Unionid Mollusks from the Upper Cape Fear River Basin, North Carolina, with a Comparison of the Faunas of the Neuse, Tar, and Cape Fear Drainages (Bivalvia: Unionacea)

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ABSTRACT.— The unionid molluscan fauna of the piedmont portion of the Cape Fear River System consists of 10 genera and 15 species. Six additional species in the Coastal Plain part of the basin are known from literature records, and the reported occurrence of *Alasmidonta heterodon* (Lea 1830) cannot be verified. *Elliptio complanata* (Lightfoot 1786), *Uniomerus tetralasmas* (Say 1831), *Anodonta cataracta* Say 1817, and *Villosa delumbis* (Conrad 1834) are numerical dominants, while *Fusconaia masoni* (Conrad 1834), *Carunculina pulla* (Conrad 1838), *Lampsilis cariosa* (Say 1817), *Anodonta imbecilis* Say 1829, and *Lasmigona subviridis* (Conrad 1835) are least abundant. Photographic plates and diagnostic comments are provided to facilitate identifications of unionids in the Atlantic drainages of North Carolina.

Thirty years have elapsed since Walter (1956) surveyed the mollusks, of the upper Neuse River basin and provided the first detailed study on these invertebrates in a North Carolina drainage. Nine years later Dawley (1965) published an uncritical listing of freshwater mollusks for the entire state, based in part on Walter's paper, the author's personal collection, and materials at the Academy of Natural Sciences, Philadelphia, and the Museum of Zoology at the University of Michigan. Clarke (1983) published a comprehensive report on the mollusks of the Tar River system as part of an assessment of the status of the endemic spiny mussel, *Elliptio* (*Canthyria*) *steinstansana* Johnson and Clarke 1983. This study also included less intensive sampling in parts of the Roanoke (Roanoke and Cashie rivers) and Neuse (Neuse, Little, and Trent rivers) watersheds. Porter (1985) conducted a detailed sampling of the mollusks of Lake Waccamaw and the Waccamaw River system. These four works are the major ones dealing exclusively with aquatic mollusks of North Carolina, and additional records are available in Johnson (1967, 1970, 1984), Johnson and Clarke (1983), Fuller (1972, 1973, 1977), Burch (1975), Porter and Horn (1980, 1983, 1984), Horn and Porter (1981), Clarke (1981, 1983, 1985), and Shelley (1983). Earlier literature pertinent to the state is summarized by Walter (1956).

From 1971 to 1978 I sampled unionids non-quantitatively in the Piedmont Plateau section of the Cape Fear River basin, mostly in lower

reaches of the Haw and Deep rivers, which join along the Chatham-Lee counties line to form the Cape Fear River proper. Sampling of the live individuals and empty valves on the banks took place at public access points, and smaller creeks were waded for most of their lengths. In addition, Dr. Charlotte Dawley donated to the State Museum her collection of mollusks, most of which came from headwater areas of the Haw River in Guilford County and formed the basis for her checklist (1965). Thus her material plus mine spans the upper part of the basin, and this contribution supplements the works of Walter and Clarke in detailing the unionid fauna of central North Carolina. For the sake of completion, I include records and species from the lower or Coastal Plain section of the basin and also summarize reports from other North Carolina drainages. The paper concludes with a discussion and comparison (Table 1) of the faunas of the Tar, Neuse, and Cape Fear basins, the three major drainages located wholly within the state.

THE CAPE FEAR RIVER BASIN[1]

The Cape Fear River basin, the largest wholly within North Carolina, drains about 18% of the state (14,624 km^2) and all or part of 26 counties (Fig. 1,2). The basin is roughly 322 km long by a maximum of 96 km wide, extending from northwest of Greensboro to southeast of Wilmington. About 6 billion gallons of water a day flow into the Atlantic Ocean through the Cape Fear estuary, the only major one in North Carolina with direct access to the sea. Three locks and dams in Bladen County control flow of the Cape Fear River, and tidal influences are felt to the lowest of these, approximately 59 river km above Wilmington or just above site L (Fig. 2). The upper third of the watershed is in the Piedmont Plateau Physiographic Province and is characterized by undulating terrain with relatively deep valleys and narrow flood plains. Most of the basin, however, lies in the Sandhills and Coastal Plain provinces, where flat terrain causes relatively sluggish streams. Between the Piedmont Plateau and Coastal Plain is the Fall Zone, so named because of the small, discontinous rapids formed as water passes from the consolidated rock substrates of the Piedmont onto the unconsolidated sediments of the Coastal Plain. Elevations in the basin range from mean sea level to 90 to 120 m in the Fall Zone to around 300 m in the headwaters.

The Cape Fear River begins on the inner edge of the Fall Zone near the town of Moncure, and the area of study was entirely in the Haw and Deep river sub-basins, of which the former, draining an area of 2,712 km^2, is slightly larger. This sub-basin is about 112 km long and

[1] All information in this section is from the 1983 report titled "Status of Water Resources in the Cape Fear River Basin," North Carolina Department of Natural Resources and Community Development, Raleigh.

Table 1. Comparison of the native unionid faunas of the Tar, Neuse, and Cape Fear river systems.

	Tar [1]	Neuse [2]	Cape Fear
Fusconaia masoni	+	+	+
Villosa constricta	+	+	+
V. delumbis		+	+
V. vibex			+
Carunculina pulla	+	+	+
Lampsilis cariosa	+	+	+
L. ochracea	+		
L. radiata radiata	+	+	+
Anodonta cataracta		+	+
A. imbecilis	+		+
A. couperiana			+
Strophitus undulatus	+	+	+
Alasmidonta varicosa			+
A. undulata	+	+	+
A. heterodon	+	+	
Lasmigona subviridis	+	+	+
Elliptio folliculata			+
E. raveneli			+
E. complanata	+	+	+
E. congaraea			+
E. lanceolata	+	+	+
E. marsupiobesa			+
E. steinstansana	+		
Uniomerus tetralasmus		+ [3]	+
Total species	14	14	21

[1] Clarke (1983) also reported a live specimen of *Anodontoides ferussacianus* (Lea) from the upper reaches of the Tar in Granville County, but Johnson (1970) does not record this species from any Atlantic drainage, even as a junior synonym. Burch (1975) gives the range as the interior basins of the United States and Canada, the Great Lakes, and the St. Lawrence River drainages.

[2] Taken from Johnson (1970).

[3] Based on Johnson (1970), which is in accordance with Burch (1975), who reports the range as being from the Altamaha River system of Georgia to the Chowan of North Carolina. However Clarke (1983) questioned the concept of *U. tetralasmus* and considered it absent from the Roanoke, Tar, and Neuse systems.

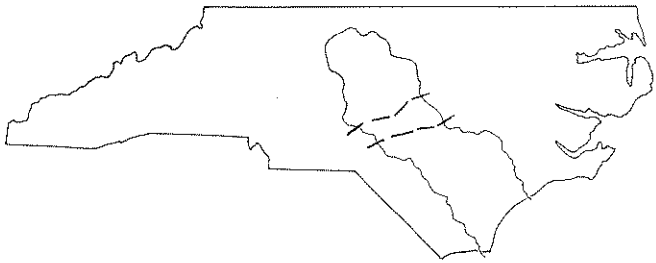

Fig. 1. Map of North Carolina showing the location and proportionate size of the Cape Fear Basin.

