CAMPOSTOMA ANOMALUM ROANOKENSE,

A NEW SUBSPECIES OF THE STONEROLLER MINNOW IN THE JAMES AND ROANOKE RIVERS

by

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CAMPOSTOMA ANOMALUM ROANOKENSE, A NEW SUBSPECIES OF THE STONEROLLER MINNOW IN THE JAMES AND ROANOKE RIVERS

INTRODUCTION

Specimens of Campostoma anomalum taken from populations in the New, Roanoke, and James River watersheds of Virginia, West Virginia, and North Carolina were examined by Ross (1952: 190-223) and served as the basis for establishing a new subspecies, Campostoma anomalum kanawhamum Ross, ranging in the headwaters of these streams and their tributaries. C. a. kanawhamum was subdivided into a New River Race, a Roanoke River Race, and a James River Subrace of the Roanoke River Race by Ross (1952: 190-223) who recognized the possibility that the James and Roanoke River populations might differ on the subspecific level from the New River Race of C. a. kanawhamum. The author has examined specimens from the James and Roanoke Rivers, confirms Ross, and proposes a new subspecies, Campostoma anomalum roanokense, ranging in the Roanoke and James River watersheds of Virginia, West Virginia, and North Carolina. With this addition, the subspecies of C. anomalum now known are:

1. C. a. oligolepis Hubbs and Greene: Lake Michigan and Mississippi River watersheds in Wisconsin and Iowa; and the Missouri and Arkansas River tributary systems of the northern part of the Ozark upland.

2. C. a. anomalum (Rafinesque): Ohio River Valley.

3. C. a. pullum (Agassiz): Mississippi River valley southwest to Mexico.

4. C. a. plumbeum (Girard): Northwestern Kansas and eastern slope of the Rocky Mountains.

5. C. a. kanawhamum Ross: Above the New River Falls in the upper Kanawha River system of Virginia, West Virginia, and North Carolina.

6. C. a. roanokense New Subspecies: James and Roanoke Rivers of Virginia, West Virginia, and North Carolina.

REVIEW OF LITERATURE

Cope (1869:235,241,246) collected fish from the headwaters of the Roanoke River and Craig's Creek in Virginia, and in the Kanawha River system in Virginia and West Virginia. He found that C. anomalum was one of the most abundant fishes in the Roanoke and Kanawha River systems, but did not record it from Craig's Creek (James River system). These and the following records of C. anomalum in the James and Roanoke Rivers are located by open circles on Maps 1 and 2, pp. 110, 111.

Jordan (1890: 107-113, 120-122) found Campostoma anomalum in the main stream and tributa ries of the Roanoke River at the following locations: Bottom Creek about five miles south of Allegheny Springs, Virginia; Mason's Creek two miles east of Salem, Virginia; the Roanoke River at Salem and at Roanoke, Virginia; and Back Creek, a tributary of the Roanoke River at Poage's Mill, ten miles south of Salem, Virginia.

A single small specimen of C. anomalum was collected in the James River at Midway Mills in Nelson County, Virginia, in 1917 by Mr. E. R. Dunn, and reported by Fowler (1923a:9).

Fowler (1923b:7-9) recorded C. anomalum from a tributary of the Roanoke River north of Cloverdale in Botetourt County, Virginia; a

tributary of the Roanoke River near Deltaville, Botetourt County, Virginia; and from the South Fork of the Roanoke River two miles east of Elliston, Montgomery County, Virginia.

Fowler (1924:389) reported a series of 234 specimens of C. anomalum from the Roanoke River in Virginia, as well as from several other locations in New York, North Carolina, Tennessee, Indiana, Iowa, Missouri, Arkansas, Texas, Mexico and Arizona. This series contained one specimen of C. formosulum, one of C. nasutum, and two of C. hippops, the remainder being C. anomalum. C. formosulum, nasutum and hippops are synonyms of C. anomalum. Variations in some scale characters and certain proportional measurements were given for the entire series as a whole. These are of little value because the wide range covered undoubtedly represents several races.

Hubbs and Raney (1944:12), Hubbs and Lagler (1947:69), and Raney (1947:12) (1950:169) recognized that C. anomalum in the New, James, and Roanoke Rivers was distinct from C. a. anomalum. Burton and Odum (1945:69) recognized that one subspecies of C. anomalum existed in the James River and another distinct subspecies in the upper New River, and recognized the James River campostomids as C. a. anomalum.

Ross (1952:190-223) described C. a. kanawhanum from the upper New River, the Roanoke River, and the James River.

METHOD

The following scale counts were made:

1. Scales in lateral line: all pored scales from the first scale behind the opercle to the scale on the anterior crest of the fold of

skin which appears over the hypural plate when the caudal fin is bent upwards.

2. Scales from lateral line to lateral line across back: the first row of scales in a series from lateral line to lateral line across back anterior to origin of dorsal fin exclusive of lateral line scales.

3. Scales from lateral line to lateral line across belly: scales from lateral line to lateral line across belly immediately anterior to bases of pelvic fins exclusive of lateral line scales.

4. Scales around body: scales encircling the body immediately anterior to origin of dorsal and bases of pelvic fins. This consists of count 2 plus count 3 plus two for lateral line scales.

5. Scales anterior to origin of dorsal fin: scales along the mid-dorsal line from occiput to the origin of the dorsal fin excluding closely imbricated scales at the base of the dorsal fin.

6. Scales in lateral line anterior to bases of pelvic fins: all pored scales from the first one behind the opercle to a vertical from the base of the pelvic fin.

7. Scales below lateral line at anal fin plus scales below lateral line at pelvic fin: scales between lateral line and origin of anal fin plus scales between lateral line and base of pelvic fin exclusive of lateral line scales.

8. Scales around caudal peduncle: scales encircling the narrowest part of the caudal peduncle.

9. Scales below lateral line at anal fin plus scales below lateral line at pelvic fin plus scales around caudal peduncle: the sum of count 7 and count 8.

10. Scales around body minus scales around caudal peduncle: the difference between count 4 and count 8.

11. Scales in lateral line plus scales around body: the sum of count 1 and count 4.

Scales on the left side of the body were counted except in cases where scalation was abnormal, in which case the opposite side of the body was counted or that count was omitted.

Fin rays were counted in the left pectoral and pelvic fins, and in the anal, caudal, and dorsal fins. Ray counts were made which included all rays extending to the distal edge of a fin except in the dorsal and anal fins where the last two fin ray bases were counted as one.

The following proportional measurements were made:

In standard length: distance from tip of snout to posterior edge of last scales in center of base of caudal fin:

1. Body depth: depth of body at deepest point.
2. Body width: width of body at widest point.
3. Head length: length of head from tip of snout to fleshy posterior edge of opercle.
4. Head depth: depth of head at preopercle.
5. Head width: width of head at preopercle.
6. Distance from tip of snout to base of pectoral fin.
7. Distance from tip of snout to base of pelvic fin.
8. Distance from tip of snout to origin of anal fin.
9. Distance from tip of snout to origin of dorsal fin.
10. Caudal peduncle depth: depth of caudal peduncle at narrowest point.

11. Caudal peduncle length: distance from anterior base of anal fin to posterior edge of last scales in center of base of caudal fin.

In head length:

12. Eye width: greatest horizontal distance between the margins of the fleshy rims of the orbit.

13. Interorbital width: least bony width of interorbital.

14. Snout length: distance from tip of snout to anterior fleshy rim of orbit.

15. Jaw length: distance from anterior edge of lower jaw to posterior edge of maxilla.

16. Gape width: transverse width of mouth at angle of jaw.

In predorsal distance: distance from tip of snout to anterior base of dorsal fin:

17. Base of dorsal fin.

18. Depressed dorsal fin length: distance from anterior base of dorsal fin to farthermost point when fin is flattened down.

19. Base of anal fin.

20. Depressed anal fin length: distance from anterior base of anal fin to farthermost point when fin is flattened down.

21. Length of longest pectoral fin ray; distance from anterior base of left pectoral fin to tip of longest ray.

22. Length of longest pelvic fin ray: distance from anterior base of left pelvic fin to tip of longest ray.

23. Depth of caudal peduncle: depth of caudal peduncle at narrowest point.

All measurements were made to tenths of a millimeter with a vernier micrometer. Proportions were calculated as decimal fractions and rounded off to tenths of unity.

Frequency distributions of counts and proportional measurements in all characters examined are presented in Tables 1 through 39. The arithmetical mean (M), standard deviation (σ), and standard error (σ_M) were calculated (Goulden, 1939: 17, 35) for the collections from each watershed separately, and for the total number of specimens in all watersheds in all characters examined. Standard deviation was determined for the series from each watershed by use of the formula: $\sigma = \sqrt{\frac{\Sigma f d^2}{N-1}}$; whereas for the total number of specimens for all watersheds, the formula, $\sigma = \sqrt{\frac{\Sigma f d^2}{N}}$, was used. Standard error was calculated by use of the formula: $\sigma_M = \frac{\sigma}{\sqrt{M}}$.

Populations were compared to each other according to the definition of systematic catagories proposed by Ginsberg (1938: 260-261). This involved the construction of frequency distribution curves for each character examined in a population. If the curves for a given character overlapped 10 percent or less on the average between two populations, those populations were considered to be distinct on the specific level in that character. An average overlap of from 15 to 25 percent indicated a subspecific difference, and one of from 30 to 40 percent a racial difference. Overlaps of more than 40 percent were called subracial. Complete overlaps occurred when the modes for two populations were identical.

Only characters in which a frequency distribution curve with a clearly defined mode was obtained were used in comparing populations. Large samples were compared to small samples by establishing the point at which the frequency distribution curves crossed as the mid-point between the two modes.

MATERIAL

Specimens were captured with 10, 15, 20, and 30-foot seines from October 1951 through May 1952. All material studied is listed in the Appendices and plotted in solid black circles on maps 1 and 2, pp. 110 and 111. A series of not less than 34 nor more than 59 specimens was examined from each of the following drainage systems: 1. the South Fork of the Roanoke River and one of its tributaries, Elliot Creek; 2. the North Fork of the Roanoke River; and 3. Catawba Creek and Craig Creek, tributaries of the James River. All collections were made in headwater streams within a radius of 30 miles of Blacksburg, Virginia.

No scale counts or proportional measurements of specimens other than those taken from the Roanoke and James Rivers were made by the writer. Data on the characteristics of Campostoma anomalum kanawhanum, C. a. anomalum, and C. a. pullum was obtained from Ross (1952: 1-223).

CAMPOSTOMA ANOMALUM ROANOKENSE n. subsp.

Range

C. a. roanokense ranges in the Roanoke and James River watersheds of Virginia, West Virginia, and North Carolina. It is divisible into

three races: South Fork Roanoke River Race in the South Fork of the Roanoke River and its tributary Elliot Creek; North Fork Roanoke River Race in the North Fork of the Roanoke River and one of its tributaries Bradshaw Creek; the James River Race in Craig and Catawba Creeks and Rockfish River, all tributaries of the James River.

Type Specimen

The holotype, a breeding male 113.8 mm. in standard length, was taken in Bradshaw Creek, a tributary of the North Fork of the Roanoke River, 7.6 miles east of Cambria, Virginia on May 5, 1952, and deposited at Virginia Polytechnic Institute under V. P. I. Museum Number 1.

Diagnosis

The scalation of C. a. roanokense is similar to that of C. a. pullum. It is coarser than C. a. kanawhanum and finer than C. a. anomalum. C. a. roanokense is distinguishable from C. a. kanawhanum and also from C. a. anomalum on specific and subspecific levels in three scale characters:

1. Scales around caudal peduncle: C. a. roanokense is separable fr from C. a. pullum on specific and subspecific levels in this character.

2. Scales around body before dorsal fin. C. a. roanokense (South Fork Roanoke River and James River Races) is different from C. a. pullum on subspecific and racial levels.

3. Scales in lateral line plus scales around body before dorsal fin. The James River Race of C. a. roanokense is more constant in this character than either the South Fork Roanoke River Race or the North Fork Roanoke River Race, both of which are quite variable. The Tennessee River (Tennessee, Virginia, North Carolina, and South Carolina) Race of C. a. anomalum and all races of C. a. pullum are indistinguishable from the James River Race in this character.

C. a. roanokense can be separated from C. a. kanawhamum, C. a. anomalum and C. a. pullum on racial, subspecific, and in some cases specific levels in three scale characters:

4. Scales from lateral line to lateral line across back before dorsal fin. The James River Race broadly overlaps C. a. pullum in this character, otherwise C. a. roanokense is separable from it on subspecific and racial levels.

5. Scales in lateral line.

6. Scales anterior to dorsal fin.

In three scale characters, C. a. roanokense is distinguishable from C. a. kanawhamum and C. a. anomalum on racial and subspecific levels but is completely overlapped by most races of C. a. pullum:

7. Scales from lateral line to lateral line across belly.

8. Scales in lateral line anterior to pelvic fin.

9. Scales around body minus scales around caudal peduncle.

In the following two scale characters, C. a. roanokense is separable from C. a. kanawhamum on subspecific and racial levels, but is very similar to both C. a. anomalum and C. a. pullum:

10. Scales below lateral line at anal fin plus scales below lateral line at pelvic fin. The South Fork Roanoke River Race of C. a. roanokense is different from all races of C. a. anomalum on subspecific and specific levels in this character.

11. Scales below lateral line at anal fin plus scales below lateral line at pelvic fin plus scales around caudal peduncle. The South Fork Roanoke River Race of C. a. roanokense is different from all races of C. a. anomalum on specific and subspecific levels in this character.

Proportional measurements indicate that C. a. roanokense generally has a wider bony interorbital distance, a wider gape, and has the anal and dorsal fins set further forward on the body than C. a. kanawhanum, C. a. anomalum, or C. a. pullum. The Tennessee River (Tennessee, Virginia, North Carolina and South Carolina) Race of C. a. anomalum, however, is very similar to one or more races of C. a. roanokense in the width of gape and location of the dorsal fin. C. a. roanokense is distinct from C. a. kanawhanum, C. a. anomalum, and C. a. pullum on the specific level in one proportional measurement:

12. Distance from tip of snout to origin of anal fin in standard length.

C. a. roanokense differs from other closely related or similar subspecies of C. anomalum in the four proportional measurements as follows:

13. Distance from tip of snout to origin of dorsal fin in standard length. C. a. roanokense differs on subspecific and specific levels from C. a. kanawhanum, C. a. pullum, and C. a. anomalum except for the Upper Tennessee River (Tennessee, Virginia, North Carolina and South Carolina) Race of C. a. anomalum which completely overlaps C. a. roanokense in this character.

14. Distance from tip of snout to base of pelvic fin in standard length. C. a. roanokense differs from C. a. kanawhanum, C. a. pullum, and C. a. anomalum (except for the Ohio River Race of C. a. anomalum) on the racial or some higher level in this character.

15. Gape width in head length. C. a. roanokense is separable on the racial or some higher level from C. a. kanawhanum, C. a. pullum, and C. a. anomalum except for the Upper Tennessee River (Tennessee, Virginia, North Carolina and South Carolina) Race of C. a. anomalum which it overlaps 100 percent.

16. Interorbital distance in head length: C. a. roanokense differs from C. a. kanawhanum on the specific level, from C. a. anomalum on the racial or some higher level, and is similar to all races of C. a. pullum in this character.

C. a. roanokense is generally indistinguishable from C. a. kanawhanum, C. a. anomalum, and C. a. pullum in the following three characters:

17. Snout length in head length. C. a. roanokense is separable from the Potomac River (West Virginia and Maryland) population of C. a. anomalum on subspecific and specific levels in this character.

18. Body depth in standard length.

19. Head length in standard length.

Relationships

Ross (1952: 208-211) suggested that the Roanoke and James River campostomids were established in those streams as a result of stream captures from the New River drainage. If this is so, C. a. kanawhanum and C. a. roanokense are more closely related genetically than either of these subspecies is with any other currently recognized subspecies of C. anomalum. Superficially, however, C. a. roanokense resembles C. a. pullum and some races of C. a. anomalum, while it is quite distinct from C. a. kanawhanum. This is thought to be due to parallel evolution.

In 25 out of 44 comparisons made between C. a. roanokense and C. a. kanawhanum, differences are on a subspecific or specific level. These differences are on a substantially higher level than those

between the James River, the North Fork Roanoke River, and the South Fork Roanoke River populations of C. a. roanokense, which indicates that differentiation has progressed primarily along lines tending to separate these populations from C. a. kanawhanum and secondarily along lines tending to separate these populations from each other. Thus, while subspecific differences occasionally occur between the South Fork Roanoke River Race, the North Fork Roanoke River Race, and the James River Race, such differences appear to be the result of intraracial variation.

Evidence presented by Ross (1952:217) indicates that both the James and North Fork of the Roanoke Rivers were populated with campostomids at about the same time by means of stream captures from the New River drainage. He is supported by Wright (1931: 207; 1934: 50-69; 1936: 98) who showed that a tributary of the James River probably captured a tributary of the New River in what is now the North Fork of the Roanoke River valley after the close of the Harrisburg erosion cycle. Apparently, a short time thereafter the James River in that region was in turn captured by the Roanoke River.

