STERKIANA

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ANNOUNCEMENT

STERKIANA is named after Dr. Victor Sterki (1846-1933) of New Philadelphia, Ohio, famed for his work on the Sphaeriidae, Pupillidae, and Valloniidae. It is fitting that this serial should bear his name both because of his association with the Midwest and his lifelong interest in non-marine Mollusca.

The purpose of STERKIANA is to serve malacologists and paleontologists interested in the living and fossil non-marine Mollusca of North and South America by disseminating information in that special field. Since its resources are modest, STERKIANA is not printed by conventional means. Costs are kept at a minimum by utilizing various talents and services available to the Editor. Subscription and reprint prices are based on cost of paper and mailing charges.

STERKIANA accepts articles dealing with non-marine Mollusca of the Americas in English, French, or Spanish, the three official languages of North America. Contributors are requested to avoid descriptions of new species or higher taxa in this serial as the limited distribution of STERKIANA would probably prevent recognition of such taxa as validly published. Papers on distribution, ecology, and revised checklists for particular areas or formations are especially welcome but those on any aspect of non-marine Mollusca will be considered.

STERKIANA will appear twice a year or oftener, as material is available. All correspondence should be addressed to the Editor.

SUBSCRIPTIONS: 50¢ per number; subscriptions may be entered for not more than 4 numbers in advance; please make checks and money orders payable to the Editor.

STERKIANA est une collection de travaux sur les Mollusques extra-marins des deux Amériques, distribuée par un groupe de malacologues du centre des Etats-Unis. STERKIANA publie des travaux en anglais, en français et en espagnol acceptés par le conseil de rédaction. Prière d'adresser toute correspondance au Rédacteur.

ABONNEMENT: 50¢ le numéro, par chèque ou mandat payable au Rédacteur.

STERKIANA es una coleccion de trabajos sobre los Moluscos extra-marinos viventes y fosiles de las dos Americas, editada por un grupo de malacólogos de los Estados Unidos centrales. Contenirá en el porvenir trabajos en inglés, francés, y español que serán acceptados por la mesa directiva. La correspondencia deberá ser dirigida al Editor.

PRECIO: 50¢ el número.

A CHECKLIST OF WYOMING RECENT MOLLUSCA

DOROTHY E. BEETLE

Laramie, Wyoming

The following list of Wyoming Recent Mollusca conforms in style to the arrangement advocated by Dr. Aurèle La Rocque for the preparation of preliminary state or areal lists. References have been reduced to a minimum, using the publications of Junius Henderson (1918 1924, 1936) as the basis of the list plus the subsequent records of others. The references in the text are given by author, date, and page. The complete references are to be found at the end of the list, and from them the synonymy can be obtained. Parentheses around a name indicate that the entity is erroneously reported for Wyoming; a question mark preceding a name indicates an entity doubtfully present or of doubtful systematic status.

1. NAIADES

1. LAMPSILIS VENTRICOSA (Barnes) 1923. Henderson 1918: 42, Laramie River below Uva. Henderson 1924: 83.

2. MARGARITIFERA MARGARITIFERA (Linnaeus). Henderson 1935: 107, Snake River at mouth of Flat Creek. Taylor 1952: 43. Beetle 1957: 16.

3. (MARGARITIFERA MARGARITIFERA FALCATA Gould). Henderson 1936: 82, Bear River at Evanston. This is a color form in the Rocky Mountains and is included in the synonymy of *M. margaritifera*.

2. SPHAERIIDAE

4. PISIDIUM CASERTANUM (Poli) 1791. Beetle 1954: 35, Middle Fork of Crow Creek; 1957: 16; Beetle, in press.

5. PISIDIUM COMPRESSUM (Prime) 1851. Henderson 1936: 86, 5 miles west of Evanston. Beetle 1954: 35; 1960: 157.

6. PISIDIUM CONCINNULUM (Sterki). Henderson 1933: 2, Yellowstone Park. Taylor 1952: 43.

7. (PISIDIUM CONTORTUM PRIME). Beetle 1954: 125. Corrected to *P. casertanum*, Beetle 1954: 35.

8. PISIDIUM FERRUGINEUM (Prime) 1851. Beetle 1960: 157, Libbey Creek, Albany Co.

9. PISIDIUM LILLJEBORGII (Clessin). Henderson 1936: 86, implied.

10. PISIDIUM LUCIDUM (Sterki). Henderson 1924: 99, 15 miles east of Evanston.

11. PISIDIUM MILIUM (Sterki). Henderson 1936: 86, implied.

12. PISIDIUM NITIDUM (Jenyns) 1832. Beetle 1960: 157, Texas Creek, Albany Co.

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13. ?PISIDIUM OCCIDENTALE (Newcomb). Stearns 1891: 467, Bridger's Pass. Henderson 1924: 96. Doubtful.

14. PISIDIUM SUBTRUNCATUM (Malm). Beetle 1957: 16, Christian Meadows, Teton Co.

15. PISIDIUM VARIABILE (Prime) 1851. Beetle 1957: 16, Elk Island Jackson Lake.

16. PISIDIUM SP. Taylor 1952: 43, near Lava Creek, Yellowstone Park.

17. SPHAERIUM LACUSTRE RYCKHOLTI (Normand) 1844. Beetle 1957: 16, Swan Lake, Teton Co.; Beetle 1960: iii.

18. SPHAERIUM OCCIDENTALE (Prime) 1852. Beetle 1957: 16, Togwotee Pass.

19. SPHAERIUM STRIATINUM (Lamarck) 1818. Beetle 1954: 125, Laramie River at Laramie.

20. SPHAERIUM TUMIDUM (Baird). Henderson 1936: 84, Sheridan.

3. FRESH WATER PULMONATES

21. APLEXA HYPNORUM (Linnaeus) 1758. Henderson 1924: 188, 3 miles east of Lyman; 1933:3; 1936: 130. Beetle 1954:125; 1957:17.

22. (APLEXA HYPNORUM TRYONI (Currier). Henderson 1924: 188, 10 miles west of Sage; Henderson 1936: 131. This is a color form that has been placed in the synonymy of *A. hypnorum*.

23. ARMIGER CRISTA (Linnaeus). Taylor 1952: 44, pond 1 mile southeast of Mammoth Hot Springs.

24. CARINIFEX JACKSONENSIS (Henderson). 1932. Henderson 1932: 133, Jackson Lake; 1936: 134. Baker 1945: 157. Beetle 1957: 17.

25. FERRISSIA RIVULARIS (Say) 1819. Henderson 1918: 42, Boxelder Creek northwest of Douglas; 1924: 189. Beetle 1954: 125.

26. FOSSARIA DALLI (F.C. Baker) 1906. Beetle 1960: 156, Barber Lake, Albany Co.; Beetle, in press. (As *Lymnaea (Galba) dalli*).

27. FOSSARIA DODDSI (F.C. Baker) 1911. Beetle 1960: 156, Dry Fork Canyon near Shell; Beetle, in press. (As *Lymnaea (Galba) doddsi*).

28. FOSSARIA MODICELLA (Say) 1825. Henderson 1918:42, Laramie River below Uva; 1924:166; 1936: 125. Beetle 1957:16; Beetle, in press. (As *Lymnaea humilis modicella*).

29. FOSSARIA MODICELLA RUSTICA (Lea) 1841. Henderson 1936: 125, Snake River at Flat Creek. Beetle 1957: 16; Beetle, in press. (As *Lymnaea humilis rustica*).

30. FOSSARIA OBRUSSA (Say) 1825. Henderson 1918: 42, Lodgepole Creek 13 miles north of Cheyenne; 1924: 167; 1936: 125. Beetle 1960: 84.

31. FOSSARIA PARVA (Lea) 1841. Henderson 1936: 125, slough north of Buffalo. Taylor 1952: 44. Beetle, in press.

32. GYRAULUS ARCTICUS Müller) 1842. Beetle 1957: 17, Leigh Lake on driftwood. (Corrected to *Promenetus umbilicatellus*, Beetle 1960: 156L.

33. GYRAULUS CIRCUMSTRIATUS (Tryon) 1866. Hibbard and Taylor 1960: 96, Wyoming. Beetle 1960: 84.

34. GYRAULUS PARVUS (Say) 1817. Henderson 1918: 42, Lodgepole Creek north of Cheyenne. 1924: 178. Beetle 1960: iii.

35. ?GYRAULUS SIMILARIS (Baker). Beetle 1957: 17, Snake River at mouth of Flat Creek. (Eq. *G. parvus*, *fide* Taylor).

36. ?GYRAULUS VERMICULARIS (Gould). Henderson 1933: 3, north of Moran; 1936: 135. Beetle 1954: 125; 1957: 17. (Eq. *G. parvus*, *fide* Taylor).

37. GYRAULUS SP. Taylor 1952: 44.

38. HELISOMA ANCEPS (Menke) 1830. Walker 09: 24, Yellowstone Park. Henderson 1924: 177; 1936: 131. (As *H. antrosus* Conrad).

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39. HELISOMA SUBCRENATUM (Carpenter). Beetle 1957: 17, Flagg Ranch, Teton County; Beetle, in press.

40. HELISOMA SUBCRENATUM DISJECTUM (Cooper). Beetle 1957: 17, Gladel Creek, Teton County.

41. HELISOMA SUBCRENATUM PERDISJUNCTUM (Baker) 1945. Baker 1945: 224, Yellowstone Lake. Taylor 1952: 44.

42. HELISOMA TRIVOLVIS (Say) 1817. Henderson 1936: 133, '... erroneously recorded for Rocky Mts.' Beetle 1954: 125, Spring Creek, Laramie; 1957: 16; Beetle, in press.

43. HELISOMA TRIVOLVIS MACROSTOMUM (Whiteaves). Beetle 1957: 16, Two Ocean Lake.

44. LYMNAEA HINKLEYI (F.C. Baker) 1906. Taylor 1952: 44, promontory on east side of West Thumb, Yellowstone Lake.

45. LYMNAEA STAGNALIS JUGULARIS (Say) 1817. Henderson 1933: 3 Swan Lake, Yellowstone Park; 1936: 115. Taylor 1952: 43. Beetle 1954: 125; 1957: 16 (As *L. stagnalis appressa).*

46. LYMNAEA SP. Brues 1924: 15, Yellowstone Canyon far below the lower falls. Taylor 1952: 44.

47. MENETUS COLORADOENSIS (Baker) 1945. A synonym of *Promenetus exacuous, fide* Taylor.

48. PHYSA AMPULLACEA (Gould) 1854. Henderson 1924: 182, 10 miles north of Sage; 1936: 126 ... *ampullacea* is limited to the west coast -- *gouldi* occurs in the Rockies and east according to Clench. Beetle 1954: 125; 1957: 17; Beetle, in press.

49. PHYSA ANATINA (Lea) 1864. Henderson 1918: 42, east of Shell; 1924: 182. Beetle 1957: 17; 1960: iii.

50. ?PHYSA AUREA (Lea). Brues 1924: 15, outlet of Firehole Lake (ad *P. heterostropha,* form aurea). Henderson 1933: 1, ... cites Brues record as *P. heterostropha* dwarf form, the same as described by Lea as *P. aurea* from hot springs at Bath, Va., and adds his *Physa* was almost certainly incorrectly determined. Henderson 1936: 127, doubtful. Taylor 1952: 44, as *Physa* sp.

51. PHYSA BLANDI (Lea). Henderson 1924: 182, Madison River in Yellowstone Park; 1933: 2; 1936: 128. Taylor 1952: 44.

52. ?PHYSA FORSHEYI (Lea). Beetle 1954: 125, Albany County; 1957: 17. Clench refers these collections to *P. smithiana*.

53. PHYSA GOULDI (Clench). Henderson 1936: 128 ... most Wyoming records? Clench 1935: 30.

54. PHYSA GYRINA (Say) 1821. Henderson 1918: 43, 6 miles northeast of Wheatland; 1924: 184. Beetle 1954: 25; 1957: 17.

55. PHYSA INTEGRA (Haldeman) 1841. Henderson 1918: 42, Laramie River below Uva; 1924: 185 ... questions own record. Beetle 1960: iii.

56. (PHYSA NUTTALLII Lea). Henderson 1936: 129; Jay-Em Ranch south of Lusk; 1936: 86 ...'with a large series of Physas from western localities at hand, ... concluded it would be better not to apply *nuttallii* to any specimens unless the types are available for comparison.'

57. ?PHYSA PROPINQUA (Tryon). Henderson 1936: 129, Reservoir 18 miles southeast of Sheridan.

58. ?PHYSA SAYI (Tappan) 1839. Ingersoll 1877: 132, Fort Bridger. Henderson 1918: 41; 1923: 186.

59. ?PHYSA SAYI WARRENIANA (Lea). Henderson 1918: 42, Lodgepole Creek north of Cheyenne; 1924: 186. Beetle 1957: 17.

60. PHYSA SKINNERI (Taylor) 1954. Beetle 1960: 157, Yellowstone Lake. Taylor 1960: 119; 1960: 63.

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61. PHYSA SMITHIANA (Baker) 1920. Beetle 1960: iii

62. ?PHYSA TRASKII (Lea). Henderson 1933: 3, north of Moran. Eq. *P. virgata traskii*.

63. ?PHYSA TRITICEA (Lea). Henderson 1936: 129, ditch 1 mile north of Sheridan. Beetle 1954: 125.

64. ?PHYSA VIRGATA TRASKII (Lea). Henderson 1936: 130; Beetle 1957: 17.

65. ?PHYSA WALKERI (Crandall). Henderson 1918: 42.

66. PHYSA WARRENIANA GOULDI (Clench). Beetle 1957: 17, Snake River near Moran.

67. PHYSA WOLFIANA (Lea). Taylor 1952: 44, Lava Creek, Yellowstone Park.

68. PLANORBULA CHRISTYI (Dall). Beetle 1957: 17, pond near Jackson Lake dam.

69. PROMENETUS EXACUOUS (Say) 1821. Beetle 1951: 101, lily pond off Firehole River, Yellowstone Park. Taylor 1952: 44.

70. PROMENETUS UMBILICATELLUS (Cockerell) 1887. Beetle 1960: 156; Beetle, in press. Taylor 1960: 110.

71. RADIX AURICULARIA (Linnaeus) 1758. Beetle 1960: 73, Alsop Lake, Albany County.

72. STAGNICOLA APICINA (Lea) 1839. Baker 1911: 443, Laramie. Henderson 1918: 40; 1924: 172; 1936: 116 ... may be synonymous with *solida* and not a Rocky Mt. form. Beetle 1957: 16.

73. STAGNICOLA BINNEYI (Tryon) 1865. Baker 1911: 440, Madison River at Riverside. Henderson 1918: 40; 1924: 172; 1936: 116. Taylor 1952: 44. Beetle 1957: 16.

74. (STAGNICOLA BULIMOIDES Lea 1841). Henderson 1933: 2, ... Stearns 1893 reported the Hayden Survey found this in Yellowstone Park ... doubtful. No *bulimoides* in Wyoming, Taylor, personal communication.

75. (STAGNICOLA BULIMOIDES TECHELLA (Haldeman) 1867). Henderson 1924: 164, 2 miles west of Burlington. No *bulimoides techella* in Wyoming, Taylor, personal communication.

76. STAGNICOLA CAPERATA (Say) 1829. Henderson 1918: 42, northwest of Wheatland; 1924: 165; 1933: 3; 1936: 118. Taylor 1952: 43. Beetle 1957: 16; Beetle, in press.

77. (STAGNICOLA CAPERATA WARTHINI (Baker) 1923). Baker 1923: 125, Upper Falls, Yellowstone River. Henderson 1924: 165; 1933: 1; 1936: 118. Taylor 1952: 45. Eq. *S. binneyi*. Franzen 1956: 25.

