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MOLLUSKS OF THE UPPER NEUSE RIVER BASIN, NORTH CAROLINA[1]

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INTRODUCTION.—This report of a freshwater mollusk survey of the Neu River Basin attempts to meet a need created by lack of a thorough study Atlantic drainage fluviatile mollusks in North Carolina. Several persons h studied or collected mollusks of the state in the 19th and early 20th centur Isaac Lea received North Carolina shells, some of which evoked descriptions new species, e.g. *Unio pertenuis* from E. Emmons, *U. genthii* from F. A. Gen

[1] From a thesis partly meeting requirements for the Ph.D. degree at Duke Univers 1954.

and *U. conspicuus* from C. M. Wheatley (Lea, 1867, 1857, 1872 respectively). *Melania dislocata* (Ravenel, 1834) was described from Dan River, N. C. Other state records are those of Wright, 1897; Pilsbry, 1903; Walker, 1908; van der Schalie, 1933; Pearse, 1936; Goodrich, 1942, 1950; and Rehder, 1949. Ortmann (1913, 1919) studied parts or all of various easterly draining streams from Virginia to New York. Goodrich (1939) reported the mollusks, excepting unionids, of the Ogeechee River Basin, Georgia. Except for largely unreported, sporadic collecting, chiefly by C. S. Brimley, the Neuse River Basin was unknown malacologically.

The rapid growth of population and industry in the Neuse Basin made it of first importance to record the mollusks and their distribution before dams, pollution and other signs of progress altered the fauna too greatly. Also sought were as many data on life history and environment as were consistent with completing the survey. After its molluscan fauna had been determined, the Neuse Basin could be viewed in relation to other Atlantic drainages.

The Neuse River Basin extends about 180 miles southeastward from the mid-Piedmont area north and west of Durham, through the Fall Zone to New Bern in the Coastal Plain; its greatest width is about 45 miles. The river itself is about 300 miles long. Regional geology extends the fluviatile vigor of Fall Line conditions eastward as a Fall Zone which ends a few miles above Smithfield. Roughly half the basin is below that point. The upper half consists of Piedmont and Fall Zone areas. Characteristic of it are steeper gradients, riffles alternating with quieter stretches and pools, rocky, gravel and sand bottoms, and many small headstreams. Water levels vary widely here. In the lower Coastal Plain part, gradients are more gentle and soils more absorbent. Streams are larger and slower, have clayey, sandy or muddy bottoms and are less affected by drouth.

Drouth in the basin was severe in 1950 and 1951. For those two years the rainfall deficits of five weather stations averaged eight and twelve inches respectively. Although drouth gave access to otherwise inaccessible spots and specimens, it took a toll of mollusks. Most of the dead mollusks occurred in drouth-reduced small creeks and the partly exposed beds of larger streams in the upper basin.

MATERIALS AND METHODS.—In 1950 and 1951, 136 stations were established to sample upper parts of basin streams as well as points below. There were 125 in the upper basin (Fig. 1), 11 in the lower, scattered from the Wayne-Lenoir county line to just below New Bern.

All accessible habitats at a station were explored until no further species appeared. The most useful collecting tool was a ⅛-inch mesh scraper net which was used to depths of about five feet. In the deeper water of four impoundments a Peterson dredge was used, to little avail. Specimens were returned to the laboratory alive in labeled jars of stream water. After sorting and cleaning they were kept alive for observation or put in jars containing 70 per cent alcohol and a station number tag. Shells of dead unionids were given both an individual, and the station, number.

Recorded data included: width of stream; nature of bottom and substrat depth of visibility, of stream, and of capture of specimens; pH; air and wat temperatures; aquatic vegetation; miscellaneous notes on habitats of particul specimens, station descriptions, etc. Speed of flow was timed and classifi as follows: slow, 0–½ m.p.h.; moderate, ½–1 m.p.h.; fast, over 1 m.p.h.

