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#885

The Mussel Population of an Area of Loamy-Sand Bottom of Lake Texoma[1]

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Published accounts of studies of fresh-water mussel populations in the United States are few. During the period when the pearl button industry was at its height, mussel "fishing" was extensively practiced, and the mussel fishery intensively studied by the U. S. Bureau of Fisheries, many faunal papers were published which listed the mussels of various lakes, rivers, and drainage basins. These papers included general statements on the habitat preferences and the abundance of mussels, but little exact and specific data on the number of mussels per unit of area of stream or lake bottom.

Information on mussel populations in impounded waters is even more scarce. Where impoundment occurs, undoubtedly it is responsible for the eradication of some species which lived in the stream before impoundment; it has little effect on other species, and even favors some species. Coker et al (1922), stated that wing dams in the upper Mississippi River often produced environments unfit for mussels that were formerly abundant in the same portion of the river. They also stated that lakes with a free circulation of water seem to be favorable to mussels, particularly those situated in the course of a river. This was not a reference to impoundments, however, but to lakes such as Lake Pepin in the Mississippi River. Similar conditions are present in certain impoundments, and in the absence of environmental factors decidedly detrimental to mussels (e.g., heavy siltation; extreme water level fluctuations; pollution) such impoundments should support large mussel populations, in many cases much larger than were supported by comparable areas of the river before impoundment.

Lake Texoma is formed by the Denison Dam which impounds the Red River just downstream from its confluence with the Washita River (Bryan County, Oklahoma; Grayson County, Texas). The United States Department of Interior (1943), the Oklahoma Planning and Resources Board (1946; 1953), and the U. S. Army Engineers (1948) give pertinent general data on this lake.

The Red River, because of its heavy silt load and constantly changing bed, is unsuited for mussels (Coker *et al.*, 1922; Isely, 1924). Isely (1924)[2] carefully examined its bed in three areas (all of which are now within Lake Texoma) and found very few mussels—52 living specimens and several shells, representing eight species in all. The shells included: *Quadrula pustulosa, Q. forsheyi* (= *Q. quadrula,* Neel, 1941), *Lampsilis ventricosa,* and *Anodonta*

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[1] Contribution of the University of Oklahoma Biological Station, Lake Texoma.

[2] Coker *et al.* (1922) said that Isely (1914) examined the Red River and found few mussels. Our examination of Isley (1914) showed no such statement. They probably referred to Isely (1924) which was submitted to the U. S. Bureau of Fisheries about 1914, but was never published by that organization due to World War I. This same manuscript was later published in the *Proc. Okla. Acad. Sci.*, Vol. 4.

grandis. The living species were: *Proptera* (=*Leptodea*) *laevissima* (40 specimens), *Leptodea fragilis* (8 specimens), *Truncilla donaciformis* (2 specimens), and *Lampsilis fallaciosa* (2 specimens).

The Washita River also has been classed as a poor mussel stream by Isely (1924). His intense collecting (one of his collecting sites is now included in Lake Texoma) revealed 12 species, including seven of the eight mentioned above (*Anodonta grandis* excluded), plus *Lasmigonia complanata*, *Obliquaria reflexa, Tritogonia verrucosa* (= *T. tuberculata*), *Proptera purpurata*, and *Carunculina parva*. *Leptodea laevissima* was the only abundant species. During extensive seining in the Washita River during the past five years, Riggs has found mussels only in the upper portions of the river.

Conditions in many of the tributaries of both the Red and Washita rivers are undoubtedly suitable to support sizeable mussel populations of many species. This is substantiated by Isely (1924), who found a total of 42 species in the Red River tributaries.