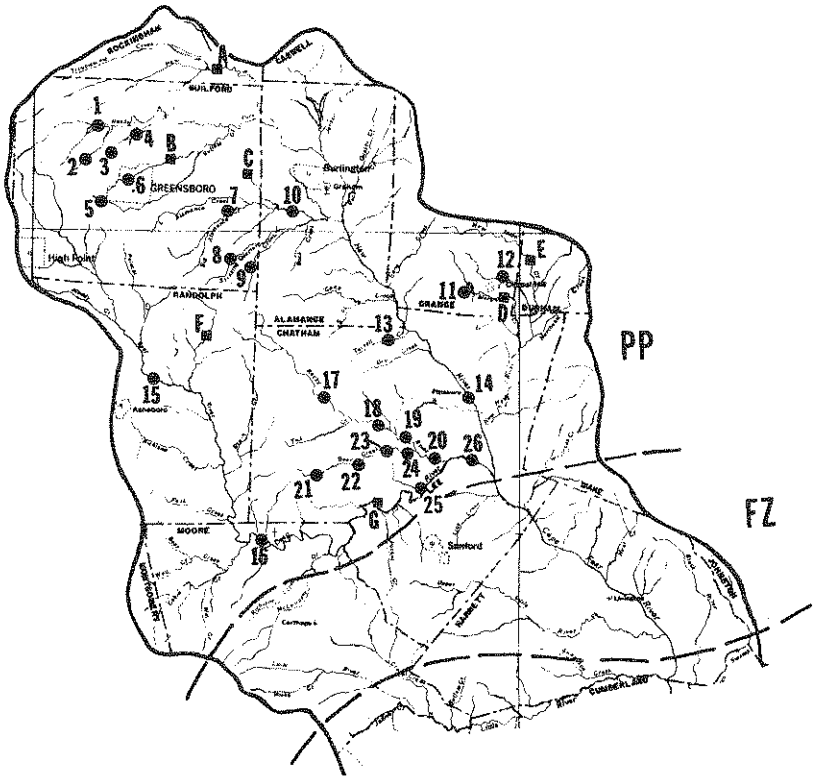

Fig. 2. PP, Piedmont Plateau; FZ, Fall Zone.

Fig. 2. The Cape Fear Basin. The dashed lines indicate the approximate boundaries of the Fall Zone. PP, Piedmont Plateau; FZ, Fall Zone; CP, Coastal Plain. Collecting sites are as follows (numbers and dots indicate new sites sampled in this study, letters and squares indicate ones cited in the literature):

Piedmont Plateau Physiographic Province
- Haw River Sub-basin
  - Rockingham County
    - A. Haw R. ca. 2.0 km NE Benaja (Johnson 1970)
  - Guilford County
    - 1. Lake Brandt
    - 2. Lake at Greensboro Country Park
    - 3. Lake at Boy Scout Camp
    - 4. Lake Philadelphia
    - 5. Lake at Hamilton Lakes subdivision
    - 6. Lake on UNC-Greensboro campus
    - 7. Alamance Cr., precise location unknown
    - 8. Stinking Quarter Cr., precise location unknown
    - 9. Lake at Kimesville
    - B. Buffalo Cr., 1.6 km E Greensboro (Johnson 1970)
    - C. Travis Cr., ca. 2.4 km N Gibsonville (Johnson 1970)
  - Alamance County
    - 10. Alamance Cr., precise location unknown
  - Orange County
    - 11. University Lake, Chapel Hill
    - 12. Booker Cr. at crossing of US 15-501, Chapel Hill
    - D. Morgan Cr., ca. 1.6 km SE Chapel Hill
  - Durham County
    - E. New Hope Cr., Duke Forest, Durham vicinity (Johnson 1970)
  - Chatham County
    - 13. Terrell Cr. ca. 0.2 km above confluence with Haw R., ca. 13.6 km ENE Pittsboro
    - 14. Haw R. at crossing of US 64, ca. 6.4 km ENE Pittsboro
- Deep River Sub-basin
  - Randolph County
    - 15. Deep R., precise location unknown
    - F. Sandy Cr., precise location unknown (Johnson 1970)
  - Moore County
    - 16. Deep R. at Highfalls
  - Chatham County
    - 17. Rocky R. at crossing of secondary road 2170, ca. 8.5 km SE Siler City
    - 18. Rocky R. at crossing of NC 902, ca. 11.2 km SW Pittsboro
    - 19. Rocky R. at crossing of secondary road 1010, ca. 17.6 km N Sanford and 9.1 km SW Pittsboro
    - 20. Rocky R. ca. 0.2 km above confluence with Deep R., ca. 8.0 km S Pittsboro
    - 21. Bear Cr. at crossing of NC 902, ca. 14.6 km S Siler City
    - 22. Bear Cr. at crossing of secondary road 2187, ca. 15.7 km SW Pittsboro
    - 23. Bear Cr. at crossing of secondary road 1010, ca. 9.1 km SW Pittsboro
    - 24. Bear Cr. at crossing or secondary road 2155, ca. 12.6 km SW Pittsboro
  - Chatham-Lee Counties
    - 25. Deep R. below crossing of US 15-501 near disjunct White Pine community, ca. 13.4 km S Pittsboro
    - 26. Deep R. at crossing of US 1, ca. 17.9 km NE Sanford
    - G. Deep R. at Gulf (Johnson 1970)

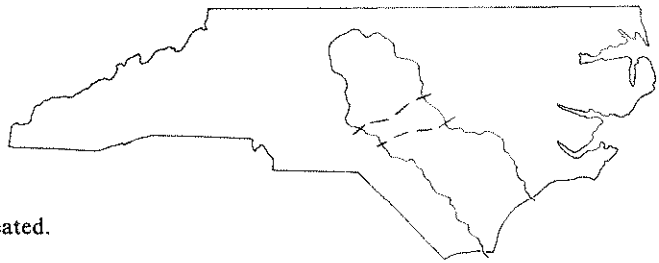

Fig. 1. Repeated.