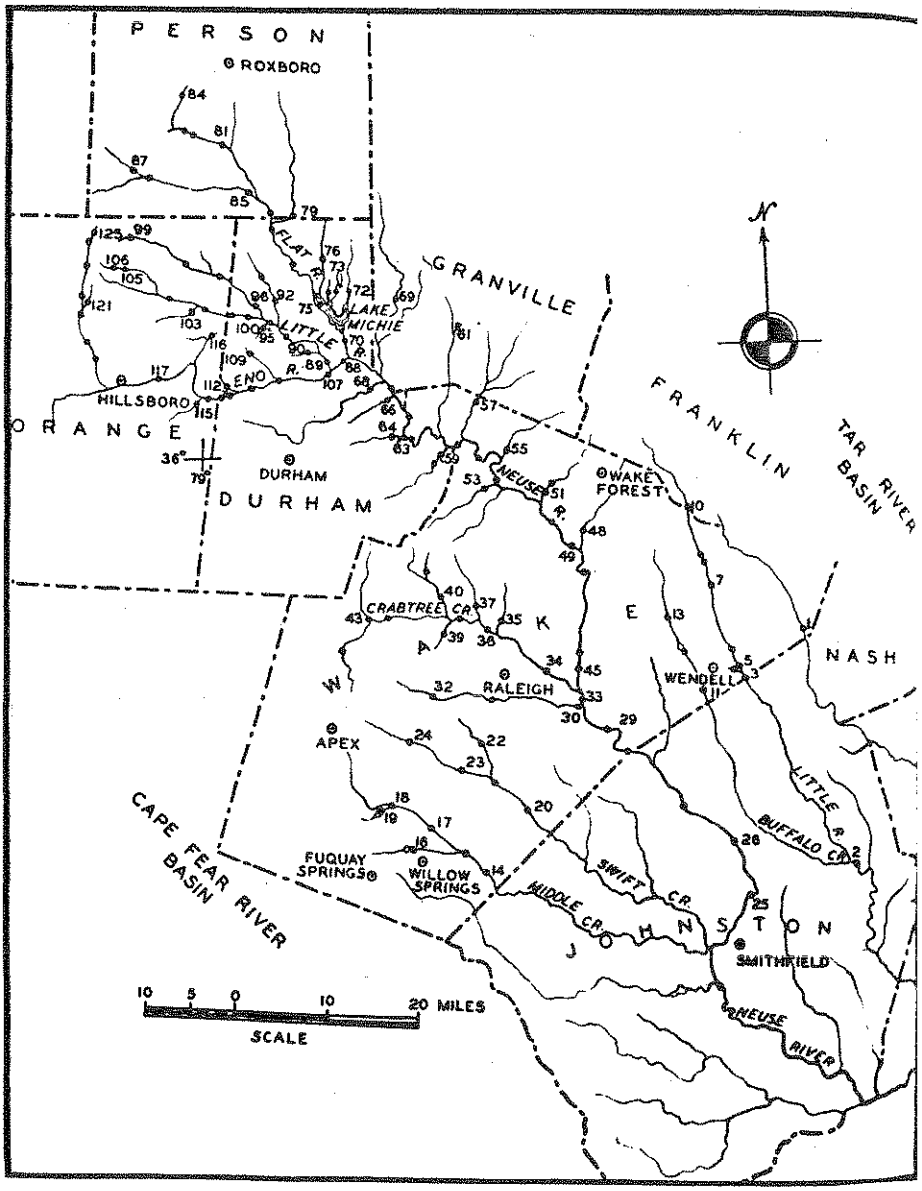

FIG. 1. Upper basin station locations. Station numbers rise as one goes upstream. Statio 1 is on Moccasin Creek which joins the lower Neuse. The Little River is the next majo tributary upstream, hence its stations are numbered 2–10, and so on. Station 69 is on Knap of Reed Creek. To avoid crowding station numbers, not all are shown.

Radulae were prepared by heating at least the snail's head in a concentrated solution of potassium hydroxide, washing well in water, mounting in Hoyer's medium (refractive index about 1.4) and partly disarticulating for study. Camera lucida drawings of representative radular teeth were made of *Clappia virginica*, *Mudalia carinata*, *Oxytrema catenaria dislocata*, *O. proxima*, *Ferrissia hendersoni* and *Physa inflata*. Opercula of the first four were cleaned and photographed. Specimens of *Lasmigona subviridis*, *Anodonta cataracta*, *Alasmidonta heterodon*, *Elliptio complanatus*, *Ligumia constricta* and *Lampsilis conspicua* were gravid. Glochidia were pipetted from the marsupia, washed in alcohol, stained in eosin, dehydrated, cleared, mounted in piccolyte and photographed. The various aspects of shells of all species were photographed.

