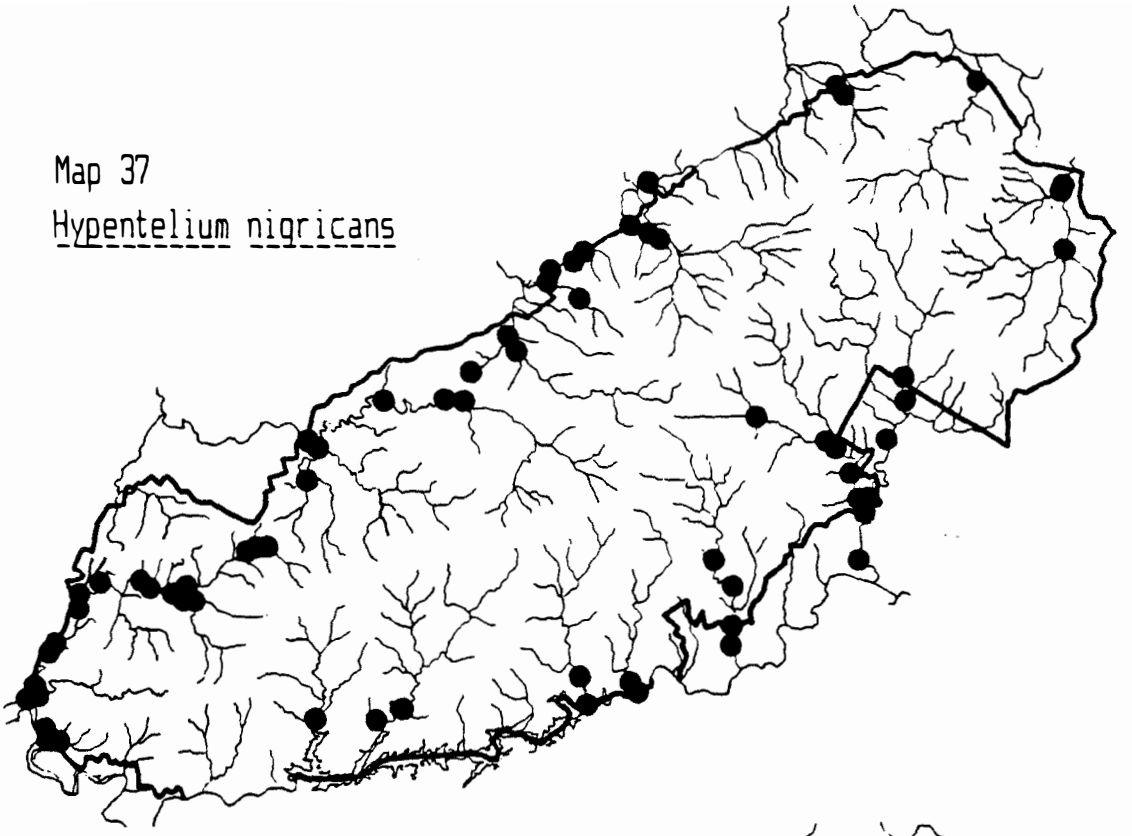
Map 36

Catostomus commersoni



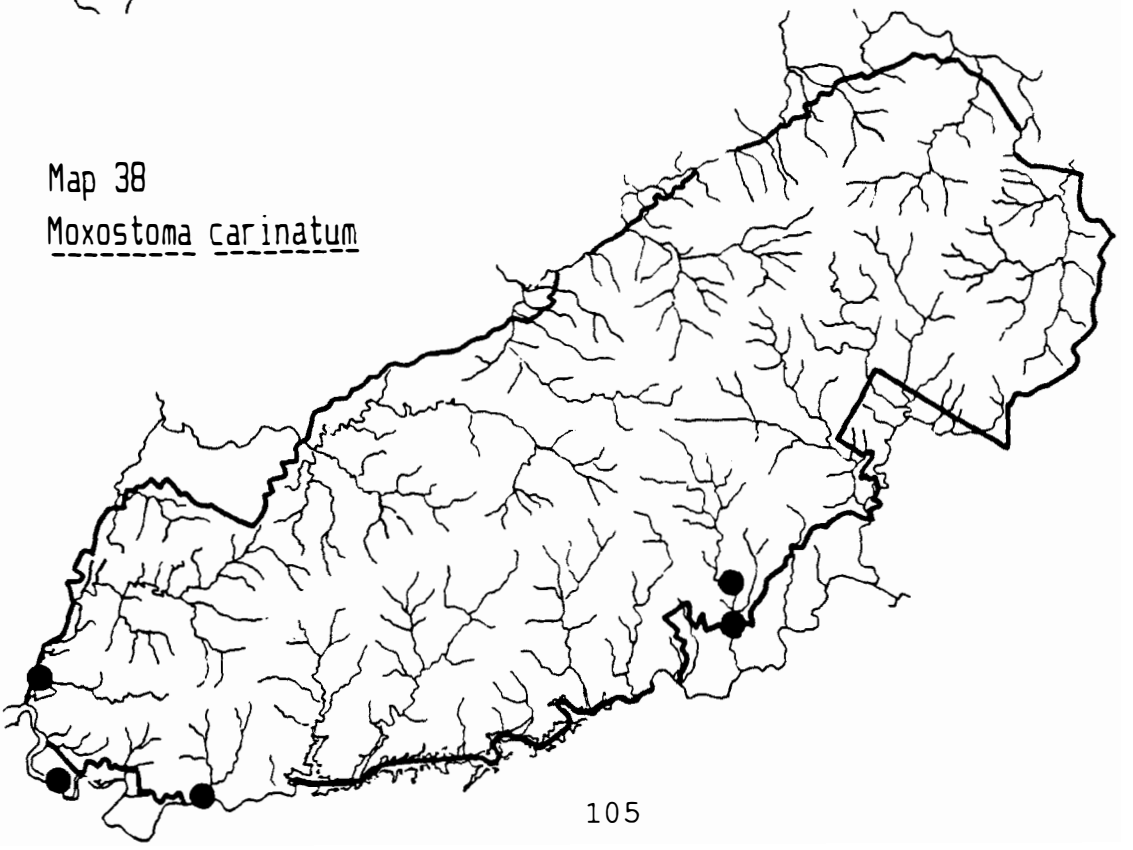
Map 37

Hypentelium nigricans



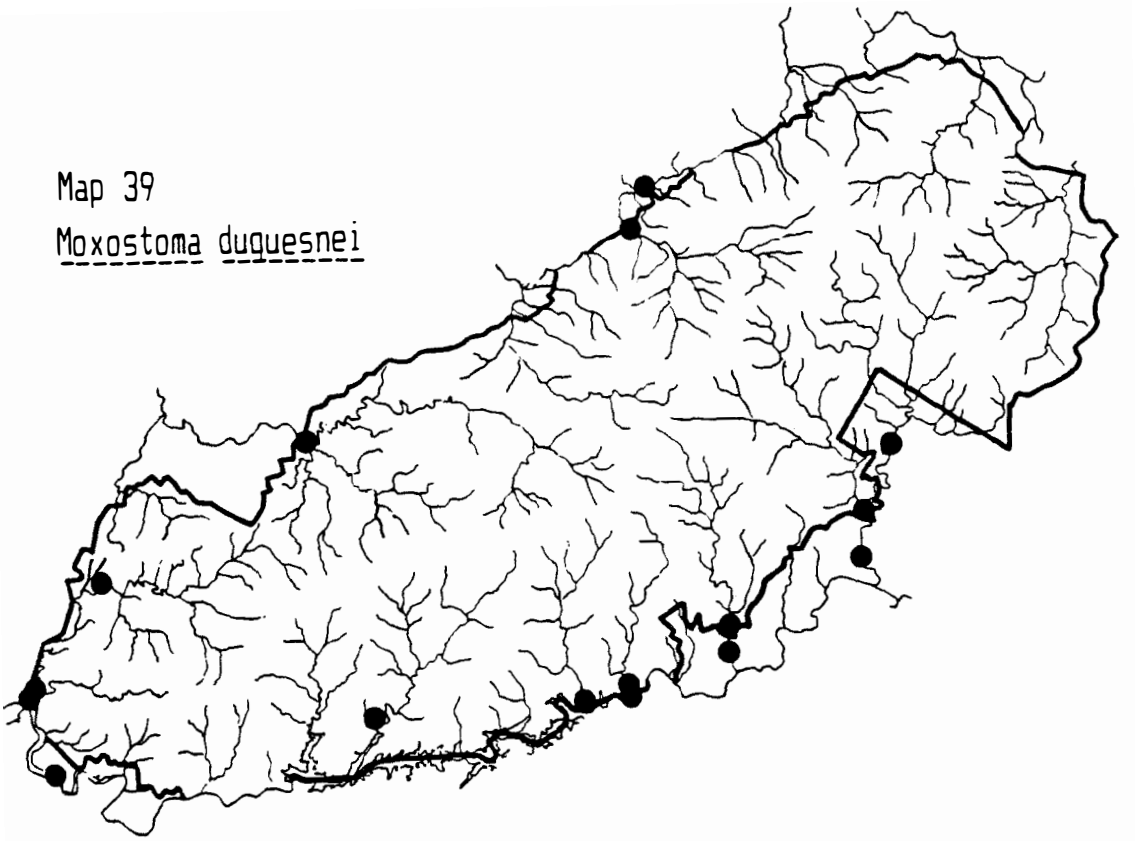
Map 38

Moxostoma carinatum



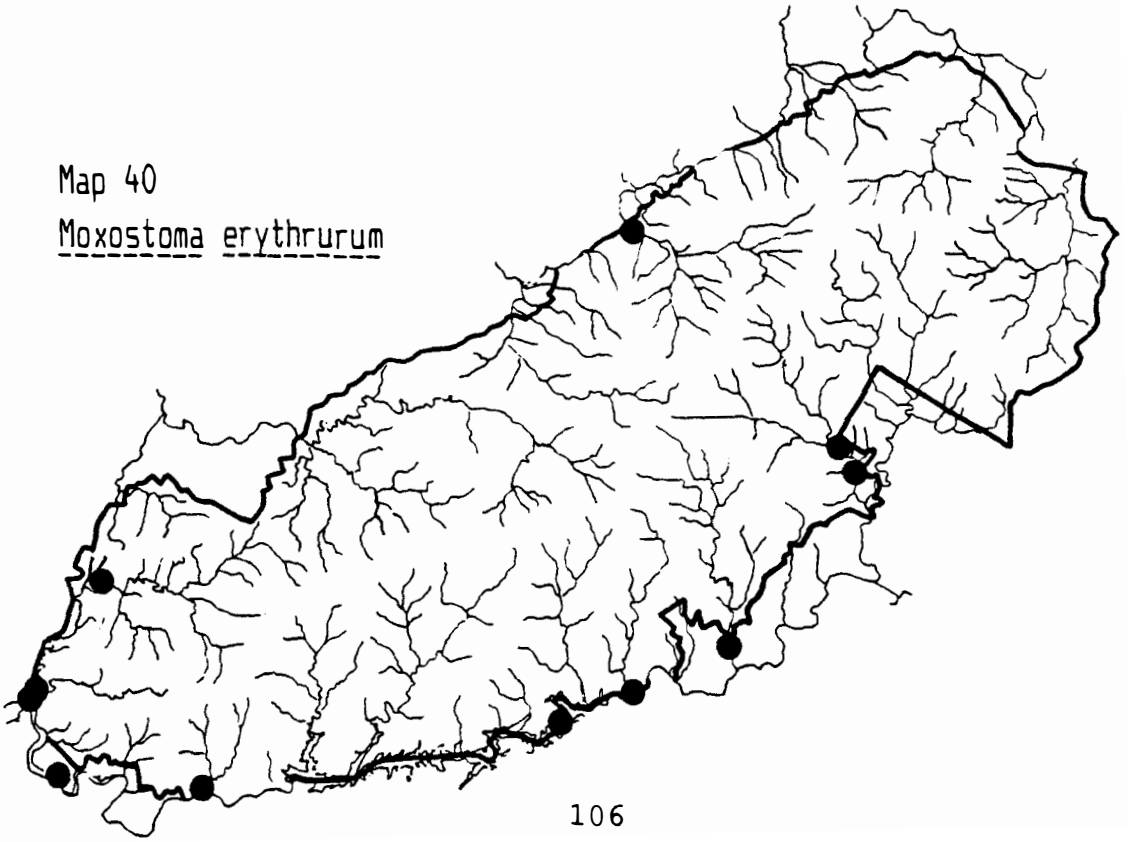
Map 39

Moxostoma duquesnei



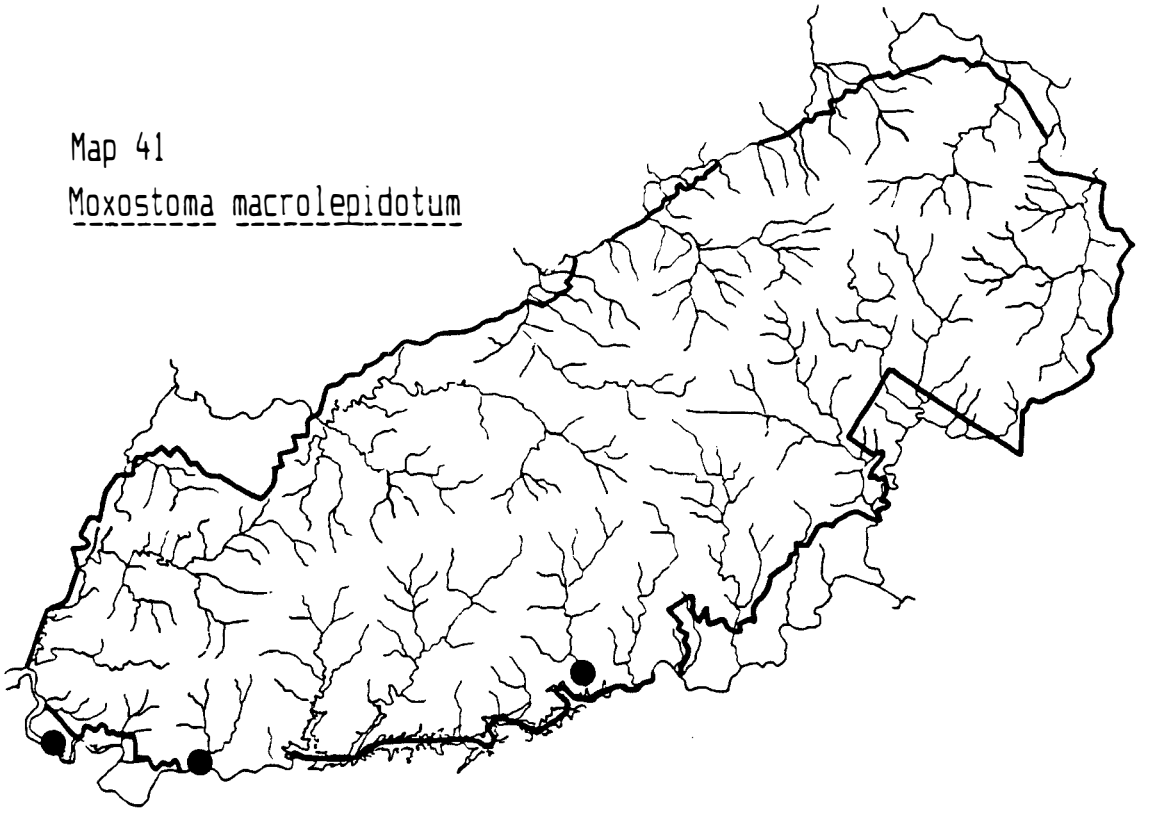
Map 40

Moxostoma erythrurum



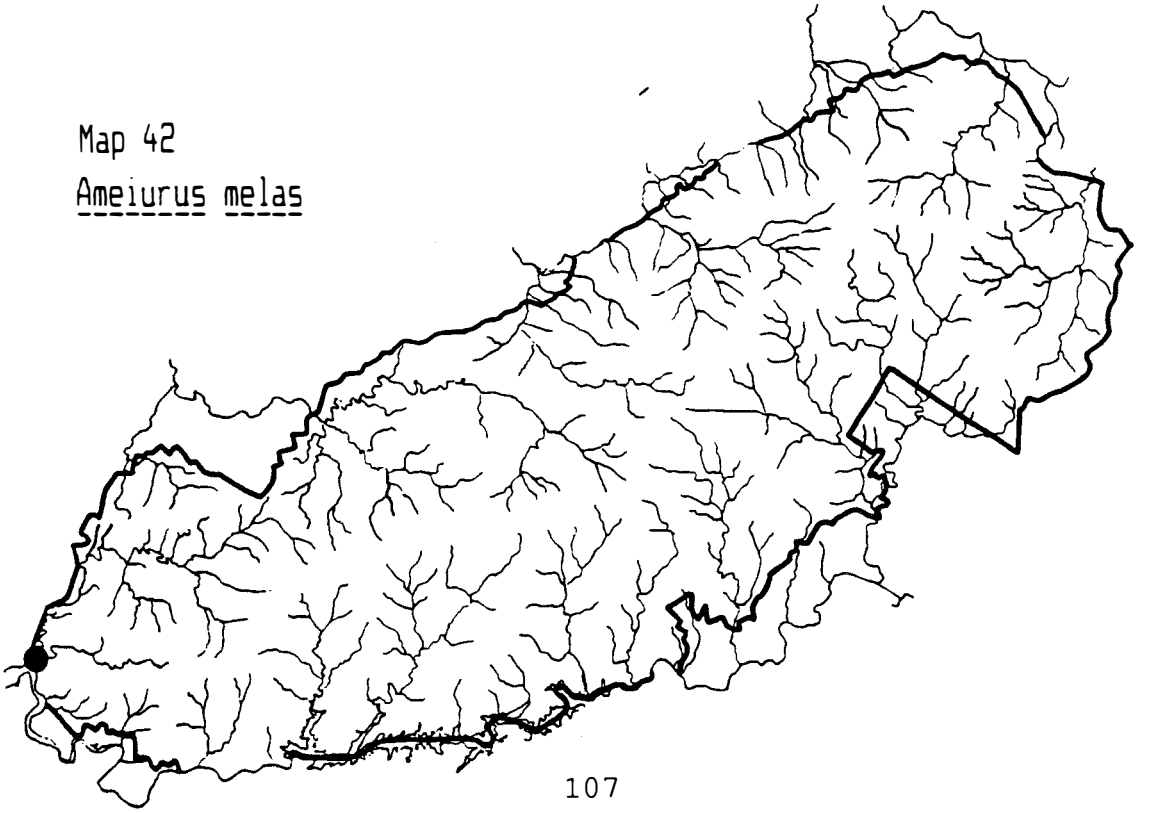
Map 41

Moxostoma macrolepidotum



