Coker, R. E.

Mussel Resources in Tributaries of the Upper Miss. River, 1915.

DEPARTMENT OF COMMERCE

BUREAU OF FISHERIES

HUGH M. SMITH, Commissioner

MUSSEL RESOURCES IN TRIBUTARIES OF THE UPPER MISSOURI RIVER

By ROBERT E. COKER, *Director*

AND

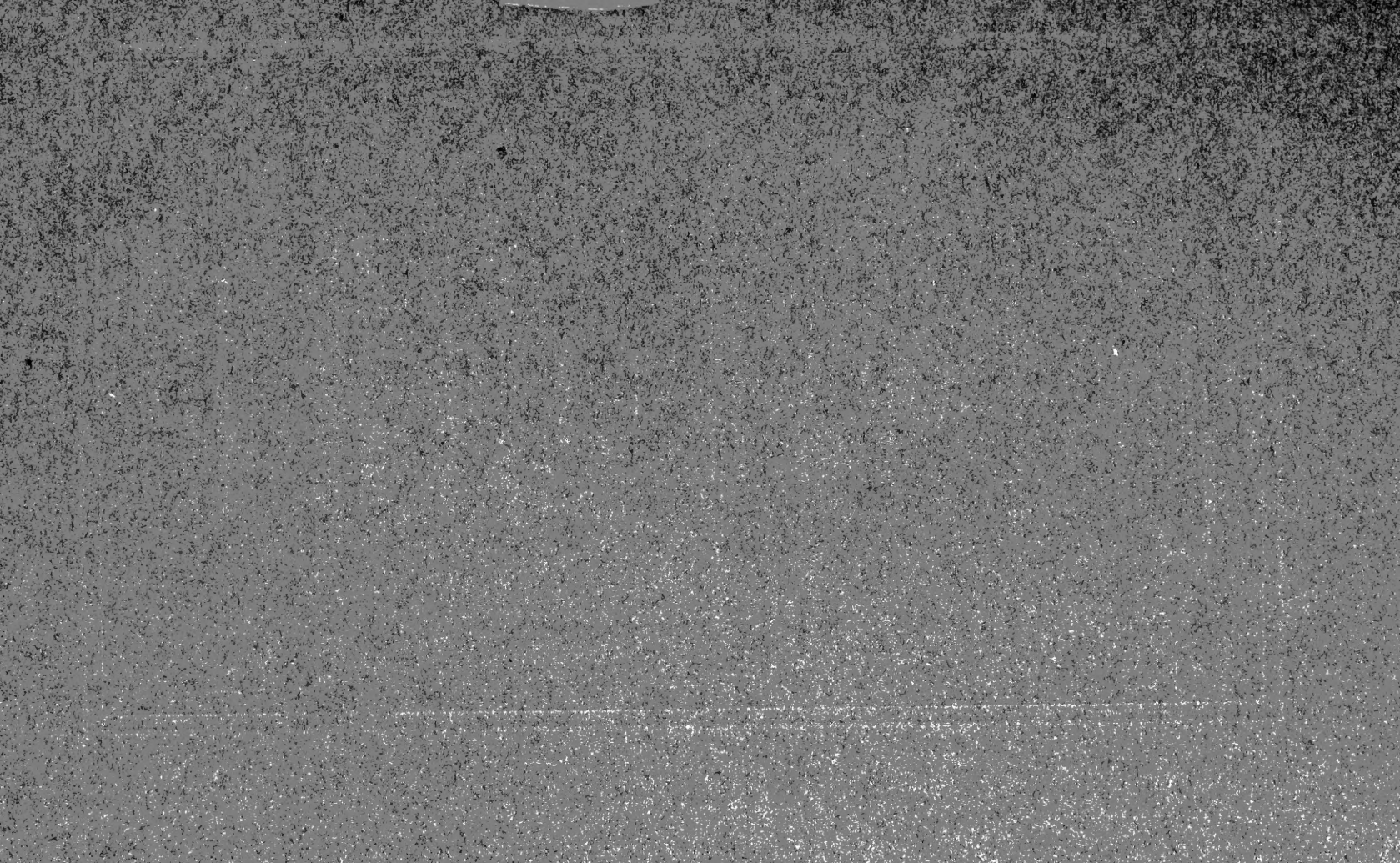
JOHN B. SOUTHALL, *Shell Expert*

United States Biological Station
Fairport, Iowa

APPENDIX IV TO THE REPORT OF THE U. S. COMMISSIONER OF FISHERIES FOR 1914

Bureau of Fisheries Document No. 812

WASHINGTON
GOVERNMENT PRINTING OFFICE
1915



DEPARTMENT OF COMMERCE
BUREAU OF FISHERIES
HUGH M. SMITH, Commissioner

MUSSEL RESOURCES IN TRIBUTARIES OF THE UPPER MISSOURI RIVER

By ROBERT E. COKER, *Director*
AND
JOHN B. SOUTHALL, *Shell Expert*
United States Biological Station
Fairport, Iowa

APPENDIX IV TO THE REPORT OF THE U. S. COMMISSIONER OF FISHERIES FOR 1914

Bureau of Fisheries Document No. 812

WASHINGTON
GOVERNMENT PRINTING OFFICE
1915

ADDITIONAL COPIES

THIS PUBLICATION MAY BE PROCURED FROM
THE SUPERINTENDENT OF DOCUMENTS
GOVERNMENT PRINTING OFFICE
WASHINGTON, D. C.

