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CHANGES IN THE DISTRIBUTION OF *IO FLUVIALIS* (SAY, 1825) IN THE UPPER
TENNESSEE RIVER SYSTEM (MOLLUSCA, GASTROPODA, PLEUROCERIDAE)

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In 1825 Thomas Say described a new species of river snail from the headwaters of the North Fork of the Holston River at Saltville, Virginia. Because the form of this species at this site resembled marine shells of the Genus *Fusus*, Say called it *Fusus fluvialis*, the "*Fusus* of the rivers." Professor Lardner Vanuxem, a geologist-paleontologist, had collected the type material. He sent specimens to his friend Isaac Lea as well as to Say. Lea (1831: 122), in the belief "that no genus should contain pelagian and fluviatile shells in common," established the Genus *Io* to receive Vanuxem's Holston River shells, which he redescribed as *Io fusiformis*. Thus the Spiny River Snail of the southern Appalachians has come to be known, under the rules of zoological nomenclature, as *Io fluvialis* (Say, 1825).

Additional collections in the upper Tennessee River system over the years brought to light additional forms of *Io* which were given additional names. As the variability of this group of river snails became known to malacologists, interest in it grew. This interest reached its peak in the monographic study of the genus made over its entire known range by Dr. Charles C. Adams. Although Adams' collections were made in 1899, 1900, and 1901, his classic study was not published until 1915.

With perception uncommon in that early period, Adams (1915: 8) wrote: "When we consider the rapid rate at which our native plants and animals are being destroyed by the encroachment of civilization, it will be realized that in a few generations a fairly full account of many of our species will be forever lost. I hope that the present record will be a contribution to the preservation of such 'vanishing data,' and that the photographic record and the collection [now preserved at the Smithsonian National Museum of Natural History] will preserve a reliable sample of one of nature's vast experiments."