Wright also suggested that after the capture of the James River tributary by the North Fork of the Roanoke River, the South Fork of the Roanoke River began a series of piracies from the New River watershed in the vicinity of Floyd, Virginia. Ross and Raney (Appendix D) have taken Rhinichthys a. atratulus, the Atlantic Coast form , in Sinking Creek (New River Tributary) where R. a. obtusus, the western form, normally occurs. The only other transfer of R. a. atratulus across the divide that is now known is at the Youghiogheny River in

Pennslyvania. The transfer at Sinking Creek indicates that contact has been made at some time between that stream and the James River watershed, probably at the head of Sinking Creek. Fish in the headwaters of a small tributary of the James River in that region are isolated by a falls. At the time the falls were established or at some more recent time, stream captures appear to have occurred above the falls, permitting the transfer of R. a. atratulus from the James River to the New River watershed.

Several recent captures of Notropis cerasinus (Appendix D), a Roanoke River endemic, by Ross Raney and others in Little River tributaries, Little Camp Creek, and Strouble's Creek, all tributaries of the New River, indicate that tributaries of the New River and the South Fork of the Roanoke River have been in sufficient contact during some recent time for fish to pass from one drainage to the other. Notemigonus c. crysoleucas (Appendix D) and Lepomis auritus (Appendix D), both Atlantic Coast forms, have been taken in the New River watershed, but they may have been planted there.

Contact between the South Fork of the Roanoke River and the New River is further supported by the relationship of C. a. roanokense in the James River and the North and South Forks of the Roanoke River. The South Fork of the Roanoke River and the James River campostomids differ on the subspecific level in seven characters, whereas the North Fork of the Roanoke River and the James River campostomids are separable on the subspecific level in only one character, and the South Fork of the Roanoke River and the North Fork of the Roanoke River campostomids differ on the subspecific level in two characters. This noticeable difference in the number of characters

different on the subspecific level between populations is due in part to the presence of more flat-topped or bimodal frequency distribution curves in the North Fork Roanoke River population than in the other two populations, as well as to a greater difference between the James River population and the South Fork Roanoke River population than between the North Fork Roanoke River population and either the South Fork Roanoke River population or the James River population.

During the period in which N. cerasinus, and possibly N. c. chrysoleucas and L. auritus, was introduced into the New River, C. a. kanawhanum may have been introduced into the South Fork of the Roanoke River or some of its tributaries where it intermixed with the campostomids then present in that portion of the Atlantic watershed. Finer scalation in the South Fork Roanoke River population than in other populations of C. a. roanokense indicates a closer relationship in that respect between the South Fork Roanoke River Race and C. a. kanawhanum than is present between either of the other two populations of C. a. roanokense and C. a. kanawhanum. Proportional measurements in the South Fork Roanoke River population are less similar to C. a. kanawhanum, however, than those of either of the other two populations of C. a. roanokense are to C. a. kanawhanum. The James River population resembles C. a. kanawhanum the least in scale characters and the most in proportional measurements of any of three populations of C. a. roanokense studied. The North Fork Roanoke River Race is intermediate between the South Fork Roanoke River Race and the James River Race in scalation and is similar to the James River Race in proportional measurements.

It is possible that after the original introduction of campostomids into the James and Roanoke River drainages, differentiation was toward a coarser-scaled form at those lower elevations than that of C. a. kanawhanum with the retention of a thin-bodied form in the James River but a tendency toward increased depth in the South Fork of the Roanoke River. Subsequent interchanges of C. anomalum between the New River system and the South Fork of the Roanoke River system could have resulted in finer scalation in the stoneroller minnows of the latter system. Intermediate scalation of the North Fork Roanoke River population may be due to a migration of fish from the South Fork of the Roanoke River bearing genes from the last invasion of the South Fork of the Roanoke River by C. a. kanawhanum. If this hypothesis is true, the North Fork Roanoke River population of stoneroller minnows is sufficiently separated from the South Fork Roanoke River population by distance to be considered a separate race. The fact that 50 percent of the characters in which populations of the North and South Forks of the Roanoke River were compared are separable on the racial or some higher level supports the formation of two races in the two drainages. Differences between the campostomids in the James River and those in the South Fork of the Roanoke River warrants establishing separate races, at least, in these two drainage systems. The James River population, however, is too similar to the North Fork Roanoke River population to be separated from it on a higher systematic category than the racial level. Application of Ross' (1952: 9-14) ratio of agreement also indicates that these three populations are separable on the racial level. Thus the three races: South Fork Roanoke River Race, North Fork Roanoke River Race, and James River Race, are suggested as suitable subdivisions of C. a. roanokense.

SOUTH FORK ROANOKE RIVER RACE

of

Campostoma anomalum roanokense, n. subsp.

Diagnosis

The South Fork Roanoke River Race is distinguishable from the North Fork Roanoke River and the James River Races of *C. a. roanokense* and from *C. a. kanawhanum* on subspecific and racial levels in the three following scale counts:

1. Scales below lateral line at anal fin plus scales below lateral line at pelvic fin plus scales around caudal peduncle.

2. Scales from lateral line to lateral line across back.

3. Scales below lateral line at anal fin plus scales below lateral line at pelvic fin.

The South Fork Roanoke River Race is separable from the James River Race of *C. a. roanokense* and *C. a. kanawhanum* on the racial or some higher level in two scale characters:

4. Scales from lateral line to lateral line across belly.

5. Scales around body before dorsal fin.

The South Fork Roanoke River Race is separable from the North Fork Roanoke River Race and *C. a. kanawhanum* on racial or subspecific levels in one scale character:

6. Scales in lateral line anterior to pelvic fin.

The South Fork Roanoke River Race and *C. a. kanawhanum* are distinct in two additional scale characters on subspecific and racial levels:

7. Scales around caudal peduncle.

8. Scales anterior to dorsal fin.

The South Fork Roanoke River Race and C. a. kanawhanum are similar in one scale character:

9. Scales around body minus scales around caudal peduncle.

Proportional measurements of the South Fork Roanoke River Race are higher than C. a. kanawhanum on the specific level in four characters, the first two of which permit separation of the James River Race and the South Fork Roanoke River Race on racial levels:

10. Distance from tip of snout to origin of dorsal fin in standard length.

11. Distance from tip of snout to base of pelvic fin in standard length.

12. Distance from tip of snout to origin of anal fin in standard length.

13. Interorbital distance in head length.

The South Fork Roanoke River Race and the James River and North Fork Roanoke River Races are separable on subspecific and racial levels in the following three characters, the first of which is subracially distinct between C. a. kanawhanum and the South Fork Roanoke River Race:

14. Body depth in standard length.

15. Body width in standard length.

16. Caudal peduncle length in standard length.

The South Fork Roanoke River Race and the James River Race are also distinct on subspecific or racial levels in three additional characters, the first of which permits separation of the South Fork Roanoke River Race and North Fork Roanoke River Race on the

subracial level:

17. Depth of caudal peduncle in its own length.

18. Length of longest pectoral fin ray in standard length.

19. Length of longest pelvic fin ray in standard length.

Subracial differences occur between the South Fork Roanoke River Race and the other two races of C. a. roanokense in one character:

20. Depressed dorsal fin length in predorsal distance.

The South Fork Roanoke River Race and the James River Race are separable on the subracial level in one other character:

21. Depressed anal fin length in predorsal distance.

A complete overlap between the South Fork Roanoke River Race and the other two races of C. a. roanokense and C. a. kanawhamum occurs in one character:

22. Snout length in head length.

The three races of C. a. roanokense are inseparable in one other character:

23. Base of dorsal fin in predorsal distance.

Description

1. Scales below lateral line at anal fin plus scales below lateral line at pelvic fin plus scales around caudal peduncle: 33-45, usually 34-37, mean 36.5 (Table 9). The South Fork Roanoke River Race differs on the subspecific level from the James River Race which averages 2.5 scales lower, and on the racial level from the North Fork Roanoke River Race which averages 1.5 scales lower. The South Fork Roanoke River Race is different on the subspecific level from

C. a. kanawhanum which averages 3.6 scales higher. All races of C. a. anomalum average from 2.3 to 4.0 scales lower in this count than does the South Fork Roanoke River Race from which they differ on subspecific and specific levels. C. a. pullum, except for the Genesee River (New York) Race and the Taughannock Creek (New York) population which are similar to the South Fork Roanoke River Race, averages from 1.6-2.5 scales lower than the South Fork Roanoke River Race and is different from it on the racial level.

2. Scales from lateral line to lateral line across back: 16-21, usually 18-19, mean 18.7 (Table 2). The South Fork Roanoke River Race averages 0.4 scales higher than the North Fork Roanoke River Race and 0.9 scales higher than the James River Race, both differences being on the racial level. The South Fork Roanoke River Race also differs on the racial level from C. a. kanawhanum which averages 0.4 scales higher. All races of C. a. anomalum and C. a. pullum differ from the South Fork Roanoke River Race on specific and subspecific levels respectively, both subspecies averaging from 2.4 to 3.3 scales and from 1.3 to 2.6 scales lower than the South Fork Roanoke River Race.

3. Scales below lateral line at anal fin plus scales below lateral line at pelvic fin: 13-21, usually 14-17, mean 15.9 (Table 7). The South Fork Roanoke River Race is distinct on the racial level from the James River and the North Fork Roanoke River Races, averaging 1.4 and 0.7 scales higher, respectively. The South Fork Roanoke River Race differs on the racial level from C. a. kanawhanum which averages 0.1 scales lower. The South Fork Roanoke River Race averages from 2.0 to 3.3 scales higher in this count than any of the races of C. a. anomalum from which it differs on subspecific and specific levels.

The Upper Allegheny River (Pennsylvania and New York), the Genesee River (New York) and Taughannock Creek (New York) populations of C. a. pullum are not separable from the South Fork Roanoke River Race, but the other races of that subspecies average from 1.0 to 2.0 scales lower than the South Fork Roanoke River Race and are separable from it on subspecific and specific levels.

4. Scales from lateral line to lateral line across belly before pelvic fins: 21-31, usually 24-26, mean 25.3 (Table 3). The South Fork Roanoke River Race averages 2.4 scales higher than the James River Race from which it is separable on the subspecific level. The South Fork Roanoke River Race averages 1.6 scales lower than C. a. kanawhanum and is separable from it on the racial level. The South Fork Roanoke River Race averages from 2.8 to 5.7 scales higher than all races of C. a. anomalum and is different from them on subspecific or specific levels. All races of C. a. pullum and the South Fork Roanoke River Race are inseparable.

5. Scales around body before dorsal fin: 39-53, usually 43-47, mean 45.4 (Table 4). The South Fork Roanoke River Race averages 2.0 scales higher than the James River Race from which it differs on the subspecific level. The South Fork Roanoke River Race averages 2.7 scales lower than C. a. kanawhanum and is different from it on the subspecific level. The South Fork Roanoke River Race differs from C. a. anomalum on the specific level by having a higher scale count of from 4.6 to 8.7 scales in this character. C. a. pullum differs from the South Fork Roanoke River Race on racial and subspecific levels, the scale counts of the latter averaging from 0.4 to 3.1 scales higher than that of the former.

6. Scales in lateral line anterior to pelvic fin: 16-22, usually 18-20, mean 19.2 (Table 6). The South Fork Roanoke River Race is similar to the James River Race but averages 0.7 scales lower than the North Fork Roanoke River Race and is separable from it on the racial level. The South Fork Roanoke River Race averages 1.5 scales lower than C. a. kanawhamum and differs from it on the subspecific level. The South Fork Roanoke River Race is inseparable from the Upper Tennessee River (Tennessee, Virginia, North Carolina) Race, but it is different on the specific level from the other races of C. a. anomalum which average from 1.6 to 2.9 scales lower. Two races, Upper French Creek (Pennsylvania) Race and Fall Creek (New York) Race of C. a. pullum average 2.0 and 0.7 scales lower, respectively, than the South Fork Roanoke River Race which differs from them on specific and racial levels. The Sandy Creek (New York) and Upper Susquehanna River (New York) populations of C. a. pullum are indistinguishable from the South Fork Roanoke River Race in this character. The South Fork Roanoke River Race averages from 0.4 to 2.0 scales lower than the remaining races of C. a. pullum from which it differs on the subracial or some higher level.

7. Scales around caudal peduncle: 19-26, usually 19-21, mean 20.6 (Table 8). The other two races of C. a. roanokense, all races of C. a. anomalum, and all races of C. a. pullum are overlapped by the South Fork Roanoke River Race in this character. The South Fork Roanoke River Race, however, averages 1.7 scales lower than C. a. kanawhamum, differing from it on the subspecific level.

8. Scales anterior to dorsal fin: 21-29, usually 21-26, mean 23.7 (Table 5). The South Fork Roanoke River Race completely overlaps

both other races of C. a. roanokense. It is different on the racial level from C. a. kanawhamum which averages 1.5 scales higher. The races of C. a. anomalum average from 2.2 to 3.9 scales lower than the South Fork Roanoke River Race, and differ from it on subspecific and specific levels. The Fall Creek (New York) population of C. a. pullum completely overlaps the South Fork Roanoke River Race. The Genesee River (New York) population of C. a. pullum averages 1.5 scales higher than the South Fork Roanoke River Race, differing from it on the racial level. Other races of C. a. pullum average from 0.4 to 0.9 scales lower than the South Fork Roanoke River Race which differs from them on racial and subspecific levels.

9. Scales around body minus scales around caudal peduncle: 19-30, usually 22-26, mean 24.8 (Table 10). The South Fork Roanoke River Race is separable from C. a. kanawhamum on the subracial level. All races of C. a. anomalum average from 3.5 to 8.0 scales lower than the South Fork Roanoke River Race, being separable on subspecific and specific levels. C. a. pullum and the South Fork Roanoke River Race are inseparable in this character.

10. Distance from tip of snout to origin of dorsal fin in standard length: 1.9-2.1, usually 2.0, mean 2.0 (Table 25). The South Fork Roanoke River Race overlaps both the James River Race and the North Fork Roanoke River Race of C. a. roanokense. This measurement averages 0.2 mm. shorter for the South Fork Roanoke River Race than it does for C. a. kanawhamum; these two populations differ on the specific level. The Upper Tennessee River (Tennessee, Virginia, North Carolina and South Carolina) Race of C. a. anomalum and the South Fork Roanoke River Race are similar. The Upper Ohio River (West

Virginia) Race and its Potomac River (West Virginia and Maryland) Subrace of C. a. anomalum, and the Genesee River (New York) Race and Susquehanna River (New York) Race of C. a. pullum all average from 0.1 to 0.2 mm. longer in this measurement than the South Fork Roanoke River Race and are separable from it on subspecific and specific levels.

11. Distance from tip of snout to base of pelvic fin in standard length: 2.0-2.3, usually 2.0-2.1, mean 2.1 (Table 23). The three races of C. a. roanokense are not separable in this character. The South Fork Roanoke River Race averages 0.1 mm. shorter than C. a. kanawhamum and is separable from it on the specific level in this character. The Upper Ohio River (West Virginia) Race of C. a. anomalum overlaps the South Fork Roanoke River Race./ The Potomac River (West Virginia and Maryland) Subrace of C. a. anomalum and the Upper Genesee River (New York) Race of C. a. pullum differ from the South Fork Roanoke River Race on the specific level. The latter population averages from 0.1 to 0.2 mm. shorter in this measurement than either of the former populations.

12. Distance from tip of snout to origin of anal fin in standard length: 1.5-1.6, usually 1.5, mean 1.5 (Table 24). The South Fork Roanoke River Race and both the North Fork Roanoke River Race and the James River Race of C. a. roanokense are indistinguishable in this character. The South Fork Roanoke River Race averages 0.1 mm. shorter and is different on the specific level from C. a. kanawhamum, the Upper Ohio River (West Virginia) Race and its Potomac River (West Virginia and Maryland) Subrace of C. a. anomalum and the Upper Genesee River (New York) Race of C. a. pullum.

13. Interorbital distance in head length: 2.8-3.9, usually 2.9-3.3, mean 3.1 (Table 29). A subracial difference exists between the South Fork Roanoke River Race and the James River Race. The South Fork Roanoke River Race and the North Fork Roanoke River Race, however, are indistinguishable. The South Fork Roanoke River Race averages 0.5 mm. narrower than C. a. kanawhamum, in this character, and is separable from it on the specific level. The Upper Ohio River (West Virginia) Race and its Potomac River (West Virginia and Maryland) Subrace, and the Upper Tennessee River (Tennessee, Virginia, North Carolina and South Carolina) Race of C. a. anomalum average from 0.1 mm. to 0.6 mm. wider than the South Fork Roanoke River Race and are distinguishable from it on subspecific and specific levels. The Upper Genesee River (New York) Race of C. a. pullum is separable from the South Fork Roanoke River Race on the racial level, averaging 0.2 mm. wider than it in this character.