78. STAGNICOLA COCKERELLI (Pilsbry and Ferriss) 1906. Henderson 1918: 42, small reservoir 4 miles southwest of Arminta; 1924: 164. Beetle 1954: 125. Taylor 1960: 90.

79. (STAGNICOLA ELRODIANA (F.C. Baker) 1935). Henderson 1936: 120, Jenny Lake. Eq. S. montana. Eq. *S. binneyi, fide* Beetle.

80. (STAGNICOLA HEMPHILLI (Baker) 1934). Baker 1934: 19, Black Rock Butte. Sweetwater County. Henderson 1936: 118.

81. STAGNICOLA JACKSONENSIS (F.C. Baker) 1907. Baker 1907: 52, Jackson Lake; 1911: 405. Henderson 1924: 172; 1933: 1; 1936: 120. Beetle 1957: 16; Bettle, in press. Franzen 1958: 32.

82. (STAGNICOLA MONTANA Elrod 1901). Henderson 1933: 3, Jenny Lake; 1936: 120. Eq. *S. elrodiana?* Beetle 1957: 16, *S. binneyi, fide* Beetle.

83. STAGNICOLA PALUSTRIS (Müller) 1774. Henderson 1924: 168, Adaville Mine southwest of Kemmerer; 1936: 121 ... no sure *palustris* occurs in western U.S., fide Baker. Beetle 1954:125; 1957: 16; Beetle, in press.

84. (STAGNICOLA PALUSTRIS HAYDENI (Lea) 1858). Henderson 1924: 170, 9 miles southwest of Riverton; 1933:2; 1936: 122, eq. *L. palustris nuttalliana*. Brues 1924: 417, eq. *L. palustris*; 1932: 274, eq. *L. palustris haydeni*.

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85. *(STAGNICOLA PALUSTRIS NUTTALLIANA* Lea 1841). Henderson 1933: 2; 1936: 122. Taylor 1952: 43 ... Brues record of *L. palustris* and 1932 record of *L. palustris haydeni* are synonyms.

86. STAGNICOLA PALUSTRIS WYOMINGENSIS (Baker) 1927. Baker 1927: 84, slough 10 miles south of Lander. Henderson 1933: 3; 1936: 123. Franzen 1956: 26. Beetle 1957: 16.

87. (STAGNICOLA PROXIMA (Lea) 1856). Baker 1911: 359, Alkali Springs 40 mines north of Almond, Sweetwater County. Henderson 1924: 171; 1936:123 ... Wyo. records of *L. proxima* = *L. palustris wyomingensis*, *fide* Baker.

88. (STAGNICOLA TRASKII Tryon). Baker 1911: 368, Black Rock Butte, Sweetwater County. Henderson 1924: 171; 1936: 123 ... confined to California. Eq. *S. palustris*, *fide* Hubendick.

4. FRESH WATER OPERCULATES

89. AMNICOLA ROBUSTA (Walker) 1908. Walker 1908: 97, Jackson Lake. Henderson 1924: 192; 1933:1; 1936: 137. Beetle 1957: 17.

90. AMNICOLA SP. Brues 1924: 418 Yellowstone Park. Taylor 1952: 43.

91. FLUMINICOLA FUSCA (Haldeman). Pilsbry 1899: 123, Black's Fork, Green River at Millsville. Henderson 1924: 192; 1936: 139. Beetle 1957: 17.

92. HYDROBIA GREGGI (Pilsbry) 1935. Pilsbry 1935: 91, Snake River at Hoback Creek. Henderson 1936: 138. Beetle 1957: 19.

93. VALVATA HUMERALIS CALIFORNICA (Pilsbry). Henderson 1933: 3, Jackson Lake; 1936: 140. Beetle 1957: 17.

94. VALVATA LEWISI (Currier) 1868. See *V. lewisi helicoidea* and *V. sincera*. 'A higher spire in the former is the principal distinction between *V. lewisi* and *V. lewisi helicoidea*' Taylor 1960: 49; Beetle 1960: iii.

95. (VALVATA LEWISI HELICOIDEA Dall). Beetle 1954: 125, Spring Creek, Laramie; 1957: 19. Eq. *V. lewisi*, *fide* Taylor.

96. (VALVATA SINCERA Say) 1824. Beetle 1954: 35, Little Laramie River near Quaely; 1957: 19. This collection eq. *V. lewisi* fide Taylor.

5. LAND GASTROPODA

97. CIONELLA LUBRICA (Müller) 1774. Beetle 1954: 125, S. Fork Pole Creek; 1957:16.

98. COLUMELLA ALTICOLA (Ingersoll) 1875. Hanna 1912: 373, Wyo. Henderson 1924: 140; 1936: 107. Pilsbry 1948: 1003. Beetle 1954: 125; 1957: 15; Beetle, in press.

99. COLUMELLA EDENTULA (Draparnaud) 1805. Beetle 1954: 125, S. Fork Pole Creek; Beetle, in press.

100. DEROCERAS LAEVE (Müller) 1774. Henderson 1918: 42, Lodgepole Creek north of Cheyenne (as *Agriolimax campestris*); 1924: 150; 1936: 114. Levi and Levi 1951: 60. Beetle 1954: 125; 1957: 14; Beetle, in press.

101. (DEROCERAS LAEVE GRACILE Rafinesque) 1820. Eq. *D. laeve*. Beetle 1957: 14, Snake River floodplain south of Wilson.

102. DEROCERAS RETICULATUM (Müller) 1774. Henderson 1933: 2, east of Mammoth (as *Agriolimax agrestis*); 1936: 114. Pilsbry 1948: 534. Beetle, in press.

103. DISCUS CRONKHITEI (Newcomb) 1865. Henderson 1933: 47, 7 miles north of Moran; 1936: 106. Pilsbry 1948: 600. Levi and Levi 1951: 61. Beetle 1954: 125; 1957: 14; Beetle, in press.

104. DISCUS SHIMEKI (Pilsbry) 1890. Pilsbry 1948: 617, Cliff Creek Canyon, Sublette County. Levi and Levi 1951: 61. Beetle 1957: 14; Beetle, in press.

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105. (DISCUS SHIMEKI COCKERELLI Pilsbry) 1898. Henderson 1936: 107, Curr Creek Canyon. Levi and Levi 1951: 61. Beetle 1957: 14; 1960: 84. Intergradation of characters with the species makes this subspecies untenable.

106. EUCONULUS FULVUS (Müller) 1774. Beetle 1954: 126; 1957: 13; Beetle, in press.

107. (EUCONULUS FULVUS ALASKENSIS Pilsbry) 1899. Henderson 1913: 38, North Fork of Clear Creek, Johnson County; 1924: 146; 1933: 2; 1936: 111. Levi and Levi 1951: 60. Beetle 1954: 126; 1957: 13. A growth form based on size alone, Beetle.

108. GASTROCOPTA ARMIFERA (Say) 1821. Beetle 1960: 155, cliffs at Guernsey Reservoir.

109. HAWAIIA MINUSCULA (Binney) 1840. Pilsbry 1946: 420, 7 miles south of Laramie. Beetle 1954: 126.

110. MICROPHYSULA INGERSOLLI (Bland) 1874. Henderson 1936: 101, Cliff Creek Canyon, Sublette County. Pilsbry 1940: 991. Levi and Levi 1951: 60. Beetle 1957: 13; 1960: 84.

111. OREOHELIX CARINIFERA (Pilsbry) 1912. Beetle 1957: 13, 15 miles south of Jackson; Beetle, in press.

112. OREOHELIX PYGMAEA (Pilsbry) 1913. Pilsbry 1913: 52, Shell Creek Canyon, Bighorn County. Henderson 1924: 117; 1936: 90. Beetle, in press.

113. OREOHELIX PYGMAEA MACULATA (Henderson) 1918. Henderson 1918: 46, White Creek and Shell Canyons (as O. maculata); 1924: 128; 1936: 90. Beetle, in press.

114. OREOHELIX STRIGOSA BERRYI (Pilsbry) 1915. Henderson 1933: 3, Clematis Gulch, Yellowstone Park; 1936: 93. Pilsbry 1939: 445.

115. (OREOHELIX STRIGOSA COOPERI Binney 1858). Henderson 1924: 113, Horse Creek Station, Laramie County. Beetle 1954: 125, fide Pilsbry. Pilsbry 1939: 444 ... Dissection of many individuals ... shows that the Black Hills cooperi is specifically distinct from the common snail of the Rocky Mountains ... now known as O. subrudis.

116. OREOHELIX STRIGOSA DEPRESSA (Cockerell) 1890. Bland and Cooper 1861: 367, Bighorn Mountains and west side of Wind River Mountains. Henderson 1924: 119; 1933: 3; 1936: 91. Pilsbry 1939: 429. Levi and Levi 1951: 60. Beetle 1957: 13.

117. OREOHELIX SUBRUDIS ("Pfeiffer," Reeve) 1854. Henderson 1933: 2, aspen grove 1 mile northwest of Mammoth Hotel; 1936: 92, ... most strigosa cooperi records belong here. Pilsbry 1939: 480. Levi and Levi 1951: 60. Beetle 1954: 125; 1957: 13.

118. (OREOHELIX SUBRUDIS form MAXIMA Pilsbry 1916). Pilsbry 1916: 351, Yellowstone Park; 1939: 489, ... based on size alone, of little taxonomic value. Henderson 1933: 1; 1936: 94.

119. (OREOHELIX SUBRUDIS form OBSCURA Henderson 1918). Henderson 1918: 45, White Creek Canyon; 1924: 116; 1936: 94. Pilsbry 1939: 490, ... distinguished only by color. Beetle, in press.

120. OREOHELIX YAVAPAI EXTREMITATIS (Pilsbry and Ferriss) 1911. Pilsbry 1913: 50, Shell and White Creek Canyons; 1939: 526. Henderson 1918: 45; 1924: 128; 1936: 94. Beetle, in press.

121. OREOHELIX YAVAPAI MAGNICORNU (Pilsbry) 1916. Pilsbry 1916: 141, Big Horn Canyon; 1939: 529. Henderson 1924: 122; 1936: 94. Beetle, in press.

122. OXYLOMA DECAMPI GOULDI (Pilsbry) 1948. Beetle 1957: 14, Bog off Snake River near Moran; Beetle, 1960: 84.

123. OXYLOMA RETUSA (Lea) 1834. Henderson 1936: 115, Cliff Creek Canyon. Levi and Levi 1951: 61. Beetle 1957: 14.

124. PUNCTUM MINUTISSIMUM (Lea) 1841. Henderson 1936: 108, Cliff Creek Canyon. Levi and Levi 1951: 61. Beetle 1957: 14; 1960: 84.

125. PUPILLA BLANDI (Morse) 1865. Henderson 1924: 135, 11 miles east of Evanston; 1936: 103. Levi and Levi 1951: 61. Beetle 1954: 125; 1957: 15; Beetle, in press.

126. PUPILLA HEBES (Ancey) 1881. Henderson 1936: 103, Chimney Rock, Albany County. Pilsbry 1948: 936. Beetle 1954: 125; 1957: 15.

127. PUPILLA MUSCORUM (Linnaeus) 1758. Henderson 1913: 38, N. Fork of Clear Creek, Johnson County; 1924: 133; 1933: 2; 1936: 103. Levi and Levi 1951: 61. Beetle 1954: 125; 1957: 15; Beetle, in press.

128. (PUPILLA MUSCORUM form XEROBIA Pilsbry 1914). Henderson 1918: 41, East of Shell; 1924: 133. Pilsbry 1948: 933 ... an arid station hunger form.

129. PUPILLA SYNGENES form DEXTROVERSA (Pilsbry and Vanatta) 1900. Beetle 1960: 155, 5 miles east of Thermopolis.

130. PUPOIDES HORDACEUS (Gabb) 1866. Beetle 1960: 155, cliffs above Guernsey Reservoir.

131. RETINELLA BINNEYANA (Morse) 1864. Henderson 1936: 110, west of Buffalo. Beetle, in press.

132. RETINELLA BINNEYANA OCCIDENTALIS (H. B. Baker) 1930. Beetle 1954: 125, South Fork of Pole Creek; 1957: 14; Beetle, in press.

133. RETINELLA ELECTRINA (Gould) 1841. Pilsbry 1946: 256, Fort Bridger. Levi and Levi 1951: 60. Beetle 1957: 14; 1960: 84.

134. SUCCINEA AVARA (Say) 1824. Henderson 1924: 159, southwest of Sage; 1936: 114. Levi and Levi 1951: 61. Beetle 1957: 14; 1960: 84.

135. SUCCINEA GROSVENORI (Lea) 1864. Beetle 1957: 14, Grand Canyon of Snake River near Hoback.

136. (SUCCINEA OREGONENSIS GABBI (Tryon) 1865.) Pilsbry 1898: 144, Wyoming. Henderson 1924: 161. Pilsbry 1948: 841, 842 ... (The type lot of gabbi consists of 3 dead shells. Oregonensis is described from a single shell, not collected again. Both bear a great resemblance to S. avara.)

137. SUCCINEA STRETCHIANA (Bland) 1865. Pilsbry 1948: 825, Green River. Beetle 1954: 125; 1957: 14; Beetle, in press.

138. VALLONIA ALBULA (Sterki) 1893. Henderson 1924: 101, Uva; 1936: 100. Beetle 1954: 125; 1957: 15; Beetle, in press.

139. VALLONIA COSTATA (Müller) 1774. Beetle 1960: 155, Ayers Natural Bridge near Douglas.

140. VALLONIA CYCLOPHORELLA (Ancey) 1892. Henderson 1924: 102, Lodgepole Creek north of Cheyenne; 1933: 2; 1936: 100. Pilsbry 1948: 1035. Levi and Levi 1951: 61. Beetle 1954: 125; 1957: 15; Hibbard and Taylor 1960: 136. Beetle, in press.

141. VALLONIA EXCENTRICA (Sterki) 1893. Beetle 1960: 155, Thermopolis.

142. VALLONIA GRACILICOSTA (Reinhardt) 1883. Henderson 1918: 42, Lodgepole Creek north of Cheyenne; 1924: 102; 1936: 100. Pilsbry 1948: 1028. Beetle 1954: 125; 1957: 15; Beetle, in press.

143. (VALLONIA GRACILICOSTA form MONTANA (Sterki) 1893. Pilsbry 1948: 1030, ... an ecologic or other form ... Usually it has not been thought desirable to attempt the assortment of mixed lots of gracilicosta and montana.

144. VALLONIA PULCHELLA (Müller) 1774. Henderson 1936: 101, Sheridan. Pilsbry 1948: 1023. Beetle 1954: 125; Beetle, in press.

145. VERTIGO CONCINNULA (Cockerell) 1897. Pilsbry 1948: 978, 29 miles south of Jackson. Levi and Levi 1951: 61. Beetle 1954: 125; 1957: 15; Beetle, in press.

146. VERTIGO GOULDI BASIDENS (Pilsbry and Vanatta) 1900. Beetle 1957: 15, Hoback Canyon; Beetle, in press.

147. VERTIGO GOULDI COLORADENSIS (Cockerell) 1891. Beetle 1954: 125, South Fork of Pole Creek; 1957: 15.

148. VERTIGO MODESTA (Say) 1824. Beetle 1954: 125, Middle Fork of Little Laramie River; 1957: 15; Beetle, in press.

149. (VERTIGO MODESTA form PARIETALIS (Ancey) 1887). Beetle 1954: 125, Middle Fork of Little Laramie River; 1957: 15. The range of variation makes this form of little value, Beetle.