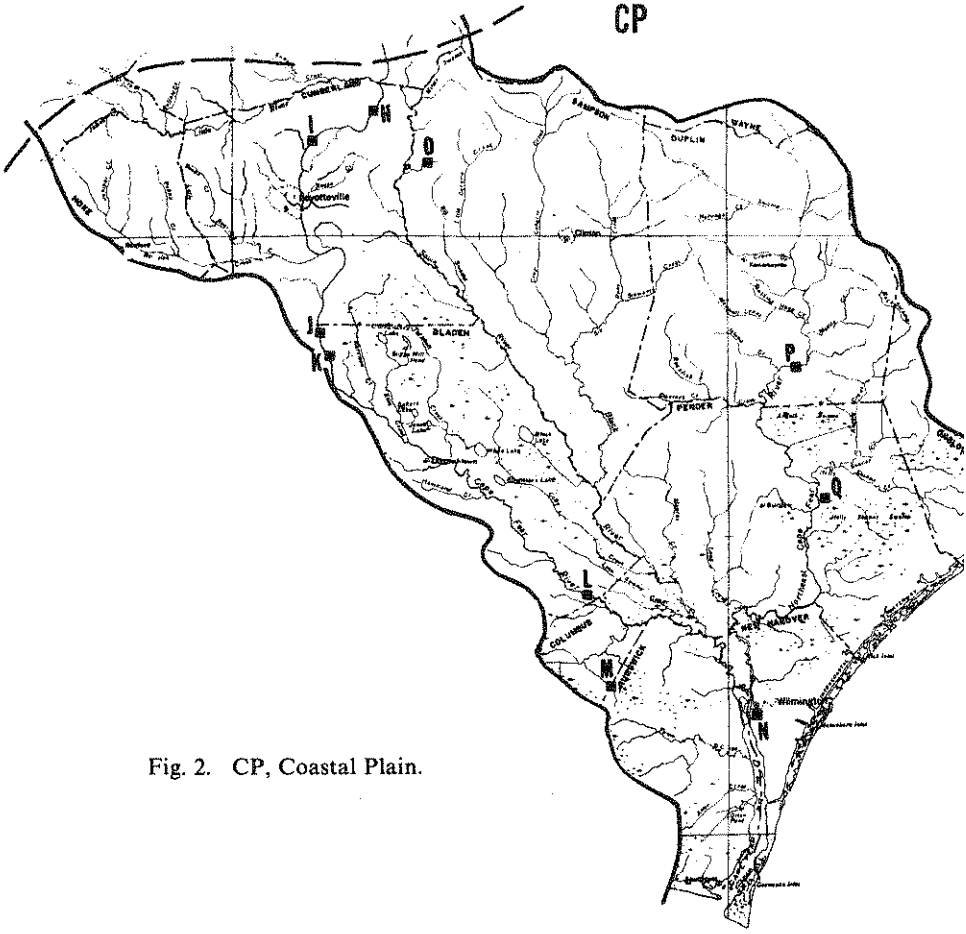

Fig. 2. CP, Coastal Plain.

Coastal Plain Physiographic Province
- Cape Fear River Sub-basin
  - Cumberland County
    - H. Cape Fear R. near Carlos (Johnson 1970)
    - I. Cape Fear R. ca. 4.8 km SW Slocomb and 9.6 km NNE Fayetteville (Fuller 1973, 1977)
  - Bladen County
    - J. Cape Fear R. ca. 4.8 km ENE Tobermoy (Fuller 1972)
    - K. Cape Fear R. ca. 2.0 km ESE Duart (Fuller (1972)
    - L. Cape Fear R. ca. 3.2 km S Kings Bluff (Johnson 1970)
  - Columbus-Brunswick Counties
    - M. Livingston Cr., precise location unknown (Johnson 1970, Dawley 1965)
  - New Hanover County
    - N. Greenfield Lake (formerly Greenfield Mill Pond) and outlet stream, Wilmington (Johnson 1970)
- South River Sub-basin
  - Sampson County
    - O. Six Runs Cr., precise location unknown (Johnson 1970)
- Northeast Cape Fear River Sub-basin
  - Duplin County
    - P. Northeast Cape Fear R., precise location unknown (Johnson 1970)
  - Pender County
    - Q. Ashes Cr., precise location unknown (Johnson 1970)

an average of 38 km wide. Flows are generally in a southeasterly direction from the headwaters in eastern Forsyth County to Moncure. Stream gradients fall uniformly by 1.2 to 2.1 m per mile in the upper two-thirds of the sub-basin, but in the lower third they vary from 0.2 to 5.4 m per mile. The Haw River sub-basin, the most densely populated part of the Cape Fear watershed, includes Greensboro, Burlington, Graham, Chapel Hill, Pittsboro, and parts of Reidsville and Durham. Major tributaries of the upper Haw River include Reedy Branch, Troublesome Creek, and Alamance Creek. The New Hope River, arising in central Orange County and joining the Haw a few kilometers above its confluence with the Deep River, is the major tributary of the lower Haw. However, B. Everett Jordan Dam, recently constructed on the Haw below its confluence with the New Hope, impounds the latter into Durham County.

The Deep River sub-basin drains about 2,304 km^2. Headwaters arise in eastern Forsyth County and flow southward to northern Moore County, then northeastward to the confluence with the Haw River. Stream gradients fall at a relatively uniform rate of 1.5 m per mile in the upper two-thirds of the sub-basin before leveling off to about 0.5 m per mile in the lower third. High Point and Asheboro, both on headwater tributaries, are the only major communities in the sub-basin. The only major tributary is the Rocky River, which arises in northeastern Randolph County and flows southeastward through Chatham County. No

major impoundments exist in the Deep River sub-basin, but Randleman and Howards Mill lakes were authorized for construction in the mid-1970s (Shelley 1972). Work may soon begin on the former, but the latter is considered economically unjustifiable for the foreseeable future.

KEY TO PIEDMONT CAPE FEAR BASIN UNIONIDAE

Two regional keys are pertinent to North Carolina's Atlantic unionids, in addition to the continental publication by Burch (1975). That by Johnson (1970) to all southern Atlantic species is more detailed, but it is mechanically flawed and of limited utility. Fuller's key (1971) to the Savannah River basin fauna is more useful but contains species absent from this state. The following key relies mostly on conchological features and was devised to facilitate determinations in any Piedmont North Carolina drainage when used in combination with the diagnoses and figures herein and in Johnson (1970).

1. Valves with lateral teeth 2
   Without this character 11
2. Left valve with small interdental projection .....
   ..... *Lasmigona subviridis* (Conrad)
   Without this character 3
3. Post-basal mantle margin (before or ventral to incurrent aperture) with caruncle ... *Carunculina pulla* (Conrad)
   Caruncle absent 4
4. Post-basal mantle margin with ribbon-like flap of tissue ....
   ..... *Lampsilis cariosa* (Say)
   Without this character 5
5. Mantle and viscera pink or reddish in color .....
   ..... *Fusconaia masoni* (Conrad)
   Mantle and viscera white or cream colored 6
6. Shells sexually dimorphic, females swollen ventrad to accommodate marsupium; post-basal margin with long papillate projections 7
   Shells not sexually dimorphic; post-basal mantle margin not modified 8
7. Valves small, periostracum dark green to black .....
   ..... *Villosa constricta* (Conrad)
   Valves moderately-large, periostracum yellow .....
   ..... *Villosa delumbis* (Conrad)
8. Valves over three times as long as high .....
   ..... *Elliptio folliculata* (Lea)
   Valves about twice as long as high 9
9. Dendritic branchial papillae present .....
   ..... *Uniomerus tetralasmus* (Say)
   Without this character 10

10. Post-basal mantle margin heavily pigmented; periostracum dull ..... *Elliptio complanata* (Lightfoot)
Post-basal mantle margin not heavily pigmented; periostracum glossy ..... *Elliptio raveneli* (Conrad)

11. Valves without pseudocardinal teeth 12
Valves with prominent or vestigial pseudocardinal teeth 13

12. Umbos extending above dorsal margin ..... *Anodonta cataracta* (Say)
Umbos flat, not protruding above dorsal margin ..... *Anodonta imbecilis* (Say)

13. Pseudocardinal teeth slight, barely detectable ..... *Strophitus undulatus* (Say)
Pseudocardinal teeth prominent 14

14. Posterior slope corrugated, with radial undulations or wrinkles; umbos relatively low ..... *Alasmidonta varicosa* (Lamarck)
Posterior slope smooth; umbos high, inflated ..... *Alasmidonta undulata* (Say)

SPECIES COMPOSITION

Unionid species collected in the upper Cape Fear system are listed below along with synonyms that have been used to refer to North Carolina records. Localities refer to symbols in Figure 2. Previous North Carolina records from the Cape Fear and other drainages, observations on preferred habitat, and the statewide conservation status reported by Fuller (1977) are variously included under "remarks." Subfamilies and tribes follow the arrangement of Burch (1975).