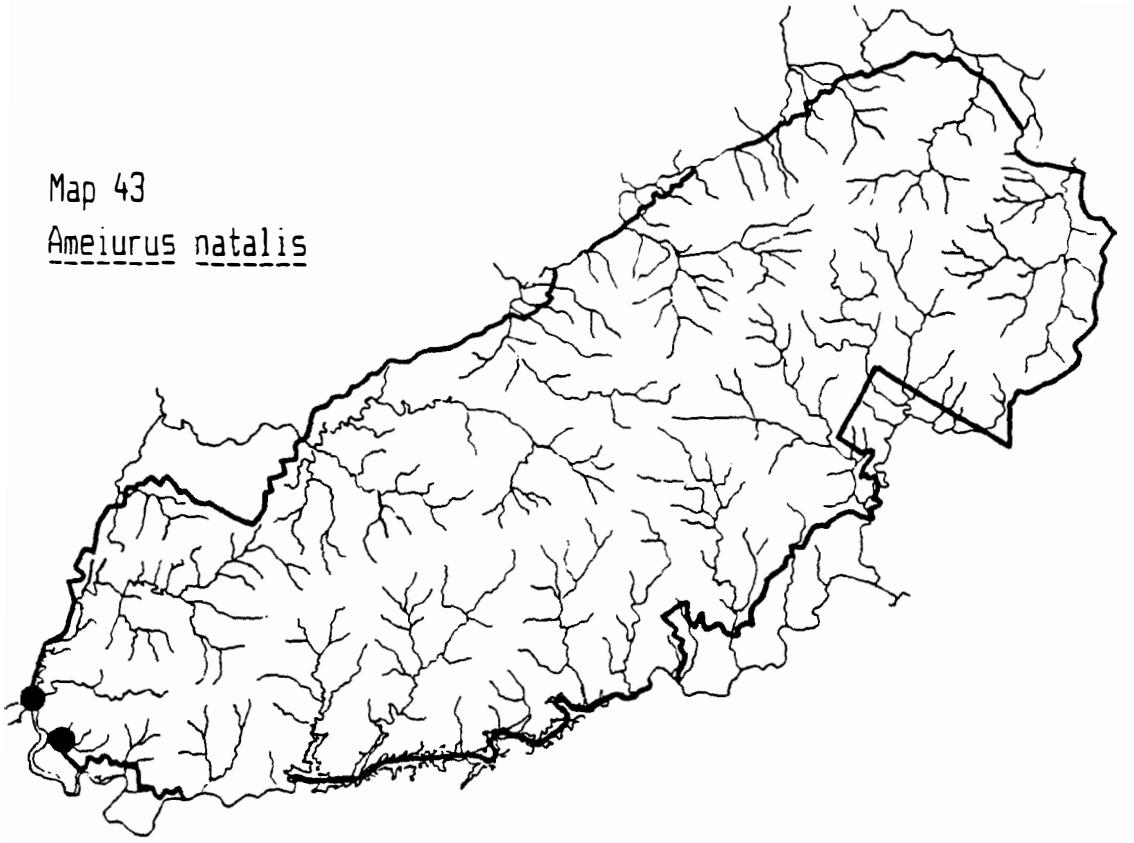
Map 42

Ameiurus melas



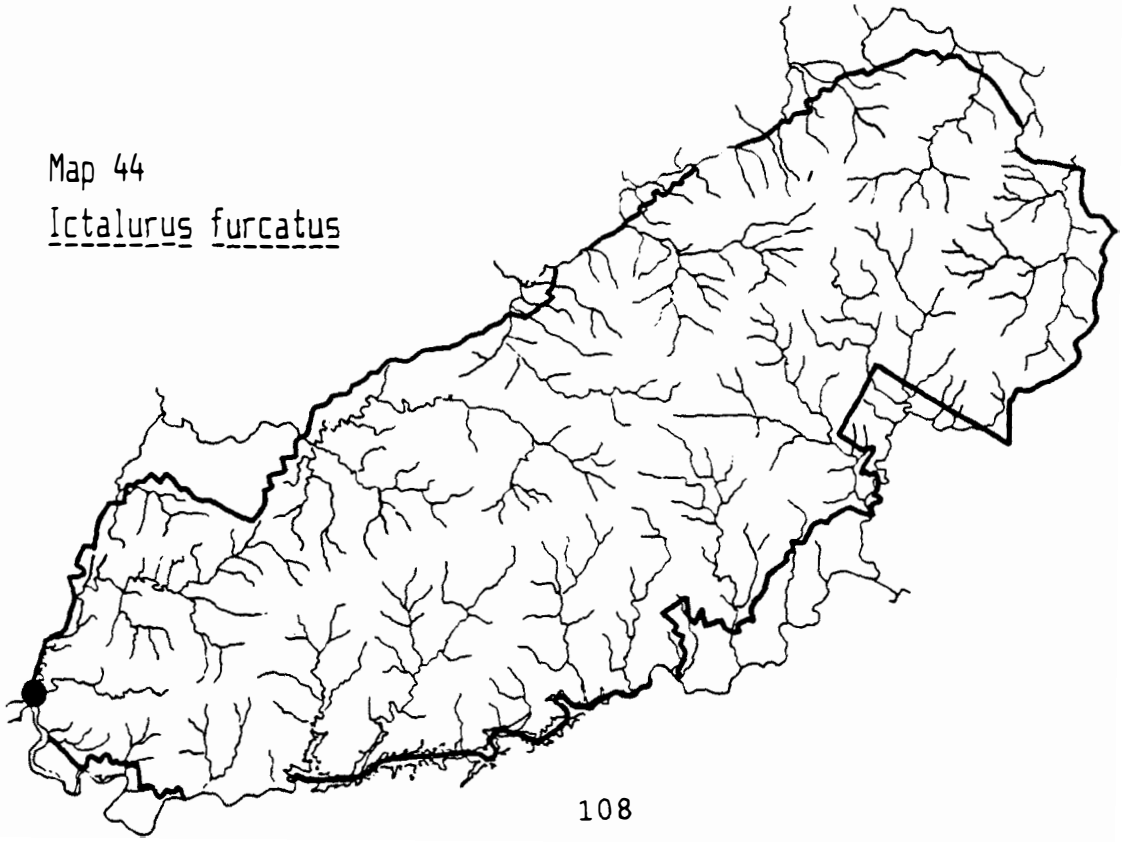
Map 43

Ameiurus natalis



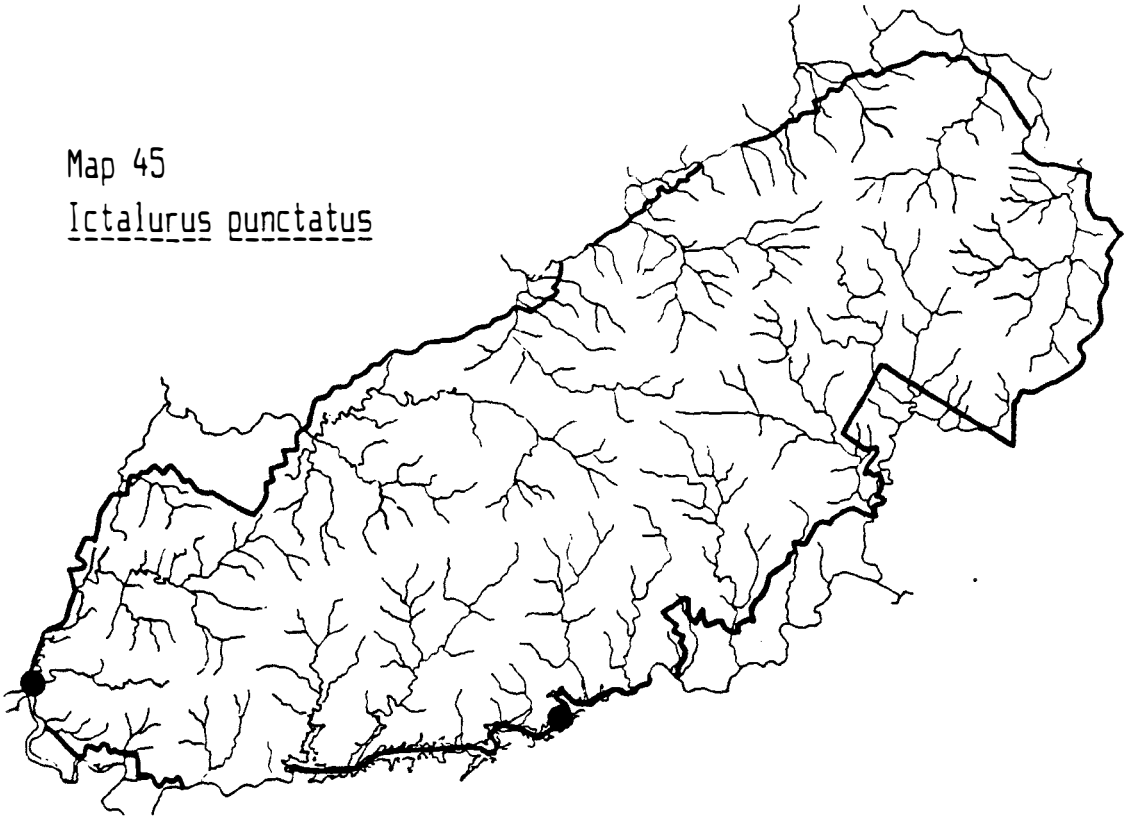
Map 44

Ictalurus furcatus



Map 45

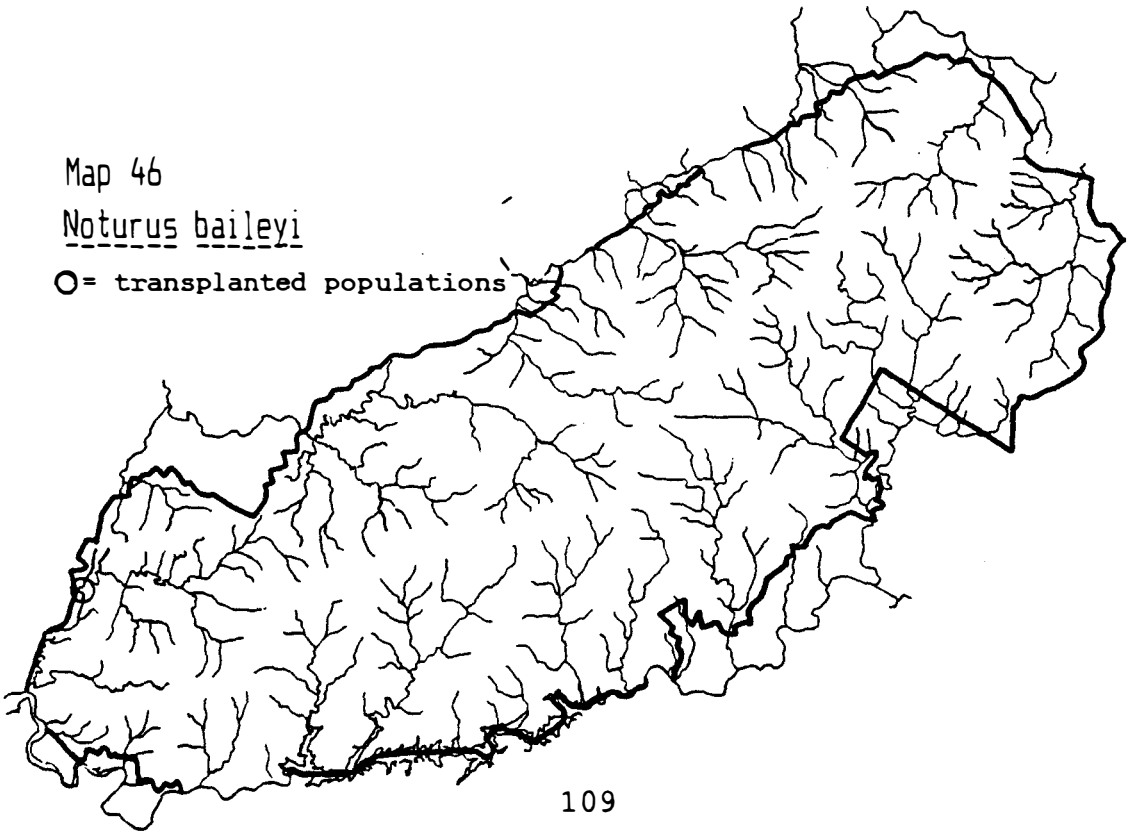
Ictalurus punctatus



Map 46

Noturus baileyi

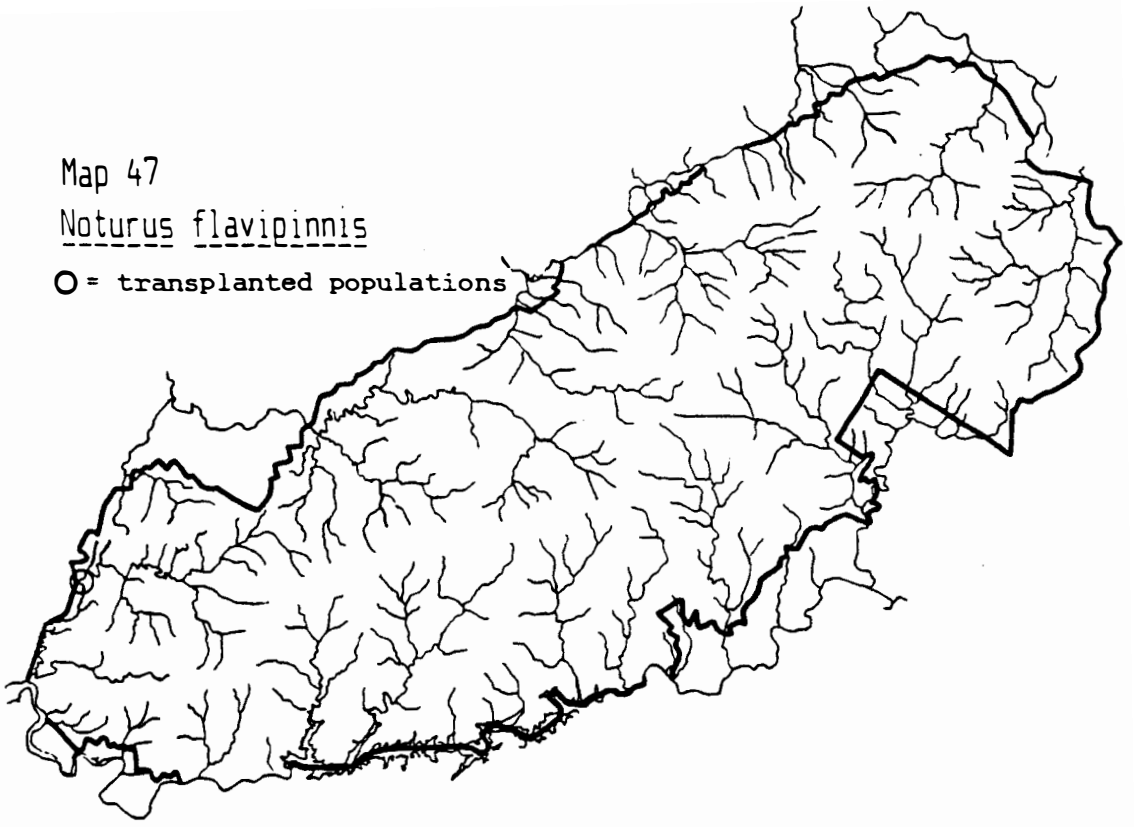
O= transplanted populations



Map 47

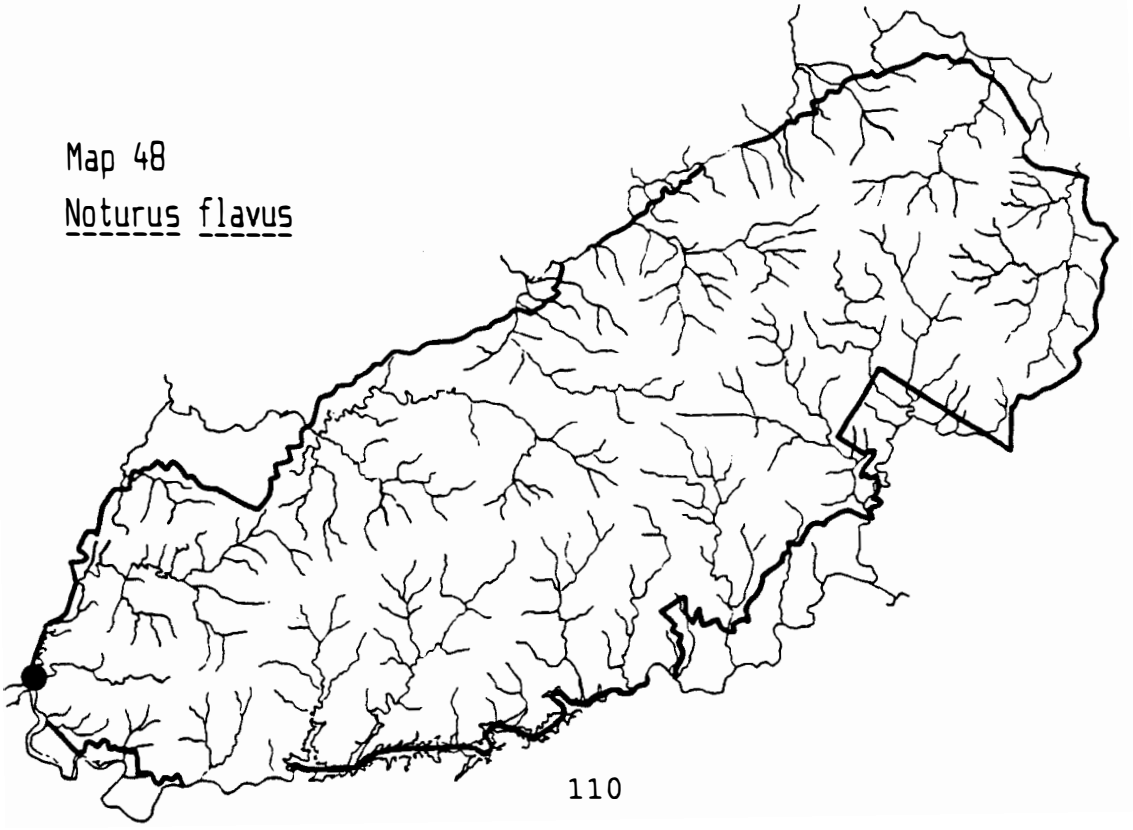
Noturus flavipinnis