AT

5 CENTS PER COPY

MUSSEL RESOURCES IN TRIBUTARIES OF THE UPPER MISSOURI RIVER

By ROBERT E. COKER, *Director*

AND

JOHN B. SOUTHALL, *Shell Expert*

United States Biological Station
Fairport, Iowa

Appendix IV to the Report of the U. S. Commissioner of Fisheries for 1914

CONTENTS.

MUSSEL RESOURCES IN TRIBUTARIES OF THE UPPER MISSOURI RIVER.

By Robert E. Coker, *Director*, and John B. Southall, *Shell Expert*, *United States Biological Station, Fairport, Iowa.*

FIELD OF INVESTIGATION.

The Missouri River itself has been known to be without shell resources, although some of its tributaries may compare favorably in mussel fauna with streams of other divisions of the Mississippi-Missouri Basin. The fact of the general poverty in mussels of the Missouri River has led to an almost entire neglect of its more favored tributaries until quite recently, when shelling operations have been undertaken in such streams as the Osage River in Missouri and the James River in South Dakota.

During the summer of 1912 the Bureau conducted a reconnaissance of lakes and streams constituting the headwaters of the Mississippi River in Minnesota, [a] and it was hoped to extend the survey this season westward to the headwaters of the Missouri. Such a desire was strengthened by the receipt of information that important shells were being found in the James River, and perhaps in the Vermilion River of South Dakota also. Accordingly, in July, 1913, Mr. J. B. Southall, shell expert of the Fairport station, made an examination of several streams, principally the James and the Vermilion Rivers. The director was able to visit only the James River at Huron, and the Vermilion River at Parker, S. Dak. For observational data, therefore, this report is based principally upon the field notes and collections of Mr. Southall.

It may be recalled that the extreme upper portions of the Missouri and the Mississippi Basins, respectively, are not adjacent, but are separated by that far-reaching arm of the Hudson Bay drainage constituting the basin of the Red River of the North. The southernmost units of the Red River system are the Ottertail River in Minnesota and Lake Traverse and the Cheyenne River in the eastern and southern portions of North Dakota. The party en route for the James River found it convenient to make a few observations on the Red River at Fargo and the Cheyenne River at Lisbon.

[a] Wilson, Charles B., and Danglade, Ernest: The mussel fauna of central and northern Minnesota. Bureau of Fisheries Document no. 503, 26 p., 1 map. 1914.
Mussels of central and northern Minnesota. Bureau of Fisheries Ecomomic Circular no. 3, 6 p. 1912.

The James River was first examined at Oakes, N. Dak., from whence the party proceeded by rail from point to point down to the mouth of the river, stopping at Columbia, Frankfort, Huron, Riverside, Milltown, and Lesterville, S. Dak. (See map.)

The Vermilion River was examined at Parker, Davis, Centerville, and Vermilion, the latter point being 7 miles above its mouth.