Subfamily Amleminae

Fusconaia masoni (Conrad 1834) [= *Pleurobema brimleyi (Wright) (Walter 1956); Elliptio merus* (Lea) (Dawley 1965); and *Pleurobema* (*Lexingtonia*) *masoni* (Conrad) (Johnson 1970)]—Fig. 3.

Diagnosis: Valves rhomboidal in outline; mantle and viscera pink or reddish in color.

Localities: 19, I.

Remarks: Walter (1956) encountered *F. masoni* below dams in tributaries of the Neuse River near Raleigh, and Clarke (1983) found it at 13 stations throughout the length of the Tar River. Johnson (1970) cited specific localities in the Roanoke, Tar-Pamlico, Neuse, Yadkin, and Catawba systms but recorded the Cape Fear River without further data. Fuller (1973) placed this species in the genus *Fusconaia* on anatomical grounds and reported it from the Coastal Plain section of the Cape Fear River at site I. Fuller (1977) alluded to its occurrence in the Rocky River and assigned *F. masoni* to "Threatened" status in North Carolina.

Subfamily Unioninae
Tribe Lampsilini

Villosa constricta (Conrad 1838) [= *Lignumia* (*Micromya*) *constricta* (Conrad) (Walter 1956); and *Ligumia constricta* (Conrad) and *V. lienosa* (Conrad) (Dawley 1965)]—Fig. 4-5.

Diagnosis: Valves small, sexually dimorphic, periostracum dark green to black; post-basal mantal margin papillate.

Localities: 2, 4, 19, 26, G.

Remarks: Walter (1956) collected *V. constricta* at nine unspecified sites in the upper Neuse basin; Johnston (1970) listed these along with two in the Tar, four in the Catawba, and two in the Cape Fear systems. In the Tar drainage, Clarke (1983) found living specimens at seven stations and empty valves at nine. Fuller (1977) considered *V. constricta* to be "Of Special Concern" to North Carolina.

Villosa delumbis (Conrad 1834) [= *Ligumia* (*Micromya*) *delumbis* (Conrad) (Walter 1956); *Ligumia delumbis* (Conrad), *V. ogeecheensis* (Conrad), and *V. tenera* (Lea) (Dawley 1965); *V. ogeecheensis* (Conrad) (Porter and Horn 1980); and *V. delumbus* (Conrad) (Johnson 1984)]—Fig. 7-8.

Diagnosis: Valves moderately large, sexually dimorphic, periostracum yellow; post-basal mantle margin papillate.

Localities: 9, 10, 11, 15, 16, 18, 19, 24, 26, N, P.

Remarks: *Villosa delumbis* is the most common lampsiline mollusk in the Cape Fear basin. Walter (1956) found it at only one site in the upper Neuse, but Johnson (1970) listed two localities in the Neuse, four in the Cape Fear, one in the Waccamaw, one in the Yadkin, and six in the Catawba basins. Porter and Horn (1980) and Johnson (1984) reported the species from Lake Waccamaw. The Neuse system is the northern range limit (Johnson 1970, Burch 1975); thus, Clarke (1983) did not encounter *V. delumbis* during his survey of the Tar River.

Carunculina pulla (Conrad 1838) [= *Toxolasma pullus* (Conrad) (Porter and Horn 1980)]—Fig. 6

Diagnosis: Post-basal mantal margin with prominent caruncle.

Localities: 11, 17.

Remarks: Johnson (1967, 1970) and Burch (1975) give the range of this species as being from the Neuse River to Georgia. Clarke (1983) found one questionable specimen in the Tar drainage, and *C. pulla* has since been collected in the Tar River at Spring Hope, Nash County (Gerberich, pers. comm.). University Lake at Chapel Hill (site 11) is the most commonly recorded North Carolina locality, but the species was also found in this study at site 17 in the Rocky River. Johnson (1970) recorded *C. pulla* from the Neuse River near Raleigh, but Walter failed

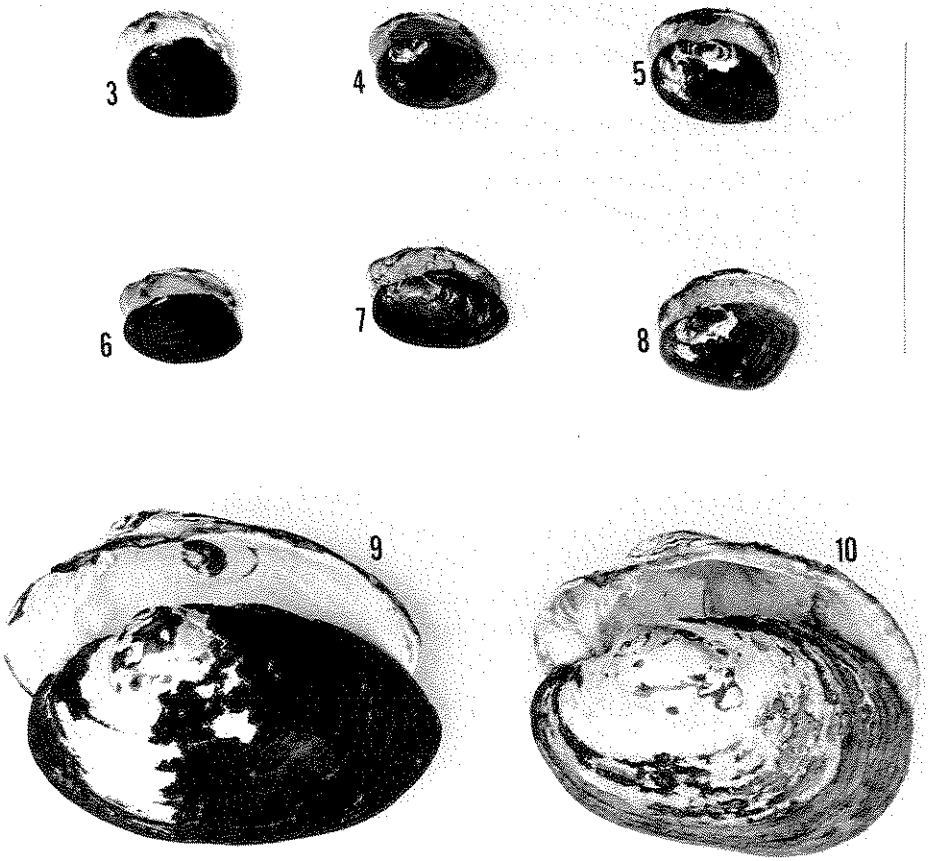

Fig. 3-10. Ambleminae and Lampsilini (Unioninae), localities in parentheses. "M" and "F" refer to male and female shells, respectively. 3, *Fusconaia masoni* (19). 4, *Villosa constricta* M (24). 5, *V. constricta* F (24). 6, *Carunculina pulla* (17). 7, *Villosa delumbis* M (18). 8, *V. delumbis* F (24). 9, *Lampsilis cariosa* M (14). 10, *L. cariosa* F (15). Scale line = 10 cm.

to find it in his study. Johnson (1970) also reported four localities near Charlotte (Catawba drainage), and Porter and Horn (1980) listed it from the Waccamaw system. According to Fuller (1977) the only sizeable population is in the Savannah River, and because of its rarity and the decline in recorded occurrences, he considered *C. pulla* "Endangered" in North Carolina.

