RICHARD J. NEVES

Dillon
1977

FACTORS IN THE DISTRIBUTIONAL ECOLOGY OF UPPER NEW RIVER MOLLUSKS (VIRGINIA / NORTH CAROLINA)

by

Robert T. Dillon, Jr.

Thesis submitted to the Biology Honors Committee

in partial fulfillment of the requirements for a bachelors degree

IN HONORS

in

Biology

APPROVED:

E. F. Benfield, Faculty Advisor

H. R. Steeves, Honors Committee Chairman

R. A. Patterson, Dept. Head

T. verrucosa = pistolgrip
C. tuberculata = purple wartyback
E. dilatata = spike
L. ovata = pocketbook
L. subviridis = green floater
A. grandis = giant floater (Clayton)
A. imbecillis = paper pondshell (Clayton)

May, 1977

Virginia Polytechnic Institute and State University

Blacksburg, Virginia

this study, designating as "hard" all water with greater than 7 ppm calcium. Hard tributaries include Little River (the northernmost of the two), Peak Creek, Pine Run, Reed Creek, and Cripple Creek, and all other tributaries of the drainage will be considered soft (Table 2). The main river has both hard and soft halves, the dividing line running between Stations 7 and 8, at the water gap (Table 1).

UNIONIDAE

Introduction

Table 3 lists the six species of mussels collected in this study, along with collection records. The four most common species, T. verrucosa, C. tuberculata, E. dilatata, and L. ovata are generally found throughout the Mississippi basin (Burch 1973). Burch lists A. marginata in the Mississippi drainage as restricted to the Ohio, Cumberland, and Tennessee systems. The most unusual element of the New River unionid fauna, L. subviridis, is believed to have evolved in the New River and spread from there to the Atlantic drainages by means of stream capture (Ortmann 1913, cited in Johnson 1970). It is now found in the New and Greenbriar rivers and in Atlantic drainages from South Carolina to New York (Burch 1973).

Distributions

The five most common mussels display three different distribution patterns. T. verrucosa and L. ovata are both found only in the main river and not further upstream than Station 106. Both are very common at Stations 8 and 103 well upstream from Claytor Lake, and Lampsilis is very common at Station 9 downstream from the dam. Cyclonaias tuberculata and L. subviridis are not as common in the New but are

found over a slightly larger range, upstream to the Station 7 or 114 area. Elliptio dilatata is by far the most common and widespread mussel, found throughout the main river and in many tributaries: Little River N., Reed Creek, Cripple Creek, and the South Fork. I collected the sixth species, A. marginata only in two disjunct areas, one station on the main river and two stations in Reed Creek. Since this mussel is so uncommon and spottily distributed, it will be omitted from further discussion.

Effect of Fish Distributions

Because most unionids are parasitic on fish at the glochidial stage, Fuller (1974) believed the influence of fish on the distribution of mussels to be "enormous". Observed patterns of mussel distributions may reflect limits to a fish host's range rather than the true limits of the mussel, so the ranges of known fish hosts must be examined. A comprehensive table compiled by Fuller lists fish hosts known for only three of the six New River mussels: Elliptio dilatata, Lampsilis ovata, and Alasmidonta marginata. The flathead catfish (Pylodictus olivaris) is the only known host of E. dilatata that has been collected from the upper New River. Virginia Tech teams collected this catfish from many stations on the main river in Virginia (Benfield and Cairns 1974) and Crowell (1974) recorded it from one station in North Carolina, but I find no record of Pylodictus outside the main river. Elliptio has here outstripped the range of its known hosts, for this mussel can be very common in smaller tributaries (e.g. Reed Creek). Conversely, L. ovata was found at only three stations while its host fishes, the white sucker (Catostomus commersoni), the northern hog sucker (Hypentelium

nigricans) and the rock bass (Ambloplites rupestris) were found throughout the upper New River drainage (Benfield and Cairns 1974). Benfield and Cairns also found that the host fishes of L. ovata, the smallmouth bass (Micropterus dolomieui) and the bluegill (Lepomis machrochirus) are common well into North Carolina, while I found the mussel itself restricted to a small area of Virginia. Since no correlation between mussel ranges and host fish ranges is apparent in the upper New River, concerns that limiting factors of a fish are being considered rather than those of the mussel seem unfounded.