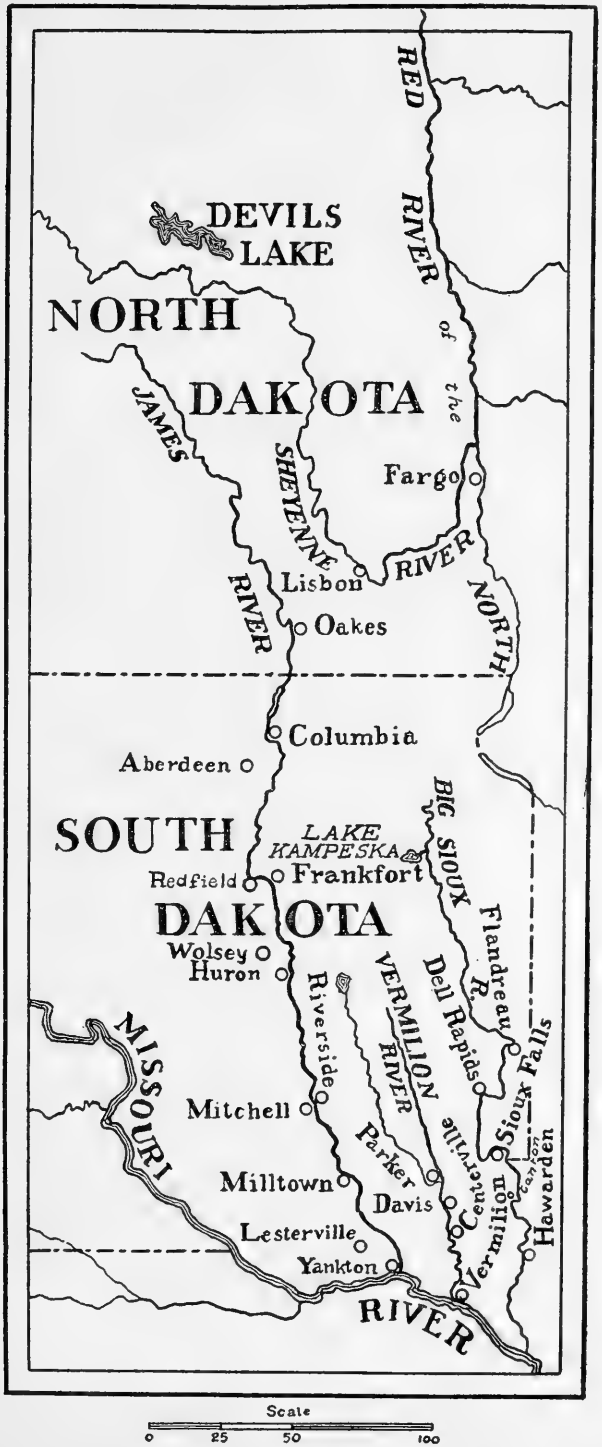
The Big Sioux River was visited at Flandreau, Dell Rapids, Sioux Falls, Canton, S. Dak., and Hawarden, Iowa. Examination was also made of Lake Kampeska, connected with the Big Sioux River.

The more western and northern tributaries of the Missouri generally were not included, although side trips were made to the Bad River at Philip, S. Dak., the Cheyenne River at Wasta, S. Dak., and Rapid Creek, a tributary of the Cheyenne, at Rapid City, S. Dak.

Some species of mussels were found in every locality visited except in the streams west of the Missouri; but the only streams containing mussels of economic quality and abundance were the James River, between Riverside and Lesterville, and the Vermilion River, near its mouth. It may well occasion surprise to find a luxuriant mussel fauna narrowly circumscribed within what is otherwise, for mussels, a broad and barren waste. The rivers of the region under consideration do indeed form an integral part of the great Mississippi-Missouri system, in which the Unionidæ have reached their greatest development; but the James and the Vermilion Rivers are, by water connection, far away from the nearest prolific mussel streams. Constituting a part of the greatest mussel plantations, metaphorically speaking, these particular fields are within the abandoned corner, and their productivity arouses a peculiar interest. Unquestionably these rivers have been stocked from streams lower down in the basin, and it will appear that there are some facts to suggest that the stocking is continued from time to time, though occurring somewhat spasmodically.

JAMES RIVER.

The James (or Dakota) River rises in the west central part of Wells County, N. Dak., and, after flowing in a southerly direction for a distance of about 450 miles, enters the Missouri a short distance southeast of Yankton, S. Dak. The stream itself is permanent, although it is practically devoid of perennial tributaries, and its basin is long and narrow. The region through which it flows is covered generally with the glacial deposits of the Quaternary. One may scarcely speak of a valley. In the upper portions examined the river flows through a seemingly level prairie; the stream is sluggish and comparatively wide (80 to 100 feet), with a depth of 1 to 2 feet (Oakes, N. Dak.). The low banks, composed chiefly of blue clay, are subject to overflow, while the bottom is soft and mucky. Neither live mussels nor empty shells were found.



Map of the James, Vermilion, and Big Sioux Rivers.

69375°—15——2

About 20 miles below Oakes the river widens to form a slough or lake, approximately a mile wide and about 22 miles long, extending to within a couple of miles of Columbia, S. Dak. The depth in this lake-like portion is 3 to 10 feet. Apparently the lake is well stocked with pickerel and bullheads, so that good fishing is afforded in the deeper places. At Columbia the river becomes extremely narrow, with a width of only 15 feet and a depth of 6 inches to 3 feet, and displays a strong current of 3 to 4 miles per hour. The bottom is variously sand, gravel, and soft mud, and the water has a reddish or iron-rust color. Living mussels were not seen, but many empty shells of *Anodonta grandis* (floater) were found.

Similar conditions seem to exist for a stretch of about 50 miles, or as far as Frankfort, but at the latter place a few scattering beds of mussels were observed. The shells were too thin for commercial use and comprised the following species:

Anodonta grandis, floater.
Symphynota complanata, white heel-splitter.
Lampsilis ventricosa, pocketbook.
L. luteola, fat mucket.
L. gracilis, paper-shell.
Quadrula undulata, three-ridge.
Arcidens confragosus, rock pocketbook.