Lampsilis cariosa (Say 1817) Fig. 9-10.

Diagnosis: Valves subovoid in outline, sexually dimorphic, periostracum smooth and yellow; post-basal mantle margin with ribbon-like flap.

Localities: 14, 15.

Remarks: *Lampsilis cariosa* is widely distributed along the eastern seaboard from Nova Scotia to Georgia (Johnson 1970, Burch 1975), but only five North Carolina records are cited—one each in the Tar and Cape Fear rivers, and three in the Neuse River. In the Tar, Clarke (1983) found living individuals and empty valves at five and six stations, respectively, from Franklin County in the Piedmont Plateau to Edgecombe County in the Coastal Plain. The present study records *L. cariosa* from both the Haw and Deep river sub-basins, and as in the Tar, *L. cariosa* occurs in both physiographic provinces in the Cape Fear drainage.

Tribe Anodontini

Andonta cataracta Say 1817 [= *A. hallenbeckii* Lea and *A. doliaris* Lea (Dawley 1965); and *A.* (*Pyganodon*) *cataracta cataracta* Say (Johnson 1970, 1984)]—Fig. 11-14.

Diagnosis: Valves moderately thick and heavy, without lateral or pseudocardinal teeth, umbos extending beyond hinge line.

Localities: 1, 2, 3, 4, 5, 6, 11, 13, 14, 17, 19, 26, C, M.

Remarks: *Anondonta cataracta*, the most common anondontine mussel in North Carolina, is a variable species sometimes reaching large size, especially in impoundments. Figures 11 through 14 show four forms encountered in the Cape Fear basin. The species occurs from the St. Lawrence to the Alabama-Coosa river systems (Johnson 1970, Burch 1975). In North Carolina, Johnson (1970, 1984) reported specific localities in the Roanoke, Neuse, Cape Fear, Waccamaw, Yadkin, and Catawba drainages. Although *A. cataracta* is not known from the Tar watershed and was not encountered by Clarke (1983), it should be expected there and in any North Carolina drainage in headwater streams, farm ponds, and small impoundments. Both Walter (1956) and Johnson (1970) cite only one collection from the Piedmont portion of the Neuse basin, but *A. cataracta* was common in the adjacent part of the Cape Fear. As explained by Shelley 1983, it was erroneously reported from the Rocky River as *A. implicata* Say by Fuller (1977).

Anodonta imbecilis Say 1829—Fig. 15-16.

Diagnosis: Valves relatively thin and fragile, without lateral or pseudocardinal teeth, umbos flat, not protruding above hinge line.

Localities: 26, N.

Remarks: *Anodonta imbecilis* occurs sporadically from the St. Lawrence to the Rio Grande river systems (Burch 1975). Walter (1956)

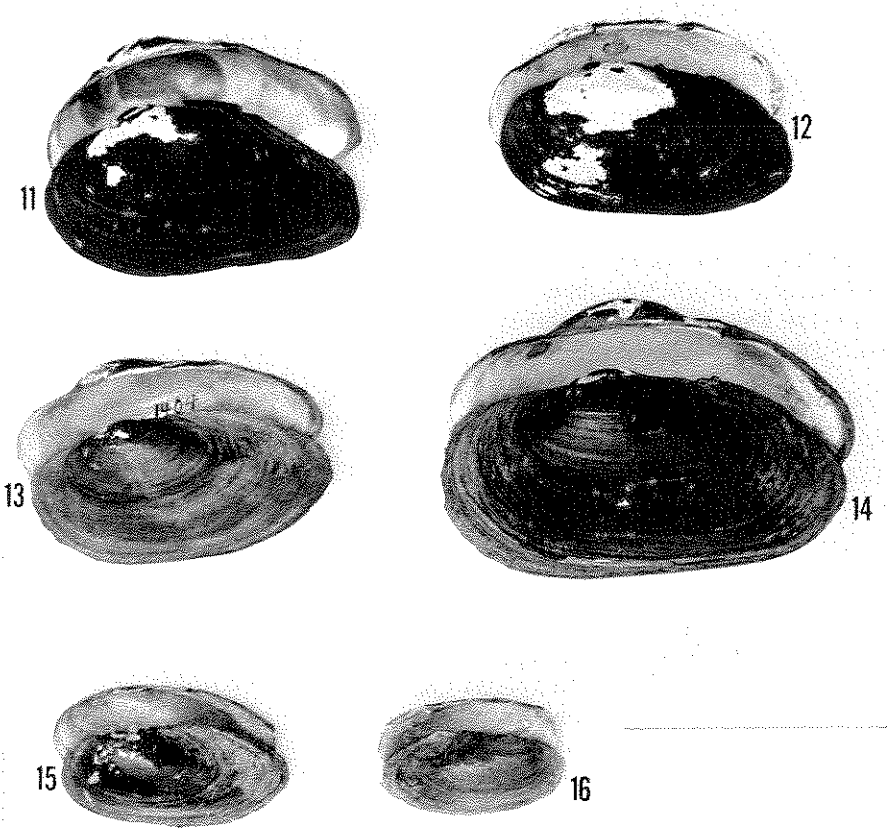

Fig. 11-16. Anodontini (Unioninae), localities in parentheses. 11-14, *Anodonta cataracta:* 11 (17), 12 (14), 13 (1), 14 (6). 15-16, *A. imbecilis* (both 26). Scale line = 10 cm.

reported two localities in the upper Neuse, but Johnson (1970) did not include any from this basin among his three North Carolina records—one each from the Yadkin, Catawba, and Cape Fear watersheds. In the Tar, Clarke (1983) encountered living specimens and empty valves at two and three stations, respectively, and found a thriving population in the impoundment upstream from Rocky Mount, Nash County. *Anodonta imbecilis* may be confused with *A. couperiana,* which also has flattened umbos and is known from Greenfield Lake (site N), but the former has a straight ventral margin and the latter a broadly curved profile.

Strophitus undulatus (Say 1817) [= *S. rugosus* (Swainson) (Dawley 1965)] —Fig. 17-18.

Diagnosis: Valves without lateral teeth, pseudocardinal teeth vestigial.

Localities: 14, 17, 19, 21, 26.

Remarks: Widespread in small creeks in both the Mississippi and Atlantic drainages from Canada to Texas, *S. undulatus* is known only from the Tar, Neuse, and Cape Fear systems in North Carolina. Walter (1956) found it at four localities in the Piedmont portion of the Neuse, and these were later listed by Johnson (1970). In the Tar (Clarke 1983), *S. undulatus* was found alive at five stations, and empty valves were encountered at ten. The species is prevalent in the lower reaches of the Haw and Deep sub-basins and has not been collected outside of Chatham County.

Alasmidonta varicosa (Lamarck 1819) [= *A. marginata varicosa* (Lamarck) (Dawley 1965)]—Fig. 19-20.

Diagnosis: Valves without lateral teeth, pseudocardinal teeth prominent; posterior slope with radial wrinkles.

Localities: 14, 19, 24, 25, 26.