Effect of Hardness

The positive correlation between limestone and mussel diversity and abundance is well known (Clarke and Berg 1959). The range of E. dilatata, the mussel for which the most data are available, illustrates this dependence on hard water. Elliptio is noticably absent from Reed Island Creek, even though Map 2 shows this tributary near creeks where Elliptio was collected (Little River N and Reed Creek). Table 2 compares the calcium concentrations and hardnesses of these three tributaries. It is apparent that low hardness prohibits E. dilatata from entering Reed Island Creek, and this same factor probably excluded the species from other soft tributaries such as Little River (the southern tributary by that name) or Fox Creek.

The effect of water hardness is even more clearly demonstrated in the distributions of T. verrucosa and L. ovata. These two species range only up to the water gap, where the New River meets the Great Valley of Virginia limestone. A few miles upstream the basin geology has changed to shale and sandstone, almost all hardness parameters are

halved (Table 1), and Tritogonia and Lampsilis have disappeared. Cyclonaias and Lasmigona, however, are able to live several miles upstream from the gap, where the water is quite soft. As evident in Table 1, water quality at Station 7 is nearly identical to that of Station 4, so there is no immediately evident explanation for the absence of Cyclonaias and Lasmigona further upstream. A reasonable hypothesis is that while these two species are more tolerant of soft water than either Lampsilis or Tritogonia, Cyclonaias and Lasmigona are unable to reproduce in this water quality. Perhaps the wall of soft water at the gap kills the glochidia of Lampsilis and Tritogonia while those of Cyclonaias and Lasmigona are uneffected.

In soft areas of the New River, C. tuberculata and L. subviridis apparently mature fairly normally but may themselves be sterile. This hypothesis would explain the extreme scarcity of these two species at Stations 7 and 114, for they can arrive only when their fish hosts run several miles upstream in a short period of time.

Effect of Stream Size

Another long-recognized limiting factor to the distributions of unionids is stream size. Van der Schalie (1938) surveyed the mussel fauna of the Huron River and characterized the species present by stream size preferred. He found both Alasmidonta marginata and Lampsilis ventricosa (the form of L. ovata found in the New River) most commonly in small rivers. Elliptio dilatata was very common in a wide variety of stream sizes but seemed to be a medium river species, and Cyclonaias tuberculata was restricted to rivers "fairly large" to "large".

Stream size is important as a limiting factor in the New River as

well. Elliptio dilatata, as an example, was not found in the small, hard, Pine Run drainage at Station 175. Table 2 shows that the calcium concentration in this creek is quite high, but the area of the entire Pine Run drainage is only 15 square miles (Table 4). And even though Reed Creek is certainly hard enough to support Elliptio everywhere the water has been measured, I found this species only in the main body of that tributary (Stations 166 and 167), never in any branches (Stations 168 and 169). Clearly Elliptio is not established in Pine Run or the Reed Creek branches because these streams are too small.

The other species of mussel are restricted to the main river only, even though some tributaries approximate the main river's water quality, e.g. Little River N. Perhaps smaller streams do not dependably provide sufficient water for the mussel or its fish host, or perhaps physico-chemical parameters vary too radically for the mussel to become established. More probably, there is not sufficient organic material to serve as food, or the organic particle size is too great. Regardless of its mechanism, stream size dependence is an important factor in the distributional ecology of mussels in the upper New River drainage.

Interaction of Factors

Some details of mussel distribution in the upper New River do not agree with a model based entirely on hardness and stream size. Elliptio is moderately common in the South Fork, even though the hardness at Station 1 is comparable to that of Stations 10, 11, and 12 on tributaries where Elliptio was not found, i.e. Wilson and Fox Creeks and Little River South. However, Table 4 shows that the South Fork is much larger than any of these other three streams. Macan (1974) noted that the threshold

value of any limiting factor can be influenced by the intensity of any other limiting factor. Perhaps hardness and stream size interact in some manner so that a large stream can support E. dilatata even though its hardness may be low, and a small stream can support mussels if it has high hardness. The presence of Elliptio at Station 183 on Meadow Creek (Table 2) would support this proposal, for the stream here is barely 3 meters wide. Outside the Great Valley of Virginia, I collected the species only in larger streams. Clearly some factor has stimulated this mussel to adapt to such a small stream, and hardness is a logical choice.