No thorough study of the mollusks of Lake Texoma has been made. Mollusk collections made by classes in invertebrate zoology at the University of Oklahoma Biological Station, and those which Riggs has made incidentally while seining fishes, do not indicate the presence of a large mussel population, either of species or of individuals. Sublette (1956) reported five species of mussels in Texoma: *Quadrula q. apiculata, Truncilla donaciformis, Leptodea laevissima, Anodonta corpulenta,* and *A. imbecillis*. We have taken four of these five species in Lake Texoma (*A. corpulenta* excluded); also *A. grandis Carunculina parva,* and *Leptodea fragilis* (table 1). Of the seven species which we took, *Leptodea laevissima, L. fragilis, Andonta grandis, Q. quadrula,* and *Carunculina parva* were taken as both living specimens and shells. The remaining species are represented only by shells found on the lake bottom exposed by low water. Only one of the seven species which we took, *Andonta imbecillis,* was not listed by Isely (1924)[3] from the Red or Washita rivers, although it was listed as taken from several tributaries. Some of Isely's specimens are in the University of Oklahoma Museum of Zoology.

On July 14, 1953, Riggs visited a large flat peninsula (approximately 60 acres) immediately downstream from the mouth of Big Mineral Creek in Grayson County, Texas. This area was normally lake bottom, but due to low water it was exposed at the time of Riggs' visit. Several thousand mussel shells were scattered over this area. It had been a peanut field before it was inundated. Some of the plow furrows faintly showed and parts of many dead peanut plants remained, still partly rooted. About one-third of this area was a very shallow basin with gently sloping sides about 8 to 12 inches higher than the floor. Most of the shells in this shallow basin were still imbedded in the earth in the position of living mussels. Because of the size and shape of the basin, its near-center location in the large flat area, and the rapid rate at which the lake falls during the times of year when this

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[3] Isely's table of mussels from the Red River drainage lists *Anondonta corpulenta* from the Red River. From reading his text (p. 51) it is obvious that this is a transposition and the species should be *A. grandis* (listed immediately below *A. corpulenta* in the table).

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area has been exposed (April 1 to 8; October 1 to 9, 1952), it seems almost certain that all living mussels literally "died in their tracks." It is improbable that any within the basin escaped. Those that retreated with the lowering water moved toward the center of the basin where they were trapped when the water level fell below the rim of the basin. Most of them were probably killed by high water temperature[4] during September and October, 1952, before the entire area was exposed, since surface temperatures of water less than two feet deep are often above 80° F through mid-October. There was no indication that the shells had been disturbed; no human or livestock tracks were evident.

The situation seemed to offer an excellent opportunity for a population study. Examination of recorded lake levels since impoundment first began (January 6, 1944), and Riggs' field notes for 1949, furnished data which indicated that it was an extraordinary opportunity. The area was first inundated in February, 1945. It remained covered until January, 1949. During this time the depth of the water over the area varied from 0 to 19 feet, and was more than 3.5 feet deep until November, 1948. The area was exposed for at least 20 days during January and February of 1949 which should have killed any mussels present.

On February 5, 1949, Riggs made a careful examination of the ground in the area and noted that "mollusks were practically nonexistent and were probably quite scarce in the entire lake." Although we have no data which verify this, it is logical that such scarcity did exist when the following facts and possibilities are considered: (1) The lake was only four years old. (2) Both the Red and Washita rivers are poor mussel streams. (3) The lake environment might not be suitable for some of the few stream-dwelling species that were present at impoundment, as well as for some of the host fishes. (4) The sudden great increase in water volume would dilute, at least temporarily, some of the important host fishes. (5) Much of the bottom would at first be unsatisfactory to support mussels.

The area was again inundated by late February, 1949, and remained covered (minimum depth—2.0 feet; maximum—18.5 feet) until early April, 1952. It was exposed for 14 days, re-inundated by the end of April, and re-exposed by October 8, 1952. It remained exposed until after the time of this study, July, 1953.

The above data indicated that most of the shells distributed over the shallow basin represented a mussel population established between February, 1949, and April, 1952. Although many young mussels might have been shed from host fishes over this area between April and October, 1952, none could have attained the size of most of the specimens which we collected. Except for the two small species, *Carunculina parva* and *Truncilla donaciformis,* very few shells under one inch in length were found and growth rings indicated that very few were less than one year old. It seems unlikely that

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[4] No data indicating temperatures lethal to mussels can either be furnished or found in the literature. Without exception, however, it was noticed that in Lake Texoma mussels caught in shallow, warm water by a falling lake level either move into deeper water or die within two days.