150. VERTIGO OVATA (Say) 1822. Beetle 1960: 155, Little Laramie River near Centennial.

151. VITRINA ALASKANA (Dall) 1905. Henderson 1918: 42, north of Uva; 1924: 141; 1933: 2; 1936: 108. Pilsbry 1946: 503. Levi and Levi 1951: 60. Beetle 1954: 125; 1957: 14; Beetle, in press.

152. ZONITOIDES ARBOREUS (Say) 1816. Henderson 1918: 42, below Uva; 1924: 147; 1933: 2; 1936: 109; Levi and Levi 1951: 60. Beetle 1954: 125; 1957: 14; Beetle, in press.

153. ZOOGENETES HARPA (Say) 1824. Pilsbry 1948: 1043, Shoshone Canyon 1 mile west of Elephant Head, Park County. Levi and Levi 1951: 61. Beetle 1954: 125; 1957: 16.

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Continued p. 14

LAND SNAILS FROM THE LOESS OF MISSISSIPPI

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On the river bluffs in western Mississippi thick deposits of loess are frequently found. This loess in many places is highly fossiliferous. Although there are some records of loess fossils from the vicinity of Vicksburg and Natchez, the loess fauna of the State has been largely neglected. Recently the author had the opportunity to collect in the loess of Mississippi at a number of localities extending from near the northern border to near Fort Gibson in the southern part of the State. Because of available time it was not possible to make the kind of search necessary to find the minute species. For this reason the following lists should be considered as only a preliminary report. The author hopes to be able to make more thorough collections at some future date.

DE SOTO County: 3 miles east of Lake Cormorant.

Stenotrema barbatum (Clapp)
Hawaiia minuscula (Binney)
Zonitoides arboreus (Say)
Helicodiscus parallelus (Say)
Gastrocopta contracta (Say)
Gastrocopta pentodon (Say)
Cionella morseana Doherty

DE SOTO County: 4.5 miles northeast of Banks.

Haplotrema concavum (Say)
Retinella electrina (Gould)
Hawaiia minuscula (Binney)
Zonitoides arboreus (Say)
Discus catskillensis (Pilsbry)
Punctum minutissimum (Lea)
Helicodiscus parallelus (Say)
Strobilops labyrinthica (Say)
Gastrocopta pentodon (Say)
Hendersonia occulta (Say)

DE SOTO COUNTY: 3 miles west of Eudora

Stenotrema barbatum (Clapp)
Stenotrema fraternum (Say)
Triodopsis fosteri (F. C. Baker)
Allogona profunda (Say)
Haplotrema concavum (Say)
Ventridens ligerus (Say)
Anguispira alternata (Say)
Helicodiscus parallelus (Say)
Hendersonia occulta (Say)

TATE County: 4 miles south of Savage

Stenotrema barbatum (Clapp)
Stenotrema fraternum (Say)
Mesodon clausus (Say)
Triodopsis fosteri (F. C. Baker)
Triodopsis albolabris (Say)
Allogona profunda (Say)
Haplotrema concavum (Say)
Retinella electrina (Gould)

Retinella indentata (Say)
Mesomphix friabilis (W. G. Binney)
Hawaiia minuscula (Binney)
Ventridens ligerus (Say)
Anguispira alternata (Say)
Helicodiscus parallelus (Say)
Succinea gelida F. C. Baker
Strobilops labyrinthica (Say)
Gastrocopta armifera (Say)
Gastrocopta pentodon (Say)
Vertigo elatior Sterki
Cionella morseana Doherty
Hendersonia occulta (Say)

TATE County: 5.5 miles south of Savage.

Stenotrema barbatum (Clapp)
Triodopsis albolabris (Say)
Allogona profunda (Say)
Retinella electrina (Gould)
Retinella indentata (Say)
Ventridens demissus (Binney)
Zonitoides arboreus (Say)
Anguispira alternata (Say)
Helicodiscus parallelus (Say)
Strobilops labyrinthica (Say)
Gastrocopta contracta (Say)
Gastrocopta pentodon (Say)
Cionella morseana Doherty
Hendersonia occulta (Say)

PANOLA County: 2.8 miles west of Pleasant Grove.
Allogona profunda (Say)
Anguispira alternata (Say)
Helicodiscus parallelus (Say)
Hendersonia occulta (Say)
Pomatiopsis lapidaria (Say)

TALLAHATCHIE County: 4 miles north of Paynes.
Stenotrema barbatum (Clapp)
Allogona profunda (Say)
Retinella indentata (Say)
Hawaiia minuscula (Binney)
Helicodiscus, sp. This is a new species which will be described in another paper.
Strobilops labyrinthica (Say)
Gastrocopta armifera (Say)
Gastrocopta contracta (Say)
Gastrocopta pentodon (Say)
Vertigo milium (Gould)
Hendersonia occulta (Say)
Pomatiopsis lapidaria (Say)

GRENADA County: 5.5 miles southwest of Holcomb.
Stenotrema barbatum (Clapp)
Stenotrema leai aliciae (Pilsbry)
Mesodon inflectus (Say)
Anguispira alternata (Say)
Helicodiscus sp.
Helicodiscus singleyanus inermis H. B. Baker
Strobilops labyrinthica (Say)
Gastrocopta contracta (Say)
Gastrocopta pentodon (Say)
Hendersonia occulta (Say)
Helicina orbiculata (Say)

CARROLL County: 3.5 miles southeast of Avalon
Stenotrema barbatum (Clapp)
Allogona profunda (Say)
Helicodiscus sp.
Hendersonia occulta (Say)

CARROLL County: 1 mile west of Valley Hill.
Stenotrema barbatum (Clapp)
Stenotrema stenotrema (Pfeiffer)
Stenotrema fraternum (Say)
Stenotrema leai aliciae (Pilsbry)
Mesodon clausus (Say)
Mesodon inflectus (Say)
Triodopsis albolabris (Say)
Allogona profunda (Say)
Haplotrema concavum (Say)
Retinella indentata (Say)
Zonitoides arboreus (Say)
Anguispira alternata (Say)
Discus catskillensis (Pilsbry)
Helicodiscus sp.
Strobilops labyrinthica (Say)
Gastrocopta armifera (Say)
Gastrocopta pentodon (Say)
Gastrocopta contracta (Say)
Cionella morseana Doherty
Hendersonia occulta (Say)
Helicina orbiculata (Say)
Pomatiopsis lapidaria (Say)

YAZOO County: near Junction of U.S. 49 and U.S. 49E, 1 mile east of Yazoo City.
Stenotrema barbatum (Clapp)
Stenotrema stenotrema (Pfeiffer)
Stenotrema leai aliciae (Pilsbry)
Mesodon zaletus (Binney)
Triodopsis vulgatus (Pilsbry)
Triodopsis denotata (Férussac)
Triodopsis fosteri (F. C. Baker)
Ventridens ligerus (Say)
Zonitoides arboreus (Say)
Anguispira alternata (Say)
Discus patulus (Deshayes)
Helicodiscus sp.
Succinea ovalis Say
Strobilops labyrinthica (Say)
Gastrocopta armifera (Say)
Hendersonia occulta (Say)
Pomatiopsis lapidaria (Say)

HINDS County: 3 miles northwest of Edwards.

Stenotrema barbatum (Clapp)
Stenotrema stenotrema (Pfeiffer)
Stenotrema leai aliciae (Pilsbry)
Stenotrema fraternum (Say)
Mesodon thyroidus (Say)
Mesodon clausus (Say)
Mesodon inflectus (Say)
Triodopsis fosteri (F. C. Baker)
Allogona profunda (Say)
Haplotrema concavum (Say)
Euconulus chersinus (Say)
Retinella indentata (Say)
Mesomphix friabilis (W. G. Binney)
Hawaiia minuscula (Binney)
Ventridens ligerus (Say)
Anguispira alternata (Say)
Helicodiscus sp.
Gastrocopta contracta (Say)
Gastrocopta corticaria (Say)
Vallonia perspectiva Sterki
Cionella morseana Doherty
Helicina orbiculata (Say)

WARREN COUNTY: near Clear Creek, 0.6 mile northeast of Bovina.
Stenotrema barbatum (Clapp)
Stenotrema stenotrema (Pfeiffer)
Stenotrema fraternum (Say)
Mesodon inflectus (Say)
Retinella indentata (Say)
Zonitoides limatulus (Binney)
Succinea ovalis Say
Succinea gelida F. C. Baker
Cionella morseana Doherty
Helicina orbiculata (Say)

WARREN County: 3.5 miles east of Vicksburg.

Stenotrema barbatum (Clapp)
Stenotrema stenotrema (Pfeiffer)
Stenotrema fraternum (Say)
Mesodon clausus (Say)
Mesodon zaletus (Binney)
Mesodon inflectus (Say)
Triodopsis vulgatus (Pilsbry)
Triodopsis obstricta (Say)
Triodopsis fosteri (F. C. Baker)
Allogona profunda (Say)
Haplotrema concavum (Say)
Euconulus fulvus (Müller)
Guppya sterkii (Dall)
Retinella indentata (Say)
Paravitrea multidentata (Binney)
Hawaiia minuscula (Binney)
Ventridens ligerus (Say)
Ventridens intertextus (Binney)
Zonitoides limatulus (Binney)
Anguispira alternata (Say)
Discus patulus (Deshayes)
Helicodiscus parallelus (Say)
Helicodiscus sp.
Punctum minutissimum (Lea)
Succinea ovalis Say
Strobilops aenea Pilsbry
Gastrocopta contracta (Say)
Gastrocopta pentodon (Say)
Gastrocopta corticaria (Say)
Vertigo gouldi (Binney)
Columella edentula (Draparnaud)
Cionella morseana Doherty
Helicina orbiculata (Say)
Carychium exile H. C. Lea
Snail eggs. These are quite small. They are probably those of Discus patulus.

CLAIRBORNE County: 4 miles east of Port Gibson.

Stenotrema barbatum (Clapp)
Stenotrema stenotrema (Pfeiffer)
Stenotrema leai aliciae (Pilsbry)

Mesodon thyroidus (Say)
Mesodon elevatus (Say)
Mesodon inflectus (Say)
Triodopsis fosteri (F. C. Baker)
Mesomphix friabilis (W. G. Binney)
Paravitrea significans (Bland)
Ventridens demissus (Binney)
Anguispira alternata (Say)
Anguispira strongylodes (Pfeiffer)
Helicina orbiculata (Say)

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CHANGES IN THE GASTROPOD POPULATIONS IN THE SALT FORK OF THE BIG VERMILION RIVER IN ILLINOIS, 1918 - 1959[1]

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I. INTRODUCTION

Between 1918 and 1920 Frank Collins Baker made a survey of the mollusks in the Big Vermilion River in east-central Illinois (Baker, 1922). His study was made largely in the Salt Fork of that river. He collected from 30 stations located from the headwaters north of Urbana to the junction of the Salt Fork with the Middle Fork just west of Danville. It is at this point that the Big Vermilion is formed from its tributaries. Baker was especially interested in the bivalves, but he collected all mollusks over a stream distance of 45 miles. He worked by hand — collecting to the depth of about two feet. Habitats included mud, sand, and gravel, with occasional piles of rubble and boulders. The drainage area is an upland plain which was glaciated by the early Wisconsin Glacier. Between 1908 and 1912, the channelway of the Salt Fork between Urbana and St. Joseph (Stations 4 - 12) was dredged, destroying all bottom vegetation and fauna.

This drainage system receives the effluent from the Urbana-Champaign Sewage Disposal Plant. In 1918 this plant discharged 1.5-2.0 million gallons per day with about 20 percent purification. In 1958 the plant discharged up to 8 - 10 million gallons per day with about 85 percent purification. As the volume of effluent increased, the degree of purification also increased, so that the actual amount of pollution has remained at about the same level. (Information from E. S. Beatty, Engineer-Manager, Urbana-Champaign Sewage Treatment Plant.)

Between 1934 and 1953 the writer collected gastropods in the five drainage systems of Champaign County, including three of Baker's original stations, plus nine others in the watershed of the Salt Fork (Dexter, 1956). Between 1956 and 1959 the writer repeated Baker's survey of the Salt Fork, except for four stations which lie outside of the main channel of this drainage. Gastropods only were collected, and the time spent at each station was approximately one-half the time Baker spent in his collection of all mollusks. Comparative results are given in Table I.

1 This study was supported by the Environmental Sciences Branch of the U. S. Atomic Energy Commission, Contract No. AT(11-1) -- 411.

TABLE 1. — COMPARISON OF GASTROPOD POPULATIONS IN THE SALT FORK OF THE BIG VERMILION RIVER, ILLINOIS, 1918-1959.

SPECIES	STATION NUMBERS												
	1	2	3	4	5	6	7	8	9	12	13	14	15
Physa spp.	0-C	A-C	A-A	A-C	0-C	0-A	0-A	0-C	0-C	4-C	C-C	C-12	0-C
Ferrissia rivularis;													
Ferrissia tarda	0-C	0-C	S-0	0-A	0-5	0-1	0-4	0-10	0-10	3-3	0-8	0-A	0-C
Helisoma trivolvis		S-2	A-A	0-9	0-1	0-11	0-1			0-S	C-0	C-0	0-1
Lymnaea humilis		S-0	0-8	C-C		0-1	0-1			0-2			
Goniobasis livescens													
Pleurocera acutum													
Amnicola limosa													
Promenetus exacuous			0-1										
Deroceras sp.			0-1										

	16	17	18	19	20	21	22	23	24	25	26	28	30
Physa spp.	0-14	0-14	C-C	3-0	C-1		0-2			A-1		0-2	C-3
Ferrissia rivularis;													
Ferrissia tarda	A-4	S-C	1-C	A-C	A-2	0-C	C-C	0-17	0-7	0-A	0-C	0-2	0-6
Helisoma trivolvis		S-1	S-0										
Lymnaea humilis				2-0									
Goniobasis livescens			S-0							A-C	A-A	0-6	A-C
Pleurocera acutum										0-A			
Amnicola limosa			S-0	C-0	S-0								
Promenetus exacuous													
Deroceras sp.													
Campeloma rufum			1-0	1-0						A-0			

First symbol is number collected by F. C. Baker, 1918-20; second symbol is number collected by R. W. Dexter, 1956-59. A = abundant; C = common; S = scarce.

II. CHANGES IN THE GASTROPOD FAUNA: 1918-20 (Baker) — 1956-59 (Dexter)

A. Discussion by Species

Physa spp. Baker (1922) listed *P. gyrina* and *P. crandalli*. Specimens collected by the writer were identified by Dr. W. J. Clench as *P. gyrina* and *P. integra*. Specimens sent to Dr. C. B. Wurtz were identified as *P. integra* and *P. heterostropha*. Brown (1935) reported *P. anatina* from from the sewage disposal plant and in the nearby drainage ditch. Her specimens had been identified by Dr. W. J. Clench. Because of the uncertain specific determination in this group and the mixed nature of the population, all records are grouped together under the genus for the purposes of this study. In the first study (Baker) *Physa* spp. were more abundant at four stations, while in the second survey (Dexter) *Physa* spp. were more abundant at ten stations. (All differences in abundance reported in this study are based upon obvious differences noted in the field data. See Table I for complete field data.) In the first survey *Physa* was found to a greater extent downstream, while in the second survey this group was found to a greater extent upstream. Baker found this group at 11 stations, while the writer found it at 21 stations.