There must certainly be some absolute minimum stream size and minimum hardness to support Elliptio. The mussel was found nowhere in the upper New River's largest tributary, the very soft big Reed Island Creek. It was also not found in Pine Run at Station 175, even though that creek has the highest calcium concentration recorded in this study. But within these broad, absolute tolerances there seems to be a balancing of one consideration with the other. There does not seem to be any interaction of hardness and stream size in the other four species I examined, but rather two strict criteria which must be met, a large river of a minimum size and hardness. It is possible, though, that an interaction mechanism controls the distributions of the other species of mussels in this study, but that since they have much lower tolerances to softness and stream size, this effect is not apparent in their distributions here.

Effect of Perturbation

The North Fork at Station 2 has higher calcium concentrations than the South Fork at Station 1, and the stream size at Station 157 on the

North Fork is much greater than that of the South Fork at Station 152. Yet Elliptio was collected throughout the South Fork and was not found in the North Fork. This may be attributed to the higher levels of heavy metals Benfield and Cairns (1974) tabulated at Station 3, on the North Fork downstream from a small electronics plant. Wright (1976) noted that levels of aluminum downstream from this plant may be 65 times higher than the upper limit established in the U.S. Environmental Protection Agency's Water Quality Criteria. Wright also noted a high concentration of zinc at Station 3. These findings are especially significant in light of the fact that mollusks are among the first animals to be eradicated by heavy metals (Hurtz 1962), and the fact that heavy metal toxicity can be greater in soft water than in hard (Cairns and Scheier 195). Since the North Fork upstream form the plant is probably too small to support unionids at that hardness, Elliptio is excluded from the sub-drainage.