In the lower course we find the river a generally sluggish stream with a width of 50 to 80 feet and a depth of 3 to 10 feet at ordinary stages, although there are occasional short reaches of shallow water connecting the longer stretches of more lagoon-like character. Here a river valley is more noticeable; the river forms the deepest part of a trough representing the broad ancient river bed, about a mile in width and some 50 to 75 feet in depth. From Huron to Mitchell the river has a fall of 30 feet in 75 miles (Todd and Hall).[a]

At Huron the following species of mussels were found, listed in order of apparent abundance:

Anodonta grandis, floater, 48 per cent.
Symphynota complanata, white heel-splitter, 30 per cent.
Lampsilis luteola, fat mucket, 8 per cent.
Quadrula undulata, three-ridge, 7 per cent.
Lampsilis ventricosa, pocketbook, 5 per cent.
Quadrula coccinea, sometimes called "flat niggerhead," 2 per cent.

The percentages stated are based upon a count of shells in a pile left by a pearl fisher.

Even the better shells here are too light as well as too small for effective commercial use, but it was learned that fishing for pearls was prosecuted at certain times by itinerant pearlers.

[a] Todd, J. E., and Hall, C. M.: Geology and water resources of part of the lower James River Valley, South Dakota. Water Supply and Irrigation Paper no. 90, U. S. Geological Survey, Washington, D. C., 1904.

A very remarkable shell was found at Huron by Mr. J. B. Southall. The shell clearly can not be identified with any described species, but as further search failed to produce another example it scarcely appears justifiable to regard this unique specimen as representing a new species. The accompanying illustrations (fig. 1, 2, and 3, pl. 1) give an idea of the form and appearance of the shell, which seems to combine characters of the three-ridge (*Quadrula undulata*) and the fat mucket (*Lampsilis luteola*). The question is often asked: Do mussels ever hybridize? The present example may suggest an affirmative answer, for, in the absence of further information, the crossing of two known forms is the only apparent explanation of the anomaly presented. Unfortunately, the peculiar characters were not noted until after the shell in question, along with a number of others, had been cleaned and the meats discarded.

At Riverside commercial shelling was found in progress. Here one fisherman, with an assistant, had taken 20 tons of shells up to the date of our visit (July 27, 1913). Approximately 90 per cent of the shells taken were the three-ridge (*Q. undulata*). Other species observed were *Q. coccinea* (flat niggerhead), *Q. postulosa* (pimple-back), *Q. lachrymosa* (maple-leaf), *L. ventricosa* (pocketbook), *L. luteola* (fat mucket), *L. recta* (black sand-shell or long John), *L. alata* (pink heel-splitter), *L. gracilis* (paper-shell), *L. fallaciosa* (slough sand-shell), *Arcidens confragosus* (rock pocketbook), *Tritogonia tuberculata* (buck-horn or pistol-grip), and *Symphynota complanata* (white heel-splitter).

The three-ridges were of medium size, clear in color, and not heavy, having faintly iridescent tips that were too thin for buttons. The other shells generally were too light or too scarce to be of value, but a few pimple-backs, maple-leafs, and fat muckets were suitable for market.

This fisherman had found a large number of pearls, many of which were of some value. An interesting fact was the large percentage of "dead" pearls. About two-thirds of the catch were entirely "dead" and of a brown color. The majority of them were perfectly spherical. Even with the large percentage of worthless material, the pearling was evidently not unprofitable, and the good pieces altogether were probably worth upward of $500.

About 3 miles below Riverside there was another fisherman who had taken out about 15 tons of shells. The mussels were gathered with a coke or coal fork, having a piece of 2 by 4 lumber fastened to the handle, the length of this piece being according to the depth of the river. This fisherman had a novel way of anchoring his boat. At each end of the boat a hole was bored through the bottom large enough to insert a piece of 1½-inch pipe, making a water-tight joint. These perpendicular pipes, rising to the level of the gunwales of the

boat, served as sockets or sleeves through which a long iron rod could be shoved into the soft mud bottom of the river. By anchoring in this way the boat was kept abreast of the current, while the fisherman used the sides as a fulcrum for the handle of his fork. After gathering all the mussels possible within reach he would pull up the rods, let the boat drift downstream a suitable distance, or beyond the portion of river just worked, and then anchor and resume operations as before.

In places like that just described, where a carload or more of shells can be taken in a season, commercial shelling may be followed profitably. From Milltown to Lesterville the river is very productive. Approximately 400 tons of shells have been taken out of the river between these two points.