O = transplanted populations



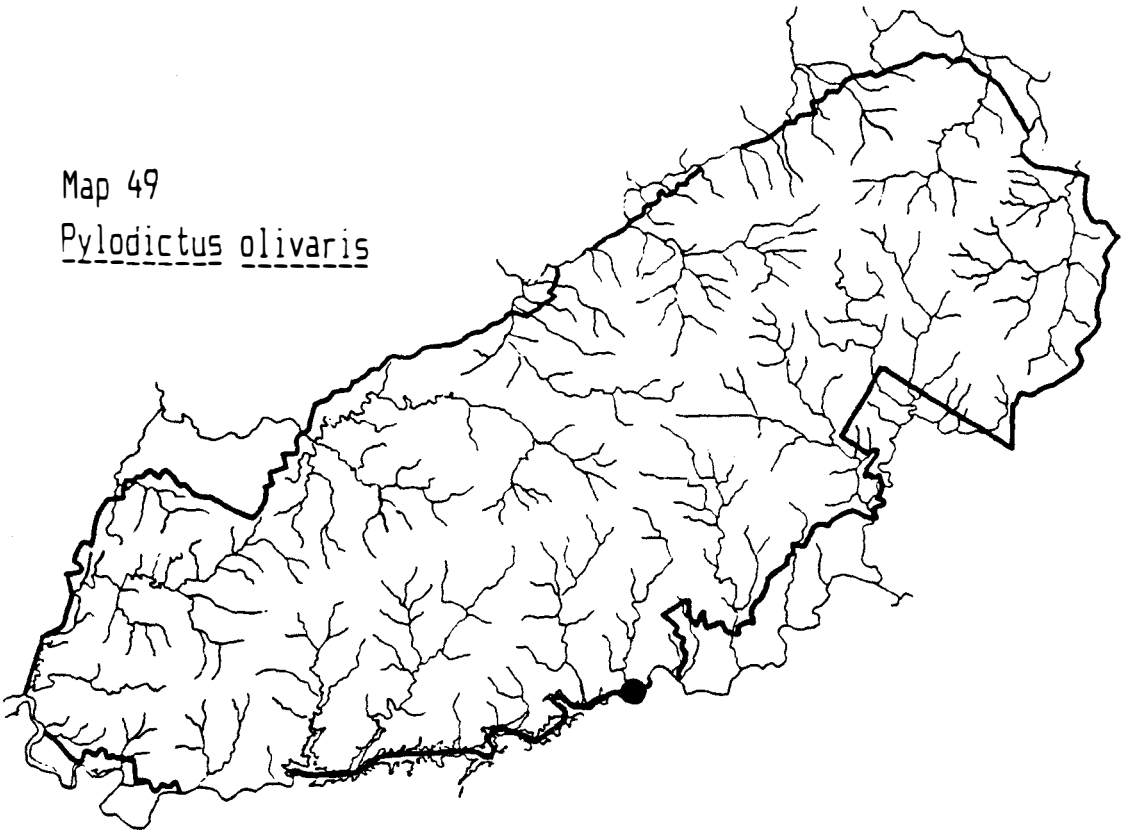
Map 48

Noturus flavus



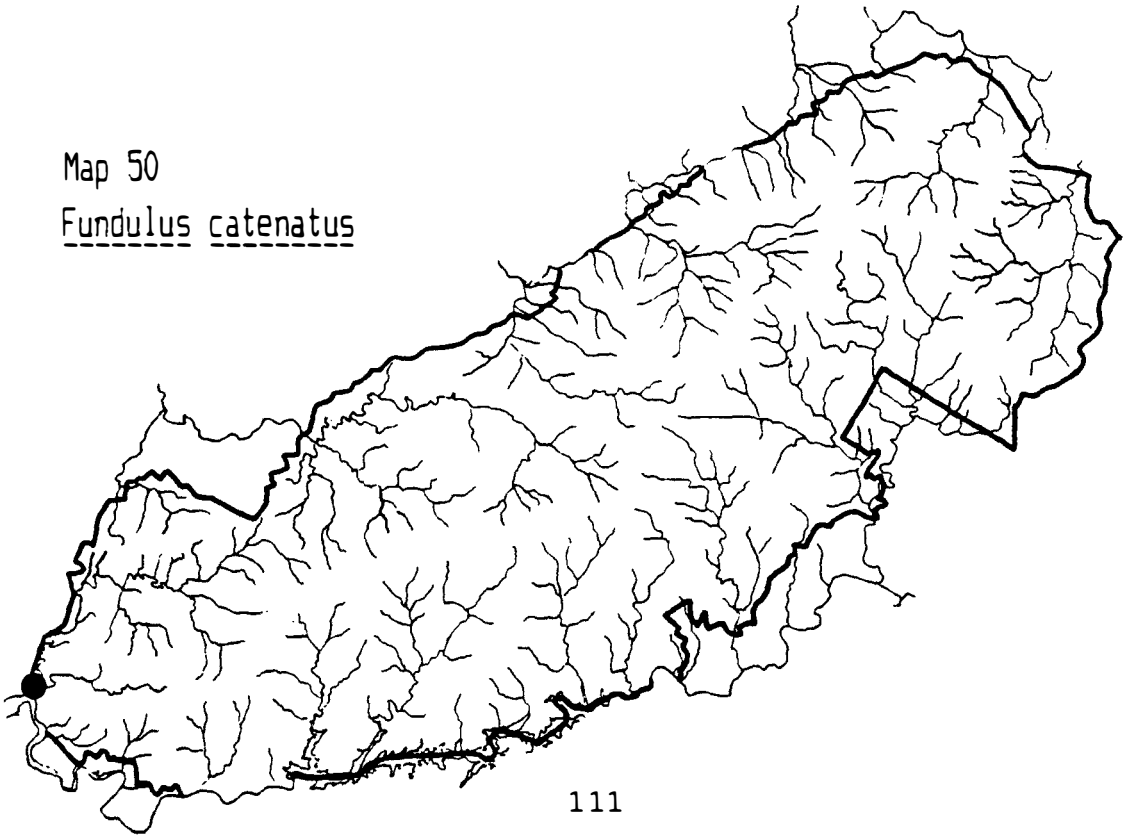
Map 49

Pylodictus olivaris



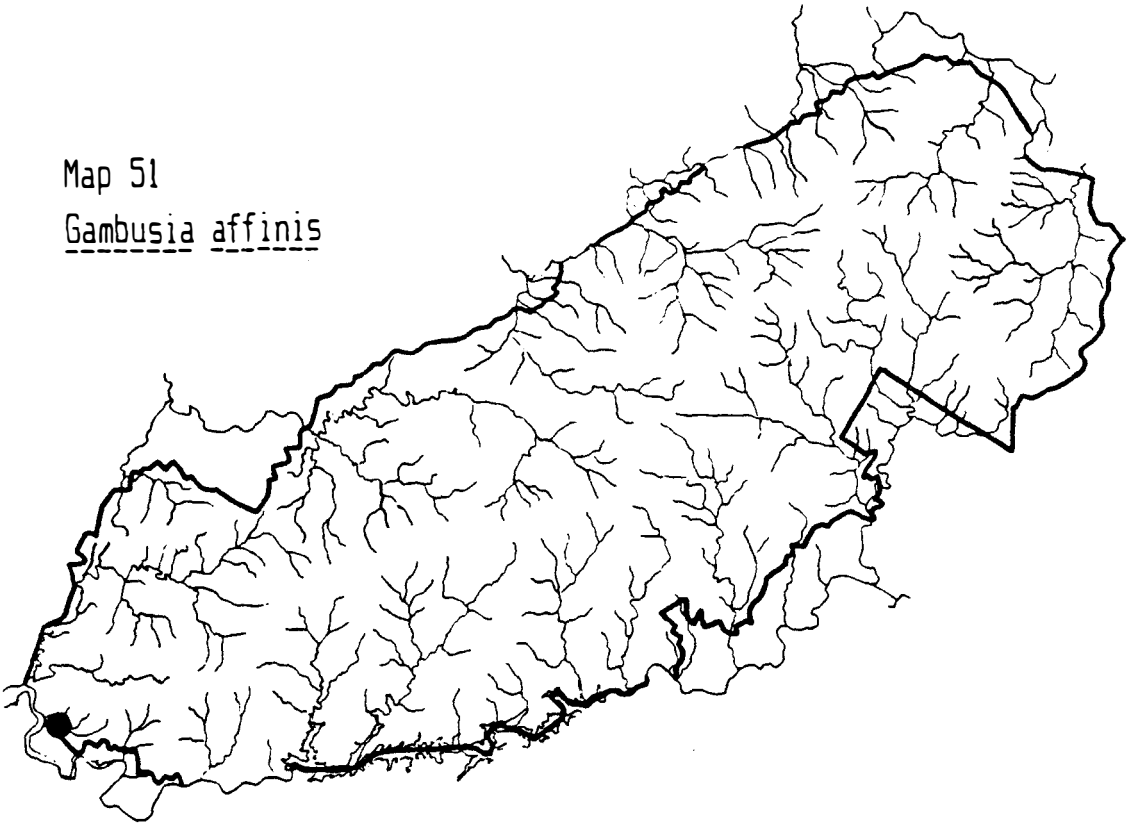
Map 50

Fundulus catenatus



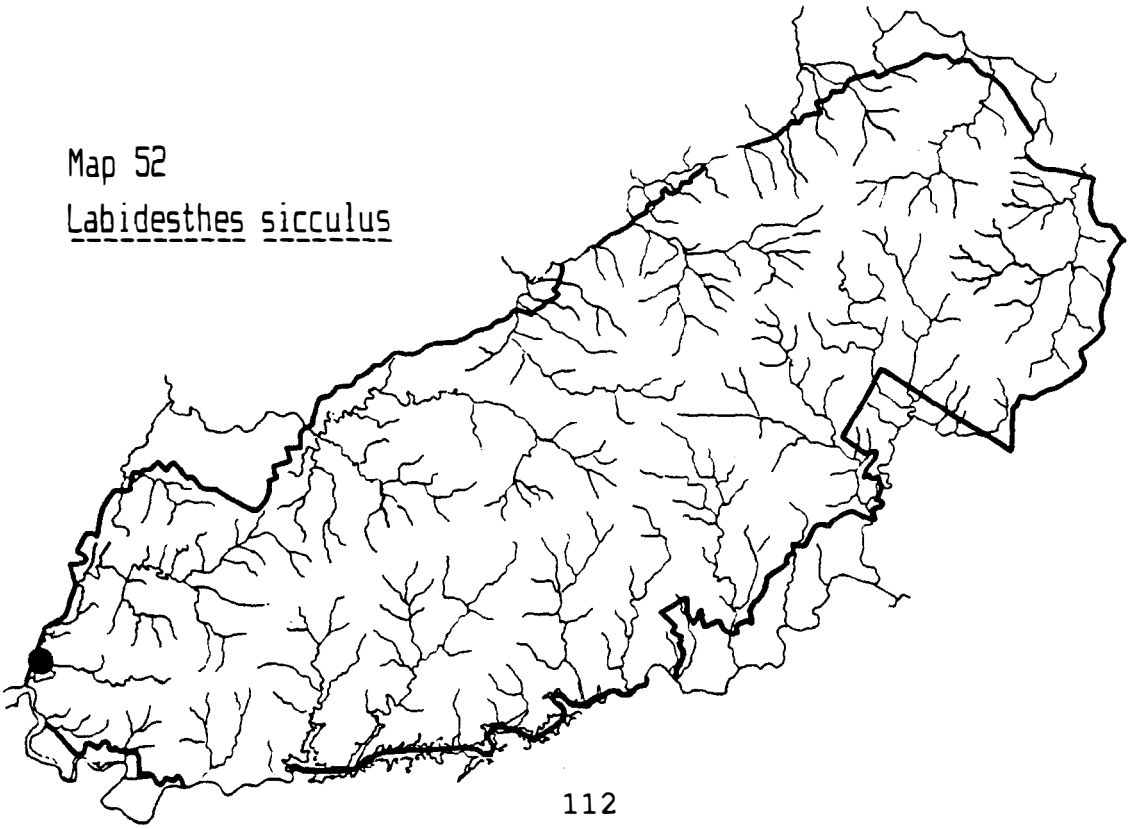
Map 51

Gambusia affinis



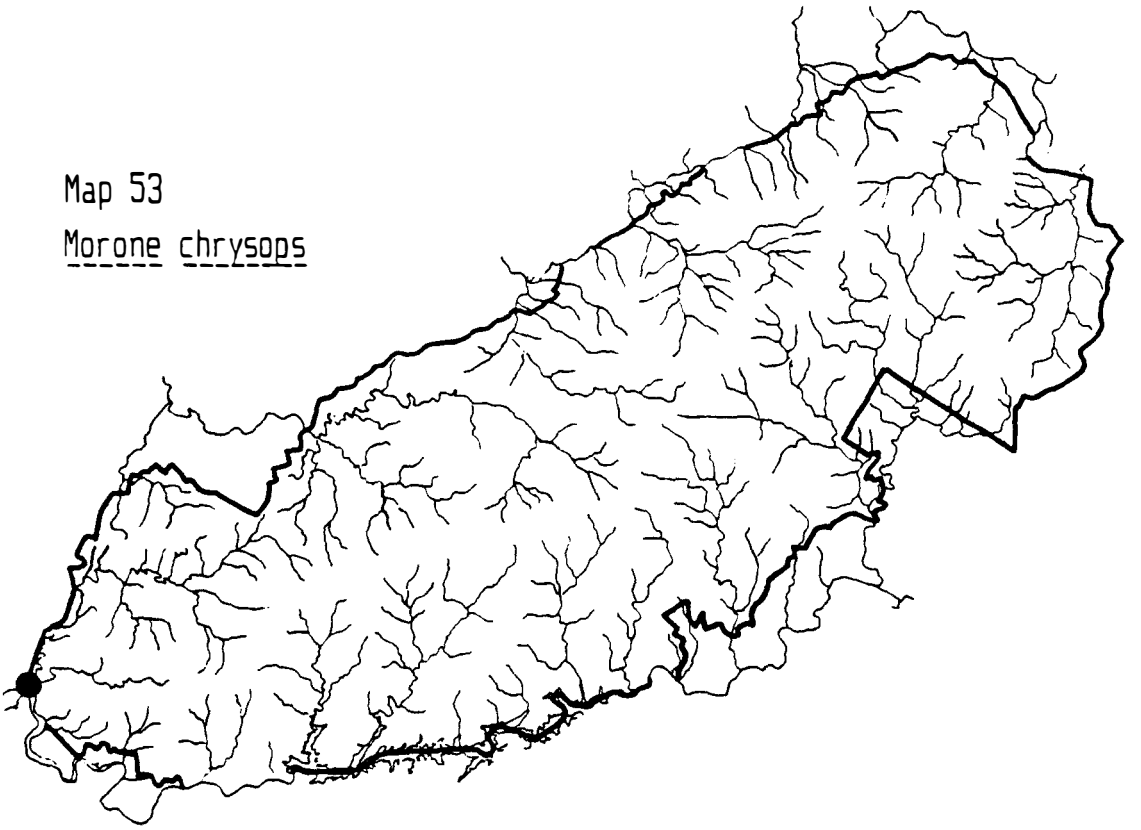
Map 52

Labidesthes sicculus



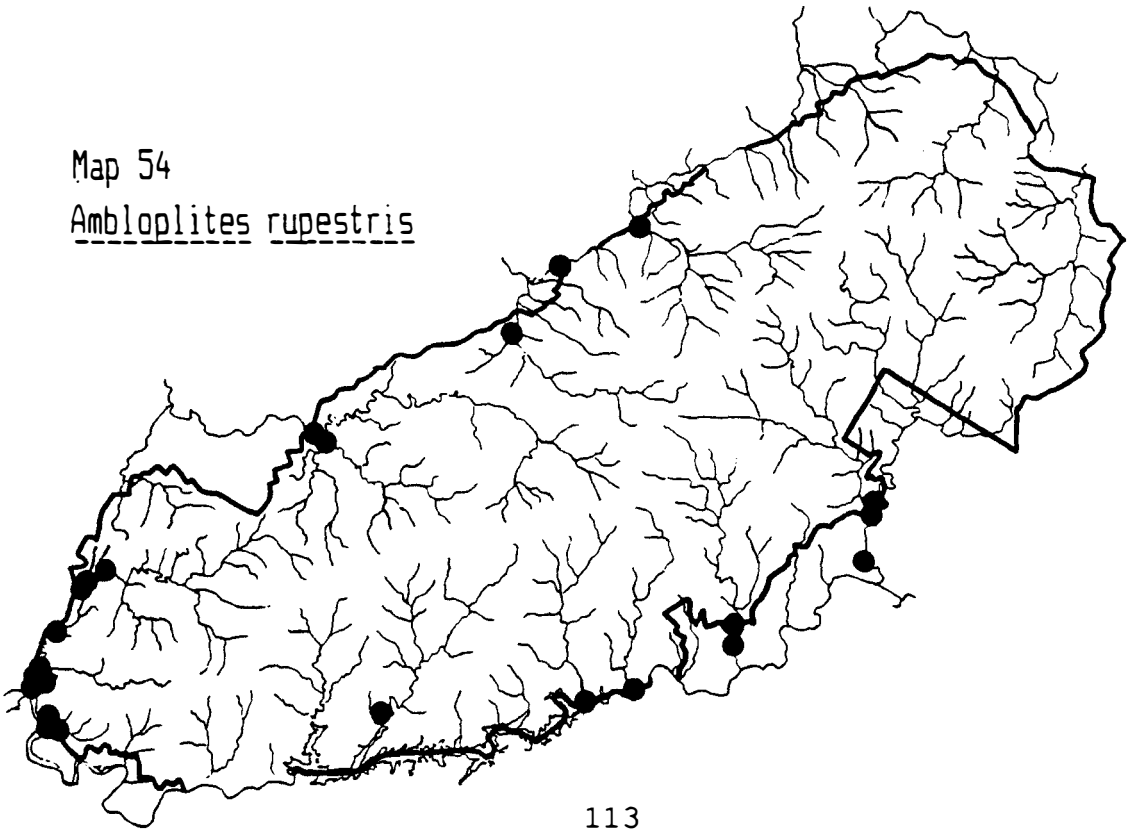
Map 53

Morone chrysops