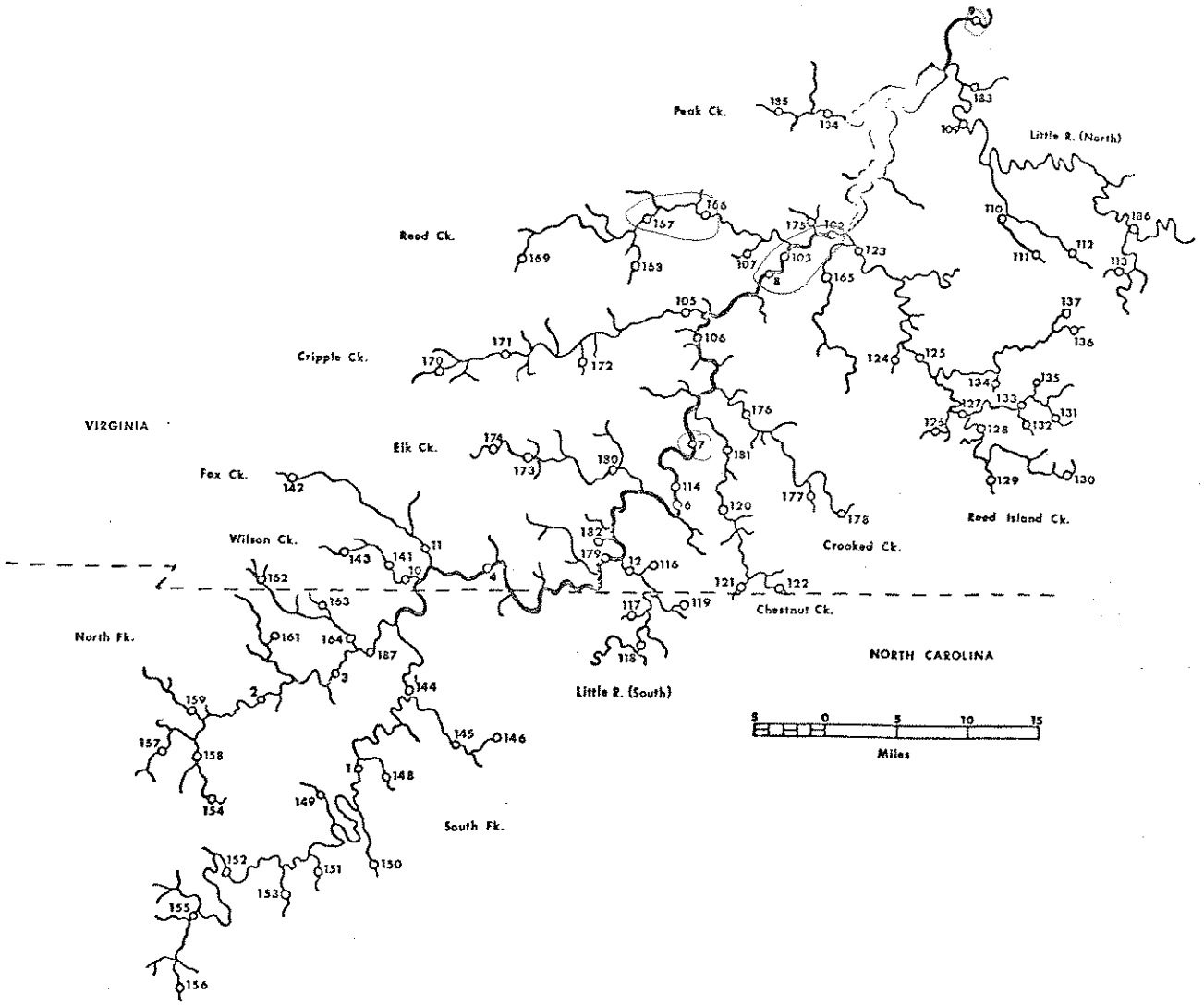
The absence of E. dilatata from Station 9, the most downstream station of this study, is also interesting. This species tends to become more abundant proceeding from the South Fork at Station 152 to Station 102 just upstream from Claytor Lake Dam. Cyclonaias and Tritogonia, also common above the impoundment, were present only as relics at Station 9. Since no chemical pollutants are indicated in the data of Benfield and Cairns (1974), these gaps in the distributions are probably an effect of the dam several miles upstream. The river here is still subject to pronounced fluctuations in flow according to the electrical generating schedule. See Fuller (1974) for an excellent discussion of both heavy metal toxicity and dam effects on freshwater mussels.

Table 3. Distribution and abundance of the Unionidae

Species	Relative Abundance	Station
Tritogonia verrucosa (Raf.)	uncommon	9, 106.
	moderately common	102.
	very common	8, 103.
Cyclonaias tuberculata (Raf.)	uncommon	7, 8, 9.
	moderately common	102, 103.
Elliptio dilatata Raf.	uncommon	1, 4, 8, 105, 109, 179, 183.
	moderately common	7, 106, 114, 144, 152, 166, 167.
	very common	102.
Lampsilis ventricosa Say	uncommon	7, 166, 167.
Leptodea subviridis (Con.)	uncommon	8, 9, 103, 106, 114.
Lampsilis ovata (Say)	moderately common	102, 106.
	very common	8, 9, 103.

uncommon - dead shells present, usually in moderate abundance. If living specimens were collected, it was with great diligence.
moderately common - several live specimens found with some difficulty.
very common - live specimens present in large numbers and many collected.

L. fasciola
A. grandis


Peak Ck.
Little R. (North)
Reed Ck.
Cripple Ck.
VIRGINIA
Elk Ck.
Fox Ck.
Wilson Ck.
North Fk.
Crooked Ck.
Reed Island Ck.
Chestnut Ck.
NORTH CAROLINA
Little R. (South)
South Fk.
5 0 5 10 15
Miles

APPENDIX

Collection station locality data. Note that "Quad" is an appreviation for United States Geological Survey topographic map, 7.5 minute series.

1 - South Fork New River at NC 16 bridge, near Index, Ashe Co. Jefferson Quad.

2 - North Fork New River off NC 88 at Lou Jones Road bridge (Co. 1343), 1.6 mi. W of Warrensville, Ashe Co., NC Warrensville Quad.

3 - North Fork New River above Co.1642 bridge, .08 miles below Sprague Electric Co. near Lansing, Ashe Co., NC. Warrensville Quad. (No mollusk collections at this site.)