At Milltown, mussels were gathered by means of the basket-rake dragged by a power-boat. The rake was peculiar in being without teeth but having a square brail made of $\frac{1}{4}$ by $1\frac{1}{2}$ inch flat iron, to which was fastened a wire basket of 1-inch mesh. With each boat was a crew of four men, three to work with the rakes and one to operate the engine. One dragged the rake at the rear of the boat, while the other two worked at the sides. In this manner a strip of the river bottom 6 feet wide was thoroughly scraped. One crew said that they had gathered 3 tons of mussels in three hours.

Of all the shells gathered by the party at various points on the James River, or observed at the clammer's camps, no small ones were seen. Mr. Kennedy, a shell dealer, informed our party that he had prospected the James River from Riverside to its mouth, and had not found any small shells. The basket-rake implement employed on this river and described above would have taken small shells as well as larger ones had they been present. This poverty of young mussels may be due to the fact that long-continued low stages of the river cause the run of fishes that are essential to the reproduction of the mussels to occur only at irregular intervals (see also p. 12). We were told by the people who live along the river that in some years fish appear in large numbers, but that usually the fishing was very poor, only an occasional bullhead being caught.

CHARACTER OF THE JAMES RIVER DRAINAGE AREA.

Particular attention was not given to geological conditions, but because of the interest attached to the rather isolated mussel beds in this semiarid region, it may be instructive to refer to the character of the country through which the river passes, especially as it affects the water supply. The data are gleaned largely from the report of Todd and Hall previously cited.

The general surface is covered variously by sand, clay, and gravel till and by stream deposits of recent geological times. Tertiary and

Upper Cretaceous formations are wanting, so that the glacial deposits overlie immediately the Lower Cretaceous, Niobrara, Benton, and Dakota formations. The Dakota formation is of particular interest as being the principal source of the artesian wells which yield such abundant flows of water and have a profound effect upon the agricultural development of the region (as about Mitchell, Huron, and Artesian). Finally beneath the Cretaceous (Triassic and Jurassic being wanting) there is encountered the Algonkian granite and Sioux quartzite, the latter forming the bedrock over a large part of the valley.

The James River intersects three low terminal moraines which form long loops directed southward. Previous to their formation the ice had covered the whole area to a depth of several hundred feet and pushed south and west to the vicinity of the Missouri River, where it rested for a time and formed the first, or Altamont moraine; then retreated and formed the second, or Gary moraine, about Mitchell, and finally the third, or Antelope moraine, which is found west of Wolsey. Between these moraines many lateral valleys, generally dry, lead into the James River.

While perennial streams are rare, springs are not uncommon along the river. Shallow wells may be had, although these are not permanent except when located in the valley or basin, since they depend for supply upon the surface waters, which are very limited in amount. There are deeper pump-wells in which a tubular or force pump is often necessary, or where the water supply is reached after passing through an impervious layer. Three distinct geological horizons supply such water in this area, particularly in the northern part, viz, (1) the sands below the till; (2) either porous strata or crevices, probably in the chalk; and (3), of most importance, the sandstone below the chalk, which is the first regular water-bearing stratum of the Benton-Dakota series. It is from this source that the great artesian wells of this district derive their supply. (Todd and Hall.)

The drainage area of the James River lies in a region of moderate rainfall, the average annual precipitation being between 20 and 25 inches, occurring principally from May to August. The annual precipitation in this valley fluctuates widely. The following data from the Weather Bureau, "Summary of Climatological Data for the United States by Sections," may serve as illustration:

Stations.	Period.	Annual precipitation.		
		Lowest.	Highest.	Mean.
Aberdeen	1891–1908	15.96	38.39	27.05
Redfield	1898–1908	13.31	30.76	20.34
Huron	1882–1908	13.56	28.93	21.04
Mitchell	1892 1895–1908	16.97	36.14	24.05

NATURAL PROPAGATION OF MUSSELS IN RELATION TO FLOOD STAGES IN THE JAMES RIVER.

From the account of the drainage area just given it is evident that the ground waters, although plentiful at great depths, can supply but a small flow to the river. While, therefore, the river may at all times cover sufficient bottom to support an abundance of mussels, it can have a considerable volume only when there is a direct inflow of surface waters after periods of rainfall. It is even probable that light rains are so completely absorbed by the loose dry soils that the river is only slightly affected by them.

The effect of such conditions upon the stages of the river is of particular interest in connection with the observations regarding the mussels. The fact that scarcely any small mussels were found led to the inference, as previously mentioned, that the opportunity for natural propagation of the mussels occurred only at irregular intervals.

From the data regarding the average river stages given in the following table,[a] it appears that while the James River is occasionally subject to high stages it ordinarily maintains a very low level. Thus, during the entire year 1911 the monthly average stage did not attain 3 feet in any month, and exceeded 1 foot in only three months, viz, February (1.1 feet), April (2.6 feet), and May (2.2 feet). The conditions in 1913, up to September, were nearly the same, the spring stage being just a little later. On the other hand, during the three preceding years (1908–1910) higher averages were made, particularly during 1909 and 1910, when monthly averages of 11.7 feet and 10.9 feet, respectively, are found in March. The highest recorded stage, 14.6 feet, was made March 15, 1910.