Gastropod classification follows that of F. C. Baker (1928, 1945) except in the use of the generic names *Mudalia* and *Oxytrema* for *Anculosa* and *Goniobasis* respectively (Morrison, 1952, 1954). Pelecypod classification is largely that of F. C. Baker (1928). However, the subgeneric names of the genus *Anodonta* are based on data pointed out by J. P. E. Morrison (personal communication). Like *Anodonta imbecillis*, *A. cygnea*, the genotype, is monoecious (Bloomer, 1940, 1943, 1946), and has flat umbones. Therefore *A. imbecillis* is *Anodonta* s.s. For the American anodontas represented by *A. grandis* and *A. cataracta*, Crosse and Fischer (1893) created *Pyganodon*, naming *A. globosa* Lea as type species. These mussels differ from the *A. imbecillis* group in their raised umbones and in usually being dioecious.

Insofar as possible the author identified specimens by study of shell and anatomical features. These tentative identifications were confirmed or corrected by study of the U. S. National Museum collections under the guidance of Dr. J. P. E. Morrison. Dr. W. J. Clench of the Harvard University Museum of Comparative Zoology identified *Physa inflata*.

Following are the species and the total number of stations at which each occurred.

CLASS GASTROPODA

ORDER CTENOBRANCHIATA

1. *Valvata bicarinata* Lea, 1841, 1. Only dead specimens found.
2. *Campeloma decisum* (Say, 1817), 49.
3. *Amnicola* (*Amnicola*) *limosa* (Say, 1817), 2.
4. *Clappia virginica* (Walker, 1904), 11.
5. *Mudalia carinata* (Bruguière, 1792), 15.
6. *Oxytrema catenaria dislocata* (Ravenel, 1834), 22.
7. *Oxytrema proxima* (Say, 1825), 3, and an upper Cape Fear River Basin station.

ORDER PULMONATA

8. *Pseudosuccinea columella* (Say, 1817), 48.
9. *Fossaria modicella* (Say, 1825), 2.
10. *Helisoma anceps* (Menke, 1830), 47.
11. *Menetus* (*Micromenetus*) *dilatatus dilatatus* (Gould, 1841), 29.

12. *Ferrissia* (*Ferrissia*) *hendersoni* (Walker, 1908), 38.
13. *Ferrissia* (*Laevapex*) *diaphana* (Haldeman, 1841), 22.
14. *Physa inflata* Lea, 1841, 65.

CLASS PELECYPODA

ORDER PRIONODESMACEA. Family Unionidae

15. *Ligumia* (*Micromya*) *constricta* (Conrad, 1838), 9.
16. *Ligumia* (*Micromya*) *delumbis* (Conrad, 1834), 1, all dead.
17. *Lampsilis ochracea* (Say, 1817), 1.
18. *Lampsilis conspicua* (Lea, 1872), 1.
19. *Strophitus undulatus* (Say, 1817), 4.
20. *Lasmigona* (*Platynaias*) *subviridis* (Conrad, 1835), 18.
21. *Alasmidonta* (*Alasmidonta*) *undulata* (Say, 1817), 6.
22. *Alasmidonta* (*Proalasmidonta*) *heterodon* (Lea, 1830), 1.
23. *Anodonta* (*Anodonta*) *imbecillis* Say, 1829, 2.
24. *Anodonta* (*Pyganodon*) *cataracta* Say, 1817, 1.
25. *Pleurobema brimleyi* (S. H. Wright, 1897), 2.
26. *Elliptio complanatus* (Solander, 1786), 40.
27. *Elliptio complanatus roanokensis* (Lea, 1836), 6.
28. *Elliptio productus* (Conrad, 1836), 2.

ORDER TELEODESMACEA. Family Corbiculidae

29. *Polymesoda caroliniana* (Bosc, 1802), 1.