many individuals could have migrated into the area during the seven-month period. This would have required straight-line movement of at least 100 yards. Remarks about mussel migration and movement by Coker, *et al.* (1922), and Isely (1914; 1924) indicate that in favorable environments, mussels, especially the heavy-shelled forms, rarely move far from the place where they were dropped. Furthermore, the fact that the water level was falling during half of the seven-month period should have caused movement away from the area and into deeper water. Such movement by *Leptodea laevissima* was described by Isely (1924) who found that this species also moved up the bank with rising water. Some of the larger shells of *L. laevissima* which we collected appeared to be four years old or older, and might have migrated into the area after it was re-inundated in 1949 or 1952. It is also possible that some of these old shells are the remains of mussels that died during the 1949 exposure, or that survived the 20-day period of exposure (as young mussels) and lived on until 1952 after the area was re-inundated. However, Riggs should have found any old shells during his examination of the area in 1949.

On July 17, 1953, we visited this area of exposed lake bottom and began a study of the clam population based on the number of shells collected. We had decided to establish a number of quadrats at random over the shallow basin. All quadrats were 50-foot squares, and were laid out with four sticks connected by heavy string. A 100-foot steel tape was used to measure the sides and construct the 90° angles. We were careful not to walk through a quadrat and step on shells.

When a quadrat was established one of us walked to its center, picking up any shells that were in our path, and set down a box. We then worked away from the box in a tight spiral pattern, returning periodically to the box to deposit shells. After this had been done several times, we traversed the quadrat in a boustrophedonic pattern, both parallel with its sides and at 45° to them. This was continued until no additional shells were found. All fragments were picked up. Each box was dated, and its contents later analyzed

TABLE I.—Kind, number, and size of mussels (shells) found on an area of exposed bottom of Lake Texoma, 1953.

Species	Total number of shells	Number of fragments (umbos)	Number of entire individuals	Average number per quadrat	Range in numbers per quadrat	Average length of shell (mm)	Range in length of shell (mm)
Anodonta grandis	17	3	14	1.7	1-6	131.8	100-15
A. imbecillis	2	0	2	0.2	0-1	35.5	31-40
Carunculina parva	31	15	16	3.1	0-7	23.6	17-32
Leptodea fragilis	2	0	2	0.2	0-1	113.5	98-12
L. laevissima	536	62	474	53.6	27-95	123.6	42-16
Quadrula quadrula	220	60	160	22.0	12-33	43.7	11-10
Truncilla donaciformis ..	90	11	79	9.0	5-21	72.4	10-50
Total and grand average	898	151	747	89.8			

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Number of fragments (umbos)	Number of entire individuals	Average number per quadrat	Range in numbers per quadrat	Average length of shell (mm)	Range in length of shell (mm)
3	14	1.7	1-6	131.8	100-156
0	2	0.2	0-1	35.5	31-40
15	16	3.1	0-7	23.6	17-32
0	2	0.2	0-1	113.5	98-129
52	474	53.6	27-95	123.6	42-161
50	160	22.0	12-33	43.7	11-101
11	79	9.0	5-21	72.4	10-50
1	747	89.8			

laboratory. Only those shell fragments including umbos were counted shells, and opposite umbos were matched. The type and condition of was noted. Altogether ten quadrats were examined.

The data in table 1 show *Leptodea laevissima* (536 specimens) to have been far more abundant than all of the other six species combined (a total 362 specimens). It is the dominant mussel in the lake. *Q. quadrula* (220 specimens) was more abundant than all of the remaining species (142 specimens). These two species were also the most abundant in the incidental and general mollusk collections mentioned earlier from the lake. Some of the factors that have probably contributed to their success follow: (1) The fish host reported for *L. laevissima* (Baker, 1928), the freshwater drum (*Aplodinotus grunniens*), is abundant in Lake Texoma. (2) The unusual migratory ability of *L. laevissima* (Coker, *et al.*, 1922; Isely, 1924). (3) The rapid growth-rate of *L. laevissima* (Coker, *et al.*, 1922) and the thick, heavy shell of *Q. quadrula*, two factors making these species unavailable or generally unsuitable for fish food. (4) The quadrulas tend to remain in deep water (Coker, *et al.*, 1922; Isley, 1914) and thus avoid exposure and stranding by receding water. (5) The quadrulas are also able to endure unfavorable conditions (Isely, 1914). (6) *L. laevissima* appears to have been the dominant mussel in the Red and Washita rivers before impoundment (Isely, 1924).

