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## Aquatic mollusks in North Dakota during the last 12000 years

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# Aquatic mollusks in North Dakota during the last 12000 years[1]

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Aquatic mollusks occurred in North Dakota during the last 12 000 years as follows: 12 000 – 10 000 years ago, 19 species (dated material from 3 sites); 10 000 – 8000 years ago, 22 species (dated material from 5 sites); 8000–4000 years ago, 11 species (material of inferred age from 2 sites); 4000 years ago to present, 36 species (dated material from 1 site and material of inferred age from 23 sites); and present day, 44 species (material from about 300 stations). The gastropods *Valvata sincera* (Say), *Fossaria decampi* (Streng), and *Helisoma campanulatum* (Say) have not been found in sediments younger than about 9600 years. They may have become regionally extinct about 9000 years ago because of a warmer, drier climate and a corresponding increase of dissolved salts in surface waters. Of two hydrobiid gastropods, *Amnicola limosa* (Say) has not been found in sediments younger than about 9000 years and has been found at relatively few localities today. *Cincinnatia cincinnatiensis* (Anthony) has not been found in sediments older than about 2500 years and has been found at many localities today. The occurrence of these two species with time may also be the result of changing climate and surface-water chemistry.

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Les mollusques aquatiques ont habité l'état du North Dakota durant les 12 000 dernières années de la façon suivante: il y a 12 000 – 10 000 ans, 19 espèces (spécimens datés de 3 localités), il y a 10 000 – 8000 ans, 22 espèces (spécimens datés de 5 localités), il y a 8000–4000 ans, 11 espèces (spécimens d'âges estimés, de 2 localités), il y a 4000 ans à nos jours, 36 espèces (spécimens datés d'une localité et spécimens d'âges estimés de 23 localités), enfin aujourd'hui, 44 espèces (spécimens d'environ 300 localités). Les gastéropodes *Valvata sincera* (Say), *Fossaria decampi* (Streng), et *Helisoma campanulatum* (Say) ne se retrouvent que dans les sédiments de plus de 9600 ans. Il se peut que ces espèces soient disparues de certaines régions il y a environ 9000 ans, à cause d'un climat plus chaud et plus sec, et à cause d'une augmentation de sels dissous dans les eaux de surface, subséquente à ce climat. De deux gastéropodes hydrobiidés, *Amnicola limosa* (Say) ne se retrouve que dans les sédiments de plus de 9000 ans et dans relativement peu de localités aujourd'hui. L'espèce *Cincinnatia cincinnatiensis* (Anthony) n'a pas été trouvée dans les sédiments de plus de 2500 ans et elle habite plusieurs localités de nos jours. La présence de ces deux espèces à certains moments s'explique sans doute par des changements dans le climat et dans la chimie des eaux de surface.

[Traduit par le journal]

## Introduction

Quaternary aquatic mollusks are generally not as well known in North Dakota as elsewhere, but many studies have been made. Fossil mollusks have been studied primarily by Tuthill (1961, 1963*b*, 1964, 1965, 1967*a*, 1967*b*, 1969; Tuthill *et al.* 1964; Tuthill, Laird, and Frye 1965; Tuthill, Laird, and Kresl 1965). Other studies include those by Bickley (1970), Clayton (1961, 1962, pp. 65–67), my associates and I (Cvancara *et al.* 1972; Cvancara and Harrison 1966; Cvancara *et al.* 1976), Groenewold (1971), Kresl (1956), McAndrews *et al.* (1967), Norby (1967), and Thompson (1962).