4 - New River at Va. 601 low water bridge, 1.2 mi. E of Cox Chapel, Grayson Co. Sparta West Quad.

5 - New River, 1.0 mi. downstream from U. S. 58 bridge near Galax, VA. Grayson Co., Galax Quad. (No mollusk collections at this site.)

7 - New River at low water bridge near Fries, Carroll Co., VA. Galax Quad.

8 - New River, .5 mi. upstream from U. S. 52 bridge near Austinville, Wythe Co., VA. Max Meadows Quad.

9 - New River at Va. 114 bridge, 2 miles downstream from Radford, Montgomery Co., VA. Radford North Quad.

10 - Wilson Creek at Va. 767 bridge, .5 mi. NE of Mouth of Wilson, Grayson Co. Mouth of Wilson Quad.

11 - Fox Creek at U. S. 58 bridge, .1 mi. upstream from mouth in Grayson Co., VA. Mouth of Wilson Quad.

12 - Little River at Va. 689 low water bridge, 2.5 mi. SW of Baywood, Grayson Co. Sparta East Quad.

104 - New River .08 mi. downstream from Allisonia guaging station near Allisonia, Pulaski Co., VA. Dublin Quad.

103 - New River at end of Va 619, 4.5 mi. downstream from Fosters Falls, Wythe Co. Fosters Falls Quad.

105 - Cripple Creek at Va 94 bridge, 2 mi. N of Ivanhoe, Wythe Co. Austinville Quad.

106 - New River at the mouth of Powder Mill Branch at Ivanhoe, Wythe Co., Va. Austinville Quad.

107 - Cedar Run at Va. 619 and Va. 626, near Major Grahams, Wythe Co. Foster Falls Quad.

109 - Little River at Va. 613 bridge below Graysontown, Montgomery Co. Radford South Quad.

110 - Little Indian Creek, .2 mi. upstream from mouth, .5 mi. S of Copper Valley Church, Floyd Co., VA. Indian Valley Quad.

111 - Little Indian Creek at jct. of Va. 753 and Va. 812, 1.5 mi. NW of Indian Valley, Floyd Co. Indian Valley Quad.

112 - Big Indian Creek along Va. 766, .2 mi. upstream from Duncan, Floyd Co. Alum Ridge Quad.

113 - Spurlock Creek at Va. 740 bridge, 1.7 mi. NE of Greasy Creek Church, Floyd Co. Alum Ridge Quad.

114 - Low River, .9 mi. downstream from Va. 641, 1.8 mi. SW of Fries, Grayson Co. Galax Quad.

117 - Roccasin Creek at County 1411 bridge, .5 mi. S of Pleasant Home Church, Alleghany Co., NC Sparta East Quad.

118 - Little River at Hooker Road (Co. 1433) bridge, 1 mi. upstream from confluence with Brush Creek, 1.3 mi. E.of Edwards Cross-roads, Alleghany Co., NC. Sparta East Quad.

119 - Crab Creek at NC 18 bridge, .5 mi. N of Ennice, Alleghany Co. Cumberland Knob Quad.

120 - Chestnut Creek at jct. of Va. 97 and Va. 608, 1 mi. S of Galax, Grayson Co. Galax Quad.

121 - Cook Fork of Chestnut Creek, first time Blue Ridge Parkway crosses heading North, 1.1 mi. S of Fairview School, Grayson Co., VA. Cumberland Knob Quad.

122 - Chestnut Creek at confluence of E and W Forks, 1 mi. E of Fairview School, Grayson Co., VA. Cumberland Knob Quad.

123 - Big Reed Island Creek, at Va. 607 low water bridge, .5 mi. above mouth, Pulaski Co. Hiwassee Quad.

124 - Small creek at Va. 750 bridge, .7 mi. NW of Allison Chapel, Carroll Co. Hillsville Quad.

125 - Big Reed Island Creek at U. S. 221 bridge, 5 mi. NE of Hillsville, Carroll Co., VA. Hillsville Quad.

126 - Cherry Creek, by Va. 664, .3 mi. from mouth, 6 mi. E of Hillsville, Carroll Co. Hillsville Quad.