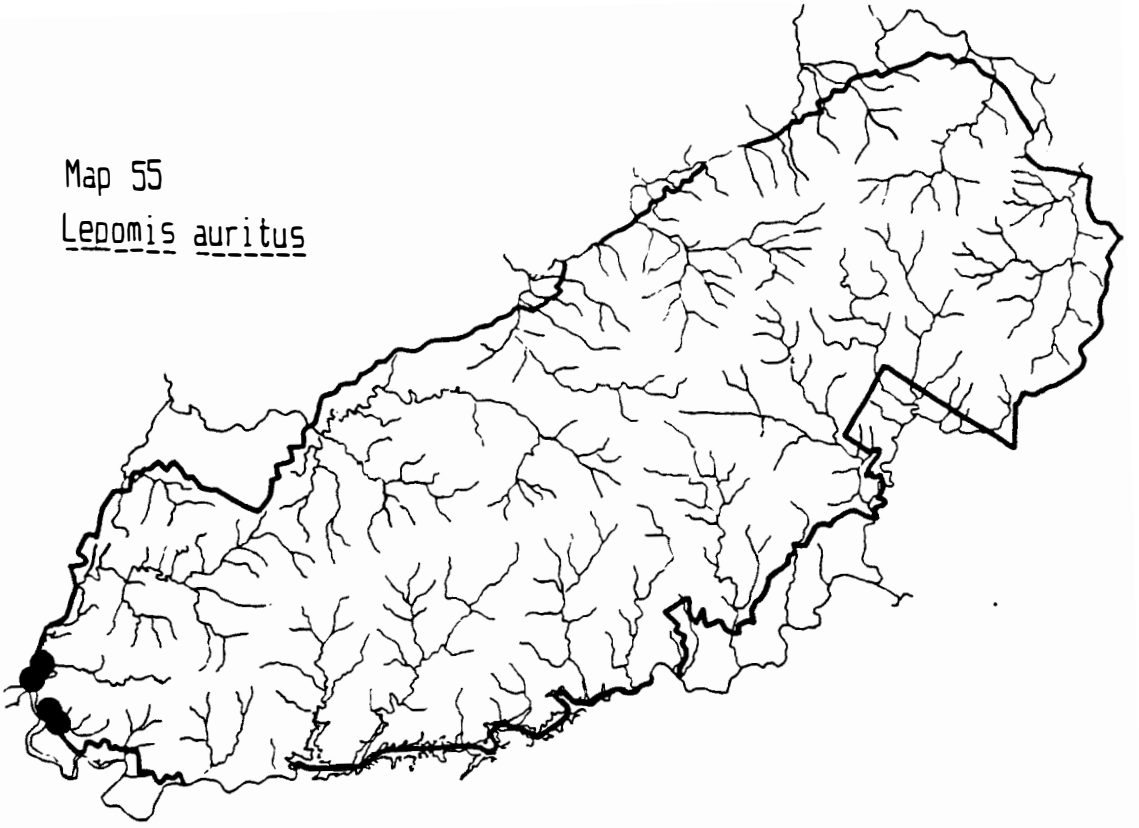
Map 54

Ambloplites rupestris



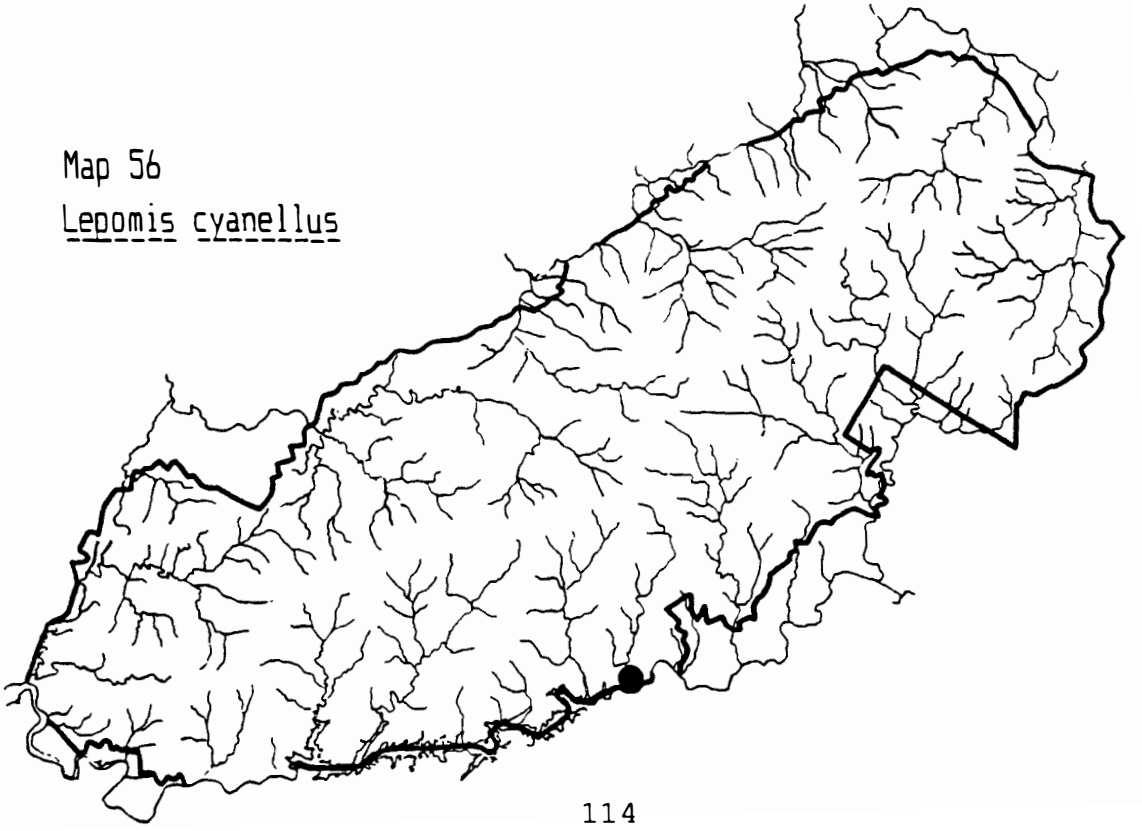
Map 55

Lepomis auritus



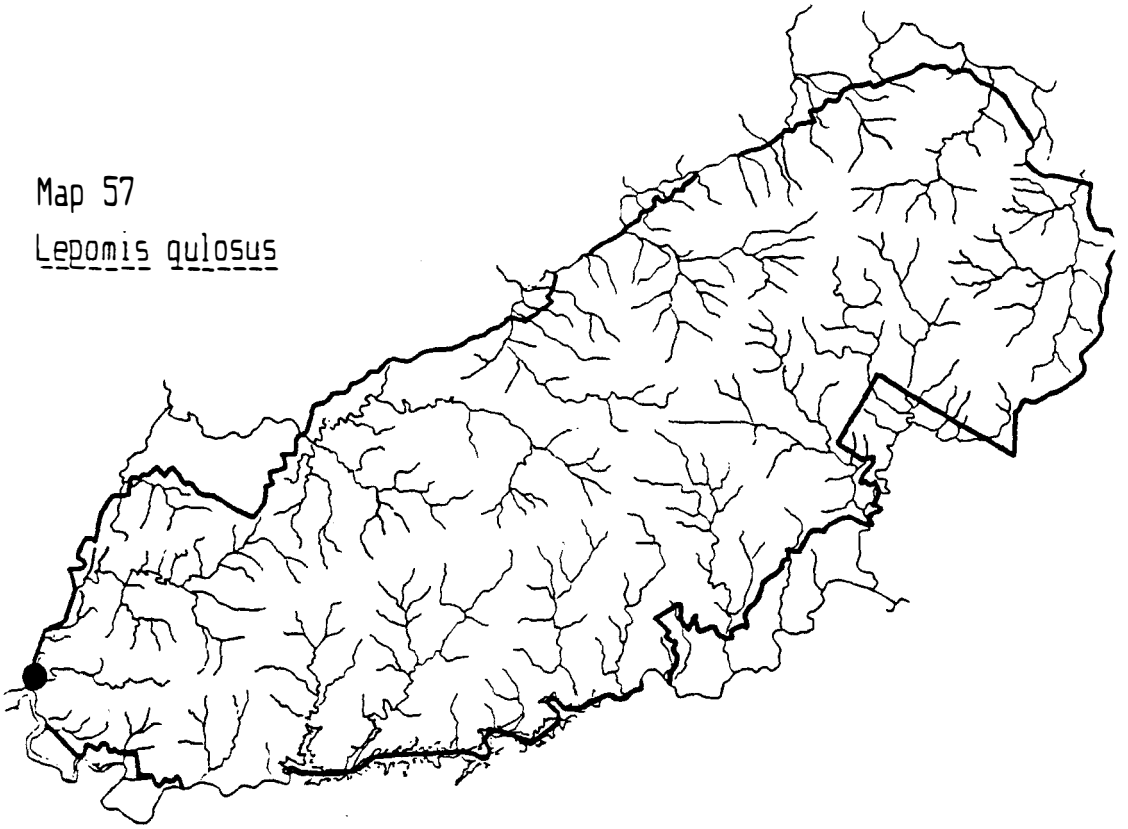
Map 56

Lepomis cyanellus



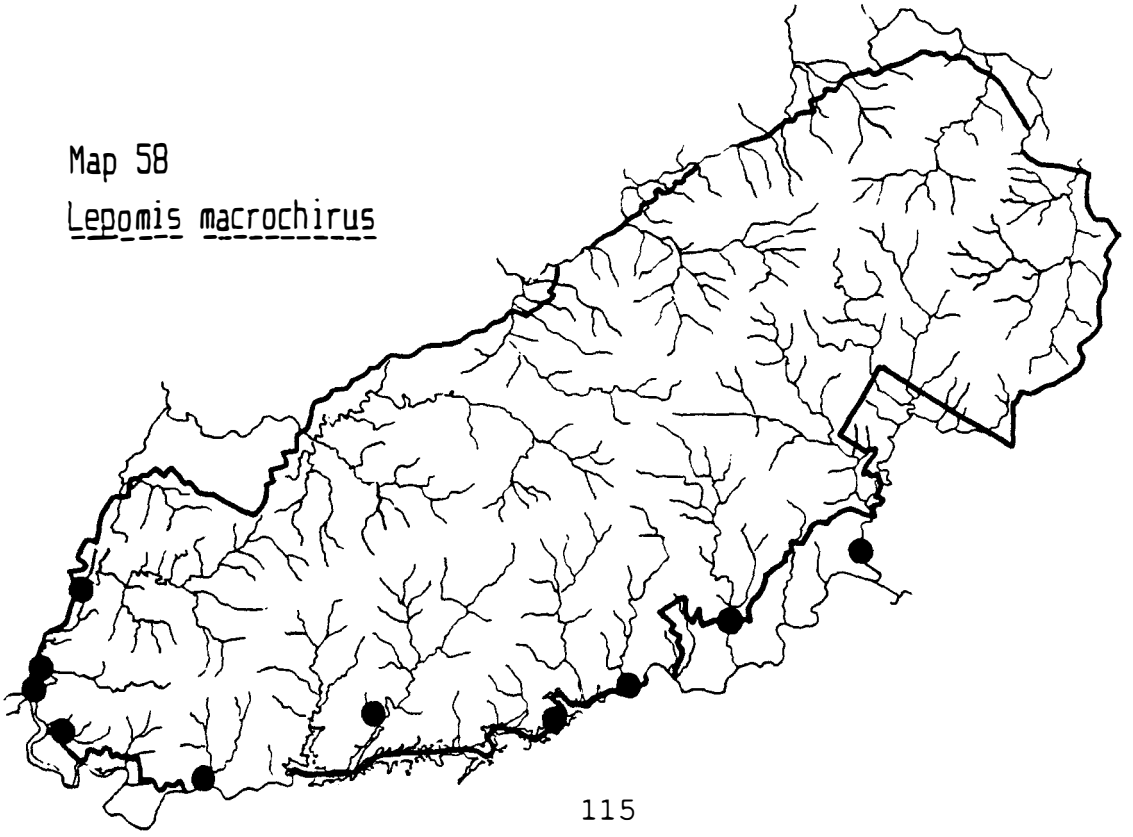
Map 57

Lepomis gulosus



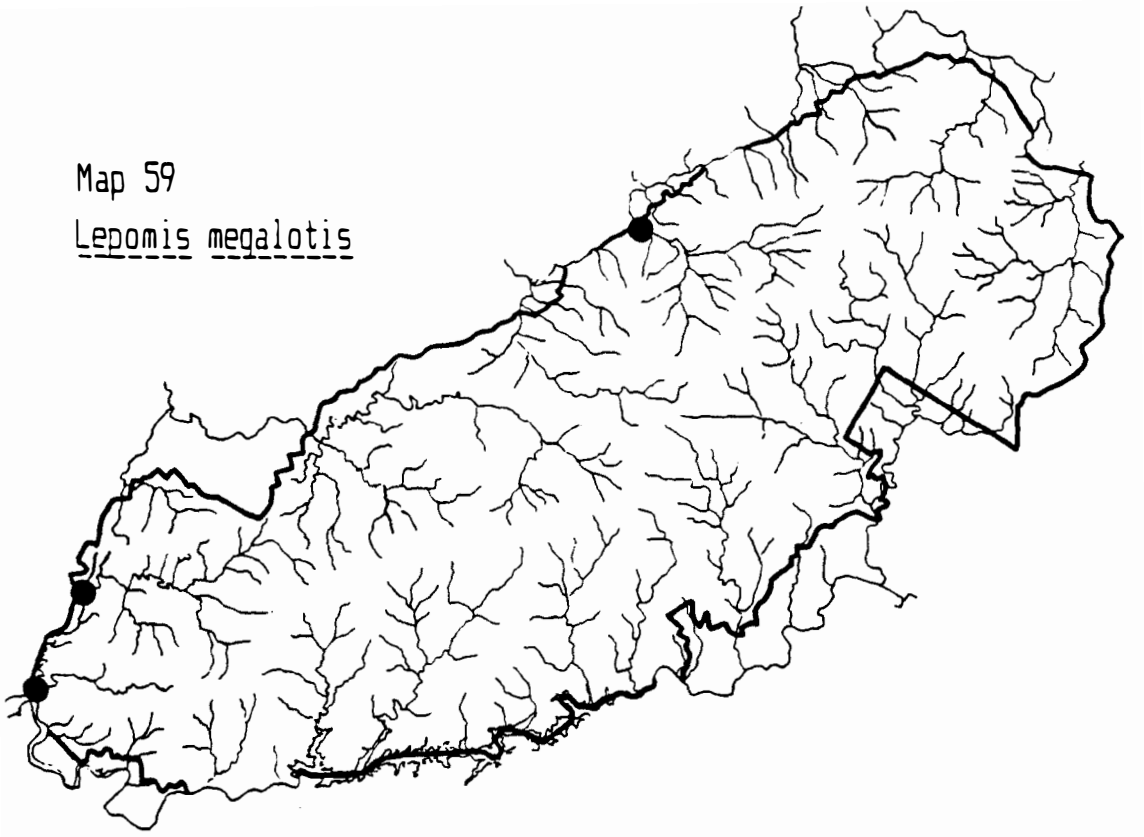
Map 58

Lepomis macrochirus



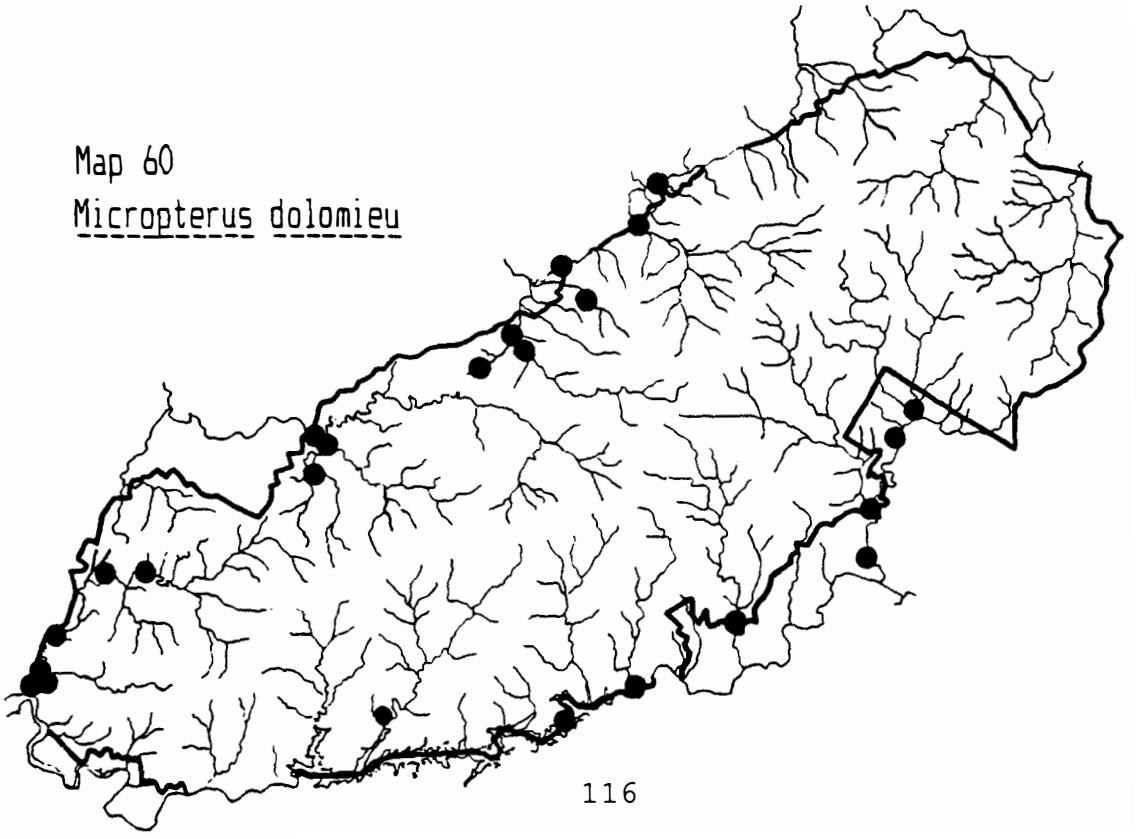
Map 59

Lepomis megalotis



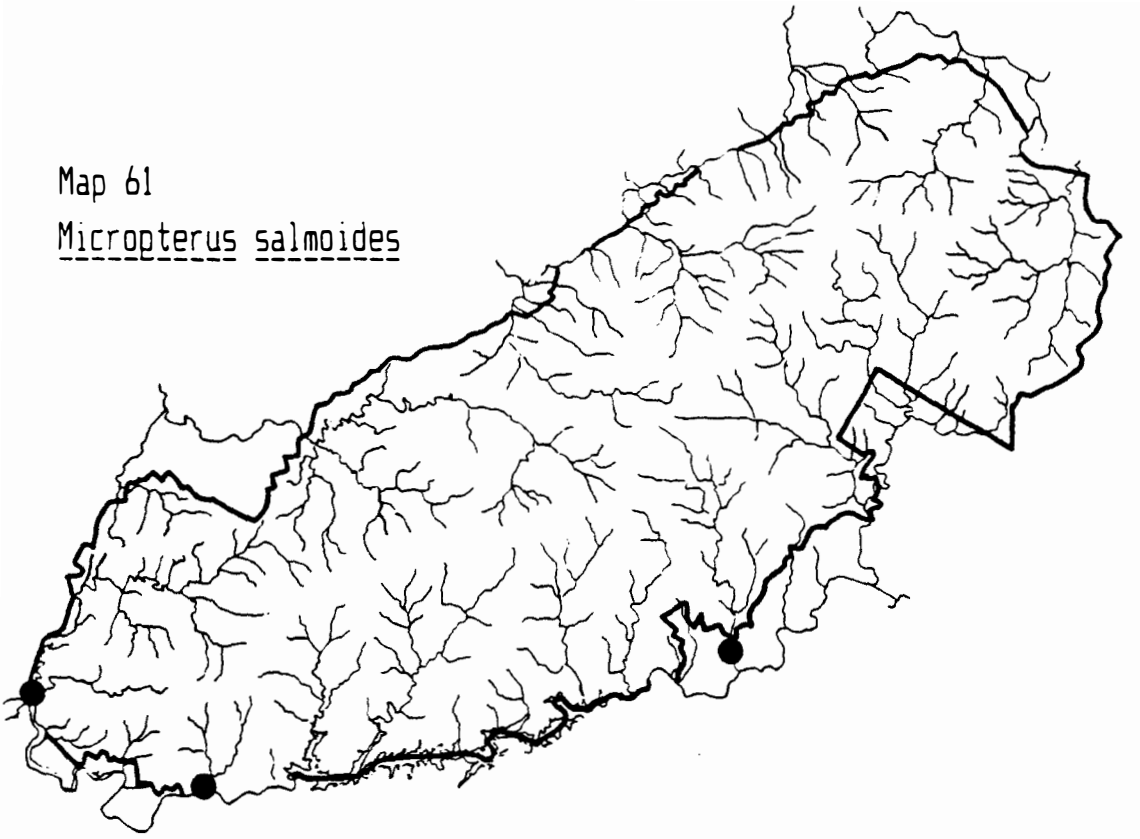