14. Body depth in standard length: 3.6-4.4, usually 3.9-4.2, mean 4.1 (Table 17). The South Fork Roanoke River Race is separable on the subspecific level both from the North Fork Roanoke River Race and the James River Race, having average measurements of 0.2 mm. deeper in the former and 0.3 mm. deeper in the latter. The South Fork Roanoke River Race differs on the subracial level from C. a. kanawhamum and averages 0.1 mm. deeper. The Upper Ohio River (West Virginia) Race and its Potomac River (West Virginia and Maryland) Subrace of C. a. anomalum and the Genesee River (New York) Race of C. a. pullum all differ on the subspecific level from the South Fork Roanoke River Race which averages from 0.2 to 0.3 mm. deeper in this measurement.

15. Body width in standard length: 4.1-6.6, usually 5.0-5.3, mean 5.1 (Table 18). Both the James River Race and the North Fork Roanoke River Race of C. a. roanokense average 0.5 mm. narrower in this measurement than the South Fork Roanoke River Race and differ from it on the subspecific level. Measurements in this character made by the writer are not comparable to those made by Ross because of a difference in techniques.

16. Caudal peduncle length in standard length: 2.5-2.9, usually 2.6-2.8, mean 2.7 (Table 27). Racial differences exist between the South Fork Roanoke River Race and both the North Fork Roanoke River Race and the James River Race of C. a. roanokense, the latter averaging 0.1 mm. shorter in this measurement. Measurements in this character made by the writer are not comparable to those made by Ross because of differences in techniques.

17. Depth of caudal peduncle in its own length: 2.7-3.3, usually 2.9-3.1, mean 3.0 (Table 39). The South Fork Roanoke River Race is 0.1 mm. wider than both the James River Race and the North Fork Roanoke River Race. The former differs from it on the subspecific level, however, and the latter on the subracial level. Measurements in this character made by the writer are not comparable to those made by Ross because of differences in techniques.

18. Length of longest pectoral fin ray in standard length: 2.3-3.0, usually 2.5-2.9, mean 2.7 (Table 37). The South Fork Roanoke River Race averages 0.1 mm. shorter than the James River Race of C. a. roanokense and is different from it on the subspecific level in this character. This measurement was not reported by Ross (1952: 1-223).

19. Length of longest pelvic fin ray in standard length: 3.1-3.7, usually 3.2-3.5, mean 3.4 (Table 38). The South Fork Roanoke River Race averages 0.1 mm. longer than the James River Race in this character and is different from it on the racial level. This measurement was not reported by Ross (1952: 1-223).

20. Depressed dorsal fin length in predorsal distance: 2.2-2.8, usually 2.4-2.7, mean 2.5 (Table 34). The South Fork Roanoke River Race differs on the subracial level from the James River and the North Fork Roanoke River Races of C. a. roanokense. This measurement was not reported by Ross (1952: 1-223).

21. Depressed anal fin length in predorsal distance: 2.5-3.2, usually 2.6-3.0, mean 2.8 (Table 36). The South Fork Roanoke River Race and the James River Race of C. a. roanokense completely overlap in this measurement. This measurement was not reported by Ross (1952: 1-223).

22. Snout length in head length: 2.2-3.0, usually 2.4-2.5, mean 2.4 (Table 30). The South Fork Roanoke River Race completely overlaps the North Fork Roanoke River Race and the James River Race of C. a. roanokense, C. a. kanawhaenum, the Upper Ohio River (West Virginia) Race of C. a. anomalum, and the Upper Genesee River (New York) Race of C. a. pullum in this character. The Potomac River (West Virginia and Maryland) Subrace of C. a. anomalum differs from the South Fork Roanoke River Race on the specific level, averaging 0.2 mm. shorter.

23. Base of dorsal fin in predorsal distance: 3.8-5.9, usually 4.4-4.8, mean 4.6 (Table 33). The South Fork Roanoke River Race is indistinguishable from either of the other two races of C. a. roanokense. This measurement was not reported by Ross (1952: 1-223).

There is no significant difference in the number of fin rays between any of the subspecies or races of C. anomalum that were compared. Fin ray counts for the South Fork Roanoke River Race are as follows:

24. Rays in pectoral fin: 15-18, usually 16-17, mean 15.1 (Table 12).

25. Rays in pelvic fin: 7-8, usually 8, mean 8.0 (Table 13).

26. Rays in anal fin: 6-7, usually 7, mean 7.0 (Table 14).

27. Rays in caudal fin: 19-20, usually 19, mean 19.0 (Table 15).

28. Rays in dorsal fin: 8, usually 8, mean 8.0 (Table 16).

Flat-topped or bimodal frequency distribution curves may be due to (1) selective sampling in which a large number of specimens examined are from an atypical segment of a population, and (2) variation of a given character in one population over a wide range as compared to the range of variability in other characters in that population. Therefore, flat-topped or bimodal frequency distribution curves in the following 12 characters of the South Fork Roanoke River Race of C. a. roanokense were not compared to similar scale counts and proportional measurements of the other subspecies and races of C. anomalum:

29. Scales in lateral line: 44-54, usually 46-52, mean 49.1 (Table 1).

30. Scales in lateral line plus scales around body: 87-104, usually 91-99, mean 94.4 (Table 11).

31. Head length in standard length: 4.0-5.0, usually 4.1-4.6, mean 4.4 (Table 19).

32. Head depth in standard length: 6.2-8.0, usually 6.9-7.6, mean 7.2 (Table 20).

33. Head width in standard length: 6.8-8.5, usually 7.3-7.9, mean 7.7 (Table 21).

34. Distance from tip of snout to base of pectoral fin in standard length: 4.2-5.1, usually 4.4-4.8, mean 4.6 (Table 22).

35. Caudal peduncle depth in standard length: 7.5-9.1, usually 7.8-8.6, mean 8.2 (Table 26).

36. Eye width in head length: 3.6-6.6, usually 4.9-6.0, mean 4.8 (Table 28).

37. Jaw length in head length: 4.3-7.4, usually 4.9-6.0, mean 5.6 (Table 31).

38. Gape width in head length: 2.7-3.7, usually 2.9-3.5, mean 3.2 (Table 32).

39. Base of anal fin in predorsal distance: 3.7-6.3, usually 4.5-6.0, mean 5.2 (Table 35).

Relationships

The South Fork Roanoke River Race is finer scaled and has a generally deeper body form than either the North Fork Roanoke River Race or the James River Race. It is interesting to note that the longest pectoral fin ray of the South Fork Roanoke River Race is shorter and its longest pelvic fin ray is longer than those of the James River Race.

The South Fork Roanoke River Race is distinct from the James River Race on subspecific and racial levels in 13 characters and on subracial levels in 5 characters. There are 2 characters in which the South Fork Roanoke River Race and the James River Race overlap

other than the 9 characters which are similar in all races of C. a. roanokense. Thus there are over twice as many characters which permit the separation of these two races on subspecific and racial levels than there are in which these two races are similar or barely distinguishable.

The South Fork Roanoke River Race and the North Fork Roanoke River Race are separable on subspecific and racial levels in 7 characters and are similar or barely distinguishable in 7 other characters. The possible history of the South Fork Roanoke River Race based on these differences and the geological history of the region is discussed on page 18. The James River and North Fork of the Roanoke River apparently shared in an early capture of the New River in one locality whereas the South Fork of the Roanoke River is thought to have captured the New River drainage in a different locality at a later date.

NORTH FORK ROANOKE RIVER RACE

of

Campostoma anomalum roanokense n. subsp.

Diagnosis

The North Fork Roanoke River Race is separable from C. a. kanawhanum on the specific level in one scale character, but cannot be separated from either the South Fork Roanoke River Race or the James River Race in it:

1. Scales around caudal peduncle.

The North Fork Roanoke River Race can be separated from C. a. kanawhanum on the specific level and from both the South Fork

Roanoke River Race and the James River Race on the racial level in one scale character:

2. Scales from lateral line to lateral line across back.

C. a. kanawhamum can be separated from the North Fork Roanoke River Race on the subspecific level in two additional scale characters. The first of these characters permits the separation of the North Fork Roanoke River Race and the South Fork Roanoke River Race on the racial level. The North Fork Roanoke River Race is similar to the South Fork Roanoke River Race in the second character, and to the James River Race in both characters, however:

3. Scales below lateral line at anal fin plus scales below lateral line at pelvic fin plus scales around caudal peduncle.

4. Scales in lateral line.

The North Fork Roanoke River Race and C. a. kanawhamum are distinguishable on the racial level in two scale characters which also permit the separation of the North Fork Roanoke River Race and the South Fork Roanoke River Race on the racial level. The North Fork Roanoke River Race and the James River Race are different in only the first of these two characters, that difference being on the subracial level:

5. Scales in lateral line anterior to pelvic fin.

6. Scales below lateral line at anal fin plus scales below lateral line at pelvic fin.

The North Fork Roanoke River Race is different from C. a. kanawhamum and the James River Race on the racial level in one scale character, but cannot be separated from the South Fork Roanoke River in it:

7. Scales from lateral line to lateral line across belly before pelvic fins.

The North Fork Roanoke River Race and C. a. kanawhanum are separable on the racial level in one other scale character which is similar in the three races of C. a. roanokense:

8. Scales anterior to dorsal fin.

The North Fork Roanoke River Race and C. a. kanawhanum are separable on the specific level in three proportional measurements which are similar in the North Fork Roanoke River Race and the South Fork Roanoke River Race. The North Fork Roanoke River Race and the James River Race differ on the subspecific level in the first of these characters, on the racial level in the second, and not at all in the third:

9. Distance from tip of snout to base of pelvic fins in standard length.

10. Interorbital distance in head length.

11. Distance from tip of snout to origin of anal fin in standard length.

The North Fork Roanoke River Race differs from C. a. kanawhanum on the subspecific level in two proportional measurements, the first of which can be used to separate the North Fork Roanoke River Race and the James River Race on the racial level, but is similar in the North Fork Roanoke River and the South Fork Roanoke River Race:

12. Distance from tip of snout to origin of dorsal fin in standard length.

13. Gape width in head length.

The North Fork Roanoke River Race differs from the South Fork Roanoke River Race on the subspecific level in two proportional measurements, the first of which makes it possible to separate the North Fork

Roanoke River Race from both the James River Race and C. a. kanawhanum on the racial level:

14. Body depth in standard length.

15. Body width in standard length.

The North Fork Roanoke River Race and the James River Race may be separated on the racial level in another character:

16. Head length in standard length.

The North Fork Roanoke River Race and the South Fork Roanoke River Race can be separated on the racial level in another character in which the North Fork Roanoke River Race and the James River Race overlap completely:

17. Caudal peduncle length in standard length.

The North Fork Roanoke River Race is separable from the James River Race on the subracial level in the following character, but the North Fork Roanoke River Race and both the South Fork Roanoke River Race and C. a. kanawhanum are similar in it:

18. Snout length in head length.

The North Fork Roanoke River Race, although separable on the subracial level in the following two characters from the South Fork Roanoke River Race is completely overlapped by the James River Race in them:

19. Depressed dorsal fin length in predorsal distance.

20. Caudal peduncle depth in its own length.

The North Fork Roanoke River Race is inseparable from either of the other two races of C. a. roanokense in the following character:

21. Base of dorsal fin in predorsal distance.

Description

1. Scales around caudal peduncle: 16-23, usually 19-21, mean 19.9 (Table 8). The North Fork Roanoke River Race is indistinguishable from either of the other two races of C. a. roanokense but can be separated from C. a. kanawhanum, which averages 2.4 scales higher in this count, on the specific level. All races of both C. a. anomalum and C. a. pullum also overlap the North Fork Roanoke River Race completely in this character.

2. Scales from lateral line to lateral line across back before dorsal fin: 16-23, usually 17-20, mean 18.3 (Table 2). The North Fork Roanoke River Race is separable on the racial level from both the South Fork Roanoke River and the James River Races of C. a. roanokense in this character. The North Fork Roanoke River Race averages 0.4 scales lower than the South Fork Roanoke River Race, and 0.5 scales higher than the James River Race. The North Fork Roanoke River Race averages 0.8 scales lower than C. a. kanawhanum and is different from it on the subspecific level. The North Fork Roanoke River Race averages from 2.0 to 2.9 scales higher than the races of C. a. anomalum and is separable from them on the specific level. The average scale count of the North Fork Roanoke River Race varies from 1.1 to 2.2 scales higher than those of the races of C. a. pullum and is separable from them on racial and subspecific levels.

3. Scales below lateral line at anal fin plus scales below lateral line at pelvic fin plus scales around caudal peduncle: 28-47, usually 32-37, mean 35 (Table 9). The North Fork Roanoke River Race differs on the racial level from the South Fork Roanoke River Race

which averages 1.5 scales higher. The North Fork Roanoke River Race and the James River Race completely overlap in this character. A subspecific difference exists between the North Fork Roanoke River Race and C. a. kanawhanum which averages 4.6 scales higher. The North Fork Roanoke River Race differs on the specific level from the Chatahoochie (Georgia) River and Licking (Kentucky) River populations of C. a. anomalum which average 2.5 scales lower, on the racial level from the Ohio River (West Virginia) Race and its Potomac River (West Virginia and Maryland) Subrace and the Beaver River (Pennsylvania) population of C. a. anomalum which average from 1.3 to 1.7 scales lower, and is completely overlapped by the Alabama River (Alabama) population and the Tennessee River (Tennessee, Virginia, North Carolina) Race of C. a. anomalum. The North Fork Roanoke River Race is distinguishable from only two of the seven populations of C. a. pullum to which it was compared. These differences are on the racial level and occur between the North Fork Roanoke River Race and the Upper Genesee River (New York) Race and the Taughannock Creek (New York) population which average 1.1 and 0.7 scales higher respectively.

4. Scales in lateral line: 45-55, usually 48-51, mean 49.4 (Table 1). The North Fork Roanoke River Race is not comparable to either of the other two races of C. a. roanokense because unsatisfactory frequency distribution curves were found in them. The North Fork Roanoke River Race averages 1.2 scales less than C. a. kanawhanum and is different from it on the subspecific level. The North Fork Roanoke River Race differs from the races of C. a. anomalum on racial and subspecific levels averaging from 1.5 to 4.4 scales higher. The Tennessee River (Tennessee, Virginia, North Carolina) Race of C. a. anomalum,

however, averages 0.6 scales higher than the North Fork Roanoke River Race in this character. The North Fork Roanoke River Race averages from 0.4 to 3.0 scales lower than those races of C. a. pullum from which it differs. The North Fork Roanoke River is similar to the Taughannock Creek (New York) population of C. a. pullum, otherwise the races of C. a. pullum differ from it on racial and subspecific levels.

5. Scales in lateral line anterior to pelvic fin: 17-26, usually 19-21, mean 19.9 (Table 6). The North Fork Roanoke River Race and the South Fork Roanoke River Race are separable on the racial level, the former averaging 0.7 scales higher than the latter. The North Fork Roanoke River Race is separable from the James River Race on the subracial level. The North Fork Roanoke River Race averages 0.8 scales higher than C. a. kanawhamum from which it differs on the racial level. Racial and subspecific differences exist between the North Fork Roanoke River Race and the races of C. a. anomalum which average from 0.8 to 3.3 scales lower than the former. The North Fork Roanoke River Race differs on the subspecific level from the following three races of C. a. pullum which average 2.7 and 1.5 scales lower in the first two and 1.3 scales higher in the last: Upper French Creek (Pennsylvania) population, Fall Creek (New York) population, and the Genesee River (New York) Race. The four remaining populations of C. a. pullum that were compared to the North Fork Roanoke River Race are similar to it in this count.

6. Scales below lateral line at anal fin plus scales below lateral line at pelvic fin: 12-24, usually 13-27, mean 15.2 (Table 7). A racial difference exists between the North Fork Roanoke River

Race and the South Fork Roanoke River Race. The latter averages 0.7 scales higher than the former. No difference is apparent between the North Fork Roanoke River Race and the James River Race. The North Fork Roanoke River Race averages 0.6 scales lower than C. a. kanawhanum from which it differs on the racial level. The North Fork Roanoke River Race differs on racial and subspecific levels from the four following races of C. a. anomalum which average from 1.7 to 2.5 scales lower: Licking River (Kentucky) population, Potomac River (West Virginia and Maryland) Subrace, Beaver River (Pennsylvania) population, and Chatahoochie River (Georgia) population. The North Fork Roanoke River Race is similar to the remaining four populations of C. a. anomalum to which it was compared which includes the Upper Tennessee River (Tennessee, Virginia, North Carolina) Race. The North Fork Roanoke River Race averages from 0.6 to 0.9 scales lower than the following three populations of C. a. pullum from which it differs on the subspecific level: Upper French Creek (Pennsylvania) population, Genesee River (New York) population, and the Taughannock Creek (New York) population. The four remaining populations of C. a. pullum to which the North Fork Roanoke River Race were compared are similar to it.