If the natural propagation of mussels in the river depends upon a run of fishes during high stages, it is evident that favorable conditions had not occurred since 1910, and consequently we could not expect to find small mussels in 1913, except as they might have developed in favored spots where fish were left. It is of interest that from observations of the mussels it should have been assumed that no flood stages of the river had occurred recently, and that the records of river stages, subsequently obtained, should have offered confirmation of this presumption.

Since most of the species of mussels are in an early stage parasitic upon fish and remain in parasitism for a period of time, it follows that for a particular bed of mussels to be propagated the fish must either come to that bed infected with mussels, or else they must be on the bed when mussels are breeding, become infected from that bed, and remain or return to drop the mussels in the same vicinity

[a] These data were kindly supplied by Mr. S. W. Glenn, section director in the Climatological Service of the Weather Bureau, Huron, S. Dak.

at the expiration of the period of parasitism; in either case the regular or irregular occurrence of flood stages is of considerable moment. This factor would more particularly affect the distribution and propagation of mussels above the point on the river to which fish ordinarily have free access. As a matter of fact, the James River is so broken up that this point is comparatively low in its course.

There are small milldams at Milltown, Riverside, and Huron. These dams are only 3 to 6 feet high, but are not provided with fishways and are certainly a barrier to the movement of fish at ordinary stages. Even without these, the frequent stretches of riffles between the more lagoonlike portions of the river would ordinarily prevent the free movement of fish. In any event, the fish could seldom pass above Milltown, and it has already been noted that the principal mussel beds are between Lesterville below and Milltown above.

AVERAGE STAGES OF WATER IN JAMES RIVER AT HURON, S. DAK., FROM OBSERVATIONS BY THE WEATHER BUREAU, DEPARTMENT OF AGRICULTURE.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
1908	(a)	[b]0.2	3.1	1.9	2.3	4.2	1.8	0.2	0.0	0.2	0.4	(a)
1909	(a)	(a)	11.7	4.8	2.1	2.4	2.6	1.4	.6	.5	.4	(a)
1910	(a)	(a)	10.9	5.6	4.3	1.6	.3	.0	− .2	− .3	− .1	(a)
1911	(a)	(a)	.8	.5	.6	.3	− .2	− .3	− .4	− .3	− .3	−0.4
1912	(a)	[c]1.1	.6	2.6	2.2	.8	.3	.0	.1	.2	.4	.2
1913	0.1	.0	.1	.6	2.4	1.9	.3	− .2	− .4	.....	.....	.....

Highest stage, 14.6 feet, Mar. 15, 1910. Lowest stage, −0.5 foot, Sept. 3, 4, and 5, 1911, and Sept. 15 to 25, 1913.

[a] River frozen entire month. [b] River frozen 1st to 23d. [c] River frozen 23 days.

VERMILION RIVER.

Conditions in the Vermilion River are similar in a smaller way to those of the lower James River. This stream is parallel to the James River and only 20 to 30 miles eastward.

The Vermilion River rises at Lake Herman, Lake County, S. Dak., and after flowing about 110 miles in a southerly direction enters the Missouri River just below Vermilion, S. Dak. The uppermost point of the river examined was at Parker, where it is composed of lagoonlike portions 2 or 3 feet deep and 10 to 40 feet wide, connected by narrow riffles, with very small flow of water. Some large white heelsplitter shells were observed, but mussels were not abundant.

The river was next examined at Davis, where it flows through a trough in the seemingly level prairie from 50 to 60 feet wide. At an ordinary stage of water the stream is 20 to 30 feet wide and 1 to 2 feet deep, having a gravel and sand bottom. Only a few mussels were found.

At Centerville there is a dam, forming a mill pond 100 to 150 feet wide and about 2 miles long. At the head of this pond there is a mussel bed of fair size, the whole bed containing about two carloads of commercial shells. At the time of the investigation some men were gathering the mussels in search of pearls. During the first part of the season $500 worth of pearls were found. The pearlers had been discarding the shells, but were considering placing them on the market.

The next station (Vermilion) is about 7 miles above the mouth of the river. As the river is navigable for a short distance here, a boat was hired and a trip 7 miles upstream was made to the mouth of a long drainage ditch. Few mussels were found, and these, though large old shells, were mostly thin-shelled species and were of no value. The drainage ditch is 20 miles long, 90 feet wide at the upper end and 110 feet wide at the lower end. It was begun during the winter of 1911 and opened up the last week in May, 1913. It was constructed for the purpose of straightening the course of the river and furnishing better drainage than the old river bed, which was so built up as to be higher than the surrounding country. The ditch has therefore wholly supplanted the old bed, leaving it high and dry. Many dead mussels are found in what had been the deeper portions of the old river. The mussel fauna of the 20 miles and more of old river bed, which was thus exposed to view in its entirety, would amount in all to about three carloads of large shells, averaging considerably larger than those of any stream or mussel bed which we have yet encountered. About one carload of these shells, the best and most available ones, have been placed on the market.