Map 60

Micropterus dolomieu



Map 61

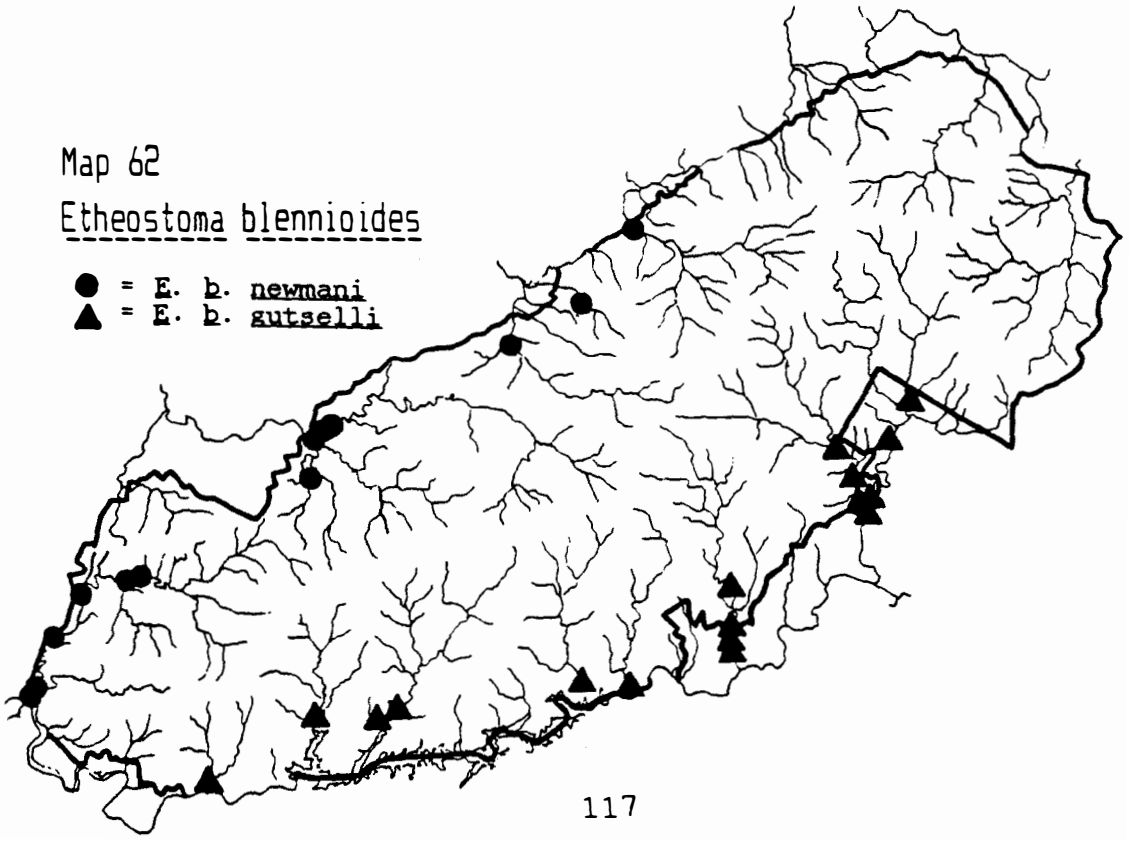
Micropterus salmoides



Map 62

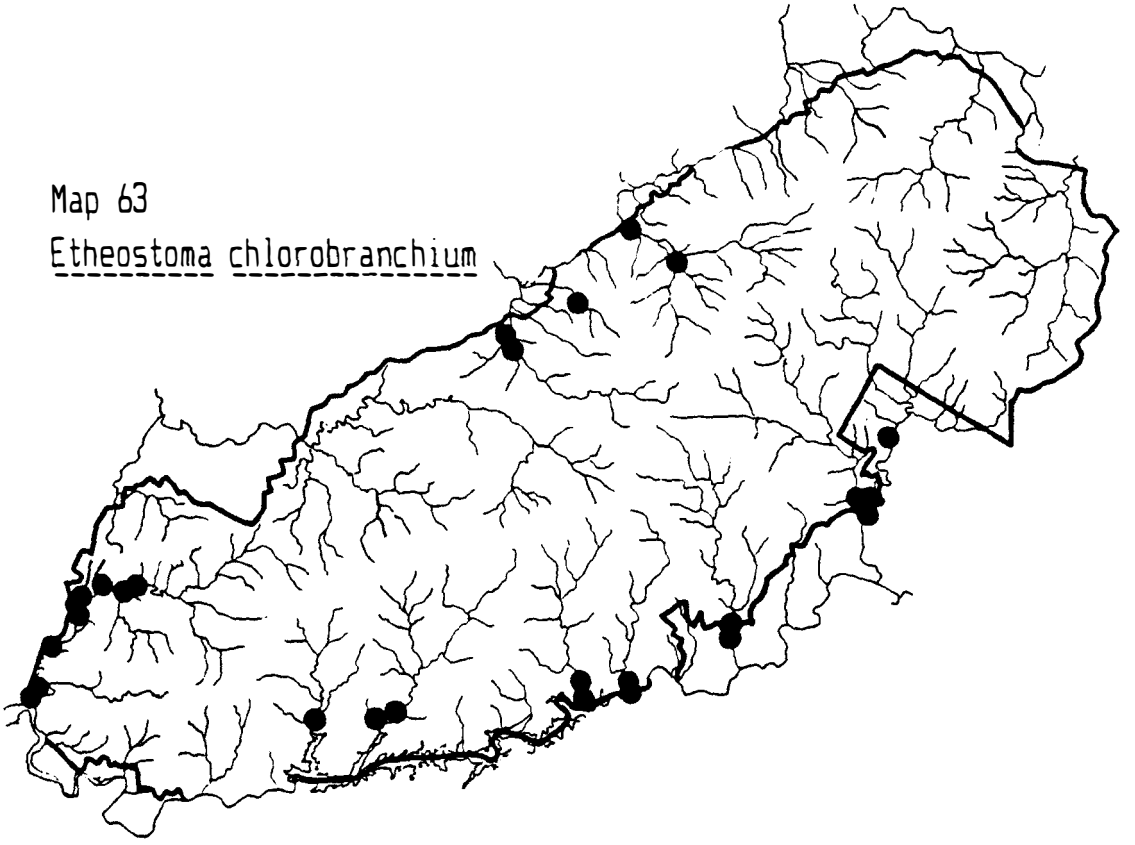
Etheostoma blennioides

● = E. b. newmani
▲ = E. b. gutselli



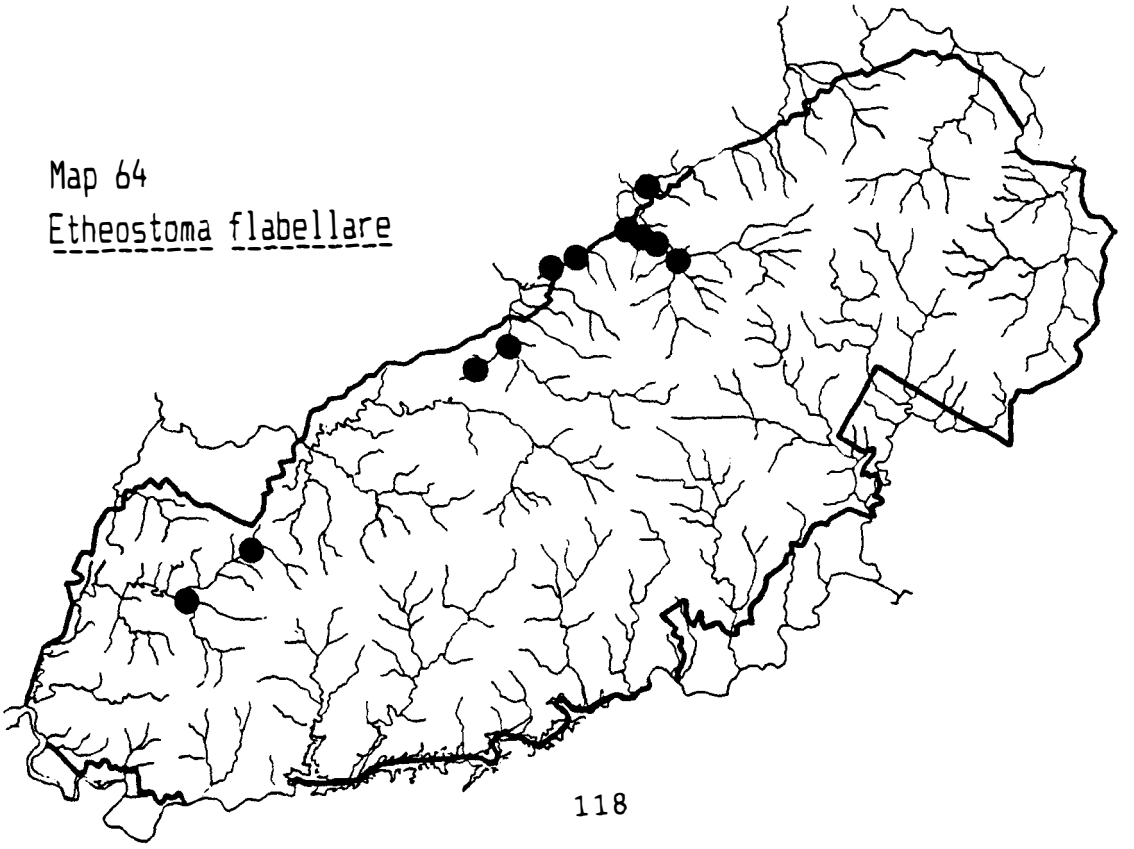
Map 63

Etheostoma chlorobranchium

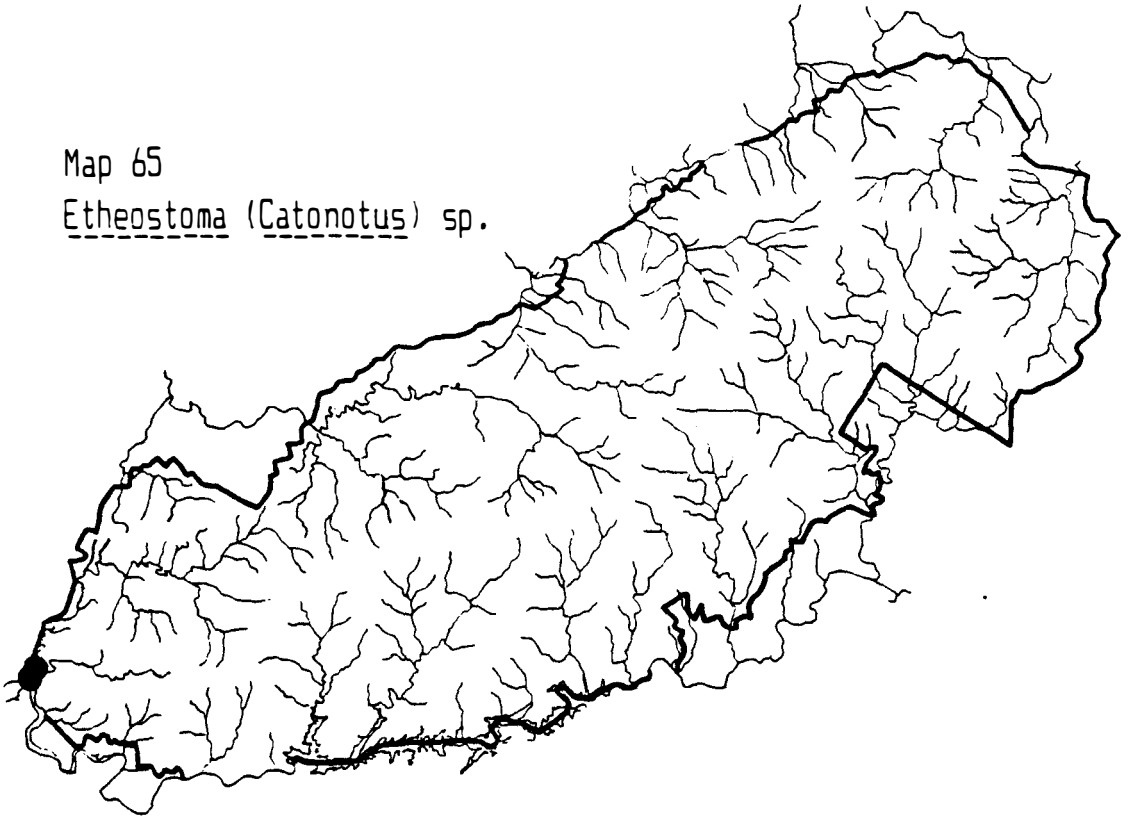


Map 64

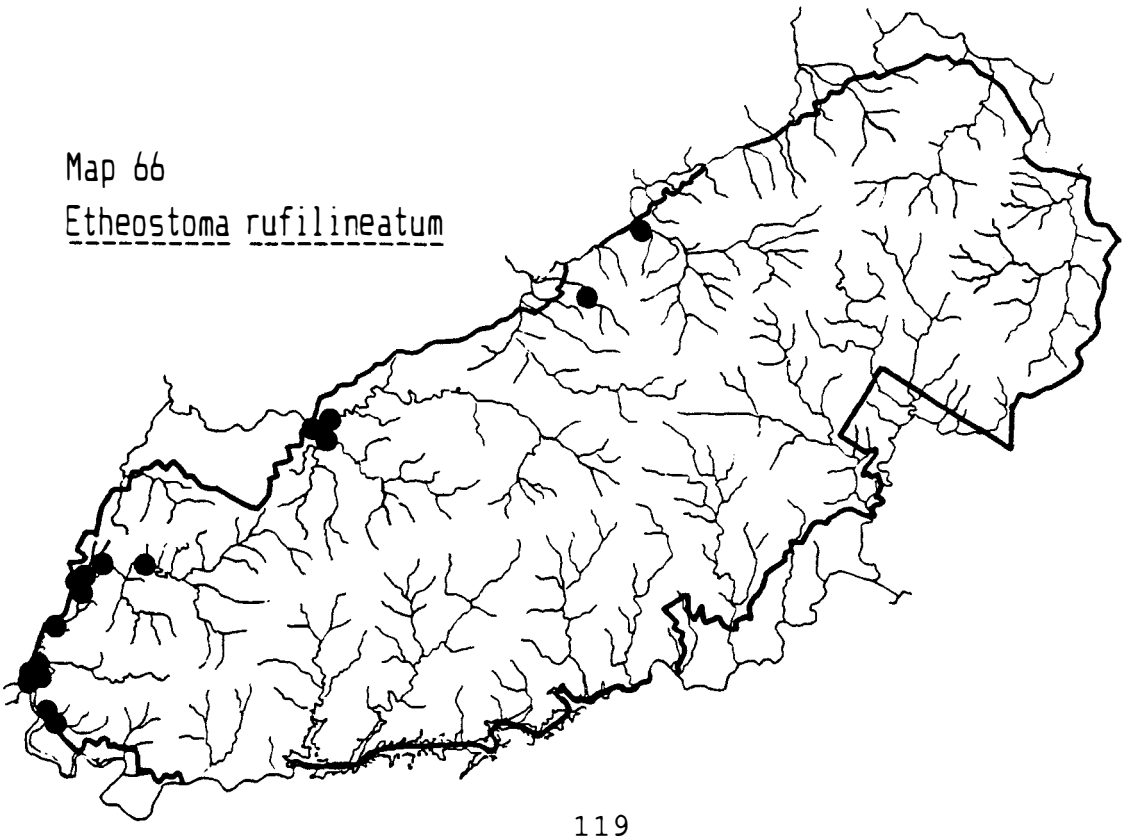
Etheostoma flabellare



Map 65
Etheostoma (Catonotus) sp.