Family Sphaeriidae

30. *Sphaerium solidulum* (Prime, 1851), 35.
31. *Sphaerium striatinum* (Lamarck, 1818), 8.
32. *Musculium contractum* (Prime, 1865), 20.
33. *Musculium transversum* (Say, 1829), 3.
34. *Musculium partumeium* (Say, 1822), 3.
35. *Eupera cubensis* (Prime, 1856), 1.
36. *Pisidium dubium* (Say, 1817), 3.
37. *Pisidium compressum* Prime, 1851, 1.
38. *Pisidium peraltum* Sterki, 1900, 1.
39. *Pisidium abditum* Haldeman, 1841, 1.

Species never before reported from North Carolina by either a specific locality or an inclusive statement of range are: *Valvata bicarinata; Clappia virginica Fossaria modicella; Musculium contractum; Pisidium peraltum.* New records fo the Neuse Basin are: *Amnicola limosa; Oxytrema proxima; Helisoma anceps Menetus dilatatus; Ferrissia hendersoni; Ferrissia diaphana; Physa inflata Anodonta cataracta; Lampsilis ochracea; Eupera cubensis.*

The collections are divided among the U. S. National Museum, the Duk University Department of Zoology, and the author.

HABITATS. *Gastropoda.*—Environmentally and somewhat distributionally th snails fall into two groups corresponding rather well with their orders. Chie

factors considered are station location, stream flow, substrate and depths occupied.

Ctenobranchiata *Clappia virginica*, *Mudalia carinata*, *Oxytrema catenaria dislocata* and *O. proxima* compose an upper basin riffle-dwelling group of which the first two are obligate members, each with its own habitat. *Clappia virginica* was always associated with riffleweed (*Podostemum ceratophyllum*), at stations where least stream width was about 40 feet, and occurred to depths of four feet. *Mudalia carinata* was associated with algae or riffleweed. Young *M. carinata* were invariably in the upper two or three inches; adults were usually in that stratum, rarely below eight inches. Observations on the oxytremas confirm Goodrich's (1950) statement that adults may be in water of only moderate velocity, but young prefer greater velocities. In this study young oxytremas were on stones or gravel, associated with algae or riffleweed in shallow, fast currents. Habitat factors common to all four riffle-snails are moderate to fast stream flow, rocks and riffles.

Campeloma decisum occupied 49 stations. One was in a lower basin tributary, five were in the Neuse proper (all Fall Zone) and the rest were well spread through the upper basin. This snail inhabits moderate to fast waters, but not riffles, and is often shallowly buried in sandy gravel or sandy clay. If such a habitat were above or below barriers to dispersal such as riffles or dams (Bovjberg, 1952), so were the snails.

Amnicola limosa was taken at Piedmont station 58 and a lower Neuse station. The latter was the only basin locality of *Valvata bicarinata*.

Among the Pulmonata, three occurred in both upper and lower basins. It is the habit of *Pseudosuccinea columella* to move slightly out of water on the numerous projections, apparently insensitive to current as a habitat factor. *Helisoma anceps* lives in slow to moderate, rather shallow currents, on a substrate of fine particles and detritus. *Physa inflata* occurs from small creeks to large rivers in slow to moderate currents, often near or at the surface, and usually associated with plant material.

Contrasted with the three large pulmonates above are *Menetus dilatatus*, *Ferrissia hendersoni* and *F. diaphana*, small leaf-dwellers. Only the last occurred in the lower basin (one station). Their stations were in slow to moderate waters of the Neuse and tributaries, correlated with the general presence of the principal substrate, fallen leaves.

Fossaria modicella, an amphibious pulmonate (Baker, 1928) was found at two Piedmont stations (24, 54).

Pelecypoda, *Unionidae*. Most unionids were embedded in a sandy or muddy-sand bottom in moderate to fast upper basin currents, but *Elliptio complanatus roanokensis* was found on its side on a hard bottom in similar, Fall Zone currents. *Lampsilis conspicua* and *Anodonta cataracta* were found only in Lake Michie. The latter bivalve took the "pond-form" of Ortmann (1919); with its inflated shell, it was common on the muddy bottom. *Lampsilis conspicua*, with a heavier, less inflated shell, was found where the firm gravel-rock bottom was shallowly mud-covered.