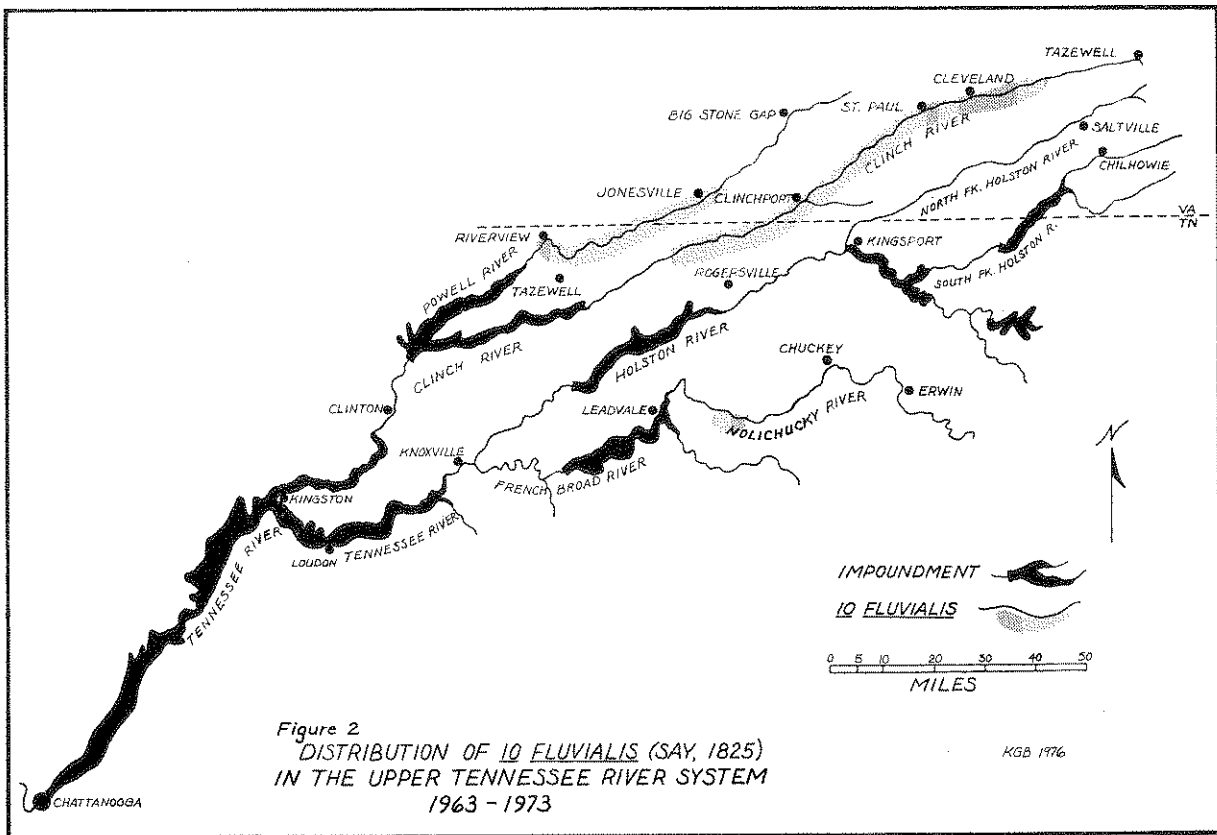
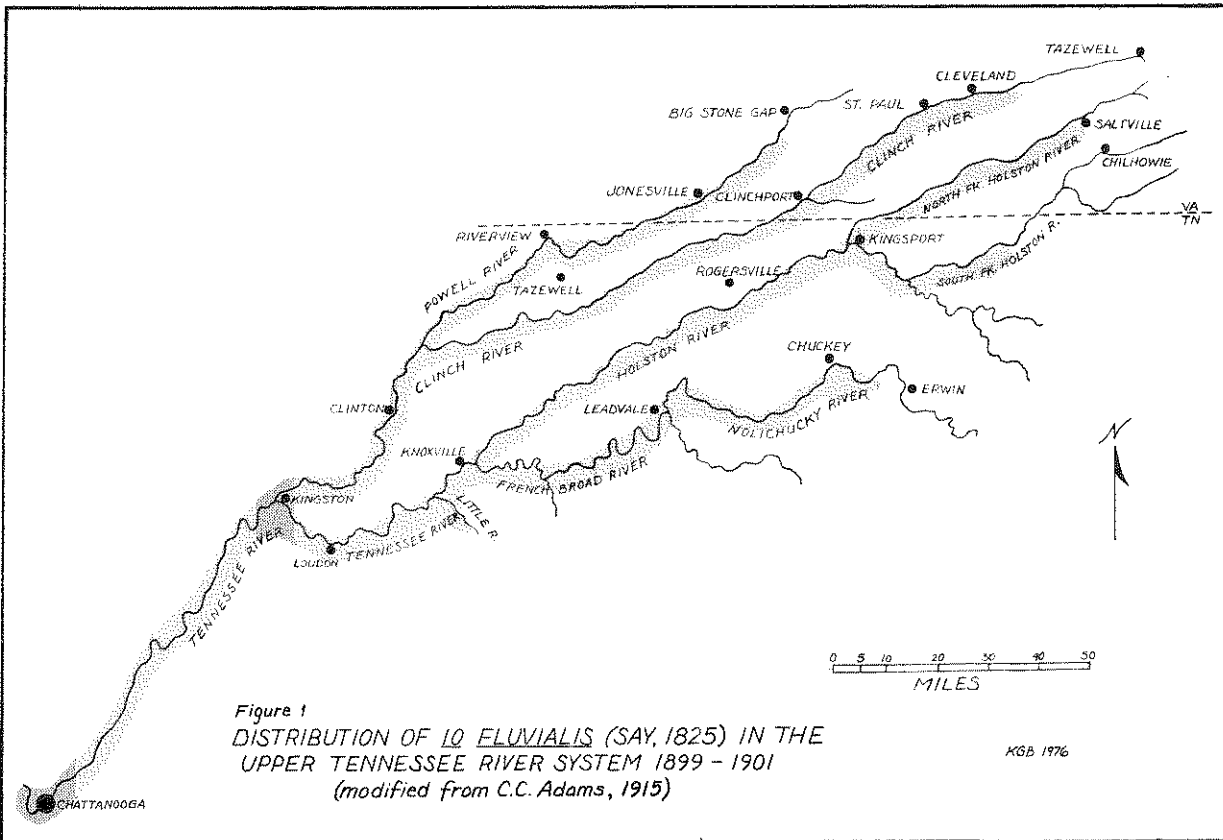
Adams confirmed the fact that the *Io* specimens found in the upper reaches of the