Ferrissia tarda. Baker listed his collection of limpets as *F. rivularis*, but Hoff (1940) identified Salt Fork limpets which he studied as *F. tarda*, and Dr. Paul Basch identified collections of the writer also as *F. tarda*. (In a recent private communication Dr. Basch stated that he is not certain whether these two species can be distinguished. If they prove to be identical, *F. rivularis* will have priority). In the first survey it was more abundant at 13 stations. It was found at only eight stations during the first survey, but at 25 stations during the second survey (in all stations studied, except the oxbow pond at station 3). *Ferrissia* has undergone a tremendous increase in abundance and distribution.

Helisoma trivolvis. Baker recorded this species, including *H. t. pseudotrivolvis* Baker, at six stations, while the writer collected this species from nine stations. It was more abundant at five stations in the original survey, but more abundant at three others during the last survey. Baker found the species farther downstream, while the writer collected it farther upstream.

Lymnaea humilis. Baker placed this species in the genus *Galba* while other writers have often placed it in the genus *Fossaria*. For the present, it seems best to assign it to *Lymnaea*. Baker found this species in three stations, whereas the writer found it at five stations. It was more abundant at one place in the original survey, and more abundant at one station in the later survey. Altogether there is no indication of much change between the two periods of time.

Goniobasis livescens. In both surveys the species was found at four stations. Baker found it more abundant in one of these, and the writer found it more abundant in another one. In the early years it was found somewhat farther upstream, but otherwise there was no important difference in the abundance and distribution of this species.

Pleurocera acutum. Baker referred to this as *P. elevatum*, but there is no question that his specimens were what we now regard as *P. acutum*. Baker found only a single empty shell, while the writer found an abundance of this snail living at station 25.

Campeloma rufum. Baker found this species at three stations, and it was abundant at station 25. It was not collected at all between 1956-59. This matter will be discussed further below.

Amnicola limosa. This is a pond species which Baker found in three places among vegetation growing in the stream. The writer did not encounter this type of habitat except in the oxbow at station 3 and did not collect this species.

Promenetus exacuous and *Deroceras* sp. These two were found among the vegetation of the oxbow at station 3 and, like the preceding species, are found in pond habitats. These two were not collected by Baker.

B. Discussion by Stations

Baker found 11 stations without gastropods (Stations 1, 5-9, 15, 21, 23, 24, and 28 had no population). In the recent survey there was no station without gastropods. One to four species are now found where Baker collected none. In six stations one species replaced another between the two periods of collecting. These changes involved seven species.

At station 25 the writer collected one specimen of *Physa* sp. on Feb. 16, 1935. It was rare at that time, as it was later in 1959. Baker, however, found abundant *Physa* at that station in 1918-20. The writer collected 168 *Goniobasis livescens* on March 28, 1935. There has been a noticeable decrease in abundance of this species at this location since that time. While Baker

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found no living Pleurocera acutum in the Salt Fork system, the writer collected several near Oakwood, a short distance below station 25, on Oct. 20, 1934. Six were collected in March of 1935 at station 25, and the species was common there between 1956-58. This has undergone a tremendous increase in abundance in recent years. On the other hand, Baker found an abundance of Campeloma at station 25. While the writer collected a number of specimens at that locality in the fall of 1934 and the spring of 1935, none was found in the survey of 1956-59.

C. General Comparison and Conclusions

The recent snail populations show an increase in abundance for 20 station records (34.6%) involving five species. On the other hand, the recent populations show a notable decrease in abundance for 18 station records (22.2%) involving seven species. A total of 23 station records (28.4%) show about the same abundance at the end of 40 years.

There has been a general increase in abundance for Physa and Ferrissia. It has recently been shown that F. tarda, formerly found attached to the nacre of shells of river mussels, has now in the absence of mussel shells taken over attachment to the fresh surface of bottles and cans dumped into the river (Dexter, 1959). The accumulation of such trash has perhaps been responsible for much of the increase of this species.

There has been in recent times a wider distribution of Physa, Ferrissia, and Helisoma, and no species has shown a contraction of distribution.

Two species were not found in the recent survey (Campeloma rufum and Amnicola limosa), but only the former is a typical stream species. On the other hand, Pleurocera acutum has been added to the stream fauna. Physa and Ferrissia remain as the most abundant and widely distributed species.

In general gastropods are somewhat more abundant and widely distributed in this stream after a period of 40 years.

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PLEISTOCENE MOLLUSCAN FAUNAS OF THE CASTALIA DEPOSIT, ERIE COUNTY, OHIO

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INTRODUCTION

Nature and Purpose of Investigation

This is a paleoecological and quantitative investigation of the molluscan faunas of a marl deposit. The purpose of the study is to ascertain what species are present in the deposit, their variation in kind and in numbers with time, and the reasons for the variation. These data yield information useful in reconstructing the development of the lake in which the marl accumulated and in ascertaining the age of the deposit. They permit comparison of the Castalia deposit with other deposits in Ohio and elsewhere and evaluation of the differences and similarities that exist between them. Investigations of the same kind have been carried out in other parts of Ohio. Similar methods and presentation of results permit close comparison between deposits of different age and from various ecological situations which may eventually yield data for detailed correlations.

Location of Deposit

In the Lake Plains section of north-central Ohio in Erie County is the town of Castalia. To the west and north of this town in Margaretta Township, Erie County, and in Townsend Township, Sandusky County, lies the Castalia Prairie. The prairie is a sequence of marl and peat beds more than 4,000 acres in area at elevations of 610 to 630 feet. It is the most extensive and continuous marl deposit known in Ohio.

The deposit studied is a part of this prairie and lies at an elevation of approximately 610 feet at a distance of 1.8 miles northwest of the town of Castalia. (See fig. 1). The site may be reached by proceeding northwest from Castalia on State Route 269 a distance of 1.6 miles. At this point a gravelled road runs in a westerly direction. By following this road a distance of 0.7 mile the site of former diggings by the Medusa Cement Company is reached. The deposit is located on a bank at the eastern side of the diggings where the road forks to the south. The exact location for the deposit is: Erie County (Bellevue Quadrangle), Margaretta Township, T. 6 N., R. 17 E., section 3, longitude 82° 49' 53", latitude 41° 25' 10".

Methods of Investigation

Collection and storage. The collections were obtained from a measured section (see below). Each collection is 12 by 12 by 2 inches or 288 cubic inches. The material from each collection was placed in a plastic bag and stored until used. Water was added to each bag to keep the material from becoming too hard. The day before a collection was to be sieved, it was emptied into four two-liter beakers and covered with water, which made the task of sieving much faster.

Sieving and drying. Sieves of 10, 20, 40, and 50 mesh were used to separate the silt from the Mollusca. When the material had dried sufficiently, it was placed in containers labelled with the proper collection number.

Sorting and identification. The total amount of dried material in each collection was divided into representative fractions taken impartially by means of a mechanical quartering device. One of these fractions (or more than one if necessary) was taken from each collection and the shells sorted from it. A total of 1,000 individuals was taken in all collections except 11 and 12; only 140 individuals were found in the fraction sorted from collection 11 and 780 individuals were obtained from the fraction in collection 12. The shells were then separated into species and the number of shells of each species counted. This number was expressed graphically so that each species was shown as a percentage of the total number of individuals in each collection. By studying each collection separately changes in faunal composition were related to time.

STRATIGRAPHY

Description of Deposit

Bedrock geology. The oldest formation underlying the Castalia area is the unexposed Tymochtee dolomite of late Silurian age. Above this, and also late Silurian, is the Put-in-Bay dolomite. This formation is not exposed at Castalia but forms Crystal Rock Hill three miles northwest of it (Carman, 1927, p. 491). Overlying this dolomite are the Columbus and Delaware limestones of middle Devonian age.

Lacustrine sediments and topographic features. Overlying the bedrock formations is approximately 30 feet of glacial drift and lake deposits. The lacustrine deposits smoothed out the uneven surface produced by glaciation so that a very gentle, northward sloping plain was formed. This lacustrine plain, whose southern limit is the shoreline of Lake Maumee III, was developed by the various lake levels within the Erie basin. Near Castalia are a number of bedrock hills 50 feet above the level of the plain. These hills, capped by the Columbus limestone, existed as shoals, islands, and peninsulas during the different lake stages. The only other feature breaking the surface of the plain is a series of long, low ridges of sand and gravel which are beaches of the former lake levels. It is on one of these beaches that the Castalia deposit formed (see fig. 2).

DESCRIPTION OF FIGURES ON OPPOSITE PAGE

Fig. 1. Index map showing the location of the Castalia deposit, Margaretta Township, Erie County, Ohio.

Fig. 2. Diagram showing the Great Lakes stages in the vicinity of the Castalia Deposit.

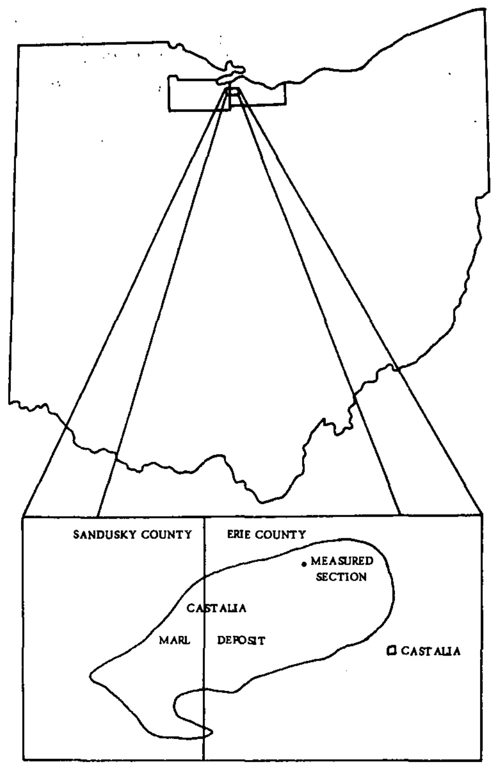

FIGURE 1

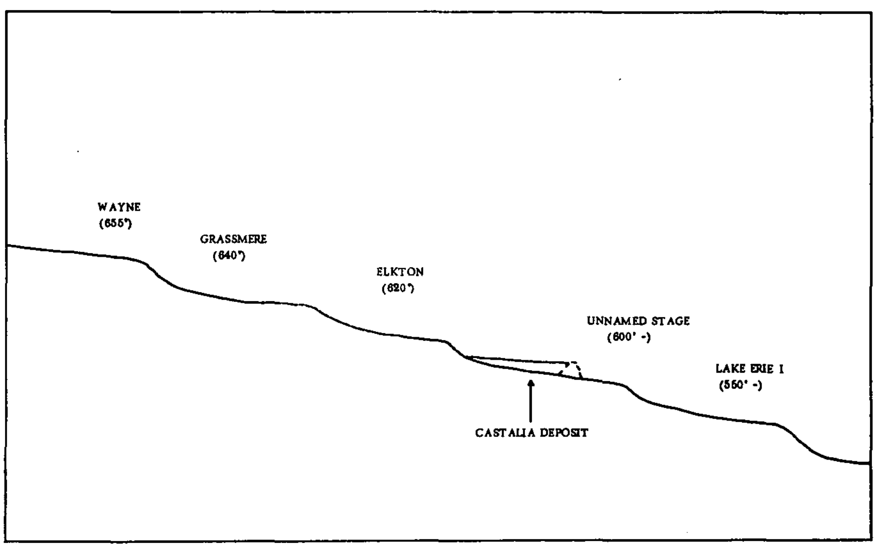

FIGURE 2

Great Lakes stages in the Castalia deposit. In the history of Lake Erie a series of lake stages began with the formation of Lake Maumee I at an elevation of 790 feet and continued to the present level of Lake Erie at 573 feet. The only stages that need be considered here, however, are the ones directly concerned with the Castalia deposit.

Between the Wayne shoreline (655 feet) and the first stage of the present Lake Erie (550 feet) are fragments of four shorelines representing the various stages of Lake Lundy. These are transitional stages caused by a cutting down of the outlet south of Syracuse, New York. Unlike the Wayne and some higher shorelines, these were never submerged but produced under conditions of a falling water level. The two uppermost shorelines, at elevations of 640 and 620 feet, correspond to the Grassmere and Elkton stages of Lake Lundy, respectively. The third shoreline (615 feet) represents the Dana stage of Lake Lundy. Campbell (1955, p. 136) found evidence of a fourth shoreline, left unnamed, at slightly less than 600 feet. Segments of both the Grassmere and Elkton stages cross the marl deposits of the Castalia Prairie. The Dana level is not represented here but occurs elsewhere in the Erie basin. Traces of the fourth shoreline are found at the northern edge of the marl deposits. Since the elevation of the Castalia deposit is approximately 610 feet, the deposit had to form after the Elkton shoreline and during recession of the water to the present lake level.

Measured Section

Unit		Thickness Inches	Coll. Nos.
4	Humus, black, fine-grained, fossiliferous	4	29-30
3	Marl, composed of alternating layers of cream-colored and gray marl; very sandy in the two bottom collections. At the level of collection 23 the lines of stratification between the cream-colored and gray marl layers become indistinct, giving an overall grayish appearance to the remaining layers in the unit. Collections 23-28. Alternating, irregular layers of cream-colored and gray marl giving these collections an overall grayish appearance; fossiliferous, with Chara stems. Collections 21-22. Cream-colored, Chara stems, fossiliferous. Collections 18-20. Gray, very fossiliferous, some tufa present. Collections 16-17. Cream-colored, Chara stems, fossiliferous. Collections 13-15. Gray, very fossiliferous, minor amounts of sand, silt, and tufa present. Collection 12. Cream-colored, Chara stems; contains less sand and more fossils than coll. 11. Collection 11. Cream-colored, very sandy, Chara stems, fossils rare.	36	11-28
2.	Peat, black, fossiliferous, with a little sand and tufa in collections 7 and 10; collections 8 and 9 contain wood fragments.	8	7-10
1.	Marl, cream-colored, consisting of Chara stems and nodules; fossiliferous; contains some clay in the three lower collections and minor amounts of sand and tongues of peat in the upper three collections; masses of tufa irregularly located throughout the unit.	12	1-6

PALEOECOLOGY

General Statement

Ecology for the individual species of mollusks in the Castalia deposit represents a compilation of facts assembled from articles by various authors. The data for the fresh-water species have been summarized from the following articles: Baker, 1911, 1916, 1918, 1919, 1920, 1922, 1928, 1929, 1931, 1935, 1937, and 1939a; Baker and Cahn, 1931; Dawson, 1911; Dennis, 1928; Dundee, 1957; Goodrich, 1945; Herrington, 1957; Leonard, 1950; Morrison, 1932; Russell, 1934; Taylor and Hibbard, 1955; Whittaker, 1921; and Winslow, 1921.

Data for the terrestrial species were summarized from the following articles: Archer, 1934 and 1938; Baker, 1935; Call, 1900; Dexter, 1956; Franzen, 1947; Franzen and Leonard, 1943; Goble and Leonard, 1943; Goodrich, 1932; Harry, 1952; Leonard, 1950; Levi and Levi, 1950; Morrison, 1939; Oughton, 1948; Pilsbry, 1940, 1946, and 1948; and Van Cleave, 1933.

This molluscan assemblage is unusual for its absence of Amnicolidae and Valvatidae. Their absence in the humus and peat units is expected because of the shallow water and deep mud bottom. In the marl units, however, the water was not only too shallow but also too warm. Some operculates are present but are confined wholly to the upper half of the deposit and are present only in very small numbers.

Sphaeriid Pelecypods

Pisidium casertanum (Poli) is found in smaller lakes and streams where it lives in the following habitats: protected bays where fine sand, mud, and ooze collect and where the animal lives among roots of vegetation or buried in the soft, black mud; a swampy shore with the water a few inches to a foot in depth and the bottom composed of soft, sticky mud filled with algae; and small ponds or swampy pools 1 to 1.5 feet in depth containing vegetation of Iris and Typha. The pH for this species is 7.6 and the fixed carbon dioxide 16.7 p.p.m.