At most of the 48 unionid-occupied stations, only one or two species were found. Six of the nine fluviatile stations which harbored more than two species were below dams. All five with four or more species were below dams (stas. 45, about a mile below Milburnie dam, 5, 6, 20, 112). Dams enrich plankton by impoundment, catch silt (see Ellis, 1931), and the falls aerate the water. Most Neuse Basin dams leaked enough to maintain at least a moderate current below, even at the height of the 1951 drouth. It seems reasonable to assume that the effects of dams make possible satisfactory minima of water, food and oxygen to habitats below the dams.

Alasmidonta heterodon, *Anodonta imbecillis*, *Pleurobema brimleyi*, *Elliptio productus* and *Lampsilis ochracea* occurred only below dams. The few previous basin records suggest that these are the only currently suitable sites. C. S. Brimley[2] recorded *A. heterodon*, *A. imbecillis*, *E. productus*, *Ligumia constricta*, *L. delumbis* and *Lampsilis conspicua* from the Neuse near Raleigh, but the author did not find them there. *Pleurobema brimleyi* was not found in Walnut Creek from which Brimley noted that it was described (see Simpson, 1914: 805). That areas below dams offer more nearly optimum habitats appears from the larger numbers of species and individuals, e.g. 39 *E. complanatus* at station 18, 14 *E. complanatus roanokensis* and 64 *Lasmigona subviridis* at station 45. Stations 5 and 6 are below dams. Since species common to both were more abundant, and there were two more species (total, six) at station 5, a cumulative effect is indicated, i.e. two dams are better than one. In the steep 15 miles from the station 50 dam to station 45 below Milburnie, species number doubles to four.

Teleodesmacea.—In the estuary below New Bern, young *Polymesoda caroliniana* were found in intertidal zone sandy clay with small, embedded twigs. A coastal or near-coastal sphaeriid, *Eupera cubensis*, occupied muddy sand in slow, shallow water a few miles upstream from New Bern. Other sphaeriid occurrences were erratic, showing no correlation with factors found important to snails and unionids.

Relationships of mollusks and pollution are discussed by Baker (1901, 1922), Ellis (1931), Ellis *et al.* (1931), Van Cleave (1940) and others. Neuse Basin cities, except Durham, discharged untreated domestic and industrial wastes into the Neuse (Stiemke, 1947). In this study, sludge was conspicuous below Raleigh at Walnut Creek station 30, slight at Crabtree Creek station 34. Biological oxygen demand (B.O.D.) measurements, supplied by the state Stream Sanitation Commission and the Durham Water and Sewer Department, extend discontinuously from early 1944 to late 1953 and from close above Ellerbee Creek to Smithfield. Taking a B.O.D. of a 2.5–5.0 p.p.m. to indicate heavy pollution, of over 5.0 p.p.m. as gross, then the limited number of data signify heavy to gross pollution.

Below effluent discharges into the Neuse, apparently suitable spots showed

[2] Remarks about C. S. Brimley in this paper derive from an unpublished, partly annotated card catalogue of North Carolina mollusks. This appeared to be based on the literature and personal collecting, and was kept in the Division of Entomology office, State Agriculture building, Raleigh.

absences or small numbers of several species. This was most striking below station 45. *Clappia virginica* and *Menetus dilatatus* were absent from above Crabtree Creek to station 27, some 22 river-miles. *Mudalia carinata*, however, was present at station 33 below the mouth of Crabtree Creek in a recovery zone, according to Campbell (1939). It was absent from there to station 27. Others not found below the mouth of Walnut Creek for varying distances were *Ferrissia hendersoni* and *F. diaphana*, *Lasmigona subviridis*, *Alasmidonta undulata*, *Elliptio complanatus* and *E. complanatus roanokensis*.