Powell, Clinch, and North Fork Holston Rivers were smooth forms which lacked spines. Moving downstream in these rivers, he found phases of *Io* best described as smooth, undulate, nodulous, low-spined, and finally prominently-spined. Specimens from the uppermost populations in the South Fork Holston River, however, were mainly undulate, while those of the Nolichucky were spinose. In general, the farther downstream an *Io* was taken, the more prominent its spines were likely to be. An exception to this generalization occurred in the main stem of the Holston River near Rogersville, where large numbers of the smooth shells, typical of the headwaters form, were found, together with spinose shells and many intergrading forms.

As can easily be seen from Adams' excellent series of plates, a great deal of variation was found in the *Io* populations of each locality, and the smooth forms appear to intergrade completely with the most spinose forms, indicating that these animals all represent a single, highly polymorphic species.

DISTRIBUTION

No valid records of living or fossil *Io* are known outside the Tennessee River System. It reached its greatest abundance, at least in historic times, in the middle and upper reaches of the Tennessee system upstream from Chattanooga. The downstream limit of its distribution evidently was Muscle (Mussel) Shoals, Alabama, where Hinkley (1906: 40) found a single living specimen of the spinose *turrita* form in 1904. The upstream limits of *Io*'s distribution were reached in tributaries the size of the North Fork Holston River at Saltville, Virginia, the type locality. Goodrich (1913) extended its known range in the Clinch River upstream to Cedar Bluff. A single specimen of the *Turrita* form was reported from Little River about eight miles above its mouth by Clench in 1928. Adams searched the Hiwassee and Sequatchie Rivers and South Chickamauga Creek without finding any specimens of this complex.



The known original range of *Io*, except for the lone Muscle (Mussel) Shoals record and another live specimen taken in the main stem of the Tennessee River a few miles above Bridgeport, Alabama, by Adams, is shown in Figure 1.

The present distribution of *Io fluviatilis* is shown in Figure 2, which is based upon specimens collected within the past two decades now deposited in the Ohio State University Museum of Zoology collection. These specimens, their condition, year of collection, and locality are listed in the accompanying table. *Io* appears to have been extirpated from the main stem of the Tennessee River, the entire Holston River system, and the French Broad River. We have found it living at one site in the Nolichucky River, where it is now very rare. In the Powell River we have found living specimens from near Pennington Gap, Lee County, Virginia, downstream as far as Riverview, Claiborne County, Tennessee. The Clinch River from Blackford, Russell County, Virginia, downstream to Sneedville, Hancock County, Tennessee, harbors most of the world's remaining populations of living *Io*.

HABITAT REQUIREMENTS

Our early collections of *Io* led us to believe that it was a creature of rushing waters, and that the collector should be prepared to collect with one hand while hanging on to a firmly seated boulder or a bedrock ledge "for dear life" with the other. *Io* populations are definitely associated with the rapid waters of riffles or shoals, but we soon learned that they are also found in the smoother stretches of runs below these rapids. An *Io* swept into a deep, quiet pool, however, appears to be an *Io* doomed to an early death. We have found only dead shells of this species in such pools. It may be, however, that these shells were washed into the pools after the animals had died.

