THE INVASION OF ASIATIC CLAM, *CORBICULA MANILENSIS* IN THE NEW RIVER, VIRGINIA

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ABSTRACT

Corbicula manilensis *appears to have successfully invaded the New River at Glen Lyn, Giles County, Virginia in 1975. Mean population densities of 18* Corbicula, *m^{-2} were recovered downstream from a coal-fired generating plant while 29 individuals m^{-2} were found immediately upstream. This seems to be the present limit of* Corbicula *immigration in the New River as no specimens were taken from sampling sites farther upstream. Relationships between shell demensions and shell weights, and viscera wet and dry weights were calculated from the one size "year class" present. Correlation coefficients ranged from 0.9683 for shell length and viscera wet weight to 0.6135 for shell dry weight and viscera dry weight.*

INTRODUCTION

The present paper is the first report of *Corbicula manilensis* Philippi in the New River, Virginia, and to our knowledge, only the second report of *Corbicula* in this state (Diaz, 1974)[1]. Until recently, extensive investigations of benthic macroinvertebrates of the New River (considered by many to be the second oldest river in the world) and its tributaries had not reported any specimens of this clam. The range extension of the Asiatic clam up this river is being carefully monitored, since the New River is an important source of water for various industries and municipalities. The biology of this organism and its relationships to other benthic and molluscan fauna can be studied, since pre-invasion data are available and this potential problem was revealed in its infancy.

MATERIALS AND METHODS

Forty specimens of *Corbicula manilensis* were randomly selected from quantitative collections starting on 12 October 1976, from sites above and below a coal-fired generating plant located on the New River at Glen Lyn in Giles County, Virginia (latitude—37°22′20″, longitude—30°51′45″, river mile 95) (Fig. 1). The upriver station was established 45 m above the intake pump station through which water is drawn for condenser cooling in the power plant. The plant generating capacity is approximately 300 MW with a maximum of 340 MW. After passage through the plant, the heated water may be raised to a maximum of 8 C above above ambient; however, during these collections there was a 3 C difference between the upriver and downriver stations (13 C and 16 C respectively). The substrate was characterized by gravel, sand and silt with sand and silt comprising minor portions (after Hynes, 1970). The downriver station was located approximately 50 m below the pipe through which the heated water is discharged. The heated effluent was usually chlorinated three times daily to control biofouling of the condenser pipes. At this station, the substrate ranged from cobbles and pebbles to very fine sand with a predominance of the former. During sampling, water depth at both

[1] The Delaware Museum of Natural History has numerous adult specimens collected in 1974 by Mrs. Betty Piech near Lanexa, Virginia, in the Chickahominy River which flows into the James River.

stations ranged from 0.5 to 0.9 m with average flows of 18-21 cm sec^{-1}. Alkalinity (as $CaCO_3$), pH and turbidity were 39 mg l^{-1}, 7.80 and 35.0 Jackson Turbidity Units, respectively.

Samples were taken at each station using a 0.25 m^2 quadrant and a net to a depth of 15 cm. Clams were picked from each sample, counted, placed in water on ice and transported to the laboratory for further analyses. Travel time was less than two hours and samples were processed immediately. Dimensions and weights were determined as described by Joy and McCoy (1975).

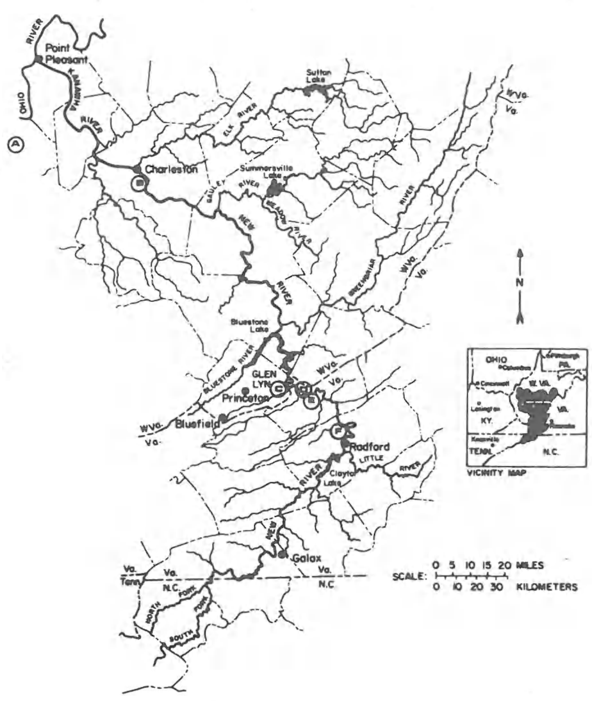

FIG. 1. *Kanawha River basin and sampling sites on the New River.* **A**—*Mud River, Cabell County, West Virginia; second report of* Corbicula *from West Virginia, 10 October 1973 (Joy and McCoy, 1975);* **B**—*Chelyan, Kanawha County, West Virginia; first report of* Corbicula *from West Virginia, 17 July 1963 - population had been established since 1961 by size "year class" data (Thomas and Mackenthun, 1964);* **C**—*Glen Lyn, Giles County, Virginia;* Corbicula *collected 12 October 1976 - population had been established since 1975 by size "year class" data (River Mile 95);* **D**—*Lurich, Giles County, Virginia (River Mile 97);* **E**—*Narrows, Giles County, Virginia (River Mile 102);* **F**—*McCoy, Montgomery County, Virginia (River Mile 131).*