Most of the distributional gaps above Raleigh extended from the Flat and Eno-Little drainages to at least eight miles below Ellerbee Creek. The treated wastes of Durham and the untreated wastes of the Camp Butner area entered this reach of the river via Ellerbee and Knap of Reed Creeks respectively. Found here were only *Lasmigona subviridis*, *Physa inflata*, *Fossaria modicella*, and *Amnicola limosa*, although others were in tributaries. *Menetus dilatatus* and *F. hendersoni* were at station 68 in Ellerbee Creek below the sewage treatment plant, but they occupied shallow riffles, not the usual, calmer, deeper waters. At riffle-station 117 below Hillsboro, *C. virginica* and *M. dilatatus* were not among the several species present, but both occurred above and below this point. *Menetus dilatatus*, having been at station 68, may not be too sensitive to pollution moderated by distance or treatment, but *C. virginica* was never found close below a known source of pollution.

DISTRIBUTION. *Unionidae and Stream Types.*—In eastward draining streams from Virginia to New York, Ortmann (1913) found a fauna of rather uniform size from lower to upper river, but one which diminished sharply in the headwaters. In the fauna of those streams most mussels had a more or less continuous occurrence. Widely varying water levels, silting and pollution may have altered the original, unknown molluscan fauna of the Neuse River Basin. In the modern state, only three naiads occupied over six stations in the entire basin, quite a different distribution from that found by Ortmann to the north. That the most widely distributed mussel is the adaptable *Elliptio complanatus*, and that others have so few stations, indicate that conditions are unfavorable to less adaptable forms often enough to prevent their establishment or spread.

Unionid-occupied stations were assigned to serial stream types based partly on widths and depths. To these were added the species and the number of stations at which each occurred in each type (Frequencies, Table I). The result is a distribution pattern confirming that reported by Ortmann (1913) for Atlantic drainages. That such manipulation of the data is necessary to uncover this pattern probably means that the modern fauna is reduced in number of individuals, if not of species. From medium-sized rivers to large creeks, the species-number is about seven, although species-composition changes. In small creeks the fauna is almost halved and frequencies are lower. Lower and large river species-number would be of the same order as the above if six mussels reported from other parts of the Coastal Plain had been present. These are: *Strophitus undulatus; Lasmigona subviridis; Alasmidonta undulata; Anodonta cataracta; Ligumia delumbis; Lampsilis ochracea.*

TABLE I

Distribution and frequencies of unionids by stream types

Type	Species	Frequencies	Stations
1. Small creeks	*Strophitus undulatus*	1	14, 22, 24, 37, 40, 43, 57, 76, 82, 115, 123
	Lasmigona subviridis	2	
	Elliptio complanatus	9	
	Ligumia constricta	1	
Totals	4		11
2. Large creeks	*Strophitus undulatus*	3	15, 17, 18, 20, 38, 42, 80, 81, 86, 101, 104, 120, 122
	Lasmigona subviridis	4	
	Alasmidonta undulata	2	
	Anodonta imbecillis	2	
	Elliptio complanatus	11	
	Ligumia constricta	4	
	Ligumia delumbis	1	
Totals	7		13
3. Small rivers	*Lasmigona subviridis*	3	2, 5, 6, 78, 88, 107, 113
	Alasmidonta undulata	1	
	Alasmidonta heterodon	1	
	Pleurobema brimleyi	1	
	Elliptio complanatus	7	
	Elliptio productus	2	
	Ligumia constricta	3	
Totals	7		7
4. Medium-sized rivers	*Lasmigona subviridis*	4	8, 47, 56, 77, 110, 112, 117
	Pleurobema brimleyi	1	
	Elliptio complanatus	5	
	Elliptio complanatus roanokensis	1	
	Ligumia constricta	1	
	Lampsilis ochracea	1	
Totals	6		7
5. Large rivers	*Lasmigona subviridis*	5	25*, 26*, 27*, 33†, 45, 49, 50
	Alasmidonta undulata	3	
	Elliptio complanatus	5	
	Elliptio complanatus roanokensis	4	
Totals	4		7
6. Lower river	*Elliptio complanatus*	2	130, 136‡
	Elliptio complanatus roanokensis	1	
Totals	2		2
7. Lake Michie	*Anodonta cataracta*	1	75 (impoundment)
	Elliptio complanatus	1	
	Lampsilis conspicua	1	
Totals	3		1

* Below mouth of Walnut Creek.

† Between mouths of Walnut and Crabtree Creeks.