Freshwater Operculate Gastropods

Pomatiopsis lapidaria (Say) is an amphibious species found in a variety of habitats which include marshes, temporary pools on the floodplains of small creeks, on grassy hummocks in wet pastures, in upland artesian-fed marshes, and under leaves. In one peculiar situation this species was found associated with Fossaria modicella on vertical sandstone bluffs, the two species intermingled on the same seepage area. P. lapidaria is not limited by stream size; it has been reported from bodies of water varying from temporary streams to fairly large rivers. The pH of the water in which it is found varies from 7.5 to 8.0. The features common to all the habitats of this species are a very moist substratum with enough sand to prevent the bottom from becoming mucky and an abundance of shade.

Pleurocera acutum tractum (Anthony). This species is a river or small lake form which occupies many kinds of habitats. It is decidedly a shallow water form, rare in water deeper than 1.5 feet. It is common on rocky shores in a swift current or on shores subject to violent wave action but is rarely found on a sand and mud bottom in slow currents.

Goniobasis livescens (Menke). A marly-clay bottom, among Chara, at a depth of 1 to 4 feet or a sand bottom, 6 feet deep, protected from wave action, are habitats for this species. It is also found on boulder and gravel bottoms, on exposed shores or points in water 0.5 to 4 feet in depth, and in streams among water-soaked leaves, branches, and logs. G. livescens lives in places containing abundant vegetation as well as places devoid of it. It is not found on muck, however, probably due to the muck's high acidity. This species flourishes best where the bottom is rocky, the depth of water from 3 to 20 feet, and there is little wave action and some vegetation. The pH of the water ranges from 7.4 to 8.0.

Freshwater Inoperculate Gastropods

Stagnicola umbrosa (Say) is an inhabitant of pond-like areas where the water is quiet and the vegetation thick. It is also found in ponds and sloughs which become more or less dry in summer. Additional information as to its ecology may be inferred from Stagnicola palustris elodes to which it is closely related. The latter is found in both clear and stagnant bodies of water and prefers a habitat where the water is not in motion and the vegetation abundant. It prefers protected bays of lakes and ponds and the margins of rivers most often but is sometimes found in swales. It is found on floating sticks, submerged vegetation, and stones. The malleated forms inhabit stagnant pools where the bottom is muddy and decayed vegetation present. The food of S. palustris elodes consists of both animal and vegetable matter. It feeds on algae, diatoms, rotten food, dead animals, and decayed vegetable matter. It lives in water with a pH of 7.4 and carbon dioxide content of 21.0 p.p.m.

Fossaria modicella (Say). This species is an inhabitant of small pools and is rarely found living in large bodies of water. F. modicella is usually found on mud flats along the edge of the water or a strip of muddy beach which is kept rather moist. It has also been found living among cat-tails associated with Physa gyrina and on rocks in shallow water near shore. It has even been observed clinging to vertical sandstone cliffs, in areas moistened by seepages from small springs. This species inhabits bodies of water whose pH is 7.0 and carbon dioxide content 13.0 p.p.m.

Fossaria obrussa decampi (Streng). This species is thought to occupy the same habitats as Fossaria obrussa. These situations include small bodies of water such as creeks, ponds, sloughs, bays, and marshy spots along river banks. The water is shallow and the bottom of soft, sticky mud filled with algae. F. obrussa decampi is found on sticks, stones, and any other debris that may be in the water or along its edge. It is sometimes seen upon mud flats of small streams and other such places. While seemingly rare today, it has been found living on a sandy silt bottom in water two feet deep on vegetation. F. obrussa decampi inhabits waters whose pH varies from 7.42 to 7.7 and whose fixed carbon dioxide ranges from 10.65 to 18.87 p.p.m.

Helisoma trivolvis (Say). This species is an inhabitant of quiet, shallow, more or less stagnant water. It flourishes in ponds or sloughs, even though they are choked with vegetation or polluted with decaying organic materials and is invariably absent from flowing streams. It also lives behind beach barriers, in large open swamps, and at the edges of lakes and streams. It may occasionally be found in stagnant pools by the roadside, clinging to rocks an inch or two below the water line, and adhering to the stems or lower surface of water lilies. The pH of the water in which it lives varies from 6.6 to 8.37 and the carbon dioxide content ranges from 7.5 to 30.56 p.p.m. The bottom is muddy or boggy and covered with vegetation which consists chiefly of Typha latifolia and several species of sedge. This species feeds on algae and other small organisms.

Planorbula armigera (Say). This species is found in large, open swamps, small ponded areas, the upper marshy portions of a bay, at the edges of marshes, and in ditches and small streams. The water is shallow (1 to 3 feet) and the bottom silty, muddy or boggy. P. armigera is sometimes found on deciduous logs and sticks. The vegetation growing on the bottom consists of

Typha, Scirpus, Potamogeton, Nymphaea, Castalia, Lemna, and Chara. The animal feeds on Castalia leaves and algae. The pH of the water varies from 6.6 to 7.6 and the fixed carbon dioxide ranges from 7.5 to 16.7 p.p.m. P. armigera prefers the quiet waters of a small lake or pond where there is abundant vegetation and a mud bottom. It is apparently capable of lying dormant in dry mud during the greater part of the year.

Promenetus exacuous (Say). This species generally lives near shore in quiet, shallow water on the under side of lily-pads, on sticks, and on stones along the margins of ponds just under the water. It is sometimes found in the shallow waters of streams where the current is slow and vegetation established, and on mud flats in quiet water. P. exacuous lives in water whose pH varies from 7.0 to 7.64 and whose carbon dioxide content ranges from 9.3 to 22.5 p.p.m. The bottom may be sandy silt, silt, or mud. The types of vegetation on which it is found are varied. The animal feeds on Castalia leaves and algae. The most important factors in its habitat seem to be its preference for cold water and the presence of vegetation.

Gyraulus altissimus (F. C. Baker). This species is the common planorbid of all Pleistocene deposits. Its status as a living form is most uncertain. Winslow (1921, p. 11) found it living in a fresh pond and small lake in North Dakota and Russell (1934, p. 35) reported it living in southern Saskatchewan. With the exception of these two occurrences, all other reports have listed G. altissimus as occurring only in fossil deposits. In these deposits, usually marl, it occurred most often with the following species: Fossaria obrussa decampi, Physa gyrina, Helisoma campanulatum, Promenetus exacuous, and Helisoma trivolvis.

The replacement of G. altissimus by Gyraulus parvus in the living fauna indicates a close association between the two species both in distribution and environment; therefore, the ecology of G. altissimus will be inferred from that of G. parvus.

G. altissimus was an inhabitant of quiet, shallow bodies of water, generally of small size. It may also have inhabited the shallow water of streams where the current was slow and vegetation flourished. The water in which it lived varied from 1.5 to 6.5 feet in depth and the bottom, which was sand, silt, or mud, supported a relatively dense cover of vegetation. The animal lived on and around the vegetation as well as on sticks and stones. The pH of the water in which it lived varied from 7.0 to 8.16 and the carbon dioxide content ranged from 8.16 to 30.56 p.p.m.

Gyraulus crista (Linnaeus). This species lives in shallow water among vegetation, under the bark of submerged logs, and on water-logged sticks and rotting leaves in stagnant water. The bottom is composed of mud or silt and is mucky in most places; the vegetation consists of Typha, Scirpus, Potamogeton, Nymphaea, Castalia, Lemna, and Chara. The food of this species is largely vegetal and algal in nature. G. crista may be restricted only to temporary bodies of water.

Ferrissia parallela (Haldeman). This species is found in enclosed bays, open swamps or small ponds, and swampy pools or swales. It is almost strictly a pond or small lake species, found in quiet waters whose depth varies from 1 to 6 feet and rarely occurs in sluggish streams. This species usually lives near the surface of the water but may be found on the lower part of such plants as Scirpus, near the bottom. It also lives on the under side of lily leaves (which gives a broad, flat look to the shell) and on sticks in boggy swales (here the shell is higher and more compressed). F. parallela lives in waters whose pH ranges from 6.05 to 8.37 and whose fixed carbon dioxide varies from 2.75 to 25.75 p.p.m. The bottom may be sand or mud covered with vegetation. The limiting factors for the distribution of this species are wave action (since it is found only in quiet water) and the presence of vegetation.

Physa gyrina (Say). This species lives in almost any kind of water body except swift-flowing streams. It has been found on muddy banks of rivers near the edge of the water, in small ponds, on lake beaches, and in swampy tracts along the edges of rivers. P. gyrina flourishes best in newly isolated ponds in which there is moderate growth of pondweed. It is a shallow-water form which inhabits a sandy silt or mud bottom, but is found most often on vegetation, generally on the upper side of pond lily leaves. The optimum conditions for its survival are shallow water which is unshaded, except by tall sedges; protection from wave and current action; a moderate amount of water weeds; and well aerated water. P. gyrina lives upon both animal and vegetable food, either fresh or partly decayed. This species does not attack or feed on living snails but will devour them once they are dead. It is an inhabitant of waters whose pH ranges from 7.1 to 8.37 and whose fixed carbon dioxide varies from 9.5 to 25.75 p.p.m.

Terrestrial Gastropods

Stenotrema monodon (Rackett) is a woodland snail found in marshes, wooded swamps along the banks of streams, on river floodplains, on shores of lakes, and in ravines adjacent to rivers. It is also present in tall grass prairies and open fields. This species thrives best in rather humid forests where its favorite hiding places are under logs, old stumps, leaves, and flat stones. The typical form of S. monodon is gregarious.

Triodopsis tridentata juxtidens (Pilsbry). This species is a forest dweller found among leaves and humus in open woods and in leaf mold on wooded hillsides. It has also been found living in stream drift which had been deposited on the roof of a limestone cave.

Haplotrema concavum (Say). This snail is seldom found in large numbers in any one locality. It prefers moist situations and has been found upon floodplains and in stream drift. It also lives in the loam deposits of forests, under logs, on stumps, in marl beds, and thickets of prickly ash; burrowing in clay. This species sometimes feeds on other snails.

Euconulus fulvus (Müller). This species is common in places which are moist and well-shaded but is sometimes found in open pastures. It is generally not found in large numbers. The favorite habitat of E. fulvus is the damp under side of decaying logs but it is also found living among damp leaves or other vegetation, in the cracks of bark, and between the bark and wood of fallen trees. It is quite common in lake and stream drift.

Retinella binneyana (Morse). This species is common in forests of birch, aspen, maple, cedar, fir, hemlock, spruce, and pine. Here it is found in several different situations but is most common under forest debris, at the base of stumps, under logs, and under the loose bark of fallen trees. This species also lives on lowlands which border lakes.

Retinella indentata (Say). This species is found in a variety of ecological situations. It prefers a drier habitat than does Retinella electrina although they are occasionally found together in moist situations. This species is found under rotten logs, loose bark and other forest debris, rocks in the grass of open fields, and decaying vegetation. It often burrows to a considerable depth in the under side of rotten logs and also frequents old stumps. R. indentata is rare in open country but sometimes lives on rocky slopes having only a sparse cover of trees and shrubs. It also lives in wooded ravines and along the banks of streams wherever trees and shrubs are present.

Hawaiia minuscula (Binney). This species prefers a woodland environment where it lives under leaves, among grass roots, under decaying logs, beneath the bark of trees, among mosses, beneath stones, on rocky ledges, and in loose, moist soil under a light layer of decaying vegetation. It is also common in stream drift. This species has also been reported near the borders of streams and lakes, but never in greater numbers than four or five individuals. H. minuscula is capable, in spite of its habitat preferences, of withstanding long periods of drought and high temperature.

Ventridens demissus (Binney). This is a woodland snail found crawling about at the base of grasses on damp ground in deciduous forests. It has also been reported on the bluffs overlooking the Kaskaskia River in Illinois, and on a railroad right of way near there.

Zonitoides arboreus (Say). This species occupies a wide range of ecological situations but prefers one that offers protection from the sun and provides a moderate amount of moisture. This species lives in woodlands under loosened bark, sticks, leaves, logs and stones. Its favorite habitats are around decaying logs, between the bark and wood of old fallen trees, and among decaying vegetation. It is also found in stream drift. This species is somewhat gregarious.

Helicodiscus parallelus (Say). This is primarily a woodland snail that lives among forest debris of various sorts. It may be found under bark, in cracks or creases of bark on fallen trees, under moss, in damp leaves, on decaying wood, and on stream drift. It also occurs in grassy fields, on sparsely timbered slopes, and on rocky ledges. The favorite habitats of this species are limestone ledges, on forest debris in stands of oak and hickory, under decaying vegetation, and among grass roots.

Punctum minutissimum (Draparnaud). This is a woodland species which lives under sticks, chips, decaying logs, and on damp leaves. It prefers the bark of beech trees and is frequently found in the large forms of fungi, such as Polyporus and Boletus. Hardwood growths appear to be its favorite habitat.

Oxyloma retusa (Lea). This is a species of marshes and other wet places. It commonly lives on mud flats above high water level along swampy shores, caused by a raising of the water level in a lake or pond. It is also found upon partly submerged sticks, on rotting weeds and often high on the stems of cat-tails. Other occurrences include: on plants along the edges of streams; on pieces of bark and wood on grass covered shores a few feet above water line; and on pond lily leaves in a community of Nymphaea and Castalia. It is frequently found in the company of lymnaeids.

Succinea avara (Say). This species has a wide range of habitat preferences. It lives in low, swampy areas crawling on the muddy banks of ditches, often exposed to the sun; under vegetable debris thrown up on muddy shores; on sticks, chips, or moss-covered rocks; under decaying logs; and in swampy places in pastures. This species has been observed climbing to a height of three feet on tall fronds in the water. It apparently thrives best on grass and reeds near or above the water in roadside ditches and similar situations. But it is an upland species as well, seen under stones, leaves, or logs with Pupillidae, or crawling up the trunks of trees after rains. In these dryer places it is of smaller size. Unlike Oxyloma retusa, it never congregates in large numbers.

Strobilops aenea (Pilsbry). S. aenea is an uplands species, in forests of oak, elm, hickory, dogwood, walnut, sassafras, and ironwood. It is rarely found in a floodplain valley and then only when the situation is dry. This species is most abundant under the loose bark of fallen trees, on the underside of decaying wood, and on chips from forest cuttings. It occurs both in old woods and recent cut-overs wherever logs and decaying wood have accumulated. S. aenea is often found associated with Strobilops labyrinthica.

Strobilops labyrinthica (Say). This species is generally confined to moist woodland habitats and is only rarely found far from the edge of the forest. It occurs most often around moist logs, among dead leaves, and in sod at the foot of trees. S. labyrinthica occasionally lives close to the water line under sticks, crawling about on old stumps and logs, and in the mossy crevices of rocks. It is often associated with Zonitoides arboreus and Retinella electrina.

Gastrocopta contracta (Say). This species is an inhabitant of shaded, wooded slopes where it lives under leaf mold and the bark of fallen logs. It also lives in the deep grass of marshes; on ferns in meadows; under sticks and driftwood; in loose soil around the roots of small trees, shrubs, tall grass, and weeds; and under leaves on the banks of small streams. This species is most numerous under forest litter in poorly drained areas near the bottom of hillsides. It is also abundant where loose limestone rock provides a cover.