7. Scales from lateral line to lateral line across belly before pelvic fins: 20-33, usually 23-26, mean 25.1 (Table 3). The North Fork Roanoke River Race and the James River Race differ on the racial level, the former averaging 2.3 scales higher than the latter. The North Fork Roanoke River Race and the South Fork Roanoke River Race are indistinguishable in this character. A racial difference exists between the North Fork Roanoke River Race and C. a.

kanawhanum which averages 1.8 scales higher. Subspecific and specific differences occur between the North Fork Roanoke River Race and the races of C. a. anomalum which average from 2.6 to 5.2 scales lower. The North Fork Roanoke River Race and all races of C. a. pullum completely overlap in this scale character.

8. Scales anterior to dorsal fin: 21-28, usually 23-25, mean 24.3 (Table 5). The North Fork Roanoke River Race is completely overlapped by the other two races of C. a. roanokense in this character. A racial difference was found to exist between the North Fork Roanoke River Race and C. a. kanawhanum which averaged 0.9 scales higher. Specific and subspecific differences occurred between the North Fork Roanoke River Race and all races of C. a. anomalum which averaged from 2.8 to 4.5 scales lower. The North Fork Roanoke River Race is similar to the Fall Creek (New York) population of C. a. pullum. The North Fork Roanoke River Race differs from the other races of C. a. pullum on racial and subspecific levels averaging higher by from 1.0 to 2.8 scales than all but the Genesee River (New York) Race which is 0.9 scales higher.

9. Distance from tip of snout to base of pelvic fins in standard length: 1.9-2.2, usually 2.0-2.2, mean 2.1 (Table 23). The North Fork Roanoke River Race and the James River Race of C. a. roanokense differ on the subspecific level, the former averaging shorter than the latter by 0.1 mm. The North Fork Roanoke River Race and the South Fork Roanoke River Race are similar in this character. The North Fork Roanoke River Race also averages 0.1 mm. shorter than C. a. kanawhanum from which it differs on the specific level. No difference exists between the North Fork Roanoke River Race and the Upper Ohio

River (West Virginia) Race of C. a. anomalum. The Potomac River (West Virginia and Maryland) Subrace of C. a. anomalum and the Upper Genesee River (New York) Race of C. a. pullum are separable from the North Fork Roanoke River Race on the specific level. They average 0.1 and 0.2 mm. longer than the North Fork Roanoke River Race respectively.

10. Interorbital distance in head length: 2.9-3.9, usually 2.9-3.3, mean 3.2 (Table 29). The North Fork Roanoke River Race and the James River Race differ on the racial level, the latter averaging wider by 0.2 mm. than the former. A complete overlap occurs between the North Fork Roanoke River Race and the South Fork Roanoke River Race. The North Fork Roanoke River Race averages narrower than C. a. kanawhanum by 0.6 mm. and differs from it on the specific level. The North Fork Roanoke River Race is distinguishable from the Upper Ohio River (West Virginia) Race and its Potomac River (West Virginia and Maryland) Subrace of C. a. anomalum on the subspecific level averaging 0.3 and 0.2 mm. narrower respectively. A specific difference exists between the North Fork Roanoke River Race and the Upper Tennessee River (Tennessee, Virginia, North Carolina and South Carolina) Race of C. a. anomalum which averages wider by 0.7 mm. The North Fork Roanoke River Race and the Upper Genesee (New York) River Race of C. a. pullum are separable on the racial level, the former averaging 0.3 mm. wider.

11. Distance from tip of snout to origin of anal fin in standard length: 1.5-1.9, usually 1.5-1.6, mean 1.5 (Table 24). The North Fork Roanoke River Race is completely overlapped by the two other races of C. a. roanokense in this character. This measurement averages 0.1 mm. shorter in the North Fork Roanoke River Race than it does in C. a.

kanawhamum which can be separated on the specific level. The same thing is true of differences between the North Fork Roanoke River Race and the Upper Ohio River (West Virginia) Race and its Potomac River (West Virginia and Maryland) Subrace of C. a. anomalum and the Genesee River (New York) Race of C. a. pullum.

12. Distance from tip of snout to origin of dorsal fin in standard length: 1.9-2.1, usually 1.9-2.0, mean 2.0 (Table 25). The North Fork Roanoke River Race averages 0.1 mm. shorter than the James River Race from which it can be separated on the racial level. The North Fork Roanoke River Race and the South Fork Roanoke River Race are similar in this character. The North Fork Roanoke River Race and C. a. kanawhamum differ on the subspecific level, the former averaging 0.2 mm. narrower than the latter. The North Fork Roanoke River Race differs on the subspecific level and specific level from the Upper Ohio River (West Virginia) Race and its Potomac River (West Virginia and Maryland) Subrace of C. a. anomalum and from the Genesee River (New York) Race and the Susquehanna River (New York) Race of C. a. pullum, all of which average at least 0.1 mm. longer. The North Fork Roanoke River Race and the Upper Tennessee River (Tennessee, Virginia, North Carolina and South Carolina) Race of C. a. anomalum overlap completely, however.

13. Gape width in head length: 2.8-3.5, usually 3.0-3.2, mean 3.1 (Table 32). The North Fork Roanoke River Race differs from the James River Race of C. a. roanokense on the racial level averaging 0.1 mm. wider in gape. An average difference of 0.1 mm. exists between the North Fork Roanoke River Race and C. a. kanawhamum which are separable on the subspecific level. The North Fork Roanoke River Race

is shorter in gape than C. a. kanawhamum. The North Fork Roanoke River Race is similar to the Upper Tennessee River (Tennessee, Virginia, North Carolina and South Carolina) Race of C. a. anomalum. Subspecific and specific differences exist between the North Fork Roanoke River Race and the Upper Ohio River (West Virginia) Race and its Potomac River (West Virginia and Maryland) Subrace of C. a. anomalum and the Upper Genesee River (New York) Race of C. a. pullum, all of which have a smaller gape by at least 0.3 mm. than the North Fork Roanoke River Race.

14. Body depth in standard length: 3.8-5.0, usually 4.2-4.5, mean 4.4 (Table 17). The North Fork Roanoke River Race averages 0.3 mm. shallower than the South Fork Roanoke River Race from which it is separable on the subspecific level. The North Fork Roanoke River Race differs from the James River Race on the racial level, the latter averaging 0.1 mm. deeper than the former. The North Fork Roanoke River Race averages 0.2 mm. shallower than C. a. kanawhamum, differing from it on the racial level. Complete overlaps occur between the North Fork Roanoke River Race and the Upper Ohio River (West Virginia) Race and its Potomac River (West Virginia and Maryland) Subrace of C. a. anomalum and the Upper Genesee River Race (New York) of C. a. pullum.

15. Body width in standard length: 4.7-6.6, usually 5.4-5.8, mean 5.6 (Table 18). The North Fork Roanoke River Race averages 0.5 mm. narrower than the South Fork Roanoke River Race from which it is separable on the subspecific level. The North Fork Roanoke River Race and the James River Race are inseparable in this character. Measurements in this character made by the writer are not comparable to those made by Ross because of differences in techniques.

16. Head length in standard length: 3.6-4.5, usually 4.1-4.3, mean 4.2 (Table 19). The North Fork Roanoke River Race averages shorter in head length by 0.1 mm. than the James River Race from which it differs on the racial level. The North Fork Roanoke River Race completely overlaps C. a. kanawhamum, the Upper Ohio River (West Virginia) Race and its Potomac River (West Virginia and Maryland) Subrace of C. a. anomalum, and the Upper Genesee River (New York) Race of C. a. pullum.

17. Caudal peduncle length in standard length: 2.6-3.0, usually 2.6-2.9, mean 2.8 (Table 27). The North Fork Roanoke River Race averages 0.1 mm. shorter in the caudal peduncle than the South Fork Roanoke River Race from which it differs on the racial level. The North Fork Roanoke River Race and the James River Race are similar in this character. Measurements in this character made by the writer are not comparable to those made by Ross because of differences in techniques.

18. Snout length in head length: 2.2-2.8, usually 2.3-2.6, mean 2.5 (Table 30). The North Fork Roanoke River Race differs on the subracial level from the James River Race and completely overlaps the South Fork Roanoke River Race. The North Fork Roanoke River Race is different on the specific level from the Potomac River (West Virginia and Maryland) Subrace of C. a. anomalum, averaging 0.2 mm. longer. No difference exists between the North Fork Roanoke River Race and the Upper Ohio River (West Virginia) Race of C. a. anomalum and the Upper Genesee River (New York) Race of C. a. pullum in this character.

19. Depressed dorsal fin length in predorsal distance: 2.3-2.9, usually 2.4-2.7, mean 2.5 (Table 34). The North Fork Roanoke River

Race differs on the subracial level from the South Fork Roanoke River Race and is similar to the James River Race of C. a. roanokense in this character. This measurement was not reported by Ross (1952: 1-223).

20. Caudal peduncle depth in its own length: 2.7-3.6, usually 3.1-3.3, mean 3.1 (Table 39). The North Fork Roanoke River Race differs from the South Fork Roanoke River Race on the subracial level and is not distinguishable from the James River Race of C. a. roanokense. Measurements in this character made by the writer are not comparable to those made by Ross because of differences in techniques.

21. Base of dorsal fin in predorsal distance: 4.0-5.8, usually 4.5-4.7, mean 4.6 (Table 33). The North Fork Roanoke River Race is inseparable from either the South Fork Roanoke River Race or the James River Race of C. a. roanokense. This character was not reported by Ross (1952: 1-223).

There is no significant difference in the number of fin rays between any of the subspecies or races of C. anomalum that were compared. Fin ray counts for the North Fork Roanoke River Race are as follows:

22. Rays in pectoral fin: 14-19, usually 15-17, mean 16.2 (Table 12).

23. Rays in pelvic fin: 8-9, usually 8, mean 8 (Table 13).

24. Rays in anal fin: 6-8, usually 7, mean 7 (Table 14).

25. Rays in caudal fin: 18-20, usually 19, mean 19 (Table 15).

26. Rays in dorsal fin: 7-8, usually 8, mean 8 (Table 16).

Flat-topped or bimodal frequency distribution curves may be due to (1) selective sampling in which a large number of the specimens

examined are from an atypical segment of a population and (2) variation of a given character in one population over a wide range as compared to the range of variability of other characters in that population. Therefore, flat-topped or bimodal frequency distribution curves in the following 13 characters of the North Fork Roanoke River Race of C. a. roanokense in the specimens counted and measured by the writer were not compared to similar scale counts and proportional measurements of the other subspecies and races of C. anomalum:

27. Scales around body before dorsal fin: 39-58, usually 41-48, mean 45.1 (Table 4).

28. Scales around body minus scales around caudal peduncle: 19-35, usually 21-28, mean 25.2 (Table 10).

29. Scales in lateral line plus scales around body: 85-113, usually 91-99, mean 94.5 (Table 11).

30. Head depth in standard length: 6.0-8.0, usually 7.0-7.4, mean 7.2 (Table 20).

31. Head width in standard length: 6.5-8.9, usually 7.4-7.8, mean 7.7 (Table 21).

32. Distance from tip of snout to base of pectoral fin in standard length: 3.8-5.1, usually 4.1-4.6, mean 4.4 (Table 22).

33. Caudal peduncle depth in standard length: 7.8-10.1, usually 8.0-8.9, mean 8.5 (Table 26).

34. Eye width in head length: 3.4-5.9, usually 4.4-5.1, mean 4.7 (Table 28).

35. Jaw length in head length: 4.8-7.4, usually 5.1-5.9, mean 5.7 (Table 31).

36. Base of anal fin in predorsal distance: 4.5-6.3, usually 4.8-5.8, mean 5.3 (Table 35).

37. Depressed anal fin length in predorsal distance: 2.5-3.4, usually 2.6-2.9, mean 2.8 (Table 36).

38. Length of longest pectoral fin ray: 2.2-2.9, usually 2.4-2.7, mean 2.6 (Table 37).

39. Length of longest pelvic fin ray: 3.0-3.7, usually 3.0-3.4, mean 3.3 (Table 38).

Relationships

The North Fork Roanoke River Race is intermediate in scalation between the South Fork Roanoke River Race and the James River Race, being coarser scaled than the former and finer scaled than the latter. The North Fork Roanoke River Race is similar to the James River Race by being more slender than the South Fork Roanoke River Race. The North Fork Roanoke River Race and the South Fork Roanoke River Race are separable on subspecific and racial levels in seven characters and are similar or barely distinguishable in seven characters. The North Fork Roanoke River Race and the James River Race differ on subspecific and racial levels in eight characters and are similar or barely distinguishable in eight others. The possible history of this form is discussed on page18, where it is proposed that the North Fork Roanoke River Race resembles the James River Race as much as it does the South Fork Roanoke River Race because of probable origin on or about the same time and in the same general region, whereas, the South Fork Roanoke River Has been in more recent contact with New River in another part of the watershed.

JAMES RIVER RACE

of

Campostoma anomalum roanokense n. subsp.

Diagnosis

The James River Race differs from C. a. kanawhamum on the specific level in one character which is similar in the three races of C. a. roanokense:

1. Scales around caudal peduncle.

The James River Race is separable from C. a. kanawhamum and the South Fork Roanoke River Race on the subspecific level in three scale characters. The James River Race differs from the North Fork Roanoke River Race on the racial level in the first of these characters but is inseparable from it in the second:

2. Scales from lateral line to lateral line across belly.

3. Scales below lateral line at anal fin plus scales below lateral line at pelvic fin plus scales around caudal peduncle.

4. Scales around body before dorsal fin.

The James River Race is separable from C. a. kanawhamum on the subspecific level in two other characters, the first of which makes separation of the James River Race and the North Fork Roanoke River Race possible on the subracial level although being similar between the James River Race and the South Fork Roanoke River Race:

5. Scales in lateral line anterior to base of pelvic fin.

6. Scales in lateral line plus scales around body.

The James River Race can be separated from C. a. kanawhamum, the South Fork Roanoke River Race, and the North Fork Roanoke River Race

on the racial level in one scale character:

7. Scales from lateral line to lateral line across back before dorsal fin.

The James River Race can be separated on the racial level from C. a. kanawhanum in two other scale characters, the first of which differs on the racial level between the James River Race and the South Fork Roanoke River Race but is similar between the James River Race and the North Fork Roanoke River Race. The James River Race is similar to both the South Fork Roanoke River Race and the North Fork Roanoke River Race in the second of these characters:

8. Scales below lateral line at anal fin plus scales below lateral line at pelvic fin.

9. Scales anterior to base of dorsal fin.

Two proportional measurements make possible the separation of the James River Race and C. a. kanawhanum on the specific level. The first of these characters is different on the racial level between the James River Race and the North Fork Roanoke River Race, and differs on the racial level between the James River Race and the South Fork Roanoke River Race. The second measurement is similar in the James River Race, the South Fork Roanoke River Race and the North Fork Roanoke River Race:

10. Interorbital distance in head length.

11. Distance from tip of snout to base of anal fin in standard length.

The James River Race and C. a. kanawhanum are separable on the subspecific level in one character in which the James River Race is different from both the North Fork Roanoke River Race and the South Fork Roanoke River Race on the racial level:

12. Distance from tip of snout to base of dorsal fin in standard length.

The James River Race and the North Fork Roanoke River Race differ on the subspecific level in one proportional measurement in which the James River Race is separable from both C. a. kanawhanum and the South Fork Roanoke River Race on the racial level:

13. Distance from tip of snout to base of pelvic fin in standard length.

One proportional measurement makes it possible to separate the James River Race and the South Fork Roanoke River Race on the subspecific level, and the James River Race and both C. a. kanawhanum and the North Fork Roanoke River Race on the racial level:

14. Body depth in standard length.

The James River Race differs from the South Fork Roanoke River Race on the subspecific level in two other proportional measurements. The James River Race and the North Fork Roanoke River Race are similar in the first of these:

15. Body width in standard length.

16. Length of longest pectoral fin ray.

The James River Race and both C. a. kanawhanum and the North Fork Roanoke River Race differ on the racial level in one character:

17. Gape width in head length.

The James River Race differs from the South Fork Roanoke River Race in the racial level in one proportional measurement which is similar between the James River Race and the North Fork Roanoke River Race:

18. Length of caudal peduncle in standard length.

The James River Race and the South Fork Roanoke River Race are different on the racial level in one other proportional measurement:

19. Length of longest pelvic fin ray.

The James River Race is separable from the North Fork Roanoke River Race on the racial level in one proportional measurement in which it varies on the subracial level with C. a. kanawhanum:

20. Head length in standard length.

The James River Race and the South Fork Roanoke River Race are separable on the subracial level in three additional characters, the first two of which are similar in the James River Race and the North Fork Roanoke River Race:

21. Depressed dorsal fin length in predorsal distance.

22. Depth of caudal peduncle in its own length.

23. Depressed anal fin length in predorsal distance.

The James River Race is separable from the North Fork Roanoke River Race on the subracial level in one proportional measurement, but is similar to C. a. kanawhanum and the South Fork Roanoke River Race in it:

24. Snout length in head length.

The James River Race is inseparable from both the North Fork Roanoke River Race and the South Fork Roanoke River Race in one additional character:

25. Base of dorsal fin in predorsal distance.

Description

1. Scales around caudal peduncle: 17-23, usually 19-21, mean 19.8 (Table 8). The James River Race is inseparable from the South Fork Roanoke River Race and the North Fork Roanoke River Race of C. a. roanokense. The James River Race averages 2.5 scales lower than

C. a. kanawhanum from which it differs on the specific level. The James River Race overlaps all races of C. a. anomalum and C. a. pullum in this character.