‡ Only dead shells of both forms found, in dry mud on base of mid-stream bridge support.

More or less continuous occurrence from lower to upper river is shown by *Elliptio complanatus* (all stream types), *Lasmigona subviridis* (large rivers to small creeks) and *Ligumia constricta* (medium-sized rivers to small creeks). Since *A. undulata* was in large and small rivers and large creeks, it probably occurs in medium-sized rivers. Those species already noted as once, but no longer, found in the Neuse are limited to one or two stream types, e.g. *Anodonta imbecillis*. *Elliptio complanatus* was the most common and widespread species in all stream types but large rivers where *L. subviridis* equalled its frequency, surpassed it in numbers of individuals. *Ligumia constricta* and *A. undulata* were next most common.

Upper versus Lower Basin.—Of the 14 stations considered to be in the Coastal Plain, 11 are in the lower basin and may be an inadequate sample. However, the fairly uniform findings seem to justify their use in a small-scale comparison.

Unionids, and branchiate and small pulmonate snails are wholly or largely restricted to the upper region of the basin, chiefly to streams larger than small creeks. The upper Coastal Plain stations (2, 25, 26) are some distance from known pollution sources. They may be under Fall Zone influence and, therefore, transitional. At any rate, their fauna (14 spp.) is larger than that of the lower basin stations.

Omitting the dead *Valvata bicarinata*, and coastal forms *Eupera cubensis* and *Polymesoda caroliniana*, leaves eight species found alive in the lower Neuse, 22 percent of the upper basin number. With tributaries, the figures become 10 species and 27 percent by adding *Campeloma decisum* and *Pisidium abditum* to: *Amnicola limosa; Pseudosuccinea columella; Helisoma anceps; Ferrissia diaphana; Physa inflata; Elliptio complanatus; Musculium contractum; M. partumeium*. Six mussels recorded from other parts of the Coastal Plain and which could conceivably have occurred here were listed in "Unionidae and Stream Types". Absence of the riffle-group was expected, but sites seemingly suitable for most other species were uninhabited.

Geographic Distribution.—The four riffle-dwellers, *Clappia virginica*, *Mudalia carinata*, *Oxytrema catenaria dislocata* and *O. proxima*, and *Ferrissia hendersoni* and *Physa inflata* are predominantly southern and eastern, the other snails occurring west of the Appalachians. *Clappia virginica* and *M. carinata* range to Maryland and New York respectively, and *P. inflata* has been recorded from the French Broad (westerly) drainage.

Lasmigona subviridis and *E. complanatus* occur to a limited extent beyond the Atlantic drainage which, however, is their center and over which they range generally (Ortmann, 1913). Likewise, *Anodonta imbecillis* and *Ligumia constricta* occur west of the Appalachian divide, but they are southern in the eastern drainage (Simpson, 1914). Other Atlantic drainage species of southern range are: *Elliptio productus; Pleurobema brimleyi; Ligumia delumbis; Lampsilis conspicua.* Also of general range are: *Alasmidonta undulata; A. heterodon; Anodonta cataracta; E. complanatus roanokensis. Strophitus undulatus* and *Lampsilis ochracea* are of northern distribution.

Most of the freshwater sphaeriids range widely in the United States (Sterki, 1916); for *Musculium contractum* only southern records were found.

Physiographic Distribution.—The provinces occupied in the Neuse Basin are those occupied elsewhere as determined from literature and museum records and by basin limits. Branchiates and small pulmonates occur in the Piedmont and Fall Zone, whereas the three large pulmonates occur also in the Coastal Plain. The known ranges of *Ferrissia diaphana* and *Physa inflata* extend now from the mountains to the Coastal Plain, while those of *Menetus dilatatus* and *Ferrissia hendersoni* extend from the Coastal Plain to the Piedmont. Six naiads (*Lasmigona subviridis; Alasmidonta undulata; Anodonta cataracta; Ligumia delumbis; Strophitus undulatus; Lampsilis ochracea*) which have been recorded from other parts of the Coastal Plain were not found there in the Neuse Basin. The last two, Piedmont forms here, are estuarine to the north (Ortmann, 1919). The few stations of most of the unionids limited them to a part of their reported physiographic range.