Remarks: *Alasmidonta varicosa* ranges from the St. Lawrence to the Savannah river systems. It is comparatively rare south of the Potomac (Johnson 1970, Burch 1975, Clarke 1981) and was not encountered in the Tar by Clarke (1983). The species was found at five sites in the lower reaches of the Haw and Deep sub-basins and is also known from the Uwharrie (Yadkin system) and the Catawba rivers in North Carolina. In general *A. varicosa* is rare in Coastal Plain sections and is more common in Piedmont habitats and other areas above the Fall Zone.

Alasmidonta undulata (Say 1817)—Fig. 21.

Diagnosis: Valves without lateral teeth, pseudocardinal teeth prominent; posterior slope smooth; umbos high and rounded.

Localities: 11, 19, 25.

Remarks: Ranging from the St. Lawrence to the Chattahoochee river systems, *A. undulata* is known from the Catawba, Yadkin, Cape Fear, Neuse, and Tar systems in North Carolina (Walter 1956; Johnson 1970; Clarke 1981, 1983). A fourth locality in the Cape Fear is the vicinity of Fayetteville, where Fuller (1977) tentatively reported a juvenile of *A. triangulata* (Lea), an apparent ecomorph that was placed in synonymy under *A. undulata* by Clarke (1981).

Lasmigona subviridis (Conrad 1835) [= *L. charlottensis* (Lea) and *L. decorata* (Lea) (Dawley 1965)]—Fig. 22.

Diagnosis: Left valve with small interdental projection fitting into groove in right valve.

Locality: 21, N.

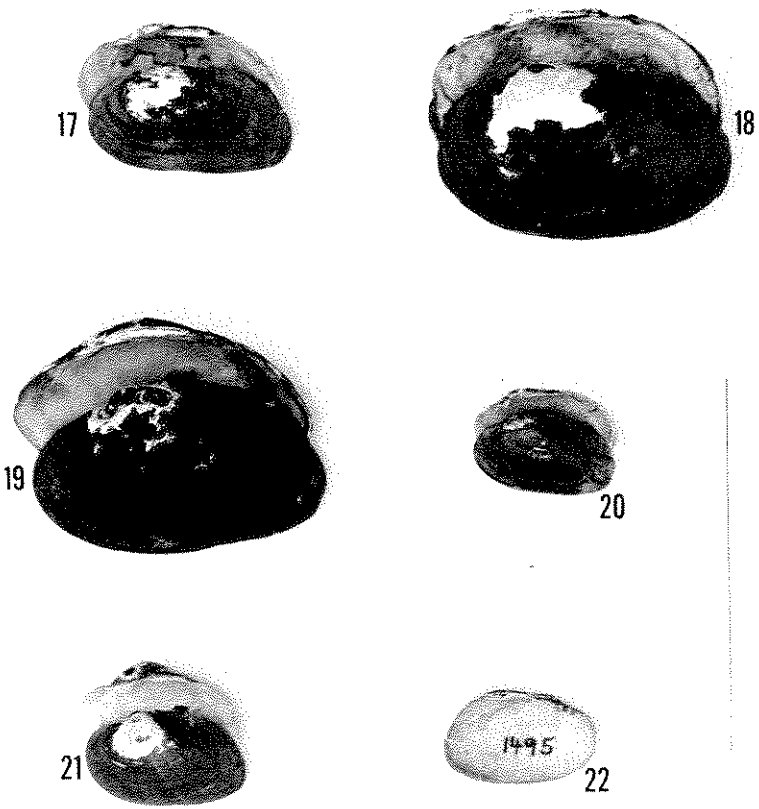

Fig. 17-22. Anodontini (Unioninae), localities in parentheses. 17-18, *Strophitus undulatus:* 17 (21), 18 (14). 19-20, *Alasmidonta varicosa:* 19 (14), 20 (24). 21, *A. undulata* (25). 22, *Lasmigonia subviridis* (21). Scale line = 10 cm.

Remarks: This species is less common in the upper Cape Fear than in the Tar system and Piedmont part of the Neuse system, where it was taken at 13 and 18 sites, respectively (Walter 1956, Clarke 1983). In this study only one valve was taken, in the headwaters of Bear Creek. Johnson (1970) reported localities in the Neuse, Tar, Yadkin, and Catawba basins, along with one from the Cape Fear River at Kinnon, near Fayetteville. Clarke (1985), however, considered the Catawba population as representing *L. decorata* (Lea) and did not record either species from the Yadkin. Thus, *L. subviridis* is widespread on the Atlantic slope from New York to the Cape Fear basin, and it is also known from the New and Greenbrier rivers of the Kanawha drainage in North Carolina and West Virginia (Johnson 1970, Burch 1975). It prefers small streams and tributaries, and tends to avoid large rivers (Clarke 1985).

Tribe Pleurobemini

Elliptio folliculata (Lea 1838) [= *E. perlatus* (Lea) and *E. perstriatus* (Lea) (Dawley 1965); and *E. arctata* (Conrad) (Johnson 1970)]—Fig. 23.

Diagnosis: Valves more than three times as long as high, ventral margin with variable indentation near midlength.

Localities: 14, 16, L.

Remarks: Johnson (1984) agreed with Davis et al. (1981) that *Unio perlatus*, assigned to the arcuate unionids in the Cape Fear system, was probably a synonym of *E. folliculata* instead of *E. arctata*, where it had been placed by Johnson (1970). In the 1970 paper Johnson reported a large series from the lower Cape Fear River, and the present material extends the range of *E. folliculata* into the Piedmont Plateau.

Elliptio raveneli (Conrad 1834) [= *E. confertus* (Lea), *E. livingstonesis* (Lea), *E. micans* (Lea), and *E. tuomeyi* (Lea) (Dawley) (1965); and *E. icterina* (Conrad) (Johnson 1970)]—Fig. 24-25.

Diagnosis: Posterior slope of valves angled, caudoventral corner slightly pointed; mantle margin slightly pigmented.

Localities: 17, 19, 22, 24, G, M, Q.

Remarks: *Elliptio raveneli* is widely distributed from the Escambia River system in Florida to the White Oak system of North Carolina (Johnson 1970, Burch 1975). Besides the Cape Fear, it is known from the Broad, Catawba, Yadkin, and Waccamaw drainages of North Carolina (Johnson 1970, 1984).

Elliptio complanata (Lightfoot 1786) [= *E. complanatus roanokensis* (Lea) (Walter 1956, Dawley 1965); *E. burkensis* (Lea), *E. catawbensis* (Lea), *E. complanatus jejunus* (Lea), *E. complanatus quadrilaterus* (Lea), *E. errans* (Lea), *E. insulsus* (Lea), *E. purus* (Lea), *E. spadiceus* (Lea), and *E. subinflatus* (Conrad) (Dawley 1965)]—Fig. 32-38.

Diagnosis: Valves rounded posteriorly; mantle margin heavily pigmented.

Localities: 1, 2, 4, 5, 7, 8, 9, 11, 12, 14, 15, 16, 18, 19, 20, 24, 25, 26, A, B, D, E, F, G, H, N, Q.