2. Scales from lateral line to lateral line across belly: 20-32, usually 20-24, mean 22.9 (Table 3). The James River Race differs on the subspecific level from the South Fork Roanoke River Race which averages 2.4 scales higher. The James River Race and the North Fork Roanoke River Race are distinguishable on the racial level, the former averaging 2.2 scales lower than the latter. The James River Race and C. a. kanawhanum can be separated on the subspecific level, the latter averaging 4.0 scales higher than the former. The James River Race is similar to the Upper Tennessee River (Tennessee, Virginia, North Carolina) population and the Beaver Creek (Pennsylvania) population of C. a. anomalum. The James River Race and other races of C. a. anomalum differ on the subspecific level, with the James River Race averaging higher by from 1.4 to 3.6 scales. The James River Race averages lower by 1.5 and 2.4 scales than the Sandy Creek (New York) and Taughannock Creek (New York) populations of C. a. pullum from which it differs on the subspecific level. The James River Race averages from 0.9 to 2.8 scales lower and is different on the racial level from all other races of C. a. pullum except the Fall Creek (New York) population to which it is similar.

3. Scales below lateral line at anal fin plus scales below lateral line at pelvic fin plus scales around caudal peduncle: 30-39, usually 33-35, mean 34 (Table 9). A subspecific difference exists between the James River Race and the South Fork Roanoke River Race with an average of 2.5 scales less in the former. The James River Race and the South

Fork Roanoke River Race are indistinguishable in this character. The James River Race averages 5.6 scales less than C. a. kanawhamm and differs from it on the subspecific level. An average of 1.5 scales more in the James River Race than in the Licking River (Kentucky) and Chatahoochie River (Georgia) populations of C. a. anomalum makes separation possible on the specific level. The James River Race is similar to both the Upper Tennessee River (Tennessee, Virginia, and North Carolina) and the Alabama River (Alabama) population of C. a. anomalum, but is separable from the remaining races of that subspecies on the racial level averaging from 0.3 to 0.7 scales higher. The James River Race is similar to all races of C. a. pullum except the Upper Genesee River (New York) Race and the Taugharnock Creek (New York) population which differ from it on the subspecific level and average 2.1 and 1.7 scales higher respectively.

4. Scales around body before dorsal fin: 38-53, usually 40-44, mean 42.4 (Table 4). The James River Race differs from the South Fork Roanoke River Race on the subspecific level and averages 3.0 scales lower. The James River Race also differs from C. a. kanawhamm on the subspecific level, averaging 5.7 scales lower. The James River Race is distinct on the racial level from the Upper Tennessee River (Tennessee, Virginia, North Carolina) Race of C. a. anomalum, averaging 0.8 scales higher. Other races of C. a. anomalum are different from the James River Race on subspecific and specific levels, averaging from 2.4 to 5.7 scales lower. The James River Race is distinguishable from all races of C. a. pullum on the racial level except the Upper Susquehanna River (New York) population to which it is similar. The James River Race averages from 0.4 to 2.6 scales lower than the

races of C. a. pullum except for C. a. pullum alone in Wisconsin which averages 0.1 scale lower.

5. Scales in lateral line anterior to base of pelvic fin: 17-22, usually 18-21, mean 19.5 (Table 6). The James River Race and the North Fork Roanoke River Race are barely distinguishable on the subracial level in this character. The James River Race and the South Fork Roanoke River Race completely overlap. The James River Race, however, is distinct from C. a. kanawhanum on the subspecific level, averaging 1.2 scales lower. The James River Race is similar to the Upper Tennessee River (Tennessee, Virginia, North Carolina) Race of C. a. anomalum but is different from other races of C. a. anomalum on the specific level, averaging from 1.9 to 3.2 scales higher. The James River Race averages from 0.1 to 1.7 scales lower than the Upper Allegheny River (New York, Pennsylvania) population, Upper Genesee River (New York) population, and Taughannock Creek (New York) population of C. a. pullum from which it differs on racial and subspecific levels. There are racial and specific differences between the James River Race and Fall Creek (New York) populations, Upper Susquehanna River (New York) populations, and Upper French Creek (Pennsylvania) populations of C. a. pullum with the James River Race averaging from 0.4 to 1.7 scales higher than these populations. The James River Race and the Sandy Creek (New York) population of C. a. pullum are indistinguishable.

6. Scales in lateral line plus scales around body: 84-102, usually 88-92, mean 90.5 (Table 11). The James River Race averages 8.3 scales lower in this count than C. a. kanawhanum, and differs from it on the subspecific level. Differences on the subspecific and specific levels exist between the James River Race and all but

one race of C. a. anomalum, the latter averaging from 3.2 to 8.7 scales lower than the former. The Upper Tennessee River (Tennessee, Virginia, North Carolina) Race of C. a. anomalum and the James River Race are similar in this count. The James River Race averages from 1.9 to 6.6 scales lower than Upper Allegheny River (New York and Pennsylvania) populations, Genesee River (New York) populations, Sandy Creek (New York) populations, and Fall Creek (New York) populations of C. a. pullum from which it differs on the racial level. The James River Race is similar to the other three races of C. a. pullum.

7. Scales from lateral line to lateral line across back before dorsal fin: 14-21, usually 17-19, mean 17.8 (Table 2). The James River Race is distinct on the racial level from the South Fork Roanoke River Race and the North Fork Roanoke River Race, averaging 0.9 and 0.5 scales lower, respectively. The James River Race is also different from C. a. kanawhanum on the racial level, averaging 1.3 scales lower. The James River Race averages 1.5 to 2.4 scales higher than all races of C. a. anomalum from which it differs on the subspecific and specific levels. The James River Race completely overlaps all races of C. a. pullum except the Upper Susquehanna River (New York) and Taughannock (New York) Creek populations which average 1.1 and 1.7 scales lower, respectively.

8. Scales below lateral line at anal fin plus scales below lateral line at pelvic fin: 12-18, usually 13-15, mean 14.5 (Table 7). The James River Race and the South Fork Roanoke River Race differ on the racial level, the former averaging 1.4 scales lower than the latter. The James River Race and the North Fork Roanoke River Race are

indistinguishable in this character. The James River Race averages 1.3 scales lower than C. a. kanawhamm. The James River Race differs from the following four races of C. a. anomalum on racial and subspecific levels, averaging from 1.1 to 1.9 scales higher: Licking River (Kentucky), Beaver River (Pennsylvania), Potomac River (West Virginia and Maryland), and Chatachoochie River (Georgia). The Tennessee River (Tennessee, Virginia, North Carolina) Race and two other races of C. a. anomalum are indistinguishable from the James River Race. The James River Race averages from 1.3 to 1.6 scales lower than the Upper Allegheny River (New York and Pennsylvania) Race, the Genesee River (New York) Race, and the Taughannock Creek (New York) population of C. a. pullum from which it differs on the subspecific level. All other races of C. a. pullum are similar to the James River Race in this character.

9. Scales anterior to base of dorsal fin: 20-29, usually 22-26, mean 24.2 (Table 5). The James River Race is indistinguishable from either the South Fork Roanoke River Race or the North Fork Roanoke River Race in this character. It is separable from C. a. kanawhamm on the racial level, averaging 1.0 scales lower. The James River Race differs from all races of C. a. anomalum on subspecific and specific levels, averaging from 2.7 to 4.4 scales higher. The James River Race is separable from all but one of the races of C. a. pullum on racial and subspecific levels. The James River Race averages 1.0 scales lower than the Upper Genesee River (New York) Race of C. a. pullum but higher than the other races of C. a. pullum by from 0.9 to 2.5 scales.

10. Interorbital distance in head length: 2.5-3.4, usually 2.9-3.2, mean 3.0 (Table 29). The James River Race and the North Fork Roanoke River Race differ on the racial level with the former averaging 0.2 mm. wider than the latter. The James River Race and the South Fork Roanoke River Race are barely distinguishable on the subracial level. The James River Race and C. a. kanawhanum are separable on the specific level, with the James River Race averaging 0.4 mm. narrower than C. a. kanawhanum. A specific difference exists between the James River Race and the Upper Tennessee River (Tennessee, Virginia, North Carolina and South Carolina) Race of C. a. anomalum which averages 0.5 mm. wider. The James River Race and the Upper Ohio River (West Virginia) Race and its Potomac River (West Virginia and Maryland) Subrace of C. a. anomalum differ on the racial level with the latter two averaging 0.1 mm. wider. The James River Race and the Upper Genesee River (New York) Race of C. a. pullum are similar in this character.

11. Distance from tip of snout to base of anal fin in standard length: 1.4-1.6, usually 1.5, mean 1.5 (Table 24). The James River Race completely overlaps the other two subspecies of C. a. roanokense in this character. The James River Race averages 0.1 mm. shorter in this measurement than C. a. kanawhanum, the Upper Ohio River (West Virginia) Race and its Potomac River (West Virginia and Maryland) Subrace of C. a. anomalum, and the Upper Genesee (New York) River Race of C. a. pullum, differing from them on the specific level.

12. Distance from tip of snout to base of dorsal fin in standard length: 1.8-2.0, usually 1.9-2.0, mean 1.9 (Table 25). The James River Race averages 0.1 mm. longer than both the South Fork Roanoke

River Race and the North Fork Roanoke River Race from which it differs on the racial level. A subspecific difference exists between the James River Race and C. a. kanawhanum, the former averaging 0.1 mm. shorter than the latter. The James River Race averages 0.1 mm. shorter than the Upper Ohio River (West Virginia) Race of C. a. anomalum and the Upper Genesee River (New York) Race and the Susquehanna River (New York) Race of C. a. pullum from which it differs on the subspecific level. No difference exists between the James River Race and the Potomac River (West Virginia and Maryland) Subrace and Tennessee River (Tennessee, Virginia, North Carolina and South Carolina) Race of C. a. anomalum.

13. Distance from tip of snout to base of pelvic fin in standard length: 1.9-2.2, usually 2.0-2.1, mean 2.0 (Table 23). The James River Race differs from the North Fork Roanoke River Race on the subspecific level, averaging 0.1 mm. longer. A racial difference is apparent between the James River Race and the South Fork Roanoke River Race, the latter averaging 0.1 mm. shorter than the former. The James River Race is also different from C. a. kanawhanum on the racial level. The James River Race and the Potomac River (West Virginia and Maryland) Subrace of C. a. anomalum and the Upper Genesee River (New York) Race of C. a. pullum are separable on the subspecific level, the latter averaging 0.1 mm. shorter than the former. The Upper Ohio River (West Virginia) Race of C. a. anomalum is inseparable from the James River Race.

14. Body depth in standard length: 3.6-4.8, usually 4.0-4.5, mean 4.3 (Table 17). The James River Race and the South Fork Roanoke River Race are separable on the subspecific level in this character.

The James River Race averages 0.2 mm. less deep than the South Fork Roanoke River Race. The James River Race is separable on the racial level from both the North Fork Roanoke River Race and C. a. kanawhanum averaging 0.1 mm. deeper than the former and 0.1 mm. less deep than the latter. The James River Race completely overlaps the Upper Ohio River (West Virginia) Race and its Potomac River (West Virginia and Maryland) Subrace of C. a. anomalum and the Upper Genesee River (New York) Race of C. a. pullum.

15. Body width in standard length: 4.2-6.5, usually 5.2-6.0, mean 5.6 (Table 18). The James River Race and the South Fork Roanoke River Race differ on the subspecific level, the former averaging 0.5 mm. narrower than the latter. The James River Race and the North Fork Roanoke River Race are similar in this character. Measurements made by the writer for this character are not comparable with those made by Ross because of differences in technique.

16. Length of longest pectoral fin ray in standard length: 2.4-2.8, usually 2.5-2.6, mean 2.6 (Table 37). The James River Race differs on the subspecific level from the South Fork Roanoke River Race averaging 0.1 mm. shorter. This measurement was not reported by Ross (1952: 1-223).

17. Gape width in head length: 2.8-3.6, usually 3.1-3.3, mean 3.2 (Table 32). The James River Race is different on the racial level from the North Fork Roanoke River Race, averaging 0.1 mm. narrower in gape. The James River Race and C. a. kanawhanum differ on the subspecific level with the former averaging 0.2 mm. narrower. The James River Race differs on the racial level from both the Upper Ohio River (West Virginia) Race and its Potomac River Subrace of C. a. anomalum,

averaging 0.2 and 0.3 mm. wider than each respectively. The James River Race differs on the subspecific level from both the Upper Tennessee River (Tennessee, Virginia, North Carolina and South Carolina) Race of C. a. anomalum and the Upper Genesee River (New York) Race of C. a. pullum averaging 0.2 mm. narrower than the first and 0.4 mm. wider than the second.

18. Length of caudal peduncle in standard length: 2.5-3.0, usually 2.7-2.9, mean 2.8 (Table 27). The James River Race and the South Fork Roanoke River Race differ on the racial level with the James River Race averaging 0.1 mm. shorter in the caudal peduncle. The James River Race and the North Fork Roanoke River Race are similar. Measurements made by the writer in this character are not comparable to those made by Ross because of differences in techniques.

19. Length of longest pelvic fin ray in standard length: 2.9-3.8, usually 3.2-3.6, mean 3.4 (Table 38). The James River Race averages the same as the South Fork Roanoke River Race but differs from it on the racial level. This measurement was not reported by Ross (1952: 1-223).

20. Head length in standard length: 3.8-4.5, usually 4.0-4.2, mean 4.1 (Table 19). The James River Race and the North Fork Roanoke River Race are distinct on the racial level, the former averaging 0.1 mm. longer than the latter. The James River Race and C. a. kanawhanum are incompletely separable on the subracial level. The James River Race overlaps completely the Upper Ohio River (West Virginia) Race and its Potomac River (West Virginia and Maryland) Subrace of C. a. anomalum and the Upper Genesee River (New York) Race of C. a. pullum.

21. Depressed dorsal fin length in predorsal distance: 2.3-3.0, usually 2.4-2.7, mean 2.6 (Table 34). The James River Race is

incompletely distinguishable on the subracial level from the South Fork Roanoke River Race and indistinguishable from the North Fork Roanoke River Race in this character. This measurement was not reported by Ross (1952: 1-223).

22. Depth of caudal peduncle in its own length: 2.8-3.4, usually 3.0-3.2, mean 3.1 (Table 39). The James River Race averages 0.1 mm. deeper than the South Fork Roanoke River Race and differs from it on the subspecific level. The James River Race and the North Fork Roanoke River Race, however, are similar in this character. Measurements made in this character by the writer are not comparable to those made by Ross due to differences in techniques.

23. Depressed anal fin length in predorsal distance: 2.6-3.2, usually 2.7-3.0, mean 2.9 (Table 36). The James River Race and the South Fork Roanoke River Race are similar in this character. This measurement was not reported by Ross (1952: 1-223).

24. Snout length in head length: 2.2-2.9, usually 2.4-2.7, mean 2.5 (Table 30). The James River Race is barely separable from the North Fork Roanoke River Race and inseparable from C. a. kanawhanum, the South Fork Roanoke River Race, the Upper Ohio River (West Virginia) Race of C. a. anomalum, and the Upper Genesee River (New York) Race of C. a. pullum.

25. Base of dorsal fin in predorsal distance: 4.0-5.3, usually 4.4-4.6, mean 4.6 (Table 33). The James River Race and both the North and South Fork Roanoke River Races are inseparable in this character. This measurement was not reported by Ross (1952: 1-223).

There is no significant difference in the number of fin rays between any of the subspecies or races of C. anomalum that were compared.

Fin ray counts for the James River Race are as follows:

26. Rays in pectoral fin: 15-18, usually 16, mean 16 (Table 12).

27. Rays in pelvic fin: 7-8, usually 8, mean 8 (Table 13).

28. Rays in anal fin: 6-7, usually 7, mean 7 (Table 14).

29. Rays in caudal fin: 18-20, usually 19, mean 19 (Table 15).

30. Rays in dorsal fin: 7-8, usually 8, mean 8 (Table 16).

Flat-topped or bimodal frequency distribution curves may be due to (1) selective sampling in which a large number of the specimens examined are from an atypical segment of a population and (2) variation of a given character in one population over a wide range as compared to the range of variability of other characters in that population. Therefore, flat-topped or bimodal frequency distribution curves in the following nine characters of the James River Race of C. a. roanokense were not compared to similar scale counts and measurements in other subspecies and races of C. anomalum:

31. Scales in lateral line: 44-54, usually 47-50, mean 48 (Table 1).

32. Scales around body minus scales around caudal peduncle: 18-32, usually 20-23, mean 22.6 (Table 10).

33. Head depth in standard length: 6.0-8.1, usually 6.8-7.3, mean 7.0 (Table 20).

34. Head width in standard length: 6.8-8.0, usually 7.1-7.8, mean 7.5 (Table 21).

35. Distance from tip of snout to base of pectoral fin in standard length: 3.8-4.9, usually 3.9-4.5, mean 4.3 (Table 22).