SUMMARY

(1) A survey of the Neuse River Basin yielded seven species of ctenobranchiate and seven of pulmonate snails; 14 of unionid and 11 of teleodesmacean mussels. (2) Known ranges of 15 species have been expanded, ten within, five into, North Carolina. (3) *Clappia virginica, Mudalia carinata, Oxytrema catenaria dislocata* and *O. proxima* composed an upper basin riffle-group; *Campeloma decisum* occurred throughout the basin in moderate to fast waters. (4) Pulmonata inhabited slow to moderate waters. *Menetus dilatatus, Ferrissia hendersoni* and *F. diaphana* were upper basin leaf-dwellers; *Pseudosuccinea columella, Helisoma anceps* and *Physa inflata* occupied the entire basin in individual habitats. (5) Most unionids occupied moderate to fast upper basin waters; *Anodonta cataracta* and *Lampsilis conspicua* were lacustrine. (6) Areas below dams were richer in unionid individuals and species, some of which may be relicts. (7) Branchiates and small pulmonates were absent or fewer below effluent outlets. (8) Assigning unionid-occupied stations to serial stream types revealed a distribution corresponding to that of other Atlantic drainage streams. (9) Species-number in the lower basin was about 75 per cent less than in the upper. (10) *C. virginica, M. carinata, O. catenaria dislocata, O. proxima, F. hendersoni* and *P. inflata* have a mostly southern and eastern distribution. *Strophitus undulatus* and *Lampsilis ochracea* are of northern range. *Elliptio productus, Pleurobema brimleyi, Lampsilis conspicua, Ligumia delumbis, L. constricta* and *Anodonta imbecillis* are southern ranging forms; the last two occur also west of the Appalachian divide. *Alasmidonta undulata, A. heterodon, Anodonta cataracta, E. complanatus roanokensis, E. complanatus* and *Lasmigona subviridis* are widely ranging species of the Atlantic drainage, but, again, the last two occur on the west side of the divide. (11) Generally, the same physiographic ranges are occupied here as in other parts of the Atlantic drainage, but six naiads which might have occurred in the Coastal Plain were not found. The known physiographic ranges of *M. dilatatus, F. hendersoni, F. diaphana* and *P. inflata* have been expanded.

ACKNOWLEDGMENTS

Of the Duke Zoology staff, especial thanks are due Dr. C. G. Bookhout for invaluable advice and assistance. Dr. W. J. Clench of the Museum of Comparative Zoology and Dr. J. P. E. Morrison of the U. S. National Museum gave generously of material and intellectual resources at their command.

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A MARKED ALIGNMENT OF EARTHQUAKE EPICENTERS I... WESTERN NORTH CAROLINA AND ITS TECTONIC IMPLICATIONS

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In the early morning hours of September 28, 1956 a small earthquak... up an area of more than 1700 square miles near the common corner of A... Allegheny Counties, N. C., and Grayson County, Va. It was felt by ma... sons in the affected area, a fair proportion of whom were awakened ... vibrations, and was recorded by the seismograph operated in Chapel H... the University of North Carolina, but seems to have done no damage.

While working out the details of this earthquake it was noticed that it... center (center of the disturbed area) fell not far from, and exactly in line w... the epicenters of two other recorded earthquakes: one in Watauga Co., N... on August 6, 1885, and one near Wytheville, Va., on October 21, 1897.

Further search of our earthquake records disclosed the fact that not ... these three quakes, but at least eight others as well, fall along an almost pe... fectly straight line trending in a northeasterly direction across western Nor... Carolina and on up into Virginia.

Figure 1 shows a crude sketch map of the general area, including the foo... the Blue Ridge Scarp according to William A. White, together with the ... proximate epicenters of these eleven earthquakes. Of course there have be... numerous other small earthquakes in western North Carolina, so that perhap... may with some justification be accused of "special pleading" in picking ... this one small group for individual consideration. Nevertheless, they fo... such a clear-cut linear series that I cannot help feeling that they represen... real tectonic alignment—a belt of structural weakness in the uplifted Blue R... mass. It seems most probable that we are dealing with a more or less contin... zone of faulting; less probably with an individual fault of considerable str...