RESULTS AND DISCUSSION

The invasion rate of *Corbicula* in the Upper Ohio and Kanawha River Drainage basin can be estimated from available reports. Due to the distinctive morphology of the adults and larvae, the Asiatic clam is easily and likely to be distinguished from indigenous bivalves. A collection of *Corbicula* reported from Chelyan, West Virginia, (Fig. 1) indicated, by size "year classes," that a population had been established there since 1961 (Thomas and Mackenthun, 1964). A subsequent collection in Cabell County, West Virginia, was made in 1973 (Joy and McCoy, 1975). If the downriver area is the source of propagules for the population becoming established at Glen Lyn, Virginia, the clams would have traversed a distance of about 138 river miles in a period of 15 years, or an average rate of about 9 miles $year^{-1}$. Several physical barriers encountered along the suspected path of invasion include London Lock and Dam above Chelyan, Kanawha County, West Virginia, and Kanawha Falls and Bluestone Dam at Hinton, Summers County, West Virginia. This dam forms Bluestone Lake, a reservoir which is utilized for both flood control and hydroelectric power. The relatively rapid movement of the clam implies some augmentation of its natural dispersive mechanisms. It is highly improbable that the nonparasitic planktonic veliger larvae would be capable of moving against the current at such a rate. Since no parasitic stage is present in the life cycle, a fish host would not be involved in dissemination (Sinclair, 1964). More likely, their movement was probably aided by fishermen as fishing pressure is relatively intense in this river system. Additionally, transportation may have been provided by waterfowl since Clench (1970) stated that *Corbicula* may be able to pass through the intestinal tracts of ducks in viable condition. Live specimens are being sold and shipped to fish hobbyists around the country (Abbott, 1975). Subsequent intensive sampling of the New River upstream from Glen Lyn at Lurich, Narrows and McCoy, Virginia, did not yield any specimens (Fig. 1). These results indicated that the clam had not yet been able to invade these areas.

Based on approximations of age from shell

TABLE 1. *Means (± S E) and ranges of parameters measured for* Corbicula *sampled from upriver and downriver stations.*

Measured Parameter	Upriver		Downriver	
	X ± S	Range	X ± S	Range
Shell Length (mm)	9.8 ± 0.37	7.2 - 12.3	9.6 ± 0.32	7.1 - 12.0
Shell Width (mm)	6.6 ± 0.27	5.0 - 8.3	6.6 ± 0.25	5.1 - 8.4
Viscera Wet Weight (mg)	26.8 ± 1.34	18.7 - 35.1	25.9 ± 1.09	19.0 - 34.1
Viscera Dry Weight (mg)	8.0 ± 0.45	5.2 - 10.7	8.7 ± 0.54	5.7 - 14.6
Shell Dry Weight (mg)	105.4 ± 9.74	8.9 - 141.1	106.6 ± 7.99	8.3 - 140.9

lengths (Joy and McCoy, 1975), it was apparent that the *Corbicula* collected at Glen Lyn were in their first year (Table 1). Most of these specimens were probably sexually mature (Gardner et al., 1976) and should have been in the area since 1975. Mean density at the downriver station of 18 clams m^{-2} was significantly less (t-test, 0.05 level) than the mean density of 29 m^{-2} at the upstream station. This difference may be attributed to the influence of the power plant discharge or a substrate-associated distribution phenomenon. This subject as well as seasonal density dynamics will be further examined in future research.

Least squares regressions (of the form $y = a + bx$) and Pearson product-moment correlation coefficients (r) were calculated for ten relationships between shell dimensions and weights, and viscera mass weights (Table 2). All correlations

TABLE 2. *Regression analysis equations ($y = a + bx$) and correlation coefficients for various relationships between shell dimensions and weights, and wet and dry viscera weights of* Corbicula.[1]

Equations	r – Value[2]
W = – 0.1643 + 0.7072 L	0.9259
S = – 92.5123 + 20.5729 L	0.8017
VWW = – 6.5322 + 3.4099 L	0.9683
VDW = – 2.2559 + 1.0988 L	0.7616
S = – 55.0134 + 1.0988 L	0.7197
VWW = – 1.4196 + 4.2002 W	0.9052
VDW = – 2.5536 + 1.6476 W	0.8666
VWW = 15.7612 + 0.1000 S	0.7292
VDW = 4.6899 + 0.0345 S	0.6135
VDW = 0.0892 + 0.1334 VWW	0.7648

[1] W = width of shell (mm)
L = length of shell (mm)
VWW = wet weight of visceral mass (mg)
VDW = dry weight of visceral mass (mg)
S = dry weight of shell (mg).
[2] Significance level, P = 0.0001.

were highly significant ($P<0.01$) although the correlation coefficients were slightly less than those of Joy and McCoy (1975). This can be explained by the variability associated within the one size class in this study compared with a range of size classes (from about one to more than four years) collected by Joy and McCoy (1975). It is interesting to note that the width of their specimens averaged about 66% of the clams' lengths which agreed closely with the average of 70% in this study. Sinclair and Ingram (1961) reported somewhat different morphology in specimens from the Tennessee River (shell width about 89% of length based on their published photographs). Only the correlation between shell length and viscera wet weight was greater in this study ($r = 0.9683$) than in the investigation of Joy and McCoy (1975) ($r = 0.9407$). Results of this study agreed with the observation of Joy and McCoy (1975) that viscera wet, rather than dry, weight correlation coefficients are greater and indicate that noncombustible mineral uptake varied more per individual than water content.

It is anticipated that the impact of *Corbicula* on this river system will be exhibited primarily in two different areas: 1) decline in populations of other bivalves as seen during the invasion of the Altamaha River in Georgia (Gardner et al., 1976); and 2) increase in problems associated with industrial and municipal water use (Sinclair, 1964, 1971). The survival of indigenous species of *Margaritifera, Tristigonia, Elliptio, Sphaerium* and *Pisidium* in the New River appears to be seriously threatened.

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