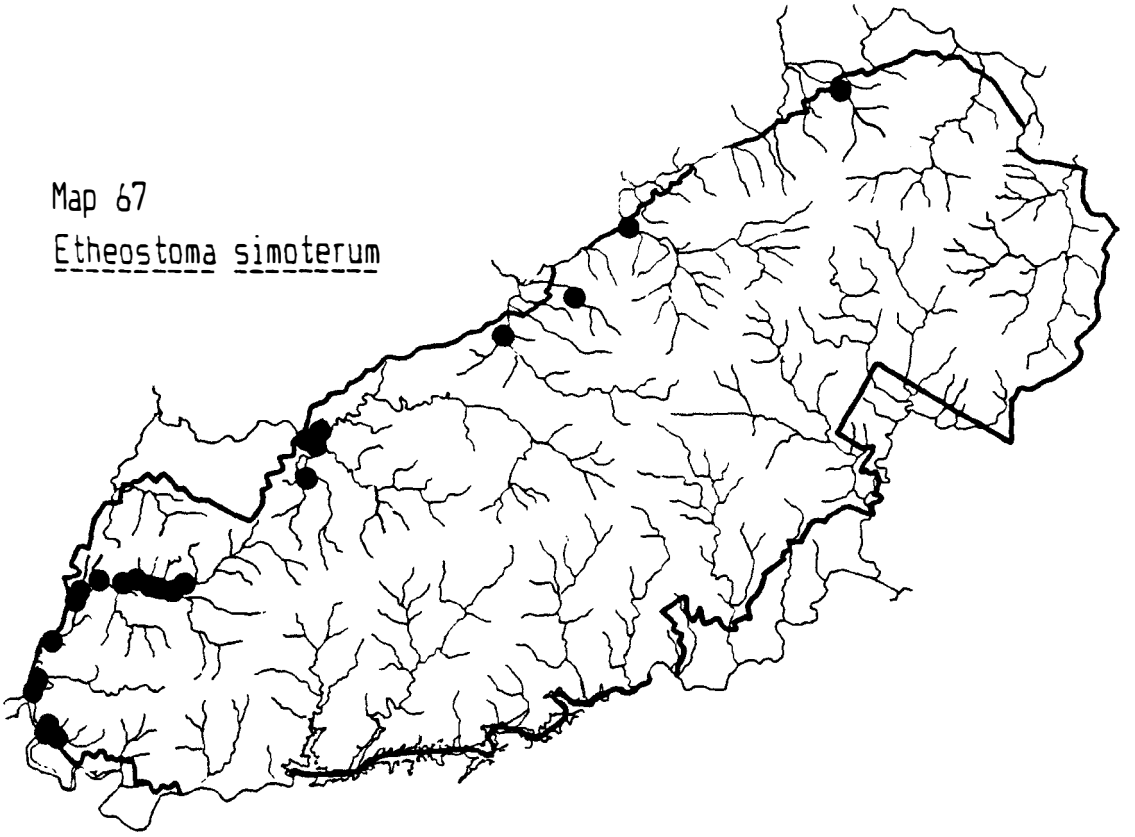


Map 66
Etheostoma rufilineatum



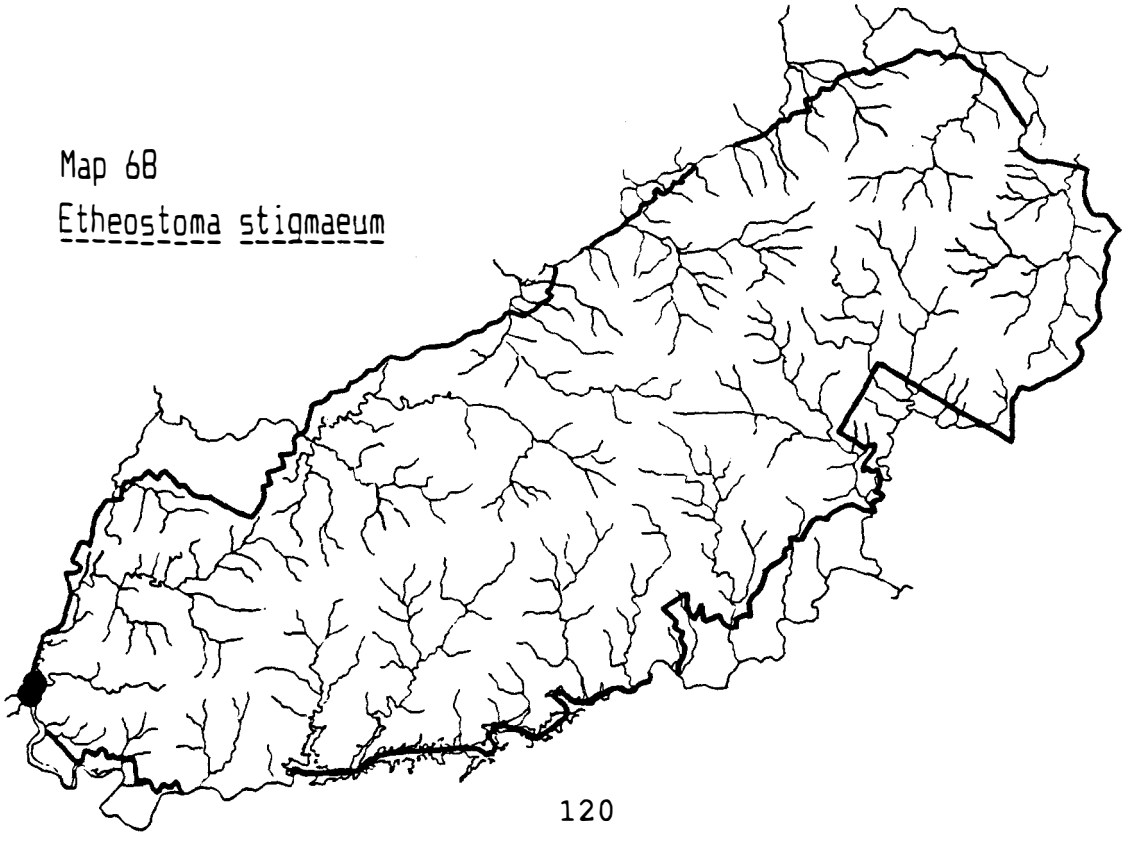
Map 67

Etheostoma simoterum



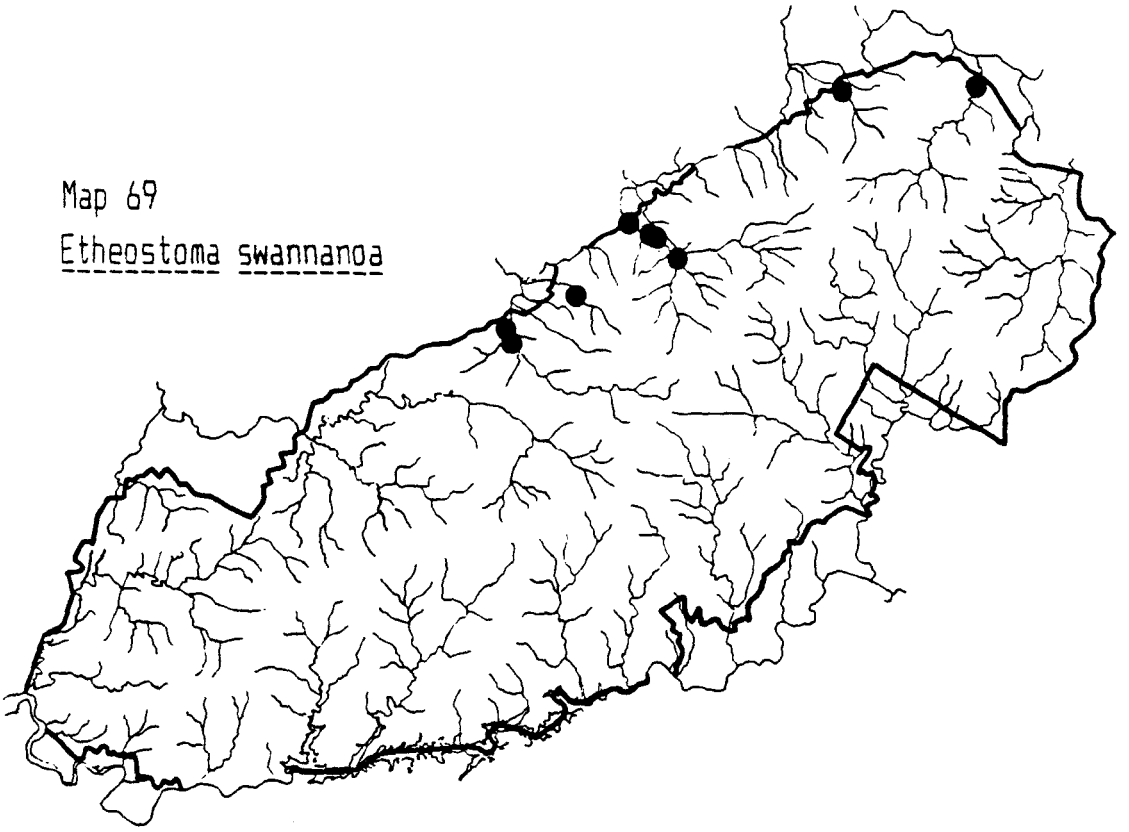
Map 68

Etheostoma stigmaeum



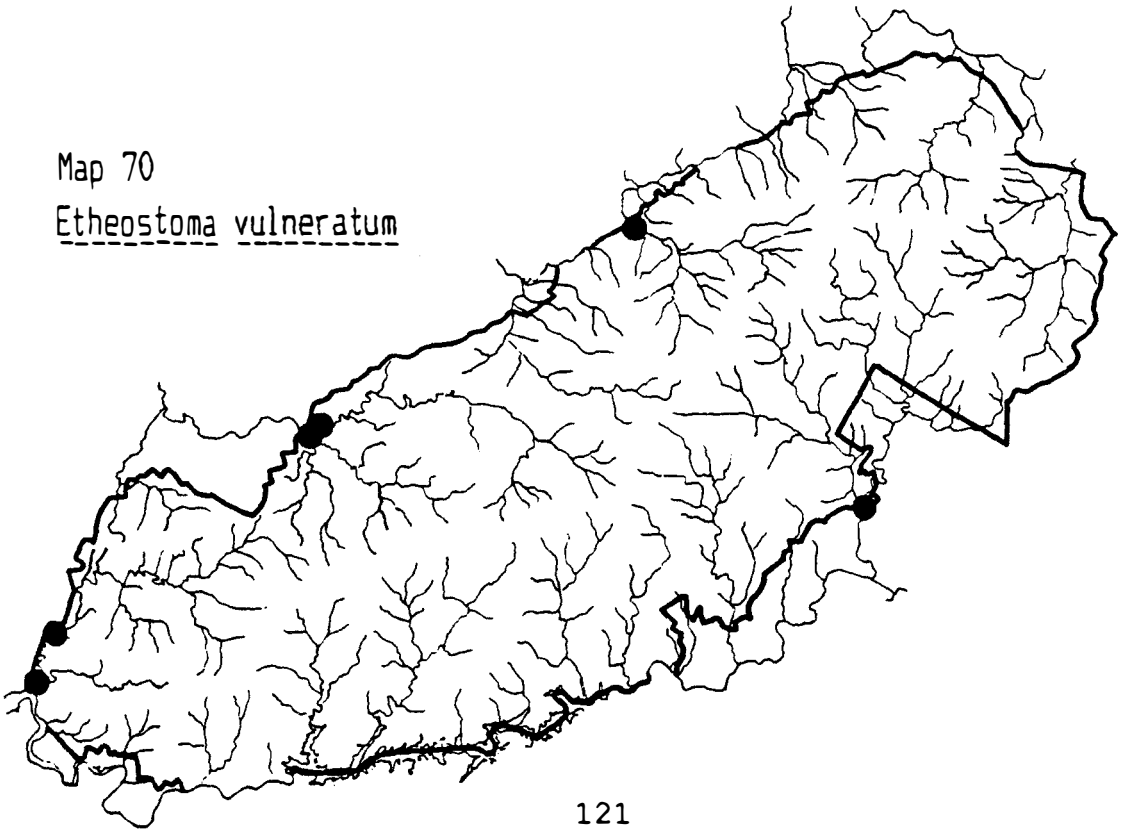
Map 69

Etheostoma swannanoa

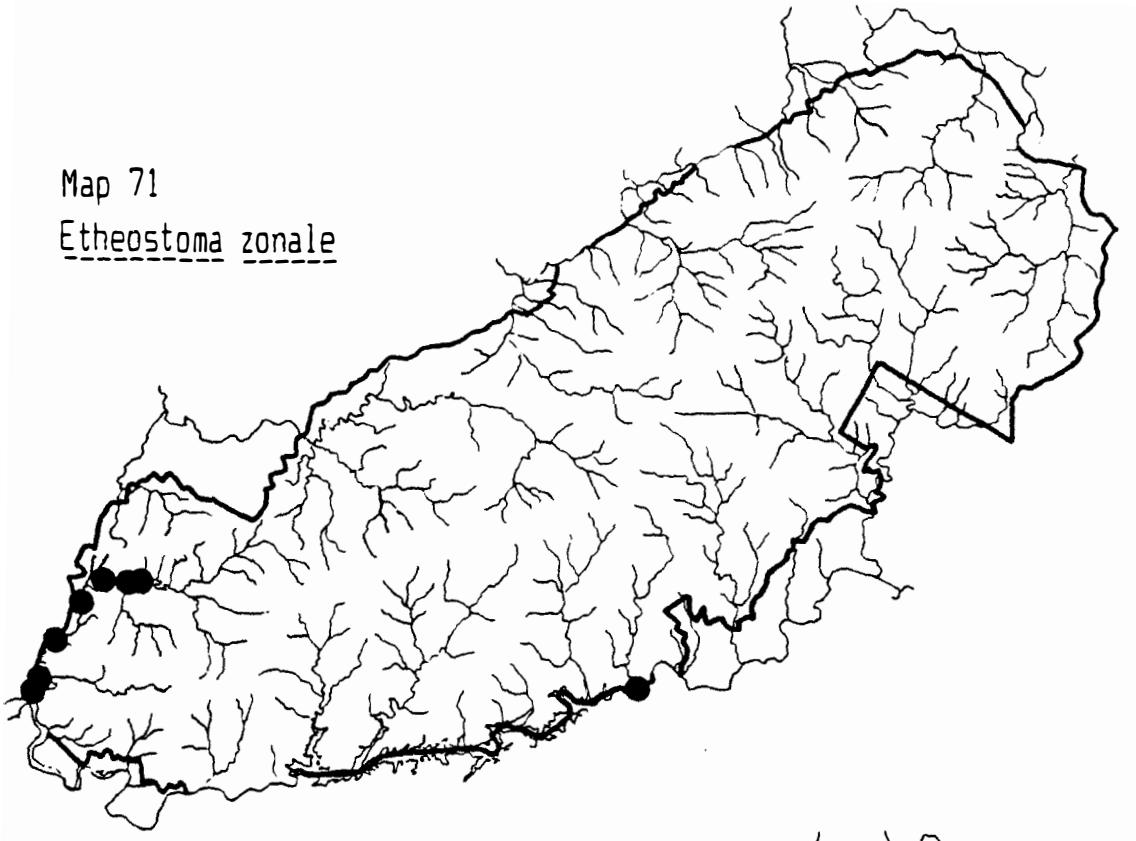


Map 70

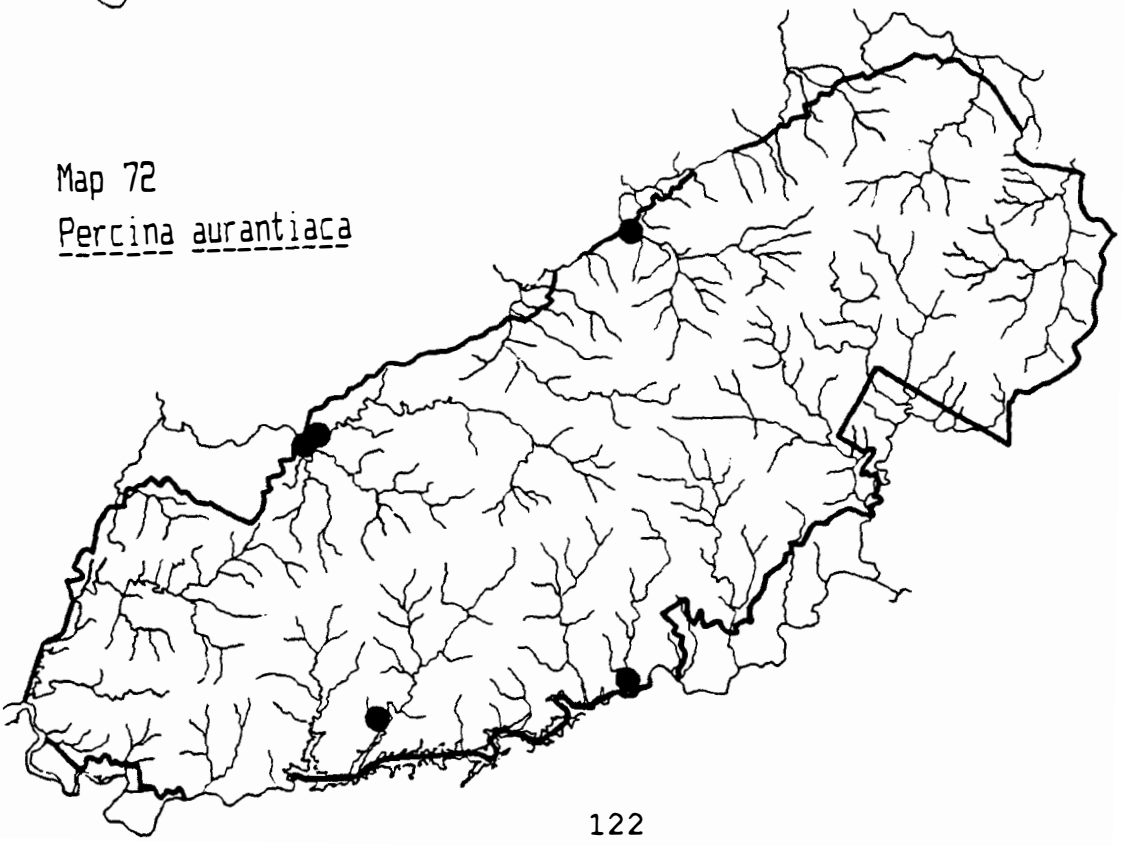
Etheostoma vulneratum



Map 71
Etheostoma zonale

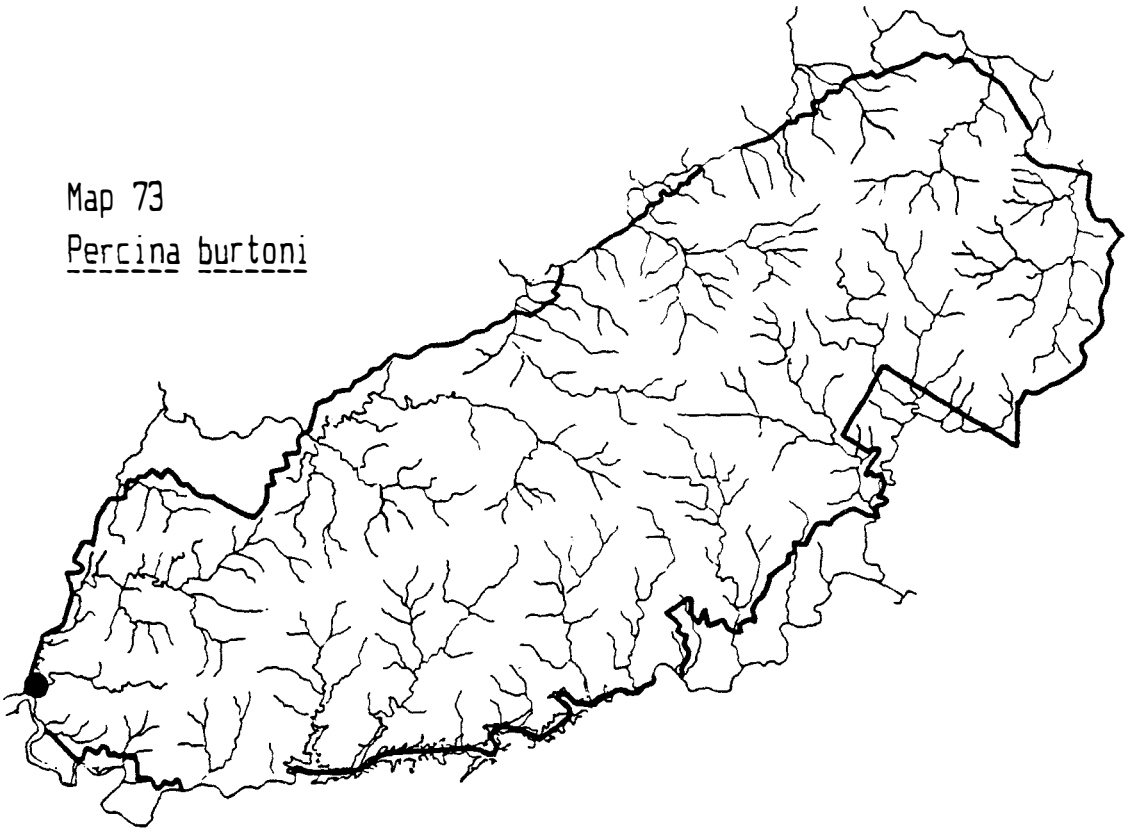


Map 72
Percina aurantiaca



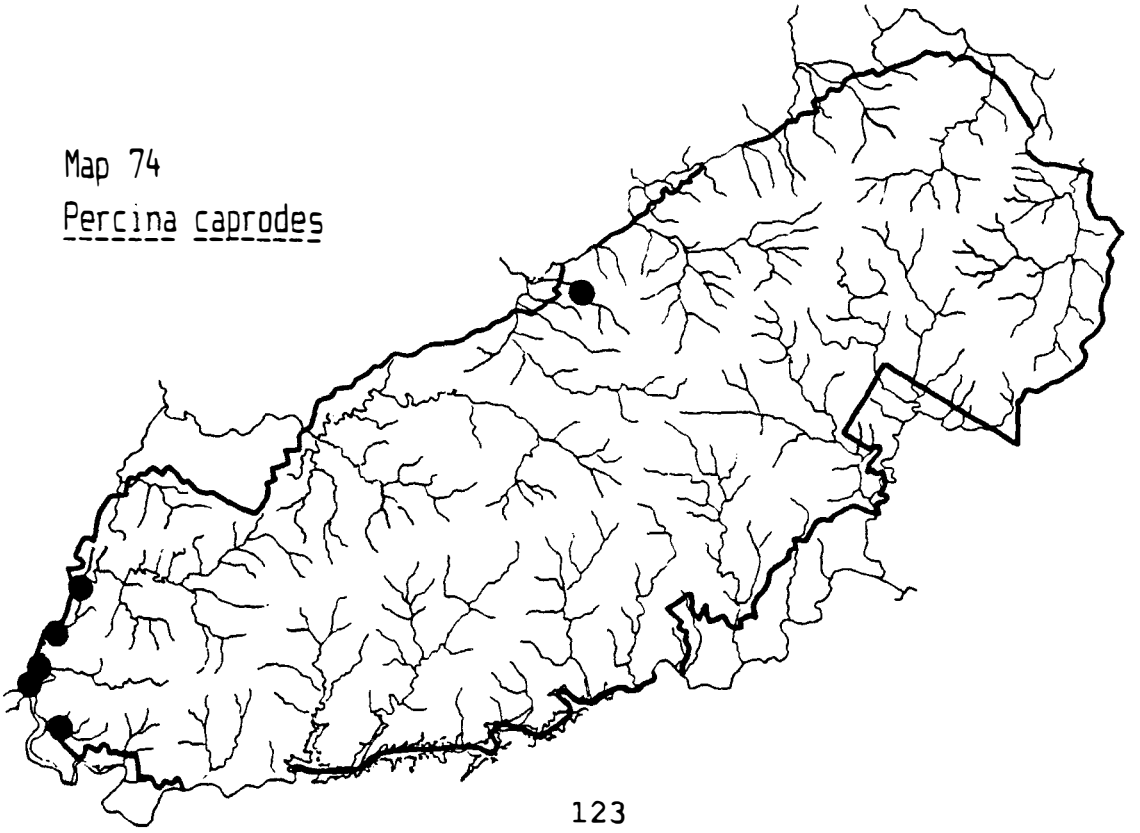
Map 73

Percina burtoni

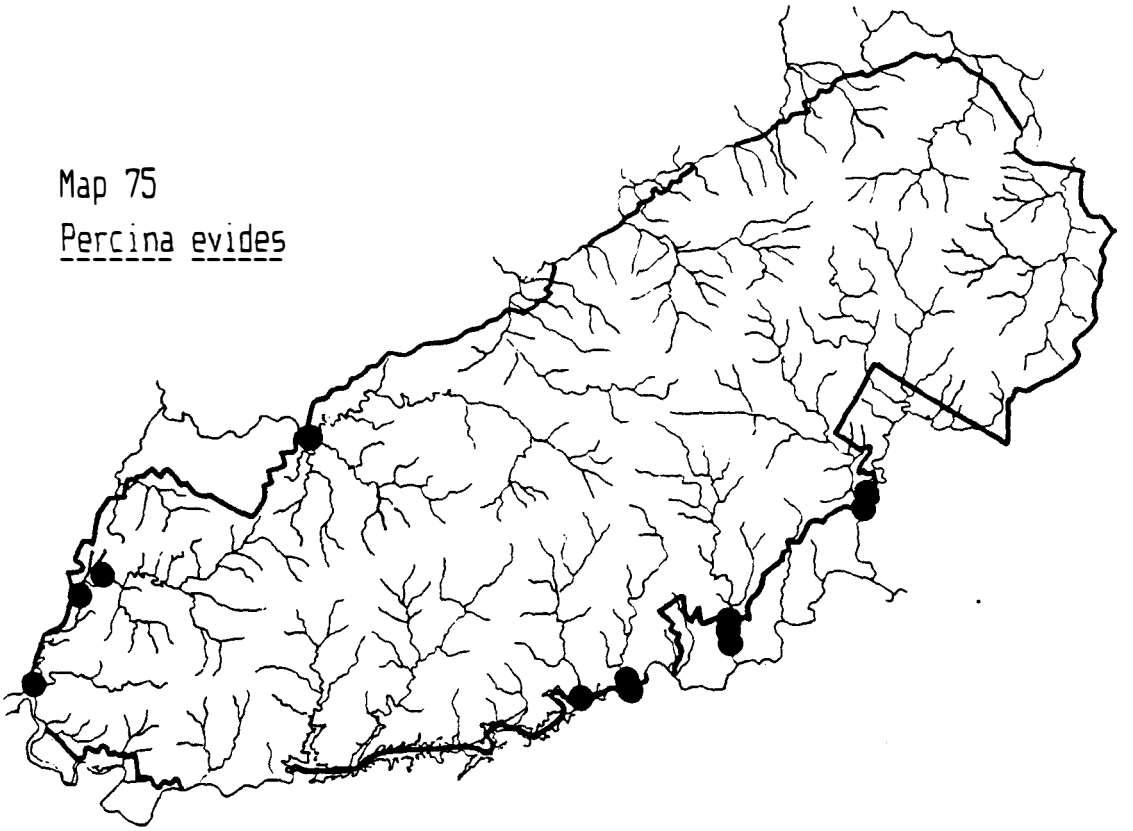


Map 74