Remarks: The most widely distributed and abundant unionid in eastern North America and one of the most poorly understood systematically, *E. complanata* ranges from northern Canada to Georgia (Johnson 1970, Burch 1975). Specimens have been collected in the Broad, Catawba, Yadkin, Waccamaw, Neuse, Tar-Pamlico, and Roanoke drainages in addition to the Cape Fear (Johnson 1970, 1984). Walter (1956) encountered this species at 46 localities in the upper Neuse basin, six of which were medium to large rivers; in the Tar drainage, Clarke (1983) found living specimens at 53 stations and empty valves at 40, mostly in the Tar River itself. This species was also the only unionid Clarke (1983)

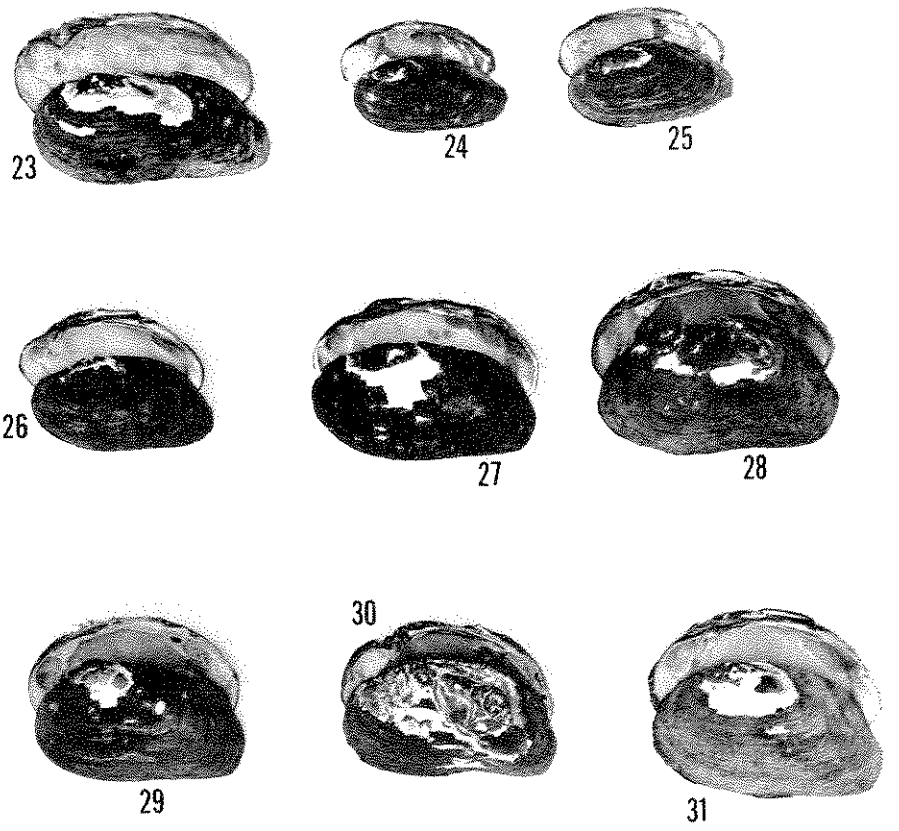

Fig. 23-31. Pleurobemini (Unioninae), localities in parentheses. 23, *Elliptio folliculata* (16). 24-25, *E. icterina* (both 24). 26-31, *Uniomerus tetralasmus:* 26-28 (17), 29 (8), 30 (18), 31 (21). Scale line = 10 cm.

encountered in the Neuse River between Raleigh and Lenoir County, a reduction in diversity that he attributed to pollution. As expected, *E. complanata* is widespread in the upper Cape Fear, and was collected at 24 stations. *Elliptio complanata* is a highly variable species and subject to extreme ecophenotypic variation, which has generated the large number of synonyms. Seven forms are shown in Figures 32 through 38. The species can be easily confused with other representatives of the genera *Elliptio* and *Uniomerus,* and close attention should be paid to the illustrations here, in Johnson (1970), and in Burch (1975) when making determinations.

Uniomerus tetralasmus (Say 1831) [= *Elliptio obesus* (Lea) and *U. obesus* (Lea) (Dawley 1965); and *U. obesus* (Lea) (Johnson 1984)]—Fig. 26-31.

Diagnosis: Periostracum coarse; mantle margin darkly pigmented.

Localities: 4, 6, 7, 8, 12, 15, 17, 18, 19, 21, 22, 23, 24, N.

Remarks: The second most abundant species in the area of study, *U. tetralasmus* is widespread in the central and eastern United States. On the Atlantic slope it ranges from the Chowan River system in Virginia to the Altamaha in Georgia (Johnson 1970, Burch 1975), and Johnson (1970), Burch (1975), and Johnson (1970, 1984) reported it from the Neuse, Roanoke, Tar, Cape Fear, Waccamaw, Yadkin, and Catawba basins of North Carolina. These views contrast with that of Clarke (1983), who considers *U. tetralasmus* a poorly understood species that is absent from the Roanoke, Tar, and Neuse systems.

LOWER CAPE FEAR SPECIES

Listed below are unionids that were not encountered in the upper Cape Fear River basin but have been reported from sites in the Coastal Plain.

Villosa vibex (Conrad 1834) [= *V. modioliformis* (Lea) (Dawley 1965)].

Localities: N and Sprunt's Pond, precise location unknown (Johnson 1970).

Lampsilis radiata radiata (Gmelin 1791) [= *L. conspicua* (Lea) and *L. radiata conspicua* (Lea) (Dawley 1965)].

Locality: N (Johnson 1970).

Remarks: Fuller (1977:166, Fig. 4) showed photographs of male and female shells of what he called the "*L. radiata* complex" from Orton Pond, Brunswick County, which empties into the Cape Fear estuary below Wilmington.

Anodonta couperiana (Lea 1842).

Locality: N (Johnson 1970).

Remarks: Fuller (1977) considered *A. couperiana* to be "Of Special Concern" to North Carolina. Its current existence at this site, Greenfield Lake in Wilmington, New Hanover County, is questionable, as recent attempts to collect it have failed (William Adams, pers. comm.).

Elliptio congaraea (Lea 1831) [= *E. dorsatus* (Lea), *E. forbesiana* (Lea), *E. sordidis* (Lea), and *E. strumosus* (Lea), (Dawley 1965)].

Locality: Cape Fear River without further specification (Johnson 1970). The White Oak system is its northern range limit.

Elliptio lanceolata (Lea 1828) [= *E. productus* (Conrad) (Walter 1956, Dawley 1965); *E. fisherianus* (Lea) and *E. viridulus* (Lea) (Dawley 1965)].