36. Caudal peduncle depth in standard length: 7.5-9.5, usually 8.1-9.1, mean 8.6 (Table 26).

37. Eye width in head length: 3.4-6.0, usually 3.4-4.0, mean 4.2 (Table 28).

38. Jaw length in head length: 4.9-6.7, usually 5.2-6.2, mean 5.7 (Table 31).

39. Base of anal fin in predorsal distance: 4.5-7.1, usually 5.0-5.6, mean 5.4 (Table 35).

Relationships

The James River Race is more slender and more coarsely scaled than the South Fork Roanoke River Race. It is more coarsely scaled than the North Fork Roanoke River Race also, but resembles that race by having a slender body form. The James River Race and the South Fork Roanoke River Race are separable on subspecific and racial levels in 13 characters and are similar or barely distinguishable in 5 characters. The James River Race and the North Fork Roanoke River Race differ on the subspecific and racial levels in 8 characters and are similar or barely distinguishable in 8 characters.

From this evidence, the James River Race is thought to be as closely related to the North Fork Roanoke River Race as it is to the South Fork Roanoke River Race. This may be due to the fact that the James and North Fork Roanoke Rivers shared in stream captures in the same general region and at about the same time. The differences between the James River Race and the North Fork Roanoke River Race and the South Fork Roanoke River Race are discussed on page 18 .

SUMMARY

1. Campostoma anomalum roanokense, a new subspecies of C. anomalum in the James and Roanoke Rivers of Virginia, West Virginia, and North Carolina is compared to C. a. kanawhanum, the most closely related form, and to other similar forms.

2. Three races of C. a. roanokense: a. South Fork Roanoke River Race, b. North Fork Roanoke River Race, and c. James River Race, are described and their relationships discussed.

3. A Roanoke River endemic (Notropis cerasinus) taken from the New River drainage and the interrelationships of the three races of C. a. roanokense may indicate a more recent contact between the New and South Fork of the Roanoke River watersheds than has taken place between the New and the James River watersheds.

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TABLE 1

SCALES IN LATERAL LINE

Campostoma anomalum roanokense

Number of scales	South Fork Roanoke	North Fork Roanoke	James	Total frequencies for three watersheds
55	-	1	-	1
54	1	-	1	2
53	1	1	-	2
52	6	4	-	10
51	10	6	2	18
50	10	11	9	30
49	4	16	11	31
48	12	8	9	29
47	7	3	12	22
46	5	1	4	10
45	2	2	3	7
44	1	-	3	4
N	59	53	54	166
M	49.1	49.4	48.0	48.8
σ	2.2	1.8	2.0	2.1
σ_M	0.29	0.25	0.27	0.34

TABLE 2

SCALES FROM LATERAL LINE TO LATERAL LINE

ACROSS BACK BEFORE DORSAL FIN

Campostoma anomalum roanokense

Number of scales	South Fork Roanoke	North Fork Roanoke	James	Total frequencies for three watersheds
23	-	1	-	1
22	-	-	-	-
21	5	2	3	10
20	7	7	1	15
19	23	9	12	44
18	17	21	14	52
17	5	10	17	32
16	2	3	5	10
15	-	-	-	-
14	-	-	1	1
N	59	53	53	165
M	18.7	18.3	17.8	18.3
σ	1.2	1.3	1.4	1.3
σ_M	0.15	0.18	0.25	0.14

TABLE 3

SCALES FROM LATERAL LINE TO LATERAL LINE

ACROSS BELLY BEFORE PELVIC FINS

Campostoma anomalum roanokense

Number of scales	South Fork Roanoke	North Fork Roanoke	James	Total frequencies for three watersheds
33	-	1	-	1
32	-	-	1	1
31	2	-	-	2
30	1	1	-	2
29	3	1	-	4
28	6	6	-	12
27	5	4	3	12
26	9	8	1	18
25	6	8	4	18
24	15	10	8	33
23	4	8	13	25
22	7	4	9	20
21	1	1	9	11
20	-	1	6	7
N	59	53	54	166
M	25.3	25.1	22.9	24.4
σ	2.4	2.4	2.2	2.6
σ_M	0.31	0.33	0.30	0.20

TABLE 4

SCALES AROUND BODY BEFORE DORSAL FIN

Campostoma anomalum roanokense

Number of scales	South Fork Roanoke	North Fork Roanoke	James	Total frequencies for three watersheds
58	-	1	-	1
57	-	-	-	-
56	-	-	-	-
55	-	-	-	-
54	-	-	-	-
53	1	-	1	2
52	1	1	-	2
51	2	2	-	4
50	3	-	1	4
49	-	1	-	1
48	4	9	-	13
47	8	3	2	13
46	4	5	3	12
45	11	5	3	19
44	10	11	5	26
43	9	2	6	17
42	3	3	11	17
41	1	6	8	15
40	-	2	7	9
39	2	2	3	7
38	-	-	3	3
N	59	53	53	165
M	45.4	45.1	42.4	44.3
σ	2.9	3.6	2.9	3.4
σ_M	0.38	0.49	0.40	0.27

TABLE 5

SCALES ANTERIOR TO DORSAL FIN

Campostoma anomalum roanokense

Number of scales	South Fork Roanoke	North Fork Roanoke	James	Total frequencies for three watersheds
29	1	-	1	2
28	-	1	2	3
27	1	4	3	8
26	9	2	9	20
25	8	10	9	27
24	16	15	10	41
23	5	8	8	21
22	10	3	9	22
21	9	1	2	12
20	-	-	1	1
N	59	44	54	157
M	23.7	24.3	24.2	24.1
σ	1.8	1.5	2.0	1.8
σ_M	0.23	0.22	0.27	0.14

TABLE 6

SCALES IN LATERAL LINE ANTERIOR TO PELVIC FIN

Campostoma anomalum roanokense

Number of scales	South Fork Roanoke	North Fork Roanoke	James	Total frequencies for three watersheds
26	-	1	-	1
25	-	-	-	-
24	-	-	-	-
23	-	1	-	1
22	3	1	4	8
21	6	7	5	18
20	7	18	12	37
19	9	11	14	34
18	9	3	7	19
17	4	2	2	8
16	1	-	-	1
N	39	44	44	127
M	19.2	19.9	19.5	19.6
σ	1.5	1.5	1.3	1.4
σ_M	0.24	0.22	0.19	0.12

TABLE 7

SCALES BELOW LATERAL LINE AT ANAL FIN PLUS

SCALES BELOW LATERAL LINE AT PELVIC FIN

Campostoma anomalum roanokense

Number of scales	South Fork Roanoke	North Fork Roanoke	James	Total frequencies for three watersheds
24	-	1	-	1
23	-	-	-	-
22	-	-	-	-
21	1	-	-	1
20	1	-	-	1
19	2	1	-	3
18	1	2	1	4
17	6	6	3	15
16	13	6	5	24
15	6	7	10	23
14	8	14	15	37
13	1	5	9	15
12	-	2	1	3
N	39	44	44	127
M	15.9	15.2	14.5	15.2
σ	1.8	2.1	1.3	1.8
σ_M	0.28	0.32	0.19	0.16

TABLE 8

SCALES AROUND CAUDAL PEDUNCLE

Campostoma anomalum roanokense

Number of scales	South Fork Roanoke	North Fork Roanoke	James	Total frequencies for three watersheds
26	1	-	-	1
25	-	-	-	-
24	-	-	-	-
23	3	2	1	6
22	5	2	-	7
21	17	7	8	32
20	25	27	26	78
19	8	10	11	29
18	-	3	5	8
17	-	1	1	2
16	-	1	-	1
N	59	53	52	164
M	20.6	19.9	19.8	20.1
σ'	1.2	1.2	1.0	1.2
σ_M	0.16	0.16	0.13	0.09

TABLE 9

SCALES BELOW LATERAL LINE AT ANAL FIN PLUS

SCALES BELOW LATERAL LINE AT PELVIC FIN PLUS

SCALES AROUND CAUDAL PEDUNCLE

Campostoma anomalum roanokense

Number of scales	South Fork Roanoke	North Fork Roanoke	James	Total frequencies for three watersheds
47	-	1	-	1
46	-	-	-	-
45	1	-	-	1
44	-	-	-	-
43	-	-	-	-
42	2	-	-	2
41	-	-	-	-
40	2	-	-	2
39	2	3	1	6
38	3	3	-	6
37	4	5	2	11
36	10	4	4	18
35	6	5	6	17
34	7	9	14	30
33	2	8	8	18
32	-	5	4	9
31	-	-	2	2
30	-	-	1	1
29	-	-	-	-
28	-	1	-	1
N	39	44	42	125
M	36.5	35.0	34.0	35.1
σ	2.6	3.0	1.7	2.7
σ_M	0.41	0.44	0.26	0.24

TABLE 10

SCALES AROUND BODY MINUS SCALES AROUND CAUDAL PEDUNCLE

Campostoma anomalum roanokense

Number of scales	South Fork Roanoke	North Fork Roanoke	James	Total frequencies for three watersheds
35	-	1	-	1
34	-	-	-	-
33	-	-	-	-
32	-	2	1	3
31	-	-	-	-
30	3	1	1	5
29	2	3	-	5
28	3	6	-	9
27	4	4	1	9
26	8	5	4	17
25	9	8	4	21
24	15	7	3	25
23	7	5	11	23
22	5	4	7	16
21	-	4	6	10
20	1	1	9	11
19	2	2	1	5
18	-	-	3	3
N	59	53	51	163
M	24.8	25.2	22.6	24.2
σ	2.4	3.3	2.8	3.1
σ_M	0.31	0.45	0.39	0.24

TABLE 11

SCALES IN LATERAL LINE PLUS SCALES AROUND BODY

Campostoma anomalum roanokense

Number of scales	South Fork Roanoke	North Fork Roanoke	James	Total frequencies for three watersheds
113	-	1	-	1
112	-	-	-	-
111	-	-	-	-
110	-	-	-	-
109	-	-	-	-
108	-	-	-	-
107	-	-	-	-
106	-	-	-	-
105	-	-	-	-
104	1	-	-	1
103	1	1	-	2
102	-	-	1	1
101	1	1	-	2
100	3	-	-	3
99	5	6	-	11
98	3	4	1	8
97	5	3	-	8
96	3	7	2	12
95	6	3	3	12
94	4	1	1	6
93	8	7	3	18
92	5	7	6	18
91	5	4	10	19
90	1	2	2	5
89	4	2	6	12
88	1	3	6	10
87	3	-	3	6
86	-	-	4	4
85	-	1	2	3
84	-	-	1	1
N	59	53	51	163
M	94.4	94.5	90.5	93.2
σ	4.0	4.6	3.5	4.4
σ_M	0.52	0.63	0.49	0.34

TABLE 12

RAYS IN PECTORAL FIN

Campostoma anomalum roanokense

Number of rays	South Fork Roanoke	North Fork Roanoke	James	Total frequencies for three watersheds
19	-	1	-	1
18	1	2	1	4
17	15	7	5	27
16	16	18	25	59
15	3	6	4	13
14	-	1	-	1
N	35	35	35	105
M	16.1	16.2	16.1	16.2
σ	0.7	1.0	0.6	0.8
σ_M	0.12	0.17	0.10	0.08

TABLE 13

RAYS IN PELVIC FIN

Campostoma anomalum roanokense

Number of rays	South Fork Roanoke	North Fork Roanoke	James	Total frequencies for three watersheds
9	-	2	-	2
8	34	32	34	100
7	1	-	1	2
N	35	34	35	104
M	8.0	8.1	8.0	8.0
σ	0.2	0.2	0.2	0.2
σ_M	0.03	0.04	0.03	0.02

TABLE 14

RAYS IN ANAL FIN

Campostoma anomalum roanokense

Number of rays	South Fork Roanoke	North Fork Roanoke	James	Total frequencies for three watersheds
8	-	1	-	1
7	32	31	30	93
6	3	3	5	11
N	35	35	35	105
M	7.0	7.0	7.0	6.9
σ	0.3	0.3	0.4	0.3
σ_M	0.05	0.06	0.06	0.03

TABLE 15

RAYS IN CAUDAL FIN

Campostoma anomalum roanokense

Number of rays	South Fork Roanoke	North Fork Roanoke	James	Total frequencies for three watersheds
20	1	1	1	3
19	34	32	33	99
18	-	2	1	3
N	35	35	35	105
M	19.0	19.0	19.0	19.0
σ	0.2	0.3	0.2	0.2
σ_M	0.03	0.05	0.04	0.02

TABLE 16

RAYS IN DORSAL FIN

Campostoma anomalum roanokense

Number of rays	South Fork Roanoke	North Fork Roanoke	James	Total frequencies for three watersheds
8	35	34	34	103
7	-	1	1	2
N	35	35	35	105
M	8.0	8.0	8.0	8.0
σ	0.0	0.2	0.2	0.1
σ_M	0.00	0.03	0.03	0.001

TABLE 17

BODY DEPTH IN STANDARD LENGTH

Campostoma anomalum roanokense

Proportion of measurement	South Fork Roanoke	North Fork Roanoke	James	Total frequencies for three watersheds
5.0	-	1	-	1
4.9	-	-	-	-
4.8	-	1	2	3
4.7	-	5	2	7
4.6	-	2	1	3
4.5	-	5	5	10
4.4	1	10	6	17
4.3	5	7	10	22
4.2	10	7	10	27
4.1	13	1	5	19
4.0	10	3	5	18
3.9	6	-	-	6
3.8	2	1	3	6
3.7	-	-	-	-
3.6	3	-	1	4
N	50	43	50	143
M	4.1	4.4	4.3	4.2
σ	0.1	0.3	0.2	0.3
σ_M	0.02	0.04	0.03	0.02

TABLE 18

BODY WIDTH IN STANDARD LENGTH

Campostoma anomalum roanokense

Proportion of measurement	South Fork Roanoke	North Fork Roanoke	James	Total frequencies for three watersheds
6.6	-	2	-	2
6.5	-	-	1	1
6.4	-	-	2	2
6.3	-	1	2	3
6.2	-	1	-	1
6.1	-	1	3	4
6.0	1	3	5	9
5.9	-	1	4	5
5.8	-	4	4	8
5.7	2	9	9	20
5.6	1	3	1	5
5.5	4	5	3	12
5.4	3	4	3	10
5.3	5	3	3	11
5.2	9	2	3	14
5.1	8	-	2	10
5.0	5	1	-	6
4.9	4	1	1	6
4.8	3	-	-	3
4.7	1	2	-	3
4.6	-	-	-	-
4.5	-	-	-	-
4.4	2	-	2	4
4.3	-	-	1	1
4.2	1	-	1	2
4.1	1	-	-	1
N	50	43	50	143
M	5.1	5.6	5.6	5.4
σ	0.4	0.4	0.5	0.5
σ_M	0.05	0.06	0.07	0.04

TABLE 19

HEAD LENGTH IN STANDARD LENGTH

Campostoma anomalum roanokense

Proportion of measurement	South Fork Roanoke	North Fork Roanoke	James	Total frequencies for three watersheds
5.0	1	-	-	1
4.9	-	-	-	-
4.8	1	-	-	1
4.7	1	-	-	1
4.6	7	-	-	7
4.5	11	2	1	14
4.4	4	4	5	13
4.3	4	7	4	15
4.2	10	13	10	33
4.1	8	9	14	31
4.0	3	5	8	16
3.9	-	2	7	9
3.8	-	-	1	1
3.7	-	-	-	-
3.6	-	1	-	1
N	50	43	50	143
M	4.4	4.2	4.1	4.2
σ	0.2	0.1	0.1	0.2
σ_M	0.03	0.02	0.02	0.02

TABLE 20

HEAD DEPTH IN STANDARD LENGTH

Campostoma anomalum roanokense

Proportion of measurement	South Fork Roanoke	North Fork Roanoke	James	Total frequencies for three watersheds
8.1	-	-	1	1
8.0	1	1	-	2
7.9	-	-	-	-
7.8	-	1	-	1
7.7	1	-	1	2
7.6	3	2	-	5
7.5	1	1	2	4
7.4	9	4	3	16
7.3	8	9	4	21
7.2	9	6	4	19
7.1	2	6	6	14
7.0	2	6	6	14
6.9	5	1	6	12
6.8	-	2	7	9
6.7	1	1	1	3
6.6	-	2	1	3
6.5	1	-	3	4
6.4	1	-	3	4
6.3	1	-	1	2
6.2	1	-	-	1
6.1	-	-	-	-
6.0	-	-	1	1
5.9	-	1	-	1
N	46	43	50	139
M	7.2	7.2	7.0	7.1
σ	0.4	0.3	0.4	0.7
σ_M	0.05	0.05	0.05	0.06