Before the 1960's, little but species lists and notes on species was published on the living aquatic mollusks of the state. These lists and notations were made by Call (1885), Coker and Southall (1915, p. 15), Dall (1905, pp. 125–136), Dawson (1875, p. 350), Froebel (1870, p. 72), Grant (1885, pp. 115–119), Hayden (1862, p. 180), Lea (1858), Ortmann (1919, pp. 17, 31, 203, 292), Owen (1852, p. 177), Say (1825, p. 11), and Winslow (1921). Tuthill (1962, 1963*a*) compiled a list of the state's aquatic mollusks based largely on previous publications; in 1963, he and Laird published the first ecologic paper on aquatic mollusks in North Dakota. Since 1966, my

[1]Paper presented at the conference on Quaternary non-marine paleoecology, University of Waterloo, May 12–13, 1975.

associates and I have reported on the distribution and ecology of the aquatic mollusks (Cvancara 1970*a*, 1970*b*, 1975; Cvancara *et al.* 1972; Cvancara and Harrison 1966; Cvancara *et al.* 1967; Cvancara *et al.* 1976). Other similar studies are those of Clarke (1973), Groenewold (1971), Norby (1967), and Peterka (1972).

This paper summarizes the known aquatic molluscan faunas during the last 12 000 years, including the present-day fauna, and suggests causes for presumed regional extinction of species and other species changes. Conclusions are tentative, particularly as dated fossil mollusks exist from only nine sites.

## Materials and Methods

For this report, I have examined a few thousand specimens, all of which are in the collection of the Department of Geology, University of North Dakota. Except for the 8000- to 4000-year interval (Table 1), a species occurrence is based on specimens examined by me, rather than on the literature. For the interval of 12 000 – 8000 years, only dated material from eight sites from the Missouri Coteau (a hilly region with nonintegrated drainage trending northwesterly through the central part of the state) was used, although 40 fossiliferous sites from this region are known (Tuthill 1967*a*, p. 73). For the interval 4000 years to present, dated material exists from only one site, but additional material of inferred age from 23 other sites was also used. The species list of the present fauna is based on specimens that I or my direct associates have collected, and I have examined specimens for each species occurrence from about 300 collecting stations in streams, lakes, and ponds (Cvancara 1975, Fig. 1).

## Results

The occurrence of aquatic molluscan species with time is shown in Table 1. Dated mollusks older than about 12 000 years are known from only one site and were omitted from the table. These species, *Lampsilis radiata*, *Sphaerium striatinum*, and *Probythinella lacustris*, are from a fluvial terrace about 11 m above and west of the Sheyenne River in Ransom County in southwestern North Dakota (SE¼SW¼ Section 19, Township 135 N, Range 54 W; Cvancara *et al.* 1976). Shells of *L. radiata* have been dated at 13 500 ± 200 years before present (BP) (Moran *et al.* 1973, p. 7).

The data in Table 1 indicate that the numbers of aquatic mollusks have increased toward the present, but the mussels (unionacean bivalves) apparently more so than the pill clams (sphaeriid bivalves) and snails (prosobranch and pulmonate gastropods). Only six branchiate (prosobranch) snails are known to have existed during the last 12 000 years. The branchiate snail *Valvata sincera* (includes *V. lewisi* of several authors) and the pulmonate snails *Fossaria decampi* and *Helisoma campanulatum* have not been found in sediments younger than about 9600 years nor have they been found living in North Dakota. Of two hydrobiid snails, *Amnicola limosa* has not been found in sediments younger than about 9000 years and has been found at relatively few localities today (Cvancara, unpublished data). *Cincinnatia cincinnatiensis* (= *Amnicola integra* of several authors), on the other hand, has not been found in sediments older than about 2500 years and has been found at many localities today (Cvancara, unpublished data).

## Discussion

The snails *Valvata sincera*, *Fossaria decampi*, and *Helisoma campanulatum* presently do not seem to occur in North Dakota, and are known essentially north and east of the state. *Valvata sincera* occurs from Maine to Newfoundland and northern Quebec and west to Minnesota and Alberta. ("*Valvata lewisi*" has also been reported to occur rarely in Pickerel Lake, northeastern South Dakota; Watts and Bright 1968, pp. 861–862.) It inhabits mostly lakes and slow rivers (Clarke 1973, pp. 223–224). Of 41 snails in New York, Harman and Berg (1971) found this species in waters of relatively low total alkalinity (about 100–150 ppm). *Fossaria decampi* occurs in the Great Lakes – St. Lawrence River basin north to the region west of James Bay to the Attawapiskat and Severn River systems, and northwest in the boreal forest region to the vicinity of Great Slave Lake. This species inhabits cold-water lakes and cold, slow-flowing rivers (Clarke 1973, pp. 271–272). *Helisoma campanulatum* occurs from Newfoundland to southern Quebec and northwest to northern Saskatchewan, and from Massachusetts to Illinois and North Dakota [?]. (Baker (1945, p. 153) also reported this species as far south as Nebraska.) It inhabits lakes and slow-flowing rivers in forested regions (Clarke 1973, pp. 447–448). Of 41 snails in New York, Harman and Berg (1971) found this species in waters of relatively low total alkalinity (about 20–140 ppm). Compared with *H. anceps* and *H. trivolvis*, *H. campanulatum* may be more susceptible to environmental perturbations (Boerger 1975, p. 1822).