Ms. Annie Law, a collector of the 1800's, observed: "The muscular power of *Io* is astonishing. I frequently find one adhering to a rock half as large as my head, and when I take up the shell, it brings the rock with it and requires much force to separate it" (Lewis, 1871: 233).

HABITAT CHANGES

Nearly all of the shoals of the Tennessee River and the lower reaches of its major tributaries are now buried beneath many feet of slack water in impoundments behind high dams. We know of no recent records of living *Io* from these impound-

ments. *Io* also appears to be absent from the rapid tailwaters of these dams, perhaps because of the great short-term variations in stream flow associated with power generation during peak and low demand periods.

In addition to *Io*'s eradication from its former downstream range, it is now losing headwater habitat because of pollution. Athearn (1968: 44) reported, "The June 1967 pollution of the Clinch River in Virginia by the Appalachian Power Company killed hundreds of thousands (of mollusks.) Among the many mollusks and other plants and animals killed was the best remaining concentrated population of our AMU symbolic mollusk *Io fluviatilis*."

Several communities, such as Tazewell, Virginia, along the *Io* streams of the upper Tennessee have recently installed municipal sewage treatment facilities, replacing former septic tank systems. Below the outfalls of these sewage treatment plants the rich endemic molluscan fauna of these streams is rapidly disappearing. The killing effect appears to be spreading downstream from these towns and is affecting not only the pleurocerids, but also the naiades. Communities which still have the septic tank treatment systems, such as Fort Blackmore, Dungannon, and Clinchport, do not appear to have an adverse effect on the molluscan fauna of the rivers.

Below Big Stone Gap in the upper Powell River, *Io* and other aquatic mollusks are absent for some miles downstream. The suspected cause is acid mine drainage from the North Fork above Big Stone Gap. The South Fork of the Powell at and above Big Stone Gap still retains a rich pleurocerid fauna, though *Io* evidently never occurred this far upstream. If coal mining is expanded further into the Clinch River watershed, acid mine drainage could eliminate the richest remaining populations of *Io*.

In the North Fork of the Holston River the *Io* population has suffered from the outfall of the chemical industry at Saltville since before 1900 (Adams, 1915: 18). No living populations of *Io* are now known to exist anywhere in the Holston River system (Stansbery, 1972; Stansbery and Clench, 1974). Since the Saltville chemical plant has now ceased operations, it is possible that the Holston River will eventually recover its ability to support a diversity of molluscan life. If so, then perhaps it will be possible to successfully reintroduce *Io* into the Holston from seed populations in the Powell,

Clinch, or Nolichucky---if these are still surviving.

Efforts are being made to preserve the natural integrity of what is left of *Io*'s habitat. If the remaining high-quality stretches of the upper Clinch, Powell, and Nolichucky can be protected from further degradation, this unique American river snail and the many other endemic species associated with it in the upper Tennessee drainage may be preserved for future generations.

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IO FLUVIALIS SPECIMENS COLLECTED SINCE 1950, DEPOSITED IN THE OHIO STATE UNIVERSITY MUSEUM OF ZOOLOGY

(Records arranged in upstream to downstream sequence for each river listed.)

POWELL RIVER

Virginia, Lee County

OSUM-7260	Live	1967	2.3 mi. SE of Pennington Gap
OSUM-7264	Live	1967	7.7 mi. SW of Pennington Gap

Tennessee, Claiborne County

OSUM-7267	Live	1967	At Hoop, 9 mi. NE of Tazewell
OSUM-7270	Live	1967	At Hoop, 9 mi. NE of Tazewell
OSUM-7274	Live	1968	At Hoop, 9 mi. NE of Tazewell
OSUM-7276	Live	1969	At Hoop, 9 mi. NE of Tazewell
OSUM-7277	Live	1973	At Hoop, 9 mi. NE of Tazewell
OSUM-7278	Live	1967	At Riverview, 10.5 mi. W of Hoop