TABLE 21

HEAD WIDTH IN STANDARD LENGTH

Campostoma anomalum roanokense

Proportion of measurement	South Fork Roanoke	North Fork Roanoke	James	Total frequencies for three watersheds
8.9	-	1	-	1
8.8	-	-	-	-
8.7	-	-	-	-
8.6	-	-	-	-
8.5	1	-	-	1
8.4	1	-	-	1
8.3	3	-	-	3
8.2	3	3	-	6
8.1	2	1	-	3
8.0	1	-	2	3
7.9	4	3	2	9
7.8	9	7	5	21
7.7	4	12	6	22
7.6	3	1	4	8
7.5	5	6	6	17
7.4	5	9	6	20
7.3	5	1	6	12
7.2	1	-	3	4
7.1	1	1	4	6
7.0	-	-	1	1
6.9	1	-	1	2
6.8	1	-	1	2
6.7	-	-	-	-
6.6	-	-	-	-
6.5	-	1	-	1
N	50	46	47	143
M	7.7	7.7	7.5	7.6
σ	0.4	0.4	0.3	0.4
σ_M	0.05	0.05	0.04	0.03

TABLE 22

DISTANCE FROM TIP OF SNOUT TO BASE

OF PECTORAL FIN IN STANDARD LENGTH

Campostoma anomalum roanokense

Proportion of measurement	South Fork Roanoke	North Fork Roanoke	James	Total frequencies for three watersheds
5.1	2	1	-	3
5.0	3	-	-	3
4.9	5	-	2	7
4.8	4	2	-	6
4.7	7	2	2	11
4.6	7	7	3	17
4.5	7	8	7	22
4.4	10	7	7	24
4.3	1	2	7	10
4.2	4	6	8	18
4.1	-	4	5	9
4.0	-	3	4	7
3.9	-	-	4	4
3.8	-	1	1	2
N	50	43	50	143
M	4.6	4.4	4.3	4.4
σ	0.3	0.2	0.3	0.3
σ_M	0.04	0.04	0.04	0.03

TABLE 23

DISTANCE FROM TIP OF SNOUT TO BASE

OF PELVIC FIN IN STANDARD LENGTH

Campostoma anomalum roanokense

Proportion of measurement	South Fork Roanoke	North Fork Roanoke	James	Total frequencies for three watersheds
2.3	2	-	-	2
2.2	6	9	2	17
2.1	27	27	15	69
2.0	15	6	30	51
1.9	-	1	3	4
N	50	43	50	143
M	2.1	2.1	2.0	2.1
σ	0.1	0.1	0.1	0.1
σ_M	0.01	0.01	0.01	0.01

TABLE 24

DISTANCE FROM TIP OF SNOUT TO ORIGIN

OF ANAL FIN IN STANDARD LENGTH

Campostoma anomalum roanokense

Proportion of measurement	South Fork Roanoke	North Fork Roanoke	James	Total frequencies for three watersheds
1.9	-	1	-	1
1.8	-	-	-	-
1.7	-	-	-	-
1.6	12	9	5	26
1.5	38	33	44	115
1.4	-	-	1	1
N	50	43	50	143
M	1.5	1.5	1.5	1.5
σ	0.0	0.1	0.0	0.1
σ_M	0.01	0.01	0.00	0.00

TABLE 25

DISTANCE FROM TIP OF SNOUT TO ORIGIN

OF DORSAL FIN IN STANDARD LENGTH

Campostoma anomalum roanokense

Proportion of measurement	South Fork Roanoke	North Fork Roanoke	James	Total frequencies for three watersheds
2.1	2	1	-	3
2.0	41	30	20	91
1.9	7	12	29	48
1.8	-	-	1	1
N	50	43	50	143
M	2.0	2.0	1.9	2.0
σ	0.0	0.0	0.1	0.1
σ_M	0.01	0.01	0.01	0.01

TABLE 26

CAUDAL PEDUNCLE DEPTH IN STANDARD LENGTH

Campostoma anomalum roanokense

Proportion of measurement	South Fork Roanoke	North Fork Roanoke	James	Total frequencies for three watersheds
10.1	-	1	-	1
10.0	-	-	-	-
9.9	-	-	-	-
9.8	-	-	-	-
9.7	-	-	-	-
9.6	-	-	-	-
9.5	-	-	2	2
9.4	-	1	1	2
9.3	-	-	2	2
9.2	-	1	2	3
9.1	1	1	4	6
9.0	-	-	3	3
8.9	-	4	3	7
8.8	1	2	4	7
8.7	1	2	3	6
8.6	4	3	6	13
8.5	1	5	4	10
8.4	7	4	2	13
8.3	8	7	1	16
8.2	3	4	4	11
8.1	6	2	4	12
8.0	3	4	2	9
7.9	6	1	2	9
7.8	4	1	-	5
7.7	1	-	-	1
7.6	1	-	-	1
7.5	3	-	1	4
N	50	43	50	143
M	8.2	8.5	8.6	8.4
σ	0.4	0.4	0.4	0.5
σ_M	0.06	0.06	0.06	0.04

TABLE 27

CAUDAL PEDUNCLE LENGTH IN STANDARD LENGTH

Campostoma anomalum roanokense

Proportion of measurement	South Fork Roanoke	North Fork Roanoke	James	Total frequencies for three watersheds
3.0	-	1	3	4
2.9	7	7	13	27
2.8	13	18	21	52
2.7	17	11	10	38
2.6	10	6	2	18
2.5	3	-	1	4
N	50	43	50	143
M	2.7	2.8	2.8	2.8
σ	0.1	0.1	0.1	0.1
σ_M	0.01	0.01	0.01	0.01

TABLE 28

EYE WIDTH IN HEAD LENGTH

Campostoma anomalum roanokense

Proportion of measurement	South Fork Roanoke	North Fork Roanoke	James	Total frequencies for three watersheds
6.6	1	-	-	1
6.0	2	-	1	3
5.9	1	1	-	2
5.8	-	1	-	1
5.7	-	-	-	-
5.6	2	1	-	3
5.5	-	-	-	-
5.4	1	2	3	6
5.3	1	1	3	5
5.2	1	1	1	3
5.1	1	5	-	6
5.0	4	1	2	7
4.9	6	2	1	9
4.8	4	4	1	9
4.7	9	3	1	13
4.6	4	4	-	8
4.5	2	4	1	7
4.4	2	4	3	9
4.3	1	2	2	5
4.2	2	1	1	4
4.1	2	-	1	3
4.0	2	1	4	7
3.9	-	1	6	7
3.8	1	1	7	9
3.7	-	1	2	3
3.6	1	-	2	3
3.5	-	1	3	4
3.4	-	1	5	6
N	50	43	50	143
M	4.8	4.7	4.2	4.6
σ	0.5	0.5	0.7	0.6
σ_M	0.07	0.08	0.10	0.05

TABLE 29

INTERORBITAL DISTANCE IN HEAD LENGTH

Campostoma anomalum roanokense

Proportion of measurement	South Fork Roanoke	North Fork Roanoke	James	Total frequencies for three watersheds
3.9	1	1	-	2
3.8	-	-	-	-
3.7	-	-	-	-
3.6	-	-	-	-
3.5	-	2	-	2
3.4	1	2	2	5
3.3	5	8	2	15
3.2	4	7	6	17
3.1	16	15	10	41
3.0	11	4	14	29
2.9	9	4	9	22
2.8	3	-	4	7
2.7	-	-	2	2
2.6	-	-	-	-
2.5	-	-	1	1
N	50	43	50	143
M	3.1	3.2	3.0	3.1
σ	0.2	0.2	0.2	0.2
σ_M	0.03	0.03	0.03	0.02

TABLE 30

SNOUT LENGTH IN HEAD LENGTH

Campostoma anomalum roanokense

Proportion of measurement	South Fork Roanoke	North Fork Roanoke	James	Total frequencies for three watersheds
3.0	1	-	-	1
2.9	-	-	2	2
2.8	-	3	1	4
2.7	2	1	9	12
2.6	2	7	9	18
2.5	18	11	13	42
2.4	18	14	8	40
2.3	6	6	6	18
2.2	3	1	2	6
N	50	43	50	143
M	2.4	2.5	2.5	2.5
σ	0.1	0.1	0.2	0.1
σ_M	0.01	0.02	0.03	0.01

TABLE 31

JAW LENGTH IN HEAD LENGTH

Campostoma anomalum roanokense

Proportion of measurement	South Fork Roanoke	North Fork Roanoke	James	Total frequencies for three watersheds
7.4	1	1	-	2
7.3	-	-	-	-
7.2	-	-	-	-
7.1	-	-	-	-
7.0	-	1	-	1
6.9	2	-	-	2
6.8	-	-	-	-
6.7	1	1	1	3
6.6	-	-	1	1
6.5	-	-	-	-
6.4	2	2	2	6
6.3	-	2	1	3
6.2	-	1	4	5
6.1	1	2	4	7
6.0	4	2	6	12
5.9	3	4	4	11
5.8	3	1	1	5
5.7	3	5	2	10
5.6	8	3	5	16
5.5	6	2	1	9
5.4	3	3	3	9
5.3	2	3	3	8
5.2	2	3	5	10
5.1	3	4	2	9
5.0	1	1	3	5
4.9	3	1	1	5
4.8	1	1	-	2
4.7	-	-	1	1
4.3	1	-	-	1
N	50	43	50	143
M	5.6	5.7	5.7	5.7
σ	0.5	0.6	0.4	0.5
σ_M	0.07	0.09	0.06	0.04

TABLE 32

GAPE WIDTH IN HEAD LENGTH

Campostoma anomalum roanokense

Proportion of measurement	South Fork Roanoke	North Fork Roanoke	James	Total frequencies for three watersheds
3.7	2	-	-	2
3.6	1	-	2	3
3.5	5	4	3	12
3.4	7	4	3	14
3.3	8	5	8	21
3.2	6	7	13	26
3.1	8	7	11	26
3.0	6	12	4	22
2.9	4	1	5	10
2.8	-	2	1	3
2.7	1	-	-	1
2.6	2	1	-	3
N	50	43	50	143
M	3.2	3.1	3.2	3.2
σ	0.2	0.2	0.2	0.2
σ_M	0.03	0.03	0.03	0.03

TABLE 33

BASE OF DORSAL FIN IN PREDORSAL DISTANCE

Campostoma anomalum roanokense

Proportion of measurement	South Fork Roanoke	North Fork Roanoke	James	Total frequencies for three watersheds
5.9	1	-	-	1
5.8	-	1	-	1
5.7	-	-	-	-
5.6	-	-	-	-
5.5	-	-	-	-
5.4	1	-	-	1
5.3	-	-	1	1
5.2	-	-	-	-
5.1	2	-	2	4
5.0	1	2	4	7
4.9	3	3	4	10
4.8	6	3	3	12
4.7	5	4	3	12
4.6	8	7	10	25
4.5	6	12	8	26
4.4	6	3	7	16
4.3	4	3	4	11
4.2	3	3	3	9
4.1	2	1	-	3
4.0	1	1	1	3
3.9	-	-	-	-
3.8	1	-	-	1
N	50	43	50	143
M	4.6	4.6	4.6	4.6
σ	0.3	0.3	0.3	0.3
σ_M	0.04	0.05	0.04	0.03

TABLE 34

DEPRESSED DORSAL FIN LENGTH IN PREDORSAL DISTANCE

Campostoma anomalum roanokense

Proportion of measurement	South Fork Roanoke	North Fork Roanoke	James	Total frequencies for three watersheds
3.0	-	-	2	2
2.9	-	1	1	2
2.8	5	2	2	9
2.7	9	8	7	24
2.6	9	9	14	32
2.5	7	11	13	31
2.4	15	9	9	33
2.3	3	3	2	8
2.2	2	-	-	2
N	50	43	50	143
M	2.5	2.5	2.6	2.6
σ	0.2	0.1	0.1	0.1
σ_M	0.03	0.02	0.01	0.01

TABLE 35

BASE OF ANAL FIN IN PREDORSAL DISTANCE

Campostoma anomalum roanokense

Proportion of measurement	South Fork Roanoke	North Fork Roanoke	James	Total frequencies for three watersheds
7.1	-	-	1	1
6.6	-	-	1	1
6.5	-	-	-	-
6.4	-	-	-	-
6.3	1	1	2	4
6.2	-	-	-	-
6.1	-	1	-	1
6.0	2	1	2	5
5.9	2	-	3	5
5.8	-	3	1	4
5.7	3	2	2	7
5.6	5	3	5	13
5.5	1	4	4	9
5.4	5	1	3	9
5.3	3	4	3	10
5.2	2	7	3	12
5.1	5	3	7	15
5.0	5	4	6	15
4.9	4	4	1	9
4.8	3	4	3	10
4.7	3	-	1	4
4.6	2	-	1	3
4.5	2	1	1	4
4.4	-	-	-	-
4.3	-	-	-	-
4.2	1	-	-	1
4.1	-	-	-	-
4.0	-	-	-	-
3.9	-	-	-	-
3.8	-	-	-	-
3.7	1	-	-	1
N	50	43	50	143
M	5.2	5.3	5.4	5.3
σ	0.5	0.4	0.5	0.4
σ_M	0.07	0.06	0.07	0.03

TABLE 36

DEPRESSED ANAL FIN LENGTH IN PREDORSAL DISTANCE

Campostoma anomalum roanokense

Proportion of measurement	South Fork Roanoke	North Fork Roanoke	James	Total frequencies for three watersheds
3.4	-	1	-	1
3.3	-	-	-	-
3.2	1	3	3	7
3.1	5	-	3	8
3.0	8	2	5	15
2.9	13	9	21	43
2.8	7	8	8	23
2.7	7	8	8	23
2.6	7	9	2	18
2.5	2	3	-	5
N	50	43	50	143
M	2.8	2.8	2.9	2.8
σ	0.2	0.2	0.1	0.2
σ_M	0.03	0.03	0.01	0.02

TABLE 37

LENGTH OF LONGEST PECTORAL FIN RAY

Campostoma anomalum roanokense

Proportion of measurement	South Fork Roanoke	North Fork Roanoke	James	Total frequencies for three watersheds
3.0	3	-	-	3
2.9	6	2	-	8
2.8	8	2	1	11
2.7	7	6	4	17
2.6	5	7	14	26
2.5	5	7	13	25
2.4	-	7	3	10
2.3	1	3	-	4
2.2	-	1	-	1
N	35	35	35	105
M	2.7	2.6	2.6	2.6
σ	0.2	0.2	0.1	0.2
σ_M	0.03	0.03	0.02	0.02

TABLE 38

LENGTH OF LONGEST PELVIC FIN RAY

Campostoma anomalum roanokense

Proportion of measurement	South Fork Roanoke	North Fork Roanoke	James	Total frequencies for three watersheds
3.8	-	-	2	2
3.7	1	1	1	3
3.6	1	2	3	6
3.5	8	1	12	21
3.4	10	7	8	25
3.3	7	4	4	15
3.2	5	9	4	18
3.1	3	4	-	7
3.0	-	6	-	6
2.9	-	-	1	1
N	35	34	35	104
M	3.4	3.3	3.4	3.4
σ	0.1	0.2	0.2	0.2
σ_M	0.02	0.03	0.03	0.02