Spruce-dominated vegetation in the North American central Great Plains probably ended

about 12 000 years ago in Kansas and Nebraska to 9500 years ago in southern Canada; this event may have occurred about 10 000 years ago at the latitude of North Dakota. The climatic change that caused the fall of the spruce forest gave rise to a completely prairie-dominated terrain in the Dakotas and western Minnesota about 8000–9000 years ago (Wright 1970, pp. 159, 163, 167). About 10 000 years ago in southeastern Minnesota, the July temperature was a few degrees less and the precipitation was nearly 2 in. (1 in. = 2.54 cm) more than at present (Bryson 1974, Fig. 2). As the climate became drier, lakes began to accumulate salts, perhaps about 9000 years ago (Clayton 1967, p. 40; McAndrews *et al.* 1967, p. 111). This date corresponds to the youngest known fossil occurrence of common *A. limosa* in the Missouri Coteau (Table 1, Gutschmidt Site), and to the time when glacial Lake Agassiz drained from the upper Red River Valley (Elson 1967, Table 6 and Fig. 6).

*Valvata sincera*, *Fossaria decampi*, and *Helisoma campanulatum* may have become regionally extinct in North Dakota about 9000 years ago as dissolved salts became more concentrated in surface waters; *Fossaria decampi*, in particular, may, however, have shifted its occurrence because of higher temperature and because of greater dissolved salts. All three species occur in Minnesota (Dawley 1947, pp. 692–694) and total dissolved salts, total alkalinity, and total sulfates increase westward and southwestward from northeastern Minnesota (Eddy 1963, pp. 302–305) to the Dakotas. The hypothesis of regional

TABLE 1. Species of aquatic mollusks in North Dakota within selected time intervals during the last 12 000 years

| | Species | Thousands of years ago | | | | |
|---|---|---|---|---|---|---|
| | | 12–10[a] | 10–8[b] | 8–4[c] | 4–present[d] | Present[e] |
| | Unionacean bivalves (mussels) | | | | | |
| 1. | *Amblema plicata* (Say) | | | | X | X |
| 2. | *Fusconaia flava* (Rafinesque) | | | | X | X |
| 3. | *Quadrula quadrula* (Rafinesque) | | | | X | X |
| 4. | *Anodonta grandis* Say | X | X | | X | X |
| 5. | *Anodontoides ferussacianus* (Lea) | X? | | | X | X |
| 6. | *Lasmigona complanata* (Barnes) | | | | X | X |
| 7. | *L. compressa* (Lea) | | | | X | X |
| 8. | *Strophitus undulatus* (Lea) | | | | X | X |
| 9. | *Lampsilis ovata* (Say) | | | | X | X |
| 10. | *L. radiata* (Gmelin) | X | X | | X | X |
| 11. | *Ligumia recta* (Lamarck) | | | | X | X |
| 12. | *Proptera alata* (Say) | | | | | X |
| 13. | *P. laevissima* (Lea) | | | | | X |
| | Sphaeriid bivalves (pill clams) | | | | | |
| 14. | *Sphaerium lacustre* (Müller) | | X | | X | X |
| 15. | *S. simile* (Say) | X | X | | X | X |
| 16. | *S. striatinum* (Lamarck) | X | X | | X | X |
| 17. | *S. transversum* (Say) | | | | | X |
| 18. | *Pisidium casertanum* (Poli) | X | X | x[g] | X | X |
| 19. | *P. compressum* Prime | X | X | | X | X |
| 20. | *P. ferrugineum* Prime | | | | | X |
| 21. | *P. milium* Held | X? | | | | |
| 22. | *P. nitidum* Jenyns | X | X | | X | X |
| 23. | *P. variabile* Prime | | | | X | X? |
| 24. | *P. ventricosum* Prime | | | | | X |
| | Gastropods (snails) | | | | | |
| 25. | *Campeloma decisum* (Say) | | | | X | X? |
| 26. | *Valvata sincera* Say | X | X | | | |
| 27. | *V. tricarinata* (Say) | X | X | | X | X |
| 28. | *Amnicola limosa* (Say) | X | X | | | X |
| 29. | *Cincinnatia cincinnatiensis* (Anthony) | | | | X | X |
| 30. | *Probythinella lacustris* (Baker) | | X | | X | X |
| 31. | *Fossaria decampi* (Streng) | X | X | | | |