Gastrocopta tappaniana (C. B. Adams). This species is found in low, moist places, in damp leaf mold, and under sticks, logs and stones on wooded slopes and poorly drained floodplains. It also lives under logs in swamps and among grass roots on open slopes. The wide latitudinal range of this species indicates that the annual mean temperature is not a primary factor in its distribution. G. tappaniana is often found with Vertigo ovata.

Pupoides albilabris (C. B. Adams). This species has a wide range of environmental conditions. It thrives in woodlands under leaf mold, loosened bark of dead trees, and stones. It is also found on wooded slopes in areas high enough not to be scoured of vegetation and mollusks by flooding during seasonal rains. This species has been found on trees a few feet above the ground following rains. In open country it lives in deep grass, among roots of short grass in unshaded areas, and in loose soil around roots of short grass in unshaded areas, and in loose soil around roots of tall grass and weeds. P. albilabris is generally more abundant in limestone areas than elsewhere. This species is unusual in its ability to flourish in arid regions as well as those of moderate annual rainfall. P. albilabris can withstand more heat and aridity than any other land snail of its area of distribution. It is abundant in places where almost no other mollusks occur.

Vertigo milium (Gould). This snail is an inhabitant of humid places, such as those afforded by marshes and wooded slopes near streams. It is found under sticks, bark, and stones, generally on low ground, but may also be found on hillsides under leaves. This species does not occur in regions where the humidity is low or there are high extremes of summer temperature. V. milium is a gregarious species.

Vertigo morsei (Sterki). This snail is found most often on the floodplains of creeks and rivers. It also occurs near the shores of lakes where it is found under dead woods, wood, etc. This species thrives in forests where there is abundant shade and moisture and prefers a stand of aspens as its favorite habitat.

Vertigo ovata (Say). This species prefers a moist environment afforded by shaded slopes near streams and the shores of ponds. It is found in swampy areas, along stream banks and other bodies of water, and under sticks and flat stones. V. ovata is abundant in meadows which have swampy areas in which Carex grows. The limiting factor for this species is a relatively high moisture requirement.

Carychium exiguum (Say). This species lives near the water or permanently moist situations. It is found on the wet underside of logs on the edges of ponds and swamps, on the margins of damp woods, and under leaves. This species prefers places that are very damp and is able to live for a long time in situations where most other land snails would be drowned. Constant high moisture and decaying vegetation appear to be the essential factors in its environment.

Carychium exile canadense (Clapp). This species lives on forest hillsides but is found most often in low, marshy woods on the forest floor. Here it may be found under rotting stumps, strips of bark, wet pieces of bark or wood, and under debris. C. exile canadense is found in drier places than C. exiguum and always at some distance from the water.

General Nature of the Castalia Deposit

Depth of water. The Castalia deposit was formed in the quiet waters of a large, shallow lake. The depth of water varied from a few inches to as much as six feet and this is clearly shown by quantitative changes of the species in the faunas. The presence of peat in the deposit is also indicative of an unsteady fluctuation of the water level. During formation of the marl, the water was deeper but where peat formed, the water level was lowered, often less than a foot. In changing from a low water level to a higher one, necessary for the formation of marl, additional water was supplied by seasonal rainfall and artesian-fed springs which abound throughout the area. Replenishment by springs is confirmed by block-like masses of tufa found in the different lithologic units of the deposit. The abundance of land snails indicates that the deposit was near shore and that a plentiful forest cover was present in the immediate vicinity.

Nature of the bottom. The composition of the bottom varied throughout the period of deposition. The deposit formed on blue lake-clay and the bottom consisted of sand, mud, and mixtures of the two.

Vegetation. The amount of vegetation varied during formation of the deposit but generally ranged from moderate to luxuriant in degree.

Hydrogen ion concentration and carbon dioxide content. The water in which the faunas lived had pH limits of 6.0 to 8.5 but the normal value was probably nearer 7.5. The carbon dioxide content may have varied from 2.85 to 30.56 p.p.m. throughout the history of the deposit but a mean value of 14.0 p.p.m. is more probable.

Food. The majority of the fresh-water species feed on vegetal matter consisting of the soft parts of plants, algae, and desmids. Some species, such as Ferrissia parallela, prefer dead and decaying vegetation. A fine detritus composed of disintegrated, decaying plant material floats about in the water and is also a source of food for many of these fresh-water snails. A number of species are omnivorous, eating dead animals as well as rotting and living plants; Physa gyrina is an excellent example. This species has been observed feeding on green shoots of Chara and Elodea, partly decayed leaves of grass and trees, and dead animal matter.

The food of terrestrial gastropods consists mainly of the fungal hyphae of decaying wood and leaves. The larger, fleshy fungi and seed plants also provide food but to a lesser extent. A source of lime is also needed for the continued growth of the shell. The snail obtains this supply from the skeletons of other animals, limestone rocks, soils rich in calcium, and plant food. The only predator among the land snails is Haplotrema concavum, but even it is not invariably a flesh eater.

Enemies. A large number of animals prey upon fresh-water mollusks, using them as food. Fish consume a large amount of snails. However, the proportion varies in different species. Some fish subsist entirely upon mollusks in the adult stage, and may be easily recognized by their flat, crushing teeth. Other fish eat only a few mollusks and many eat none. Fresh-water gastropods are also eaten by predatory insects such as dragon-fly nymphs, horse-fly larvae, giant water bugs, and water beetles. Crawfish, leeches, frogs, newts, salamanders, and turtles consume small quantities of snails. Water birds such as ducks and geese include snails in their diet. Mammals like the muskrat, mink, and otter feed on large quantities of mussel shells.

Nature may exterminate fresh-water gastropods through raising and lowering of the water level in the various bodies of water during droughts and floods. The overabundance of vegetation in shallow water is harmful to species like Physa gyrina. Man becomes an exterminator by polluting streams, rivers, and lakes with refuse from factories and mills; also by draining swamps and swampy areas. The shells of some mollusks are affected by boring plants (algae) which perforate the shell, thus destroying the epidermis and permitting carbon dioxide in the water to dissolve the calcium carbonate of the shell.

The enemies of terrestrial gastropods are legion. The occurrence of forest fires, modifications of the environment by changes in the plant community, and periods of prolonged drought are adverse factors. Man is also important as an exterminator of gastropods by burning large tracts of brush and draining soil to prepare land for farming or construction. The chief enemies of land snails in the animal world are the various kinds of mice and birds. A few insects are known to attack land snails and some of them, especially the Succineas, are infested with parasitic worms. Raccoon, squirrels, chipmunks, shrews, and moles all include snails as a part of their diet. Toads, frogs, and snakes also eat a limited quantity of them.

Environmental History

General Statement. Utilizing the data just given, a brief account of the geologic history of the deposit can be outlined. The units are discussed from oldest to youngest as they appear in the measured section, p. 21.

Unit 1, lower marl. The indigenous species of the first three collections in this unit lived in comparatively shallow water. Proof of this may be found by comparing the relative abundance of land versus freshwater shells. In these collections, the percentage of both types is approximately equal. Also, Gyraulus altissimus does not exceed 22 percent of the total individuals in any collection and Carychium exiguum has a maximum value of 22.5 percent. In collections 4 and 5, however, the water became deeper as may be observed by the great increase of freshwater species. In collection 6, the land genera became dominant again and introduced a longer period of numerical supremacy that continued throughout half of the peat unit.

Unit 2, peat. Domination by the land forms continued through collections 7 and 8. The swampy terrain was ideal for the hygrophilic land species and this is confirmed by their total abundances of 73 percent and 55 percent in these collections. Carychium exiguum increased to 38.5 percent while Gyraulus altissimus decreased to 20 percent. The bottom had now become choked with mud and vegetable debris and the water, though present the year round, was quite shallow. Conditions such as these were not suitable for such freshwater species as Physa gyrina and this is reflected by its low percentage (3.0 and 3.5) in these collections.

As the formation of peat drew to a close in collections 9 and 10, the freshwater species regained numerical supremacy just as the land genera did in collection 6. Vegetation became less dense as indicated by an increase of Physa gyrina. The water was shallow but increased in depth, confirmed by the high percentage of Planorbula armigera present. Ferrissia parallela another shallow water, vegetation-dwelling form, also increased beyond its normal percentage.

Unit 3, upper marl. The paucity of shells in collection 11 denotes an environment unfavorable for the freshwater snails. The critical event was a sudden influx of sand into the shallow water overlying the peat. The sand was carried by a sluggish stream from the higher beach line above and dropped around the vegetation in the shallow waters overlying the deposit. Microscopic examination of samples of the sand revealed no frosted grains verifying its origin as beach rather than dune sand. The presence of vegetation is readily confirmed by an extremely high percentage of Ferrissia parallela in the collection. As Gyraulus altissimus may live under a great variety of conditions, its presence is to be expected. The high percentage of Physa gyrina is a result of the snail inhabiting the waters of the sluggish stream and being transported by it into the depositional area.

Collection 12 also contained sand but in a minor amount. Stream deposition of the sand was reduced and then terminated altogether either because the stream was an intermittent one or because it changed course and emptied into another portion of the lake. With the end of sand deposition, the snails became more abundant. The bottom was mucky in the upper part of the collection and Helisoma trivolvis became abundant. The shallow water and moderate growth of vegetation continued to make Physa gyrina the most abundant species. Gyraulus altissimus was found in greater numbers than in collection 11.

In the next three collections the water deepened a little, although the level of the water was still rather low. Thus Gyraulus altissimus increased and Physa gyrina showed a considerable decrease in numbers. In collections 16 to 18 the depth of water reached the optimum level for Gyraulus altissimus to flourish while Physa gyrina continued to decrease. Following this the water became shallower once again and Gyraulus altissimus decreased as Physa gyrina increased. Fossaria obrussa decampi found conditions most favorable for its development and is more abundant here than in any other collection.

Collections 23 to 26 show a slight increase in the depth of water with a consequent rise in numbers of Gyraulus altissimus and a decrease of Physa gyrina. Conditions were still favorable for Fossaria obrussa decampi. In the last two collections of the marl unit the depth of water decreased once more. Vegetation became more abundant and the bottom muddy. Gyraulus altissimus decreased somewhat as did both Physa gyrina and Fossaria obrussa decampi.

Unit 4, humus. In the last two collections the total percentage of land snails became greater than the freshwater species. The water level once again was very low and the bottom choked with vegetation. A deep mud bottom was present and the formation of peat took place.

QUANTITATIVE DISTRIBUTION

Variation with Lithology

General Statement. The faunas of the Castalia deposit begin in the collection immediately overlying the blue lake-clay and continue throughout the various lithologic units. The change in abundance of shells from one collection to another is the direct result of a change in environmental conditions. A graphic representation of the total number of shells in each collection is shown in fig. 3 (opposite p. 32).

Unit 1, lower marl. Collection 1 contains 2,400 shells but was undoubtedly more populated than is shown. The factor here is one of human error. The collection, when extracted from the section, was saturated with running water making it difficult to judge the normal amount of sample. Were it not for this, the collection should have contained as many shells as the two directly above it since all three collections have the same lithology. In collections 5 and 6 the shells increase abruptly. Collection 6 contains more than twice the number of shells as the collection below it. The land snails constitute the greatest percentage of individuals in collection 6 due to a change in lithology. The clay and sand of the previous collections are replaced by peat, which indicates more favorable conditions for the land snails.

Unit 2, peat. Collection 7 is as replete with shells as collection 6 and the land snails are still dominant. The collection includes a little sand and contains more shells than any other collection in the peat unit. There is a sharp drop in the number of shells in collection 8 but the land snails are still more abundant. In collections 9 and 10 the amount of shells increases once again and the freshwater species regain numerical superiority. A small amount of sand is present in collection 10.

Unit 3, upper marl. Collections 10 and 11 contain large amounts of sand and very few shells. The number of shells increases as rapidly in collections 13 to 15 as they decreased in 11 and 12. There is less sand and more peat members appear in the gray marl. A band of cream-colored marl occurs above this in the next two collections and the number of shells decreases. The gray marl reappears in collections 18 to 20 and collection 18 contains the greatest number of shells in the deposit. In collections 21 and 22 the cream-colored marl reappears and the shells decrease. Collections 23 to 28 are a mixture of gray and cream-colored marl and, with the exception of collections 27 and 28, show a nearly uniform abundance of shells. The land snails become dominant in collections 27 and 28 and remain so for the last two collections in the deposit.

Abundance by Groups

Of the four groups represented, the freshwater pulmonates are the most numerous, constituting a majority in two-thirds of the collections. The freshwater gill-breathers are present in twelve of the collections but only in very small numbers. The land snails constitute a majority in one-third of the collections but are present throughout the remaining collections in minor amounts. The pelecypods are an insignificant group in the Castalia deposit. They are represented in small numbers by only one species.

Abundance by Species

Indigenous freshwater species. The indigenous species are those which lived and flourished where the deposit formed. They generally comprise the greatest percentage of the faunas. Some species, however, were present in minor amounts and still inhabited the depositional area. They, therefore, must also be considered indigenous. The following four species, all lung breathers, are indigenous.

Gyraulus altissimus is the most abundant species in the deposit. It varies from 13 to 55 percent throughout the collections and is most abundant in the cream-colored marl (collections 5, 16, 17, and 18) where it exceeds 50 percent of the total individuals in the collections (see fig. 4, opp. p. 32). Fossaria obrussa decampi is the second most abundant species in the deposit.

It is most abundant in the gray marl (collections 14, 15, 18, 19, and 20) and least abundant in the peat unit and sandy collections (11 and 12) of the upper marl unit. (See fig. 5). Physa gyrina shows its greatest abundance in the sandy collections (11 and 12) of the upper marl unit. Excluding these high percentages, it is still more abundant in the marl units than elsewhere in the deposit. (See fig. Ferrissia parallela is present in twenty-six collections. It is most abundant in collections 9 and 10 of the peat unit and the very sandy marl collection (11) above it. Ferrissia parallela is not present in collections 14 to 17, but reappears in smaller numbers throughout the remaining collections of the deposit (Fig. 7, opp. p. 34).

Non-indigenous freshwater species. The intruders did not inhabit the place of deposition but were washed, floated, or blown into it. Some species lived in other parts of the lake and others were washed into the lake by streams that emptied into it. The ten remaining freshwater species are intruders. The first six species discussed are lung breathers, the next three are gill-breathers, and the last species is a pelecypod.

Helisoma trivolvis occurs in only eight collections and these are all below collection 14. Collection 12 contains seven specimens and represents its greatest abundance in the deposit. This would seem significant, in view of its large size, but the fact that it is found in a sandy marl where no muck bottom exists would discount its importance. Planorbula armigera is found in all but eight collections. It reaches its greatest abundance in the first ten collections. Found in considerable numbers throughout the lower marl, it becomes most numerous in collections 8 and 9 of the peat unit. Its preference for stagnant, shallow water would account for this. It is virtually absent in collections 11 to 22, but is present in very small amounts in the collections above. Gyraulus crista is present in small numbers in the top part of the upper marl unit. There are also individual specimens in four of the remaining collections of the deposit. Fossaria modicella occurs mainly in the lower marl. It is more numerous in collections 2 and 3, and the top seven collections of the upper marl unit. Promenetus exacuous is represented by individual specimens in collections 20, 23, 24, and 25 of the upper marl unit. Stagnicola umbrosa occurs as individual specimens in collections 4 and 6 of the lower marl unit and 23 and 25 of the upper marl unit.

Pomatiopsis lapidaria is present in small numbers mainly in the top part of the upper marl unit and in the humus unit. Pleurocera acutum tractum occurs as a single specimen in collection 4 of the lower marl unit. Goniobasis livescens is represented by two specimens in collection 26 of the upper marl unit and one specimen in collection 30 of the humus unit.