From our data it was impossible to draw sound conclusions about the relative abundance of the remaining species throughout the lake. There was little variation in the soil of the ten quadrats. Two of them contained fine gravel (these were two of the three quadrats with over 100 shells), and two of them contained little sand (these contained the fewest shells). It seems probable that there was too much sand for an ideal environment for those species preferring a mud bottom. We have collected *Anodonta grandis* and *Leptodea fragilis* in far greater relative abundance in other parts of the lake with a mud bottom. Another area of the peninsula where the bottom was soft mud was much more densely populated with *A. grandis*. These soft-bottom-frequenting forms are, therefore, probably more abundant in the entire lake than the quadrat data indicate.

From general but careful observations of the distribution and number of shells scattered over the basin area of the peninsula, we believe that the data from the ten quadrats give a good estimate of the entire population of

TABLE 2.—Numbers of each species of mussels (shells) found in each of ten quadrats.

	1	2	3	4	5	6	7	8	9	10	Total
Leptodea laevissima	49	49	54	36	47	34	95	27	86	59	536
Quadrula quadrula	20	20	14	21	32	12	33	20	27	21	220
Truncilla donaciformis	6	6	21	13	13	6	9	6	5	5	90
Carunculina parva	2	5	7	2	4	2	5	....	3	1	31
Anodonta grandis	....	2	6	2	3	1	....	....	2	1	17
A. imbecillis	....	....	1	....	....	1	....	....	....	....	2
Leptodea fragilis	....	....	1	1	....	....	....	....	....	....	2
Total	77	82	104	75	99	56	142	53	123	87	898

the area. Expanding the average quadrat population (table 1) over the whole area gives a density of 0.36 mussels per square foot; 15,647 per acre. This is low when it is compared with stream populations. Clark and Wilson (1912) reported a density of 7.5 mussels per square foot. According to Coker, *et al.* (1922), mussel densities of three per square foot were found in Grand River, Michigan, and 16.5 per square foot in the Clinch River, Tennessee. They also stated that it is fair to assume that a density of more than three or four mussels per square foot over any considerable area is unusual. After an analysis of the data it is impossible to say whether this population density, 0.36 mussels per square foot, compares favorably with other impoundments. We found no comparable data in the literature, and even had this been possible it would mean little since eclogical conditions in different impoundments are so variable. The specific effects of such conditions on the mussel population of Lake Texoma are unknown at the present.

Because of the homogeneity of the bottom of the area studied, and because of the lack of knowledge of other environmental factors (i.e., food, current, dissolved oxygen, etc.) which should have been equally homogeneous, little valuable information on interspecific associations can be gained from the data in table 2. That these species do occur together is obvious.

We are grateful to Dr. Henry van der Schalie of the University of Michigan Museum of Zoology for verifying our identifications of the mussels.

SUMMARY

Isely (1924) reported 13 species of mussels from the Red and Washita rivers in Oklahoma, and a total of 43 species from the tributaries of the Red River.

Eight species of mussels have been taken from Lake Texoma, all of which were included in Isely's list of 43 species from the Red River and its tributaries.

Two of the Texoma species, *Anodonta corpulenta* and *A. imbecillis*, were not taken by Isely from the Red or Washita rivers.

Ten quadrats were established on a large area of exposed, loamy-sand lake bottom and all mussel shells present were collected, identified, and counted.

The quadrat samples included 7 species of mussels: *Anodonta grandis*, *A. imbecillis*, *Carunculina parva*, *Leptodea fragilis*, *L. laevissima*, *Quadrula quadrula*, and *Truncilla donaciformis*.

All species were associated with one another in the area sampled.

According to the data, *Leptodea laevissima* is the dominant species of mussel in Lake Texoma, followed by *Quadrula quadrula*.

Analysis of the quadrats showed a density of 0.36 mussels per square foot, or 15,647 per acre.

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