TABLE 1. (*Concluded*).

| | Species | Thousands of years ago | | | | |
|---|---|---|---|---|---|---|
| | | 12–10[a] | 10–8[b] | 8–4[c] | 4–present[d] | Present[e] |
| 32. | *F. obrussa* (Say) | | | x | X | X |
| 33. | *Lymnaea stagnalis* (Say) | | X | | X | X |
| 34. | *Stagnicola caperata* (Say) | | | x | X | X |
| 35. | *S. elodes* (Say) | X------ | X[f] | x | x? | X |
| 36. | *Ferrissia parallela* (Haldeman) | | | x | X? | X? |
| 37. | *F. rivularis* (Say) | | x? | | X | X |
| 38. | *Armiger crista* (Linnaeus) | X | X | x | X | X |
| 39. | *Gyraulus circumstriatus* (Tryon) | | | | | X |
| 40. | *G. parvus* (Say) | X | X | x | X | X |
| 41. | *Helisoma anceps* (Menke) | X | X | | X | X |
| 42. | *H. campanulatum* (Say) | X | X | | | |
| 43. | *H. trivolvis* (Say) | X------ | X[f] | | X | X |
| 44. | *Planorbula armigera* (Say) | | | x | X | X |
| 45. | *P. campestris* (Dawson) | | | | | X |
| 46. | *Promenetus exacuous* (Say) | X | X | x | x | X |
| 47. | *P. umbilicatellus* (Cockerell) | | | x | x | X |
| 48. | *Aplexa hypnorum* (Linnaeus) | | | x | x | X |
| 49. | *Physa gyrina* Say | X | X | | X | X |
| 50. | *P. integra* Haldeman | | | | X | X |
| 51. | *P. jennessi* Dall | | | | | X |
| Totals (excluding questioned occurrences) | | 19 | 22 | 11 | 36 | 44 |

[a]Based on three dated sites: Painted Woods (10 100 ± 300 BP; Burleigh Co., NE¼NE¼NE¼ Sec. 12, T. 144 N, R. 79 W; lacustrine sediments), Cleveland (11 070 ± 300 BP; Stutsman Co., SE¼SW¼SE¼ Sec. 17, T. 139 N, R. 67 W; fluvial sediments), and Hufnungsthall (11 650 ± 310 BP; McIntosh Co., SW¼SW¼NW¼ Sec. 20, T. 132 N, R. 68 W; fluvial and lacustrine sediments) (Tuthill 1963, 1965, 1967).

[b]Based on five dated sites: Schauer (9870 ± 290 BP; Stutsman Co., SE¼SE¼SE¼ Sec. 29, T. 137 N, R. 69 W; lacustrine sediments), Gutschmidt (9000 ± 300 BP; Logan Co., SW¼SW¼NW¼ Sec. 20, T. 135 N, R. 67 W; lacustrine sediments), Nue (9620 ± 350 BP; McIntosh Co., SE¼SE¼SE¼ Sec. 36, T. 130 N, R. 68 W; fluvial and lacustrine sediments), Boynton (9990 ± 300 BP; Burleigh Co., NE¼NE¼SE¼ Sec. 19, T. 143 N, R. 75 W; lacustrine sediments), and Seibold (9750 ± 140 BP; Stutsman Co., SE¼NW¼NW¼ Sec. 21, T. 141 N, R. 67 W; lacustrine sediments) (Bickley 1970; Tuthill 1963, 1965, 1967).