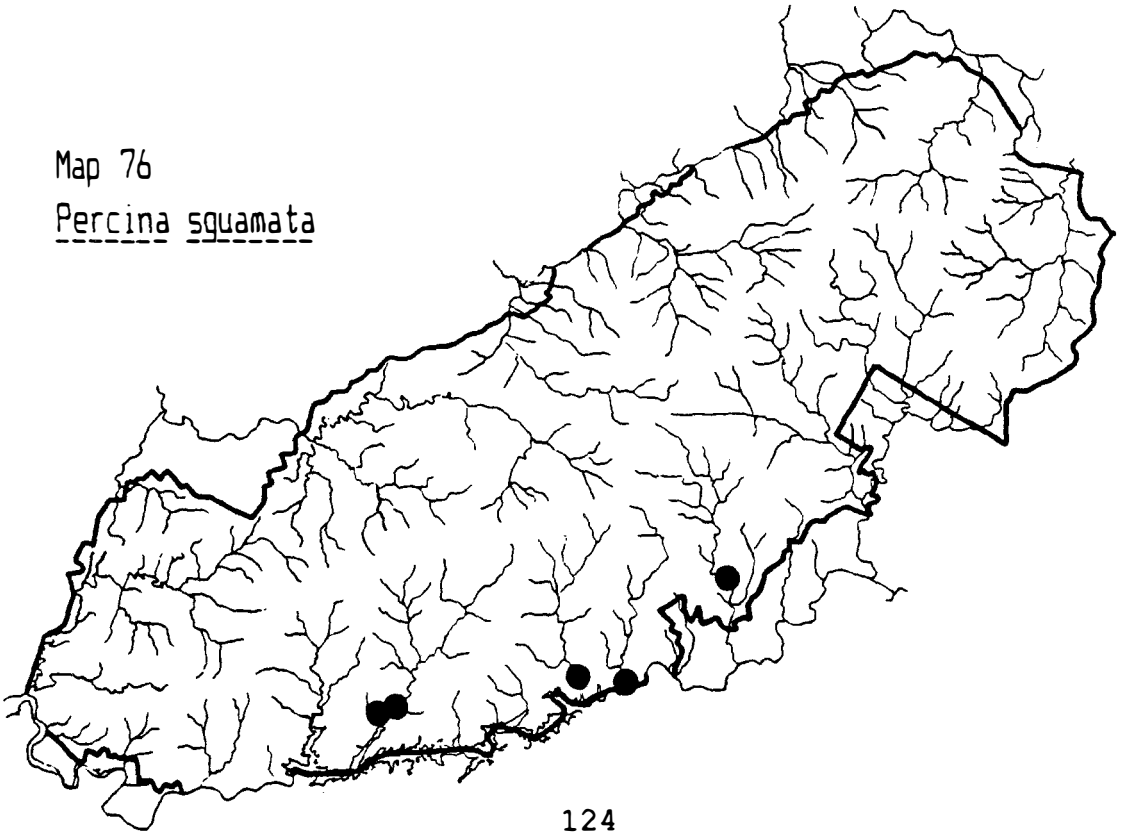
Percina caprodes



Map 75
Percina evides

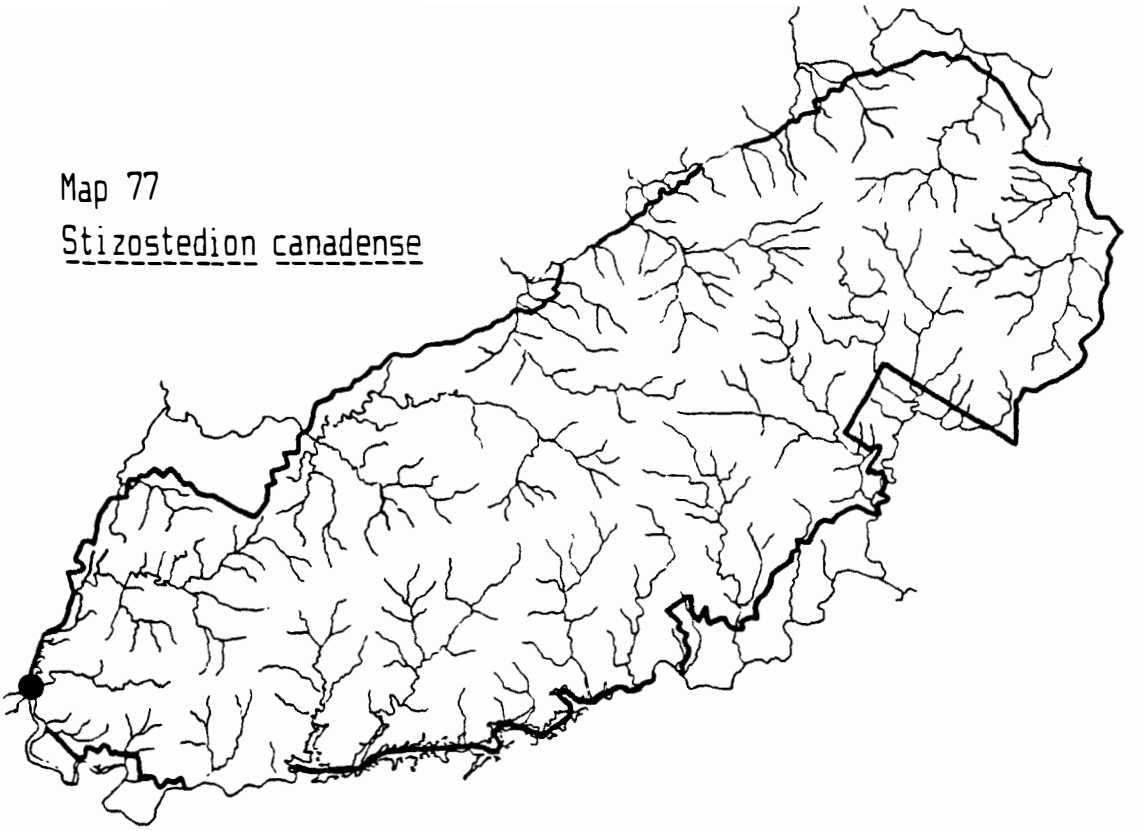


Map 76
Percina squamata



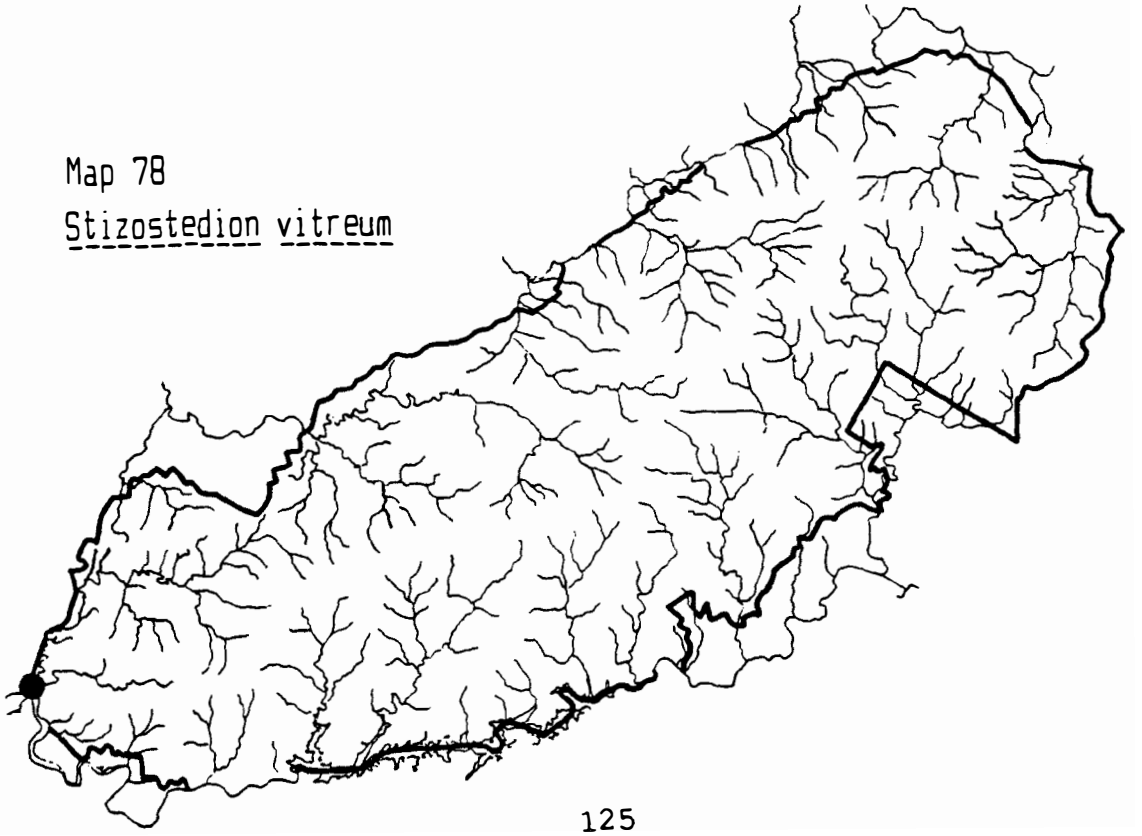
Map 77

Stizostedion canadense



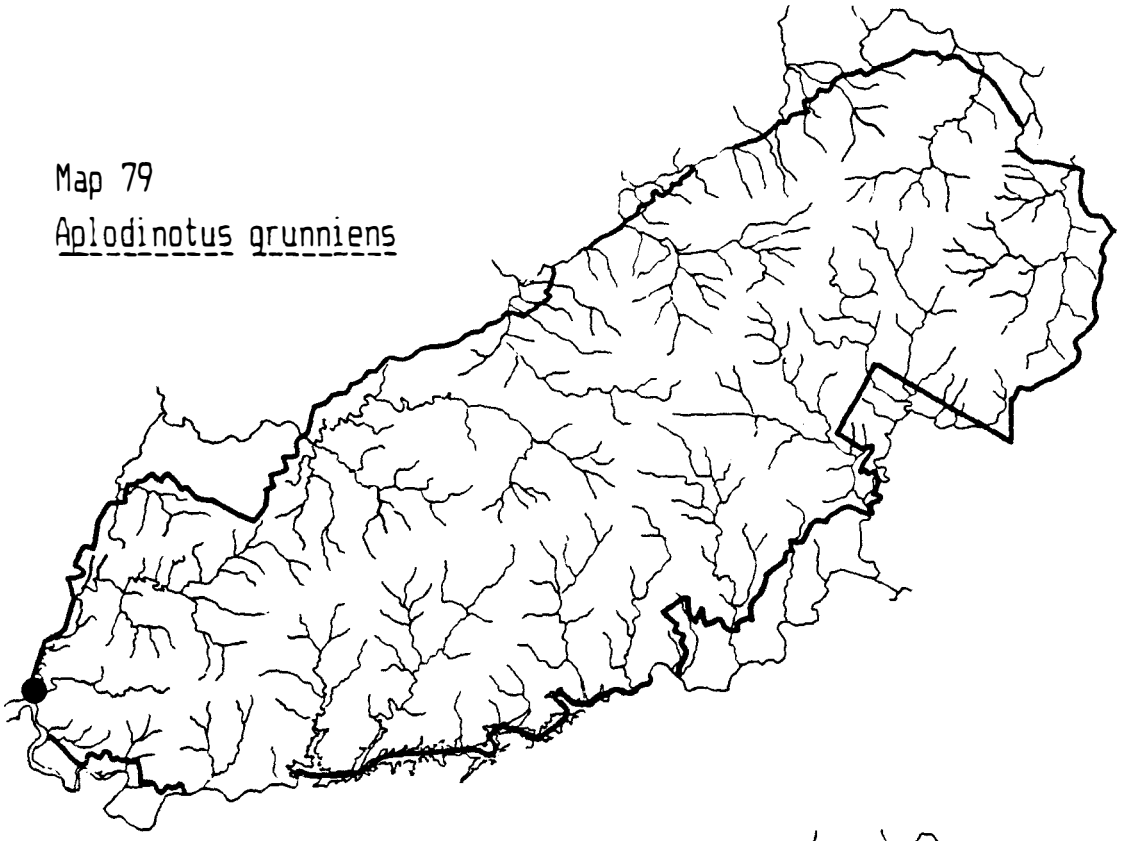
Map 78

Stizostedion vitreum



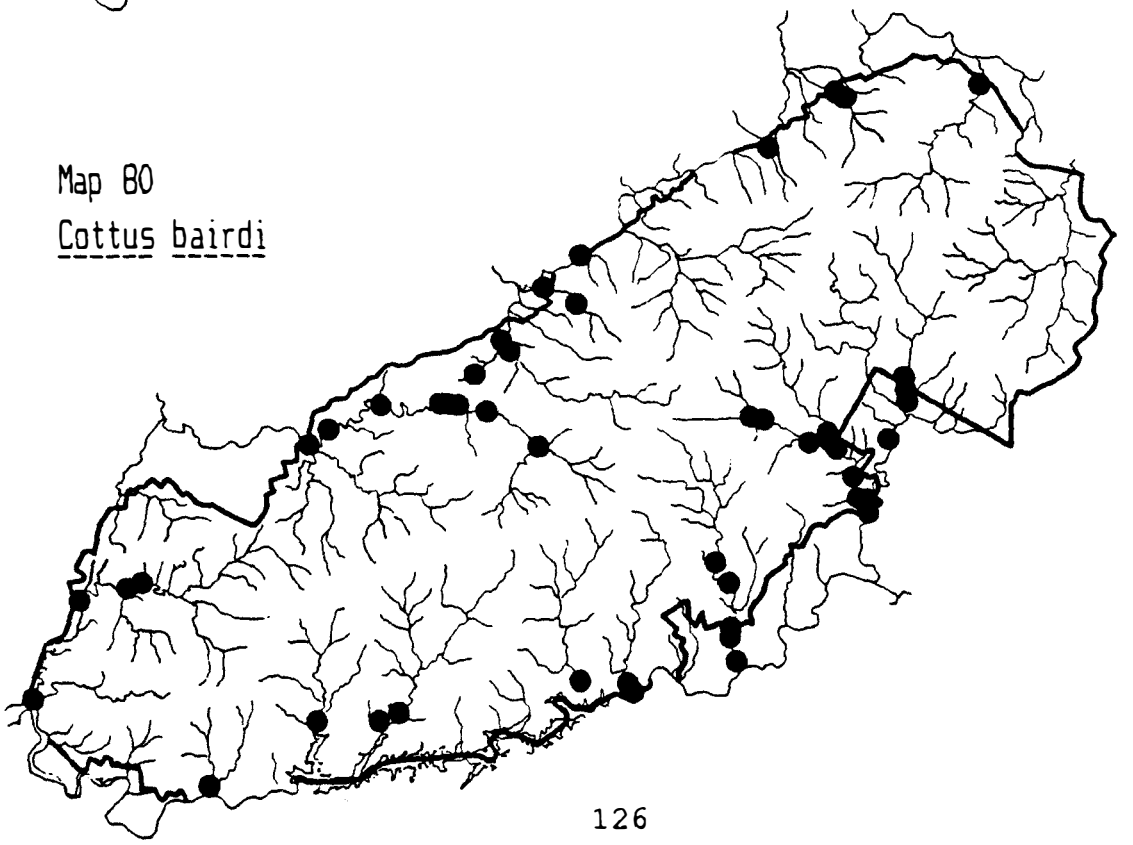
Map 79

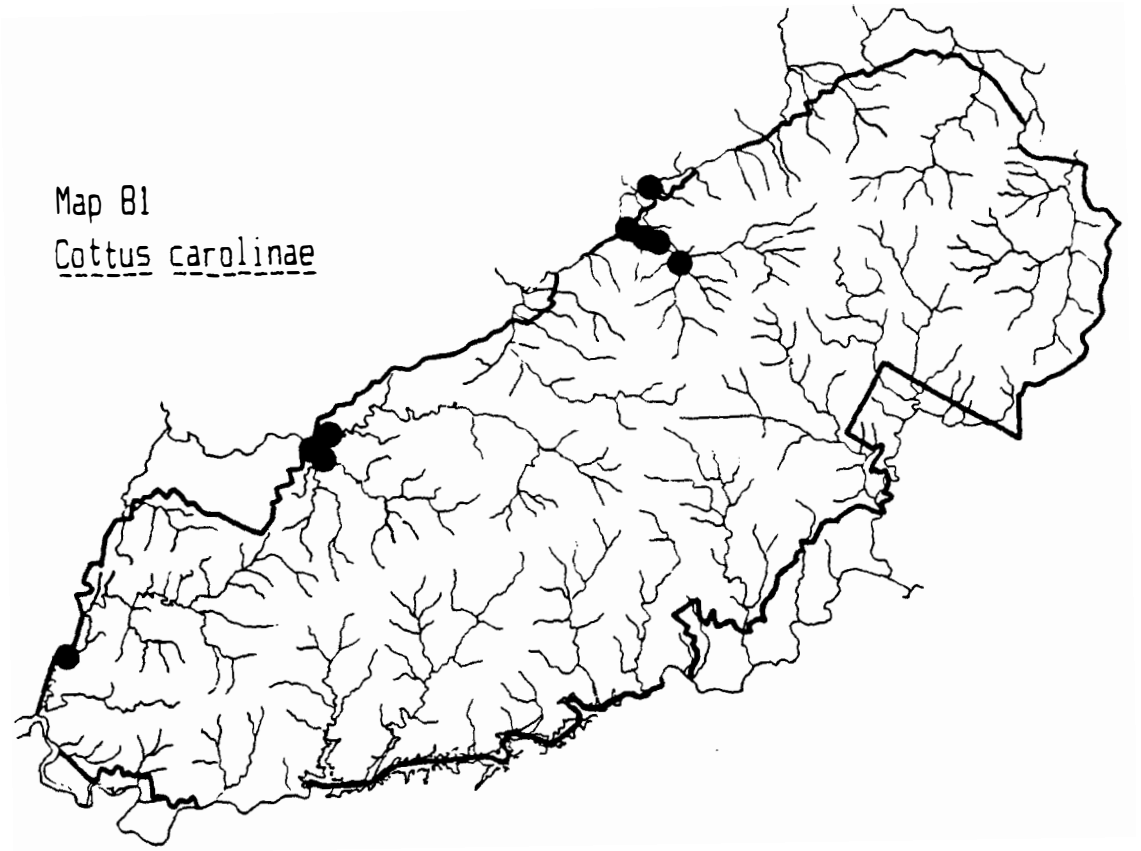
Aplodinotus grunniens



Map 80

Cottus bairdi




Map 81
Cottus carolinae

# VITA

Damien J. Simbeck was born on 12 October 1964 in Lawrenceburg, Tennessee. He attended Sacred Heart Elementary School in Loretto and graduated in June 1979. He graduated Loretto High School in June 1983. In August, 1983, he attended the University of the South in Sewanee, Tennessee. He transfered to The University of North Alabama in Florence the following January, and recieved his Bachelor of Science degree from there in December 1987. He entered graduate school at The University of Tennessee in Knoxville in August 1988. He received his Master's of Science degree in December 1990.

He married Regina D. Rogers in March 1989. They have one daughter, Christina. He is currently employeed by S-R of Tennessee in Ripley, Tennessee, serving as a biologist in their waste water treatment facility.