Pisidium casertanum is present in twenty-three collections but does not exceed 5 percent of the total individuals in any collection. It is most abundant in collections 24 and 25 of the upper marl unit.

DESCRIPTION OF FIGURES 3 - 6 (OPPOSITE PAGE)

Fig. 3. Graphic representation of the total individuals in each collection of the Castalia deposit.

Fig. 4. Quantitative distribution of Gyraulus altissimus (F. C. Baker) in the Castalia deposit.

Fig. 5. Quantitative distribution of Fossaria obrussa decampi (Streng) in the Castalia deposit.

Fig. 6. Quantitative distribution of Physa gyrina (Say) in the Castalia deposit.

COLLECTION AND UNIT		TOTAL INDIVIDUALS	GRAPHIC REPRESENTATION OF TOTAL INDIVIDUALS 5 10 15 20 25 30
4	30	12,000	
	29	6,000	
3	28	5,755	
	27	3,702	
	26	9,600	
	25	12,000	
	24	12,000	
	23	12,000	
	22	7,636	
	21	14,000	
	20	19,500	
	19	28,000	
	18	31,200	
	17	16,666	
	16	8,323	
	15	26,400	
	14	27,333	
	13	12,727	
	12	1,560	
	11	280	
2	10	9,454	
	9	7,077	
	8	4,560	
	7	22,500	
1	6	22,666	
	5	10,240	
	4	6,470	
	3	5,176	
	2	5,200	
	1	2,400	

FIGURE 3

COLLECTION NUMBER	NUMBER OF INDIVIDUALS	PERCENT OF TOTAL INDIVIDUALS	GRAPHIC REPRESENTATION OF PERCENTAGE OF TOTAL INDIVIDUALS 10 20 30 40 50
30	220	22.0	
29	243	24.3	
28	276	27.6	
27	287	28.7	
26	406	40.6	
25	437	43.7	
24	431	43.1	
23	447	44.7	
22	315	31.5	
21	275	27.5	
20	284	28.4	
19	405	40.5	
18	530	53.0	
17	528	52.8	
16	504	50.4	
15	273	27.3	
14	286	28.6	
13	400	40.0	
12	192	24.6	
11	22	15.7	
10	326	32.6	
9	315	31.5	
8	203	20.3	
7	130	13.0	
6	171	17.1	
5	552	55.2	
4	482	48.2	
3	220	22.0	
2	164	16.4	
1	190	19.0	

FIGURE 4

COLLECTION NUMBER	NUMBER OF INDIVIDUALS	PERCENT OF TOTAL INDIVIDUALS	GRAPHIC REPRESENTATION OF PERCENTAGE OF TOTAL INDIVIDUALS 10 20 30 40 50
30	111	11.1	
29	135	13.5	
28	135	13.5	
27	122	12.2	
26	100	10.0	
25	204	20.4	
24	236	23.6	
23	234	23.4	
22	290	29.0	
21	367	36.7	
20	443	44.3	
19	395	39.5	
18	328	32.8	
17	219	21.9	
16	211	21.1	
15	267	26.7	
14	245	24.5	
13	165	16.5	
12	147	18.8	
11	6	4.3	
10	111	11.1	
9	74	7.4	
8	60	6.0	
7	50	5.0	
6	69	6.9	
5	76	7.6	
4	75	7.5	
3	92	9.2	
2	164	16.4	
1	177	17.7	

FIGURE 5

COLLECTION NUMBER	NUMBER OF INDIVIDUALS	PERCENT OF TOTAL INDIVIDUALS	GRAPHIC REPRESENTATION OF PERCENTAGE OF TOTAL INDIVIDUALS 10 20 30 40 50
30	41	4.1	
29	43	4.3	
28	35	3.5	
27	44	4.4	
26	50	5.0	
25	56	5.6	
24	94	9.4	
23	150	15.0	
22	150	15.0	
21	150	15.0	
20	108	10.8	
19	67	6.7	
18	72	7.2	
17	101	10.1	
16	90	9.0	
15	133	13.3	
14	181	18.1	
13	173	17.3	
12	261	33.5	
11	53	37.9	
10	239	23.9	
9	134	13.4	
8	35	3.5	
7	30	3.0	
6	60	6.0	
5	155	15.5	
4	164	16.4	
3	79	7.9	
2	82	8.2	
1	61	6.1	

FIGURE 6

Land snails. The following three species are considered indigenous. While not actually living in the body of water, they were nevertheless found in abundance at or near the edge of it. Carychium exiguum is the most abundant land species. It is absent only in collection 19 and elsewhere ranges from 0.4 to 39 percent. It is present in considerable numbers in all collections except 16 to 21 of the upper marl unit. Carychium exiguum is most abundant in collection 6 of the lower marl unit and collection 7 of the overlying peat unit (See fig. 8, opp. p. 34). Gastrocopta tappaniana is the second most abundant land snail in the deposit. It is present in all collections and varies from 1.3 to 19.5 percent. This species is most abundant in collections 13 to 15 of the upper marl unit. It is also numerous in collections 1, 2, and 6 of the lower marl, collections 27 and 28 of the upper marl, and the humus unit. (See fig. 9, opp. p. 34). Oxyloma retusa, while not as numerous as Gastrocopta tappaniana or Carychium exiguum, was still an inhabitant of the water's edge. It is generally more numerous in the upper marl unit and percentages in the other units are considerably lower. See fig. 10, opp. p. 34.

The following species, while not indigenous, inhabited the mud flats not far from the edge of the water. Vertigo morsei is most abundant throughout the upper marl unit. It is also fairly numerous in the peat and humus units. Strobilops labyrinthica, generally a woodland species, is occasionally found close to the water under sticks and stones. This was probably the case in collections 1, 2, 3, and 6 of the lower marl unit; collections 7 and 8 of the peat unit; collections 27 and 28 of the upper marl unit; and the humus unit. The species is much more numerous in these collections than elsewhere in the deposit. Succinea avara is found chiefly in the upper marl unit but in very small numbers. This is normal as this species is not known to congregate in large numbers.

The following forest species number less than 1 percent in most collections and never more than 4 percent. The higher percentages are usually in collections where the forest cover was more abundant. These species are: Retinella binneyana, Punctum minutissimum, Carychium exile canadense, Zonitoides arboreus, Retinella indentata, Helicodiscus parallelus, Euconulus fulvus, Vertigo milium, and Gastrocopta contracta.

The remaining forest species are represented in insignificant numbers. None of the species exceeds six specimens in any one collection or totals more than seventeen in the entire deposit. These species are: Ventridens demissus, Haplotrema concavum, Pupoides albilabris, Stenotrema monodon, Strobilops aenea, Vertigo ovata, and Triodopsis tridentata juxtidens.

AGE AND CORRELATION OF DEPOSIT

Comparison with Pleistocene Faunas

General Statement. The Castalia deposit is compared with other deposits from the standpoint of both similarities and differences. The comparison is made on geologic geographic, and ecologic bases. In this way, a more accurate determination of age may be established.

Middletown, Ohio deposit. Sterki's (1907) "pre-glacial" deposit contains no quantitative data. Both land and freshwater species are present. Those marked with an asterisk in the following list are present in the Castalia deposit. The list is composed of the following species (names have been brought up to date): Mesodon elevatus, *Haplotrema concavum, Anguispira alternata, Stenotrema hirsutum, *Stenotrema leaii, Mesodon thyroidus, Allogona profunda, Triodopsis tridentata, Goniobasis sp., *Helisoma trivolvis, Anguispira kochi, *Pomatiopsis lapidaria.

Wayne's (1958, p. 11) quantitative study of a pro-Kansan loess reveals a total of twenty species, eighteen of which are terrestrial. Only six of these are found in the Castalia deposit. The dissimilar species are the following: Stenotrema hirsutum, Oxyloma decampi gouldi, Retinella electrina, Gastrocopta proarmifera, Discus cronkhitei, Columella edentula, Vallonia cf. V. excentrica, Cionella lubrica, Hendersonia occulta, Pupilla muscorum, Vertigo alpestris oughtoni, Vertigo elatior, Vertigo gouldi hubrichti, Vertigo cf. modesta.

Cleveland loess, Ohio. This early Wisconsin loess described by Leonard (1953) contains essentially terrestrial faunules. Five freshwater species are present but only Gyraulus pattersoni is represented by more than one specimen. This deposit is included here to show the composition of early Wisconsin terrestrial faunules and to compare them with the terrestrial species in the Castalia deposit. Twenty species occur in the loess but only six of them also occur in the Castalia deposit.

Orleton Mastodon Site, Ohio. The Orleton deposit, of late Wisconsin age, contains both land and freshwater species (La Rocque, 1952). It is much smaller than the Castalia deposit, but contains a surprising number of identical species. Of the twenty-one species present, the following eleven are found in the Castalia deposit: Helisoma trivolvis, Planorbula armigera, Gyraulus altissimus, G. crista, Promenetus exacuous, Physa gyrina, Ferrissia parallela, Oxyloma retusa, Stenotrema leaii, Hawaiia minuscula, Vertigo ovata. Five of the remaining species, while not identical, nevertheless occupy the same type of environment as five of the species in the Castalia deposit. Another similarity exists in the absence of amnicolids in both deposits. Valvata lewisi, an operculate, is not found in the Castalia deposit but three other operculates are present. A significant ecological difference between the two deposits is the presence of Musculium and Sphaerium in the Orleton deposit. The Castalia deposit compares favorably with the black layer of the Orleton deposit but not with the gray layer and the percentages of identical species in each of the deposits are quite different.

Rush Lake, Ohio. This molluscan assemblage, post-Wisconsin in age, is thought to have lived in a larger Rush Lake (Baker, 1920, p. 441). It is discussed here because it contains both Amnicola and Valvata, both of which are not found in the Castalia deposit. Amnicola lustrica and Amnicola leightoni compose the greatest percentage of total specimens in the deposit. Two species (four varieties) of Valvata are present but in rather small numbers. Gyraulus altissimus, third in abundance, is found in the Castalia deposit. This deposit is also distinct from the Castalia deposit by the presence of Naiad fragments and the absence of land snails. The only species common to the Castalia deposit are Gyraulus altissimus, Promenetus exacuous, Fossaria obrussa decampi, and Ferrissia parallela.

Toronto Interglacial Fauna. This fauna, described by Baker (1931), whose exact age is still in dispute, is given to show the contrast between a Great Lakes fauna and that of the

DESCRIPTION OF FIGURES 7 - 10, OPPOSITE PAGE

Fig. 7. Quantitative distribution of Ferrissia parallela (Haldeman) in the Castalia deposit.

Fig. 8. Quantitative distribution of Carychium exiguum (Say) in the Castalia deposit.

Fig. 9. Quantitative distribution of Gastrocopta tappaniana (C. B. Adams) in the Castalia deposit.

Fig. 10. Quantitative distribution of Oxyloma retusa (Lea) in the Castalia deposit.

COLLECTION NUMBER	NUMBER OF INDIVIDUALS	PERCENT OF TOTAL INDIVIDUALS	GRAPHIC REPRESENTATION OF PERCENTAGE OF TOTAL INDIVIDUALS (1 2 3 4 5)
30	2	0.2	
29	3	0.3	
28	5	0.5	
27	3	0.3	
26	8	0.8	
25	4	0.4	
24	5	0.5	
23	3	0.3	
22	4	0.4	
21	2	0.2	
20	3	0.3	
19	1	0.1	
18	1	0.1	
17	0	0.0	
16	0	0.0	
15	0	0.0	
14	0	0.0	
13	3	0.3	
12	1	0.1	
11	30	21.4	21.4
10	84	8.4	8.4
9	55	5.5	
8	15	1.5	
7	2	0.2	
6	4	0.4	
5	6	0.6	
4	25	2.5	
3	13	1.3	
2	19	1.9	
1	30	3.0	

FIGURE 7

COLLECTION NUMBER	NUMBER OF INDIVIDUALS	PERCENT OF TOTAL INDIVIDUALS	GRAPHIC REPRESENTATION OF PERCENTAGE OF TOTAL INDIVIDUALS (10 20 30 40 50)
30	135	13.5	
29	165	16.5	
28	192	19.2	
27	192	19.2	
26	207	20.7	
25	94	9.4	
24	80	8.0	
23	68	6.8	
22	27	2.7	
21	16	1.6	
20	7	0.7	
19	0	0.0	
18	4	0.4	
17	11	1.1	
16	14	1.4	
15	42	4.2	
14	55	5.5	
13	103	10.3	
12	35	4.6	
11	1	0.7	
10	46	4.6	
9	84	8.4	
8	234	23.4	
7	385	38.5	
6	390	39.0	
5	93	9.3	
4	73	7.3	
3	215	21.5	
2	200	20.0	
1	225	22.5	

FIGURE 8

COLLECTION NUMBER	NUMBER OF INDIVIDUALS	PERCENT OF TOTAL INDIVIDUALS	GRAPHIC REPRESENTATION OF PERCENTAGE OF TOTAL INDIVIDUALS (10 20 30 40 50)
30	150	15.0	
29	112	11.2	
28	112	11.2	
27	108	10.8	
26	63	6.3	
25	38	3.8	
24	33	3.3	
23	43	4.3	
22	70	7.0	
21	85	8.5	
20	78	7.8	
19	68	6.8	
18	13	1.3	
17	27	2.7	
16	82	8.2	
15	195	19.5	
14	169	16.9	
13	104	10.4	
12	57	7.4	
11	10	7.1	
10	33	3.3	
9	40	4.0	
8	57	5.7	
7	81	8.1	
6	100	10.0	
5	36	3.6	
4	32	3.2	
3	80	8.0	
2	115	11.5	
1	109	10.9	

FIGURE 9

COLLECTION NUMBER	NUMBER OF INDIVIDUALS	PERCENT OF TOTAL INDIVIDUALS	GRAPHIC REPRESENTATION OF PERCENTAGE OF TOTAL INDIVIDUALS (1 2 3 4 5)
30	24	2.4	
29	30	3.0	
28	25	2.5	
27	20	2.0	
26	15	1.5	
25	12	1.2	
24	10	1.0	
23	34	3.4	
22	55	5.5	
21	55	5.5	
20	78	7.8	7.8
19	43	4.3	
18	56	5.6	
17	71	7.1	7.1
16	63	6.3	6.3
15	48	4.8	
14	30	3.0	
13	32	3.2	
12	67	8.7	8.7
11	14	10.0	10.0
10	21	2.1	
9	8	0.8	
8	4	0.4	
7	2	0.2	
6	3	0.3	
5	7	0.7	
4	8	0.8	
3	3	0.3	
2	14	1.4	
1	22	2.2	

FIGURE 10

Castalia deposit. No quantitative data are given but the contrast becomes most apparent in the presence and abundance of Naiades. Of the twenty-six species present, only Gyraulus altissimus is found in the Castalia deposit. The species are as follows: Amblema rariplicata, Ligumia recta, Lampsilis siliquoidea rosacea, Elliptio dilatatus, Pleurobema coccineum solidum, Lampsilis ventricosa, Obovaria olivaria, Anodonta grandis, Quadrula pustulosa, Sphaerium n. sp., S. emarginatum, S. sulcatum, S. solidulum, Pisidium compressum, Pleurocera acutum, Goniobasis haldemani, Stagnicola palustris elodes, Gyraulus altissimus, Helisoma anceps striatum, Vancleaveia emarginata canadensis, Cincinnatia cincinnatiensis, Physa niagarensis, P. sayii, Birgella subglobosa, Valvata tricarinata, Campeloma rufum.