TABLE 39

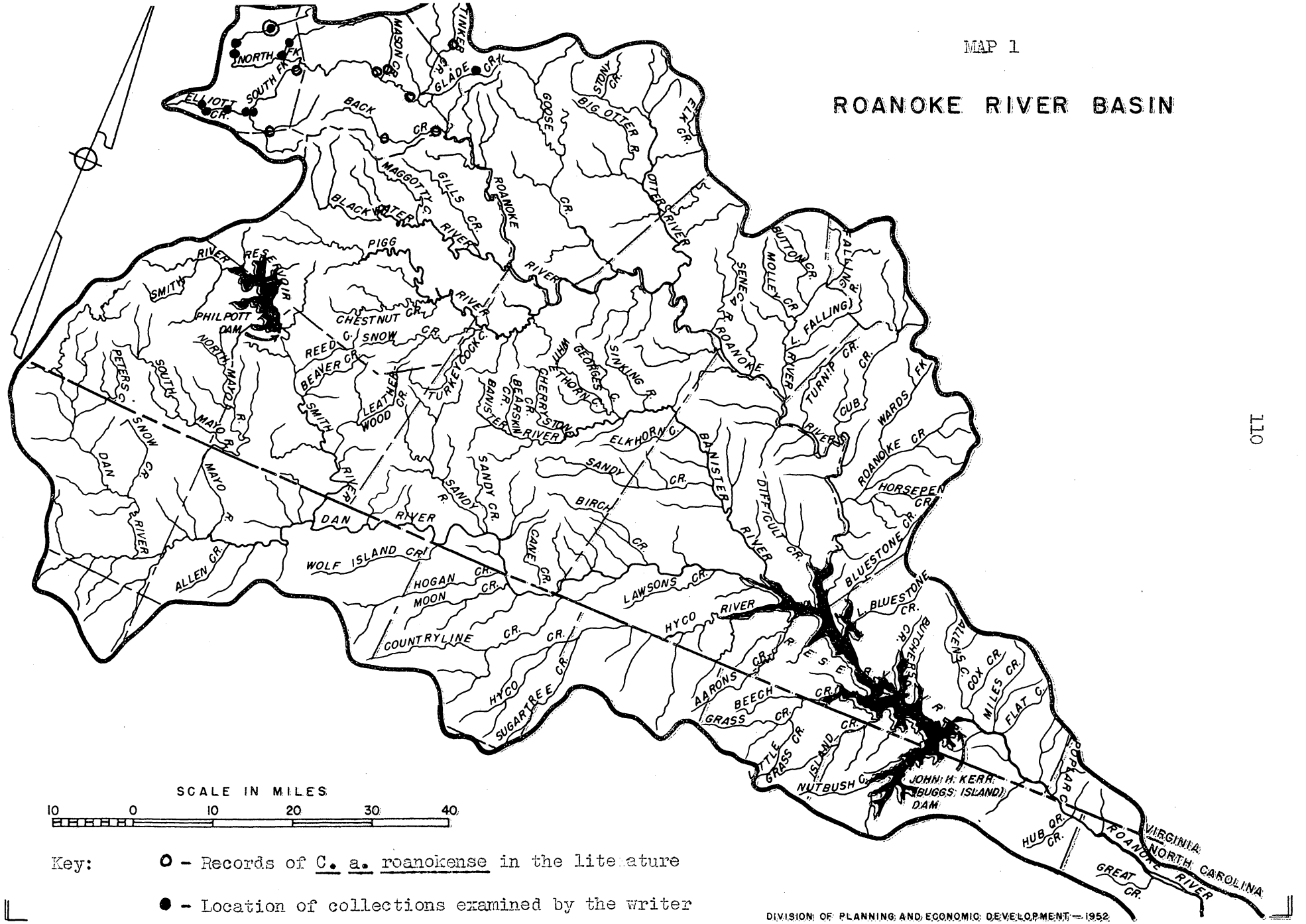
DEPTH OF CAUDAL PEDUNCLE IN ITS OWN LENGTH

Campostoma anomalum roanokense

Proportion of measurement	South Fork Roanoke	North Fork Roanoke	James	Total frequencies for three watersheds
3.6	-	1	-	1
3.5	-	-	-	-
3.4	-	-	1	1
3.3	1	4	5	10
3.2	2	10	10	22
3.1	13	10	15	38
3.0	14	12	11	37
2.9	16	2	6	24
2.8	3	3	2	8
2.7	1	1	-	2
N	50	43	50	143
M	3.0	3.1	3.1	3.1
σ	0.1	0.2	0.1	0.1
σ_M	0.01	0.03	0.01	0.01

MAP 1

ROANOKE RIVER BASIN



SCALE IN MILES

10 0 10 20 30 40

Key:

- O – Records of C. a. roanokense in the literature
- ● – Location of collections examined by the writer
- ◉ – Type locality for C. a. roanokense

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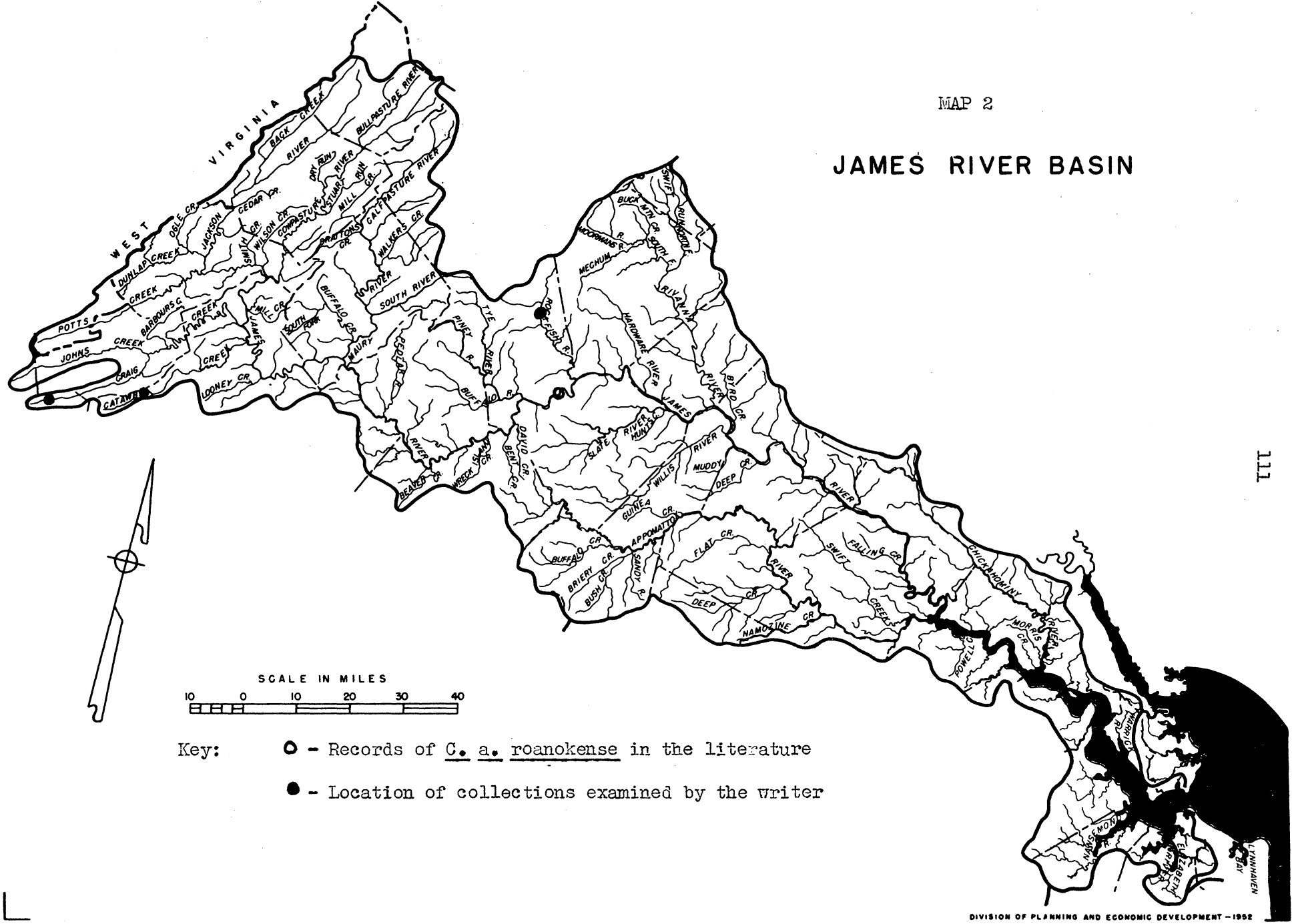
MAP 2

JAMES RIVER BASIN



SCALE IN MILES

10 0 10 20 30 40

Key: ○ - Records of *C. a. roanokense* in the literature

● - Location of collections examined by the writer

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APPENDICES

Collection numbers for the following collections are Dr. R. D. Ross' except those designated JPT (J. P. Thompson) and WSD (William S. Davis). Unless otherwise stated the collections are deposited at Virginia Polytechnic Institute, Blacksburg, Virginia.

APPENDIX A

The following collections from the South Fork of the Roanoke River and Elliot Creek in Virginia were studied:

Collection WSD 10 - May 9, 1952 - Virginia, Montgomery County, Elliot Creek 0.8 mile upstream from bridge crossing the South Fork of the Roanoke River near the mouth of Elliot Creek. U. S. G. S. Blacksburg quadrangle 1/62500, elevation about 1400. Collectors: B. D. Stough and W. S. Davis. 13 specimens.

Collection 387 - October 6, 1951 - Virginia, Montgomery County, South Fork of the Roanoke River at Allegheny Springs. Collectors: Ichthyology class. 35 specimens.

Collection 449 - April 13, 1952 - Virginia, Montgomery County, Elliot Creek tributary just south of Rogers on county road between Pilot and Christiansburg. U. S. G. S. Blacksburg quadrangle 1/62500, elevation 1800-1820. Collectors: M. H. Ross, R. D. Ross and W. S. Davis. 2 specimens.

Collection 463 - May 6, 1952 - Virginia, Montgomery County, tributary of Elliot Creek about one-half mile south of Rogers on county road 615 between Christiansburg and Pilot, U. S. G. S. Blacksburg quadrangle 1/62500, elevation 1800-1820. Collectors: R. D. Ross and W. S. Davis. 2 specimens.

Collection 464-465 - May 6, 1952 - Virginia, Montgomery County, Elliot Creek one-half mile below Rogers (464) to -0.7 mile below Rogers (465). U. S. G. S. Blacksburg quadrangle 1/62500, elevation 1700 (two collections catalogued together one-fifth mile apart taken the same day). Collectors: R. D. Ross and W. S. Davis. 4 specimens.

Collection 467 - May 7, 1952 - Virginia, Montgomery County, Elliot Creek one-half mile above mouth, about one-half mile SW Allegheny Springs; 3.2 miles South Shawsville; 7.6 miles East Christiansburg. U. S. G. S. Blacksburg quadrangle 1/62500, elevation 1400. Collectors: R. D. Ross and W. S. Davis. 1 specimen

APPENDIX A

Collection 468 - May 8, 1952 - Virginia, Montgomery County, Elliot Creek one mile East Rogers; 3.3 miles SSE Christiansburg. U. S. G. S. Blacksburg quadrangle 1/62500, elevation 1760-1780. Collectors: R. D. Ross and W. S. Davis. 5 specimens.

Collection 469 - May 8, 1952 - Virginia, Montgomery County, Elliot Creek, 2.5 to 3.0 miles East Rogers; 3.7 miles SE Christiansburg. U. S. G. S. Blacksburg quadrangle, elevation 1660-1680. Collectors: R. D. Ross and W. S. Davis. 1 specimen.

APPENDIX B

The following collections from the North Fork of the Roanoke River and Bradshaw Creek in Virginia were studied:

Collection 388 - October 7, 1951 - Virginia, Montgomery County, North Fork of the Roanoke River at Bennett's Mill. U. S. G. S. Christiansburg quadrangle 1/125000, elevation 1200-1400. Collectors: Ichthyology class. 6 specimens.

Collection 389 - October 10, 1951 - Virginia, Montgomery County, North Fork of the Roanoke River at McDonald's Mill, 12 miles NE Blacksburg on road 114. U. S. G. S. Christiansburg quadrangle 1/125000, elevation 1800-1900. Collectors: Ichthyology class. 1 specimen.

Collection 396 - October 26, 1951 - Virginia, Botetourt County, Tributary of Glade Creek at road junction 0.5 miles SW of Blue Ridge Railroad Station and 1.5 miles North Webster on road 460, 9.5 miles NE Roanoke Railroad Station. U. S. G. S. Roanoke quadrangle 1/62500, elevation 1200. Collectors: M. H. Ross and R. D. Ross.

Collection 399 - November 14, 1951 - Virginia, Montgomery County, North Fork of the Roanoke River at Bennett's Mill. U. S. G. S. Christiansburg quadrangle 1/125000, elevation 1200-1400. Collectors: J. P. Thompson and R. D. Ross. 12 specimens.

APPENDIX B

Collection 400 - November 7, 1951 - Virginia, Montgomery County, North Fork of the Roanoke River at Roanoke Valley Church. U. S. G. S. Christiansburg quadrangle 1/125000, elevation 1200-1400. Collectors: J. P. Thompson and R. D. Ross. 10 specimens.

Collection 402 - January 1, 1952 - Virginia, Montgomery County, North Fork of the Roanoke River at McDonald's Mill, 12 miles NE Blacksburg on road 114. U. S. G. S. Christiansburg quadrangle 1/125000, elevation 1800-1900. Collectors: M. H. Ross and R. D. Ross. 10 specimens.

Collection 437 - April 2, 1952 - Virginia, Montgomery County, North Fork of the Roanoke River. Collectors: W. H. Taylor and R. D. Ross. 2 specimens.

Collection 438 - April 2, 1952 - Virginia, Montgomery County, mouth of Bradshaw Creek in North Fork of the Roanoke River, 8.7 miles due East Blacksburg. U. S. G. S. Christiansburg quadrangle 1/125000, elevation 1300. Collectors: M. H. Ross and R. D. Ross. 1 specimen.

Collection 439 - April 2, 1952 - Virginia, Montgomery County, Bradshaw Creek, 7.6 miles due East Cambria. U. S. G. S. Christiansburg quadrangle 1/125000, elevation 1400. Collectors: M. H. Ross and R. D. Ross. 1 specimen.

Collection 462 - May 5, 1952 - Virginia, Montgomery County, Bradshaw Creek, tributary of North Fork of the Roanoke River, 7.6 miles due East Cambria. U. S. G. S. Christiansburg quadrangle 1/125000, elevation 1400. Collectors: W. S. Davis and R. D. Ross. 5 specimens.

APPENDIX C

The following collections from Craig Creek, Catawba Creek and Rockfish River in Virginia were studied:

Collection JPT 1 - October 20, 1951 - Virginia, Nelson County, Rockfish River, tributary of James River, 20 miles SW Charlottesville. Collector: J. P. Thompson. 30 specimens.

Collection 395 - October 21, 1951 - Virginia, Montgomery County, Craig Creek, 6.25 miles east Newport; 6.0 miles north Blacksburg. U. S. G. S. Christiansburg quadrangle 1/125000, elevation 1900. Collectors: M. H. Ross and R. D. Ross. 14 specimens.

Collection 461 - May 4, 1952 - Virginia, Roanoke County, Catawba Creek at Route 311 crossing, 5.5 miles north Salem; 8.2 miles south Newcastle; 0.7 miles SW Catawba Sanatorium. U. S. G. S. Salem quadrangle 1/62500, elevation 1660-1680. Collectors: M. H. Ross and R. D. Roass. 10 specimens.

APPENDIX D

Records of Notropis cerasinus in the New River Watershed:

Collection 460 - May 4, 1952 - Virginia, Floyd County, Little Camp Creek 200 yards above mouth at Little River on Route 8 between Floyd and Christiansburg. 8.5 miles south of Christiansburg and 4.2 miles south of Ringer. U. S. G. S.

Blacksburg quadrangle 1/62500, elevation 2100. Collectors: M. H. Ross and R. D. Ross.

Collection 500 - July 2, 1952 - Virginia, Floyd County, Beaver Creek, a tributary of Little River, 5.8 miles SE of Little River crossing on Route 8 and 5.9 miles NW of Floyd. Collectors: E. C. Raney, R. D. Ross and Ichthology class. Deposited at Cornell University under Dr. Raney's collection number 2323.

Collection 501 - July 2, 1952 - Virginia, Floyd County, West Ford Little River on Route 8 crossing 2.5 miles ENE of Floyd at mouth of Dodd's Creek. Collectors: E. C. Raney, R. D. Ross, and Ichthology class. Deposited at Cornell University under Dr. Raney's collection number 2324.

Collection 503 - July 5, 1952 - Virginia, Montgomery County, Strouble's Creek, 4.5 miles NNE of Radford, U. S. G. S. Christiansburg quadrangle 1/125000, elevation 1800-1900. Collectors: E. C. Raney, R. D. Ross and Ichthology class. Deposited at Cornell University under Dr. Raney's collection number 2326.

Records of Rhinichthys a. atratulus in the New River watershed:

Collection 479 - June 14, 1952 - Virginia, Giles County, Sinking Creek at covered bridge 0.6 miles north of Newport on county road 601. Collectors: E. C. Raney, R. D. Ross, and Ichthology class.

Deposited at Cornell University under Dr. Raney's collection number 2302.

Collection 527 - October 8, 1952 - Virginia, Giles County, Sinking Creek at covered bridge 0.6 miles north of Newport on county road 601. Collectors: Virginia Polytechnic Institute Ichthology class.

Records of Lepomis auritus in the New River watershed:

Collection 479 - June 14, 1952 - Virginia, Giles County, Sinking Creek at covered bridge 0.6 miles north of Newport on county road 601. Collectors: E. C. Raney, R. D. Ross and class. Deposited at Cornell University under Dr. Raney's collection number 2302.

Collection 495 - June 27, 1952 - Virginia, Giles County, mouth of Norris Run in New River, 10.5 air miles SW of Pearisburg, U. S. G. S. Dublin quadrangle, elevation 1650-1700. Collectors: E. C. Raney, R. D. Ross, and class. Depsoited at Cornell University under Dr. Raney's collection number 2318.

Records of Notemigonus c. crysoleucas in the New River watershed: Dr. R. D. Ross has indicated by oral communication that N. c. crysoleucas is present in Montgomery County, Virginia in Stroubles Creek near the outlet of the Virginia Polytechnic Institute college pond.