In all, 11 species of mussels were found in the river, 7 of these being of good commercial value. The commercial species are *Lampsilis ventricosa* (pocketbook), *L. luteola* (fat mucket), *Quadrula undulata* (three-ridge), *Q. coccinea* (flat niggerhead), *Q. lachrymosa* (maple-leaf), *Q. pustulosa* (pimple-back), and *Symphynota complanata* (white heel-splitter). Other species found were *Lampsilis alata* (pink heel-splitter), *L. gracilis* (paper-shell), *L. recta* (black sand-shell or long John), and *Anodonta corpulenta* (slop-bucket).

EXAMINATION OF OTHER STREAMS.

Big Sioux River, which is about 230 miles long, rises in the northwest part of Grant County, S. Dak., and, after flowing in a southerly direction through a narrow valley in the rolling prairie, enters the Missouri River just above Sioux City, Iowa. In the upper part of the river the bottom is gravel and sand, while at Dell Rapids and Sioux Falls it is quartzite, and rapids and small waterfalls prevail. The bed of the river in its lower part, from Canton to the mouth, is composed of fine shifting sand and silt.

The river was examined from Flandreau, S. Dak., to Hawarden, Iowa. Only a few mussels were found, and of these only the following 7 species were of commercial value: *Lampsilis recta* (black sand-shell), *L. ventricosa* (pocketbook), *L. luteola* (fat mucket), *Quadrula undulata* (three-ridge), *Q. coccinea* (flat niggerhead), *Q. pustulosa* (pimple-back), and *Symphynota complanata* (white heel-splitter). The non-commercial species found were: *L. gracilis* (paper-shell), *L. alata* (pancake or pink heel-splitter), *Anodonta corpulenta* (slop-bucket), *Alasmondonta truncata* (elk-toe).

Lake Kampeska, 3½ miles wide and 5¼ miles long, lying 4 miles northwest of Watertown, S. Dak., is practically an isolated lake, which receives its main supply from the Big Sioux River at flood stages through what is usually termed the "outlet" at the eastern end of the lake. The gently sloping banks are chiefly fine gravel and sand, and the average depth is about 10 feet. The mussels were very small and dwarfed, and were too thin for commercial use. The following species were observed: *Anodonta grandis footiana* (floater), with shells so thin that ordinary print can easily be read through them; *Lampsilis ventricosa* (pocketbook); *L. luteola* (fat mucket) (1 specimen gravid July 23, 1913); *Strophitus edentulus* (squaw-foot); *Symphynota complanata* variety *katharinæ* (white heel-splitter).

Bad River was examined at Philip, S. Dak., and was found to be almost dry, with the exception of a few water holes, and no mussels were found.

Cheyenne River at Wasta, S. Dak., is very swift and muddy. The bottom is covered with large rocks, along with the mud and sand. No mussels were found.

Red River of the North, where examined at Fargo, N. Dak., is about 50 to 75 feet wide, the bottom being chiefly very soft with a considerable proportion of decaying vegetation. Above the dam at this place the river is 6 to 10 feet deep. Mussels were quite plentiful in the mill pond. *Q. undulata* (three-ridge), *Q. lachrymosa* (maple-leaf), and *Q. pustulosa* (pimple-back) were the only commercial shells found. Other species collected were: *L. ventricosa* (pocketbook); *L. recta* (black sand-shell); and *L. alata* (pancake).

Sheyenne River, a tributary of the Red River of the North, was examined at Lisbon, N. Dak. At this place it is a small stream 30 to 50 feet wide and about 1 or 2 feet deep. In the mill pond above the town we found quite a few mussels, but they were too thin for commercial use. The following species were noted: *Q. undulata* (three-ridge); *Q. coccinea* (flat niggerhead); *L. luteola* (fat mucket); and *A. grandis* (floater).

SUMMARY.

In contrast to the tributaries of the upper Mississippi, those of the upper Missouri, like the main stream itself, are generally deficient in

mussel resources. The James and Vermilion Rivers are exceptions, the James River particularly having supported during the past year (1913) a shell fishery of some importance. Pearl fishing has been pursued in both streams for some years. The shell fishery on the James River is principally between Riverside and Lesterville. Modifications of the usual methods of fishing are employed to advantage. (See p. 9, 10.)

The principal shell is the *Q. undulata* (three-ridge). Several other economic species are found in less abundance. The variety of shells is limited, 14 species in all being collected.