[c]Based on material of inferred age at two sites: Seibold (location and sediments as above) and Woodworth Pond (Stutsman Co., SW¼ Sec. 6, T. 142 N, R. 67 W; lacustrine sediments) (Bickley 1970; McAndrews *et al.* 1967).

[d]Based on dated material at one site (Sheyenne River cutbank; 2540 ± 300 BP and younger; Richland Co., NW¼NW¼SW¼ Sec. 4, T. 135 N, R. 52 W; fluvial sediments; Tuthill 1964) and material of inferred age from 23 sites: Sheyenne River cutbank exposures (five sites; Barnes, Griggs, and Ransom Counties; fluvial sediments; Norby 1967; Cvancara *et al.* 1976), Turtle River cutbank exposures (three sites; Grand Forks Co.; fluvial sediments; Cvancara and Harrison 1966), Forest River cutbank exposures (three sites; Grand Forks Co.; fluvial sediments; Cvancara *et al.* 1972), Knife and Heart River cutbank exposures (10 sites; Grant, Mercer, and Morton Counties; fluvial sediments; Groenewold 1971), Woodworth Pond (location and sediments as above; McAndrews *et al.* 1967), and Seibold (location and sediments as above; Bickley 1970).

[e]Based on about 300 collecting stations in streams, lakes, and ponds (Cvancara 1975).

[f]Age of occurrence uncertain but believed to occur within interval of 12 000 – 8000 years ago.

[g]Small x indicates a species occurrence from the literature.

extinction of these three species about 9000 years ago requires considerable further testing before these snails can be used as index fossils.

Two of the three hydrobiid snails, *Amnicola limosa* and *Cincinnatia cincinnatiensis*, appear to have shifted in their occurrence and relative abundance with time as mentioned above, possibly also in response to changing environmental conditions. Clarke (1973, pp. 258–259, 242–243) has summarized the distribution and general ecology of these two species. *A. limosa* occurs from Labrador to Florida west to Utah, and Manitoba and Saskatchewan south to Texas. In Canada, it is much less abundant in the prairies than in the boreal forest. It inhabits lakes and slow- to moderately-flowing rivers. In North Dakota, I have collected this species alive at only a few localities in the Sheyenne River in the eastern part of the state (Cvancara *et al.* 1976). *C. cincinnatiensis* occurs from New York and Pennsylvania west to southern Manitoba, southern Saskatchewan, North Dakota, Utah, and Texas. It inhabits lakes and slow- to moderately-flowing rivers. Although the general distribution of *A. limosa* and *C. cincinnatiensis* is similar, *A. limosa* occurs more frequently in Canada than does *C. cincinnatiensis* (Clarke 1973, pp. 243, 259). The occurrence of abundant *A. limosa* (Tuthill 1969, p. 62) in late Wisconsinan Coteau sediments may be related to a cooler and wetter climate and perhaps lower concentrations of dissolved salts in the surface waters at that time.

The status of *Campeloma decisum* in North

Dakota is uncertain. It has not been found alive in the state, although Clarke (1973, p. 218) reported empty shells (letter dated 25 September 1974) from a single station on the Red River and lower Sheyenne River. I (Cvancara *et al.* 1976) have collected empty shells of this species from two stations in the lower Sheyenne, and have taken it also as a fossil from fine to medium sand from a cutbank in the lower part of the river. The age of the sediment is unknown but is presently considered to be within the interval of 4000 years to present (Table 1). No evidence of this species has been found in older sediments. Dawley (1947, p. 693) reported that *C. decisum* is common in the lakes and rivers of northern, eastern, and central Minnesota in waters of low total alkalinity. If this species exists in North Dakota, it must be rare. Perhaps its occurrence in the state has also been affected by higher concentrations of dissolved salts in the surface waters there, as already suggested for other species.

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