127 - Big Reed Island Creek at Va. 664 bridge, 2.3 mi. SW of Meadowview Church, Carroll Co. Dugspur Quad.

128 - Big Reed Island Creek at U. S. 58 bridge, 1.5 mi. E of Crooked Oak, Carroll Co., VA. Laurel Fork Quad.

129 - Sulfur Spring Branch at Va. 648 bridge, 2.5 mi. E of Gladesboro, Carroll Co. Laurel Fork Quad.

130 - Pine Creek at Va. 631 bridge, .3 mi. N of Bell Spur, Carroll Co. Laurel Fork Quad.

131 - "Intermittant" branch of Tory Creek at U. S. 58 bridge, .2 mi. S of Tory Creek Church, Floyd Co., VA. Meadows of Dan Quad.

132 - Woods Creek, 200 ft. upstream from mouth, 1.9 mi N of town of Laurel Fork, Carroll Co., VA. Laurel Fork Quad.

133 - Laurel Fork at Va. 638 bridge, 1.9 mi. N of town of Laurel Fork, Carroll Co. Laurel Fork Quad.

134 - Branch of Burks Fork at Va. 638 bridge, 300 ft. from intersection with Va. 623, 1 mi. N of Pine View Church, Carroll Co. Dugspur Quad.

135 - Chisholm Creek at Va. 629 bridge, .5 mi. SE of Buffalo Mt. Church, Floyd Co. Dugspur Quad.

136 - Burks Fork at Va. 799 bridge, .5 mi. NW of Burks Fork Church, Floyd Co. Willis Quad.

137 - Branch of Burks Fork, .4 mi. upstream from Union Church at Va. 799 bridge, Floyd Co. Willis Quad.

141 - Wilson Creek at Va. 16 bridge, .6 mi. W of Mouth of Wilson, Grayson Co. Mouth of Wilson Quad.

142 - Fox Creek at Va. 16 bridge, 1 mi. S. of Trout Dale, Grayson Co. Trout Dale Quad.

143 - Wilson Creek by Va. 16, .5 mi. upstream from Volney, Grayson Co. Trout Dale Quad.

144 - South Fork New River by Chestnut Hill Rd. (Co. 1567), .5 mi. upstream from U. S. 221 bridge, Ashe Co., NC. Laurel Springs Quad.

145 - Strawberry Creek at NC 88 bridge, 1.4 mi. W of Laurel Springs School, Ashe Co. Laurel Springs Quad.

146 - Piney Fork at Jones Tilley Road (Co. 1177) bridge, 2.4 mi. NE of Laurel Springs, Alleghany Co., NC. Whitehead Quad.

148 - Roan Creek at NC 88 bridge, .2 mi. W of Wagoner, Ashe Co. Jefferson Quad.

149 - Beaver Creek by NC 163, at Othello, Ashe Co. Glendale Springs Quad.

150 - Obids Creek by NC 163, at Obids, Ashe Co. Glendale Springs Quad.

151 - Pine Swamp Creek, .6 mi. upstream from mouth, 1.5 mi. N of Idlewild, Ashe Co., NC. Glendale Springs Quad.

152 - South Fork New River at Co. Rd. 1351 bridge near Grassy Island, 1.4 mi. upstream from Brownwood, Watauga Co., NC. Todd Quad.

153 - Cranberry Creek at Co. Rd. 1100 bridge, 1.2 mi. E of Brownwood, Ashe Co., NC. Todd Quad.

154 - Three Top Creek by Co. R. 1100, .7 mi. S of Toliver, Ashe Co., NC. Todd Quad.

155 - South Fork New River, .2 mi. upstream from U. S. 221 bridge, 1.8 mi. E of Boone, Watauga Co., NC. Boone Quad.

156 - Middle Fork by U. S. 221, .1 mi. S of Tweetsie Railroad, Watauga Co, NC. Boone Quad.

157 - North Fork New River, at Co. 1119 bridge off NC 88, 1.2 mi. E of Green Valley, Ashe Co. Baldwin Gap Quad.

158 - North Fork New River at Three Top Creek near Creston, Ashe Co., NC. Warrensville Quad.