Pearl fishing has been pursued on the Vermilion River and some shipments of shells have been made recently, but the stream is too small to be important.

It is probable that the self-perpetuation of the mussel beds in the James River depends upon the occurrence of unusual flood stages that allow opportunity for the entrance of fishes from the Missouri River.

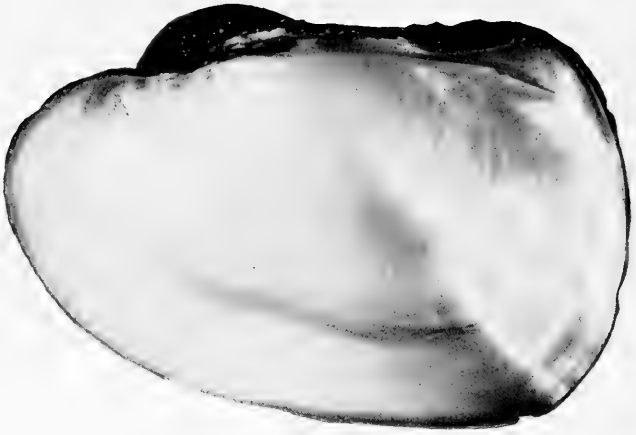


FIG. 1.

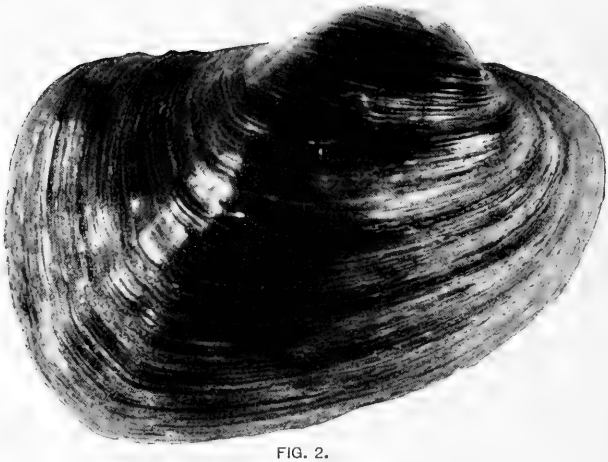


FIG. 2.

FIG. 3.

VIEWS OF THE SHELL OF A MUSSEL COLLECTED IN THE JAMES RIVER AT HURON, S. DAK.

The specimen could be referred to no previously described species or genus.

APPENDIX.

DESCRIPTION OF SHELL FOUND IN THE JAMES RIVER AT HURON, S. DAK., JULY 27, 1913.

(Fig. 1, 2, and 3, pl. I.)

Form of shell.—Subtriangular, the anterior margin forming the rounded apex of the elongated triangle, the posterior margin forming the base; dorsal margin nearly straight; ventral margin about equal in length to dorsal but slightly curved. Much inflated; the umbones high, arched, and nearly meeting; umbones situated well forward, one-third of distance from anterior margin. Greatest inflation in region of umbonal slope.

Sculpture.—A pronounced ridge extends along posterior border of umbones to postero-ventral angle of shell; the anterior border of the ridge is somewhat roughened; a slight but distinct furrow limits the posterior border of the ridge. Just beneath each of the four upper concentric color rings are pronounced ridges in the anterior portion of the shell. Rest-markings consist of three or four short concentric ridges, very distinct but thin and close together.

Color.—Generally brownish straw-color; greenish in highest part of umbones, yellowish anteriorly and ventrally, dark brownish in posterior portion. The specimen in hand shows six distinct dark concentric rings—the so-called "rest" or "growth" rings.

Internal aspect.—Shell cavity very deep; umbonal cavity deep; the shell relatively thin; nacre lustrous white anteriorly, iridescent bluish or violet in thin posterior third. Cardinal teeth double in both valves, but compressed and relatively weak, especially so in right valve; anterior much stronger than posterior in left valve; anterior somewhat stronger than posterior in right valve. Lateral teeth long, compressed, blade-like, elevated, slightly curved, double in left, single in right valve; lateral teeth scarcely continuous with cardinal teeth; hinge plate above lateral teeth practically wanting. Anterior retractor impression separate from anterior adductor, both roughened; posterior adductor impression smooth; pallial line not conspicuous, broad and faintly striate in anterior half; dorsal muscle scars scarcely visible.

Characteristic features of the shell are its triangular or pyramidal form and its remarkable inflation, which are strongly suggestive of the inflated types of *L. luteola;* its compressed sharp teeth, which are of the *Lampsilis* type to an extreme; the color of epidermis and character and color of nacre, which find correspondence only in species of *Quadrula,* especially in *Quadrula undulata.* The pyramidal shape of the shell is also suggestive of *Q. undulata.* It is not possible at the present time to place the specimen in any described genus.