CLINCH RIVER

Virginia, Russel County

OSUM-4535	fresh	1965	At Blackford, 2.5 mi. SE of Honaker
OSUM-7279	subfossil	1973	At Blackford, 2.5 mi. SE of Honaker
OSUM-7285	subfossil	1965	At Cleveland, 10.8 mi. WSW of Honaker
OSUM-7286	live	1973	At Cleveland, 10.8 mi. WSW of Honaker
OSUM-7297	subfossil	1963	At Boody (Fink), 1 mi. E of St. Paul
OSUM-7299	fresh	1963	At St. Paul, 9 mi. WSW of Cleveland
OSUM-7298	dead	1965	At St. Paul, 9 mi. WSW of Cleveland
OSUM-7291	subfossil	1973	At St. Paul, 9 mi. WSW of Cleveland

Virginia, Scott County

OSUM-7300	live	1965	At Dungannon, 7.3 mi. NE of Fort Blackmore
OSUM-7301	live	1963	At Fort Blackmore, 10.7 mi. NE of Clinchport
OSUM-7302	live	1965	At Fort Blackmore, 10.7 mi. NE of Clinchport
OSUM-7306	live	1963	At Clinchport, 2.2 mi. N of Speers Ferry
OSUM-7303	fresh	1970	At Clinchport, 2.2 mi. N of Speers Ferry
OSUM-7308	live	1973	At Clinchport, 2.2 mi. N of Speers Ferry
OSUM-7311	live	1965	Above the mouth of Copper Creek, 1.3 mi. S of Clinchport

OSUM-7315	live	1966	At the mouth of Copper Creek
OSUM-7317	live	1973	At the mouth of Copper Creek
OSUM-7312	live	1970	Copper Creek immediately above its mouth
OSUM-7316	live	1963	At Speers Ferry, 2 mi. S of Clinchport
OSUM-7320	live	1963	1-2 mi. below Speers Ferry
OSUM-7322	live	1963	1-2 mi. below Speers Ferry
OSUM-7321	live	1965	1-2 mi. below Speers Ferry
OSUM-7323	live	1974	6.2 mi. SW of Clinchport, 12.2 mi. NE of Kyles Ford

Tennessee, Hancock County

OSUM-4528	fresh	1972	13.8 mi. SW of Clinchport, 4.5 mi. E of Kyles Ford
OSUM-7330	live	1968	Below The Rounds, 3.5 mi. E of Kyles Ford
OSUM-7324	live	1972	Below The Rounds, 3.5 mi. E of Kyles Ford
OSUM-7327	live	1974	Below The Rounds, 3.5 mi. E of Kyles Ford
OSUM-7331	fresh	1970	2 mi. above Kyles Ford, 11.2 mi. E of Sneedville
OSUM-7334	fresh	ca. 1958	At Kyles Ford, 10.2 mi. ENE of Sneedville
OSUM-7335	live	1965	"
OSUM-7338	live	1967	"
OSUM-7339	subfossil	1968	"
OSUM-7342	live	1969	"
OSUM-7343	fresh	1971	"
OSUM-7346	live	1973	"
OSUM-7349	subfossil	1967	"
OSUM-7351	live	1967	From Brooks Island to Alder Hollow, 5 mi. E of Sneedville
OSUM-7363	live	1968	"
OSUM-7354	live	1969	"
OSUM-7358	live	1974	"
OSUM-7366	fresh	1967	Below Garland Hollow, 1.1 mi. SE of Sneedville
OSUM-7367	live	1972	"
OSUM-7370	live	1974	"

Tennessee, Claiborne/Grainger Counties

OSUM-7376	subfossil	1968	Below U.S. Rt. 25E bridge, 7.2 mi. SE of Tazewell
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NOLICHUCKY RIVER

Tennessee, Greene County

OSUM-7255	subfossil	1968	2.5 mi. S of Chuckey (Indian midden shells)
OSUM-7259	live	1964	Hale Bridge, 3.3 mi. SE of Warrensburg
OSUM-7258	live	1968	"

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