159 - Big Laurel Creek, at Co. 1310 bridge .2 mi. downstream from mouth of Little Laurel Creek, .1 mi N of Oliver Cemetary, Ashe Co., NC. Baldwin Gap Quad.

161 - Old Field Branch, just downstream from fork near Bethel Church, 1.8 mi. N of Lansing, Ashe Co., NC. Park Quad.

162 - Helton Creek at Co. 1370 bridge off U. S. 58, .3 mi. E of Mt. Rogers School, Grayson Co., Va. Park Quad.

163 - Little Helton Creek at N. C. Frances Road (Co. 1379) bridge, .9 mi. S of state line, Ashe Co., NC. Grassy Creek Quad.

164 - Helton Creek at NC 16 bridge, 2.6 mi. NW of Crumpler, Ashe Co. Grassy Creek Quad.

165 - Little Reed Island Creek at Va. 100 bridge, near High Rocks Mill, Wythe Co. Fosters Falls Quad.

166 - Reed Creek at U. S. 11 bridge, 1.9 mi. E of Ft. Chiswell, Wythe Co., VA. Max Meadows Quad. ←

167 - Reed Creek at Va. 667 bridge, .8 mi. S of Petunia, Wythe Co. Crockett Quad.

168 - South Fork at Va. 667 bridge, .3 mi. E of Groseclose, Wythe Co. Crockett Quad.

169 - Mill Creek, just downstream from confluence with Huddle Branch, by Va. 680, 2.9 mi. N of Rural Retreat, Wythe Co. Rural Retreat Quad.

170 - Cripple Creek at Va. 749 bridge, .5 mi. S of Cedar Springs, Wythe Co. Cedar Springs Quad.

171 - Cripple Creek at Va. 749 bridge, 1.3 mi. W of Speedwell, Wythe Co. Speedwell Quad.

172 - Francis Mill Creek by Va. 602, just upstream from town of Cripple Creek, Wythe Co. Cripple Creek Quad.

173 - Elk Creek at U. S. 21 bridge, 1 mi. SE of town of Elk Creek, Grayson Co., VA. Elk Creek Quad.

174 - Elk Creek at Va. 663 bridge, 1 mi. E of Bennington Mill, Grayson Co. Elk Creek Quad.

175 - Little Pine Run at Va. 100 bridge, by Pine Run Church, Pulaski Co. Fosters Falls Quad

176 - Crooked Creek at Va. 635 bridge, 1.9 mi. SE of Byllesby, Carroll Co. Austinville Quad.

177 - Crooked Creek at Va. 630 bridge, 2 mi. E of Pipers Gap, Carroll Co. Woodlawn Quad.

178 - East Fork at Va. 775 bridge, 1.3 mi. S of New Hope Church, Carroll Co. Woodlawn Quad.

179 - Dan River, .2 mi. upstream from Va. 624 ford, 1.4 mi. downstream from mouth of Little River, Grayson Co. Sparta East Quad.

180 - Elk Creek at Va. 660 bridge, .8 mi. N of Carsonville, Grayson Co. Briarpatch Mountain Quad.

167a Reed Creek between Ft Chiswell and Rte 613 E dilatata, A. marginata

181 - Chestnut Creek at Va. 607 bridge, 3.2 mi. N. of Galax, Carroll Co. Galax Quad.

182 - Johns Creek at Va 624 bridge, .2 mi. upstream from mouth, 1.6 mi. NE of Pleasant Grove Church, Grayson Co. Sparta East Quad.

183 - Meadow Creek at Va. 787 bridge, 2 mi. N of Graysontown, Montgomery Co. Radford South Quad.

184 - Peak Creek at Va. 99 bridge, 1 mi. downstream from Pulaski, Pulaski Co. Dublin Quad.

185 - Peak Creek, .1 mi. upstream from confluence with Rocky Branch, 1.5 mi. W of Pulaski, Pulaski Co., VA. Pulaski Quad.

186 - Little River at Va. 705 bridge, 4 mi. N of Floyd, Floyd Co. Floyd Quad.

187 - North Fork New River at Co. 1573 bridge near Crumpler, Ashe Co., NC. Grassy Creek Quad.