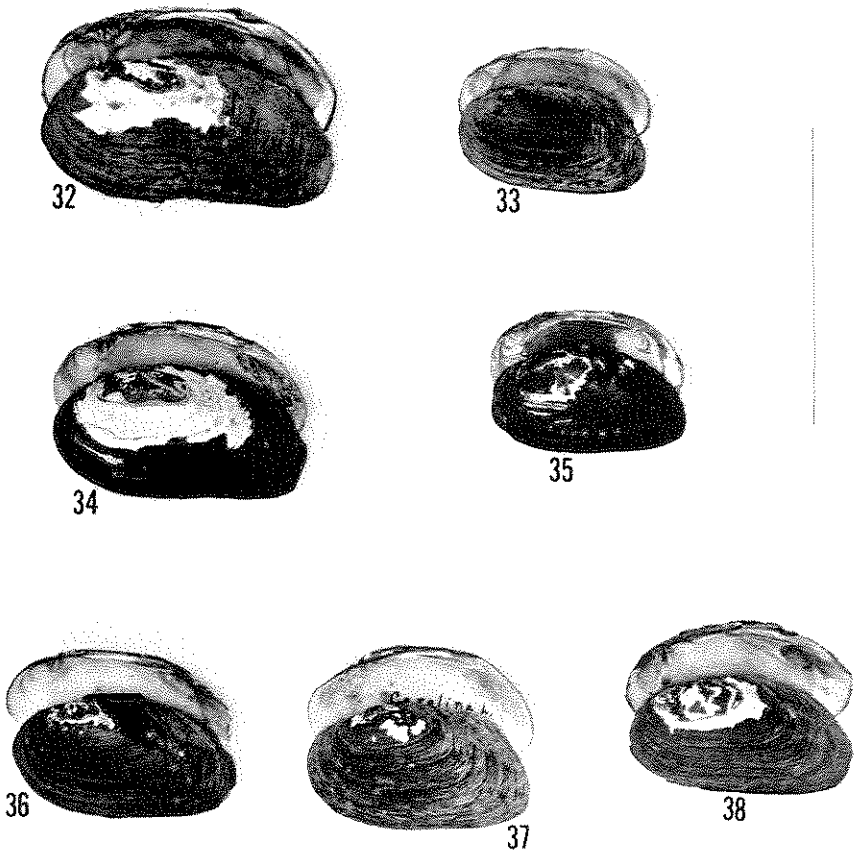

Fig. 32-38. *Elliptio complanata,* localities in parentheses. 32 (14), 33 (26), 34 (15), 35 (18), 36 (7), 37 (4), 38 (12). Scale line = 10 cm.

Localities: M, and an unspecified site in Wilmington, New Hanover County (Johnson 1970).

Remarks: Published concepts of this species vary greatly, and a diversity of forms are currently assigned to this binomial by different malacologists. Only a comprehensive taxonomic revision can clarify this confusion.

Elliptio marsupiobesa Fuller 1972.

Localities: I, J, K.

Remarks: The small size, wedge shape, and yellow periostracum distinguish the valves of *E. marsupiobesa,* which is named for its "obese" marsupium (Fuller 1972). It is known definitely from only these three

sites (Fuller 1972, 1977); however, Fuller (1977) mentioned a possible specimen from an unspecified locality in the Northeast Cape Fear River. He also listed *E. marsupiobesa* as "Endangered" within North Carolina because of proposed impoundments above Fayetteville and pollution and sedimentation in the river. As it is similar conchologically to *E. complanata* and *E. raveneli,* many collections doubtlessly contain misidentified specimens of this species. *Elliptio marsupiobesa* may be widely distributed in the lower Cape Fear and perhaps in other coastal drainages. "Undetermined" status is more appropriate than "Endangered" until this matter is resolved.

DELETION

Alasmidonta heterodon (Lea 1830).

Remarks: Dawley (1965) reported *A. heterodon* from an unspecified lake in Guilford County, but this determination is suspect because the unionid is strictly a riverine species. The specimen(s) were supposedly in her collection, but they were not among the materials donated to the State Museum of Natural Sciences. Thus without verification, this report has to be considered erroneous. Considered an "Endangered" species both within North Carolina and nationally because of the disjunct distribution and small population sizes (Fuller 1977), *A. heterodon* has been authentically reported from the Neuse and Tar systems (Walter 1956, Johnson 1970, Clarke 1981), the known southern distributional limit. However, it has not been collected in the Neuse since Walter's study; in his survey of the Tar River, Clarke (1983) found no empty valves and only one living individual, in the Piedmont section in Granville County. The Granville record is unusual as *A. heterodon* is primarily a Coastal Plain species.

DISCUSSION

With this report, the known unionid faunas of the three major drainages lying entirely within North Carolina—the Tar, Neuse, and Cape Fear—have been discussed. Surveys in the Neuse and Cape Fear were not quantitative; they concentrated on the upper or Piedmont sections, and included relatively small tributaries. Clarke's (1983) survey in the Tar was quantitative; it included both Piedmont and coastal sections, but was largely limited to the Tar River itself with little sampling in tributaries. Although the three studies are not equivalent, they nevertheless reveal the native faunas, which can be compared and contrasted with enhancement from other published records. Comparable sampling may not be done for years, and investigations in such lesser-known systems as the New (Atlantic), White Oak, and North Carolina sections of the Chowan, Lumber, Yadkin/Pee Dee, Catawba, and Broad drainages deserve equal priority.

Unionid faunas also change over time as human alterations and

pollution exert negative influences over the resident species. For example, two impoundments, Falls Lake on the Neuse near Raleigh and B. Everett Jordan Lake on the Haw, have been constructed since the most recent samplings in their areas, and a dam creating Randleman Lake on the Deep River in Randolph County may soon be built. Clarke (1983) found a diverse fauna in the Little River tributary of the Neuse River in Wake and Johnston counties, but except for *E. complanata,* the natural molluscan fauna of the Neuse itself had been eliminated, apparently by pollution, from Raleigh to Jenny Lind in Lenoir County, a distance of more than 136 river km. Similarly, the coastal Trent River tributary below Trenton was devoid of mollusks, again probably the result of pollution. The situation in the Roanoke system was similar. Clarke (1983) found a few empty valves of *Anodonta implicata* Say and *Lampsilis ochracea* (Say) in rapids between Lake Gaston dam and Weldon, only a few kilometers downstream, but from there to the river mouth no unionids were seen. In contrast, the coastal Cashie River tributary contained living *E. complanata* and *Ligumia nasuta* (Say). Clarke attributed the depauperate Roanoke River fauna to siltation complicated by pollution and fluctuating water releases from Lake Gaston dam. Thus, in contrast to the adjacent Neuse and Roanoke Rivers, coastal reaches of the Tar River still support a diverse unionid fauna, which includes the nationally endangered endemic species *Elliptio* (*Canthyria*) *steinstansana.* Every effort should therefore be made to maintain current water quality levels in the Tar River, for much of North Carolina's diverse coastal unionid fauna is in imminent danger of disappearing.

The faunas of the three drainages are compared in Table 1. The Tar and Neuse have the same number of species, but the Cape Fear has 50% more. Discounting the presence of *U. tetralasmus,* since malacologists disagree on its concept, 10 species are common to all three basins. The Tar shares or shared *Anodonta imbecilis* with the Cape Fear and *Alasmidonta heterodon* with the Neuse, and the Neuse and Cape Fear share *Anodonta cataracta* and perhaps *Uniomerus tetralasmus. Lampsilis ochracea* and *Elliptio steinstansana* occur only in the Tar, and eight species occur solely in the Cape Fear, four of which represent literature records from the lower basin. In contrast, no species are recorded solely from the Neuse, a possible reflection of its intermediate geographical position. The greater fauna of the Cape Fear is partly the result of southern elements (*V. vibex, A. couperiana, E. icterina,* and *E. congaraea*) that occur northward to this or the proximal White Oak drainage. Investigations are now needed in the latter and such drainages as the New (Atlantic) and Newport, where no one has looked for unionids. Likewise, areas in many watersheds have been sampled incompletely and/or insufficiently. Additional undescribed species may well occur in the river basins of North Carolina, and resolution of the perplexing taxonomic enigmas can come only with additional and intensive emphasis here and in other Southeastern States.

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