Castalia marl. Perhaps the most interesting comparison is with Sterki's (1920, pp. 178-183) list of species from the Castalia marl. From his total of eighty species, fifty are land snails and thirty are freshwater species. The writer's list of fourteen freshwater species and twenty-three land snails totals only thirty-seven species. Eighteen species of land snails and eight freshwater species are common to both lists. The species are as follows (the nomenclature has been brought up to date): Freshwater species, Fossaria modicella, Helisoma trivolvis, Gyraulus crista, Planorbula armigera, Physa gyrina, Goniobasis livescens, Pomatiopsis lapidaria, Pisidium casertanum; Terrestrial species, Zonitoides arboreus, Hawaiia minuscula, Retinella indentata, Euconulus fulvus, Haplotrema concavum, Helicodiscus parallelus, Punctum minutissimum, Stenotrema monodon, Strobilops labyrinthica, Pupoides albilabris, Gastrocopta contracta, G. tappaniana, Vertigo ovata, V. morsei, V. milium, Oxyloma retusa, Succinea avara, Carychium exiguum.

The vast difference in total number of species between the two lists results from Sterki's method of collection. His specimens, instead of being taken from a measured section, were obtained in the following manner (1920, p. 177): "At some places they (the shells) were found in extraordinary numbers; for example, in a perpendicular, artificial bluff at the end of a digging, about four feet from the surface, there was a layer about three inches thick, which was chiefly composed of small and minute shells. The marl of this layer was quite soft, loose, and of finer grain than above and below, and through atmospheric influences had disintegrated to fine sand and dust. The dust and clean shells had accumulated on a narrow ledge at the foot of the bluff. Somewhat less than a quart of it was scooped up and taken along .... Most of the larger shells were picked up at various places where a steam shovel had been working but many were taken in situ. Siftings for the smaller ones were gathered here and there, especially where they had been washed together by rains."

Sterki (1920, p. 177) also states that not only do the land snails predominate in the number of species, but also that "the proportion is still more marked with the number of specimens." In the writer's measured section the land snails were more abundant in only 9 of the 30 collections but never exceeded 60 percent of the total individuals in any of these collections.

Age of the Faunas

General Statement. An age determination by means of molluscan faunas is sometimes uncertain, not only due to the close similarity of Pleistocene and living faunas, but also to the fact that few assemblages have received enough detailed treatment to compare with newly discovered faunas. The age of the Castalia deposit has been established with reasonable certainty, however, not only from molluscan faunas but also from a radiocarbon dating of wood fragments in one of the peat layers in the Castalia marl.

Age determination by molluscan faunas. There can be no doubt that the Castalia deposit was formed during the Pleistocene. Of the 37 species present, only four are found in Pliocene deposits. Age ranges for all of the species were sought in the literature but only 24 were found. These 24 include all of the species important from a quantitative standpoint. An exception to this statement is Physa gyrina, one of the more abundant species in the deposit. This is not as important as it might seem, however, as the identifications of species of Physa have been changed too frequently to be reliable.

Records of the 24 species reveal the following facts: only three species are absent from sediments of early Wisconsin time; six species are absent from sediments of Kansan age; 11 species are not present in sediments of Aftonian age; and 16 species are not found in deposits of Nebraskan age. These data alone would rule out an age older than a Kansan one. A late Wisconsin age seems to be the most probable. All of the species of the deposit are found living today except Gyraulus altissimus and this would indicate at least a Wisconsin age. The inference that G. altissimus is extinct must be made with some reservations. While extinct in Ohio, it has been reported living in southern Saskatchewan (Russell, 1934) and in North Dakota (Winslow, 1921). From a quantitative standpoint, it should also be kept in mind that G. altissimus is the most abundant species in the deposit. A land species, Carychium exile canadense, is also extinct in Ohio but has been found living in other states. This would also support a late Wisconsin age.

Fossaria obrussa decampi, second most abundant in the deposit, has not been found as yet in deposits older than late Wisconsin. Although abundant as a Pleistocene fossil, it is rare in recent faunas. Baker (1935, p. 270) believes the form to be nearing extinction. The only living occurrence in Ohio is noted by Sterki (1920, p. 174) who states that it has been found living in Summit County. This identification could be wrong, however, as he states that the few specimens found little resembled the normal decampi. Considering that this is a variety of a species, Sterki's identification may not bear much weight because it is possible that the form has merely been misidentified in earlier deposits. It may be also added that misidentifications are not always restricted to varieties. One has only to consider the present state of the genus Physa and the former confusion which existed in identification of the Sphaeriids. Assuming that Sterki's identification could be wrong, the two most abundant species in the deposit are extinct in Ohio. This furnishes additional evidence from a quantitative standpoint. With the facts and assumptions presented above, a late Wisconsin age is therefore advocated for the Castalia deposit.

Age determination by radiocarbon dating. While it is a fact that the stages of the Great Lakes occurred during Wisconsin time, the times at which the different shorelines were formed was not known. Radiocarbon dating has supplied the answers and is used here as additional and more exact evidence for a dating of the Castalia deposit. Wood from a layer in front of the Grassmere level in the Castalia marl has been dated at 8,513 years by radiocarbon, plus or minus 500 years (Libby, 1951, p. 292). Since the Castalia deposit is located on the Elkton level just below the Grassmere (see fig. 2), the age of the Castalia deposit is probably a thousand years less than the figure given above, making the period of formation between 7,000 and 8,000 years ago. Thus the late Wisconsin age indicated by the Mollusca is substantiated.

ACKNOWLEDGEMENTS

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MOLLUSCS in ARCHAEOLOGY and THE RECENT, 2

Number 2 of this mimeographed circular (pages 8-15, December 15, 1960) has just reached us. It is edited by Robert J. Drake, Department of Zoology, University of British Columbia, Vancouver 8, B.C., Canada. This number contains brief reviews of 31 papers dealing with ethnoconchology, some of which may also be of interest to readers of STERKIANA. These notes are a valuable supplement to the paper on Ethno-Conchology by R. J. Lambert, Jr. (STERKIANA, No. 2, pp. 1-8, 1960) and it is hoped that our friend Bob Drake will continue to collect and distribute this kind of information.

CHECKLIST OF NEW BRUNSWICK NON-MARINE MOLLUSCA

A. LA ROCQUE

Little collecting has been done in New Brunswick, one of the Maritime Provinces of Canada adjoining Maine, Quebec, and Nova Scotia. Nevertheless, printed records go back at least to 1884 (see References Cited, Matthew) and others have appeared at intervals since then. The writer's Catalogue (La Rocque, 1953) incorporated some of these records but statements on range were necessarily brief so that New Brunswick is not mentioned specifically under individual species unless that province happened to be the eastern margin of its range. Comparison of the list given below with those for adjoining areas will show that many more mollusks probably occur in New Brunswick than the records indicate. Perhaps this list will stimulate collectors to greater activity in the area. The pages of STERKIANA will be open to anyone wishing to supplement the following list.

1. NAIADES

1. ALASMIDONTA UNDULATA (Say) 1817. Nylander 1914: 140. La Rocque 1953: 86.

2. ANODONTA MARGINATA Say 1817. Nylander 1914: 140. La Rocque 1953: 88.

3. ELLIPTIO COMPLANATUS (Dillwyn) 1817 Whiteaves 1895: 10. Nylander 1914: 140. La Rocque 1953: 91.

4. MARGARITIFERA MARGARITIFERA (Linnaeus) 1758. Nylander 1914: 140. Latchford 1911: 19, St. Croix River, near St. Stephens. La Rocque 1953: 85.

2. SPHAERIIDAE

5. SPHAERIUM STRIATINUM (Lamarck) 1818 Nylander 1914: 140. La Rocque 1953: 116.

3. FRESHWATER PULMONATES

6. FERRISSIA BOREALIS (Morse) 1864. Nylander 1914: 140. La Rocque 1953: 295.

7. GYRAULUS DEFLECTUS (Say) 1824. Nylander 1914: 141. La Rocque 1953: 294.

8. HELISOMA ANCEPS (Menke) 1830. Nylander 1914: 141. La Rocque 1953: 286.

9. ?HELISOMA ANCEPS AROOSTOOKENSE (Pilsbry) 1895. Nylander 1914: 141 (Maine only), possible for New Brunswick. La Rocque 1953: 287.

10. HELISOMA ANCEPS PORTAGENSE (Baker) 1908. Nylander 1914: 141. La Rocque 1953: 287.

11. HELISOMA CAMPANULATUM (Say) 1821. Nylander 1914: 141. La Rocque 1953: 288.

12. HELISOMA TRIVOLVIS (Say) 1817. Nylander 1914: 141. La Rocque 1953: 291.

13. PHYSA ANCILLARIA Say 1825. Nylander 1914: 141, not mentioned for New Brunswick but present in adjacent parts of Maine and Quebec. La Rocque 1953: 297.

14. PHYSA HETEROSTROPHA Say 1817. Nylander 1914: 140. La Rocque 1953: 298.

15. PHYSA SAYII Tappan 1839. Nylander 1914: 141. La Rocque 1953: 300.

16. STAGNICOLA EMARGINATA CANADENSIS (Sowerby) 1872. Nylander 1914: 140, Temiscouata Lake, Quebec, only; possible for New Brunswick. La Rocque 1953: 277.

18. STAGNICOLA EMARGINATA MIGHELSI (Binney) 1865. Nylander 1914: 140, Maine only; possible for New Brunswick. La Rocque 1953: 277.

5. LAND GASTROPODA

19. ANGUISPIRA ALTERNATA (Say) 1816. Matthew 1884. Bailey 1903: 15. La Rocque 1953: 320.

20. ARION CIRCUMSCRIPTUS Johnston 1828. La Rocque 1953: 323. Dundee and Dundee 1958: 52.

21. CARYCHIUM EXIGUUM (Say) 1822. Bailey 1903: 15. La Rocque 1953: 339.

22. CEPAEA HORTENSIS (Müller) 1774. Bailey 1903: 15. La Rocque 1953: 339.

23. CIONELLA LUBRICA (Müller) 1774. Bailey 1903: 15. La Rocque 1953: 339.

24. DISCUS CRONKHITEI (Newcomb) 1865. Bailey 1903: 15 (Patula striatella). Nylander 1914: 141 (Pyramidula). La Rocque 1953: 321.

25. EUCONULUS FULVUS (Müller) 1774. Bailey 1903: 15 (Zonites fulvus). La Rocque 1953: 311.

26. GASTROCOPTA CORTICARIA (Say) 1816. Bailey 1903: 15 (Pupa). La Rocque 1953: 331.

27. HELICODISCUS PARALLELUS (Say) 1821. Bailey 1903: 15 (H. lineatus). La Rocque 1953: 322.

28. HYGROMIA HISPIDA (Linnaeus) 1758. Bailey 1903: 15 (Fruticicola). La Rocque 1953: 302.

29. MESODON SAYANUS (Pilsbry) 1906. Matthew 1884 (Helix Sayii Binney). Bailey 1903: 15 (Mesodon sayii). La Rocque 1953: 305.

30. OXYCHILUS CELLARIUS (Müller) 1774. Bailey 1903: 15 (Zonites). La Rocque 1953: 312.

31. PARAVITREA MULTIDENTATA (Binney) 1840. Matthew 1884 (Hyalina). La Rocque 1953: 314.

32. PUNCTUM MINUTISSIMUM (Lea) 1841. Bailey 1903: 15 (Microphysa pygmaea Drap.). La Rocque 1953: 322.

33. RETINELLA ELECTRINA (Gould) 1841. Bailey 1903: 15 (Zonites viridulus). La Rocque 1953: 313.

34. STENOTREMA FRATERNUM CAVUM (Pilsbry) 1911. Nylander 1914: 141 (Polygyra monodon cava). La Rocque 1953: 304.

35. STENOTREMA LEAII (Binney) 1878. Matthew 1884 (Helix monodon Rack). Bailey 1903: 15 (Stenotrema Monodon Rackett). La Rocque 1953: 304 (Stenotrema monodon).

36. STRIATURA EXIGUA (Stimpson) 1850. Bailey 1903: 15 (Zonites). La Rocque 1953: 317.

37. STROBILOPS LABYRINTHICA (Say) 1817. Bailey 1903: 15 (Strobila). La Rocque 1953: 330.

38. SUCCINEA AVARA Say 1824. Bailey 1903: 15. La Rocque 1953: 328.

39. SUCCINEA OVALIS Say 1817. Bailey 1903: 15 (S. ovalis and S. obliqua). Nylander 1914: 141. La Rocque 1953: 329.

40. TRIODOPSIS ALBOLABRIS (Say) 1816. Matthew 1884 (Helix). Bailey 1903: 15 (Mesodon). La Rocque 1953: 306.

41. VALLONIA PULCHELLA (Müller) 1774. Bailey 1903: 15. La Rocque 1953: 338.

42. VERTIGO GOULDII (Binney) 1843. Bailey 1903: 15, questioned. La Rocque 1953: 334.

43. VITRINA LIMPIDA Gould 1850. Bailey 1903: 15. La Rocque 1953: 317.

44. ZONITOIDES ARBOREUS (Say) 1816. Matthew 1884 (Hyalina). Bailey 1903: 15 (Zonites). Nylander 1914: 141. La Rocque 1953: 316.

45. ZOÖGENETES HARPA (Say) 1824. Bailey 1903: 15 (Acanthinula). Nylander 1914: 141 (Zoögenitis). La Rocque 1953: 338.

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CHECKLIST OF NEWFOUNDLAND NON-MARINE MOLLUSCA

A. LA ROCQUE

The list given herewith is the fourth of a proposed series (see STERKIANA 1: 19-22). Earlier lists for Ohio appeared in STERKIANA (1: 23-49), for Wyoming (3: 1-9), and for New Brunswick (3: 40-42).

The non-marine Mollusca of Newfoundland present extraordinary interest first, because their presence on this island may throw some light on the connection, if any, of the island with the mainland since Pleistocene glaciation and second, because of the unusually large European element represented. The island has been visited by Europeans for more than four centuries; therefore, this large immigrant contingent may be explained quite naturally. It has given rise to some speculation involving even a possible Pleistocene connection with Europe but evidence for this is extremely tenuous. Nevertheless, a detailed list of the species that do occur on the island is necessary background for discussion.

The non-marine Mollusca of Newfoundland are particularly well-known thanks to papers by Vanatta (1925, 1927, 1930) and Brooks and Brooks (1940). The oldest paper cited is that of Packard (1863) but it was preceded by earlier ones, not cited here because their content has been included in later lists.

The list presented here does not pretend to be complete although every effort has been made to render it so. Notes on additions and corrections will be gladly received by the writer or, if they are extensive enough, they may be presented in STERKIANA.

1. NAIADES

1. ANODONTA BROOKSIANA van der Schalie 1938. Brooks and Brooks 1940: 75. La Rocque 1953: 87.

2. ANODONTA MARGINATA Say 1817. Vanatta 1925: 93, Junction Pond, Whitbourne; Vanatta 1927: 114, Otter Pond near Plum Point. Brooks and Brooks 1940: 75. La Rocque 1953: 88.

3. MARGARITIFERA MARGARITIFERA (Linnaeus) 1758. Packard 1863: 401-429. Brooks and Brooks 1940: 75. La Rocque 1953: 85.

2. SPHAERIIDAE

4. SPHAERIUM OCCIDENTALE (Prime) 1860. Vanatta 1927: 114, Otter Pond near Plum Point. La Rocque 1953: 114.

3. FRESHWATER PULMONATES

5. FOSSARIA OBRUSSA (Say) 1825. Brooks and Brooks 1940: 75. La Rocque 1953: 285.

6. FOSSARIA OBRUSSA BROOKSI (F. C. Baker) 1935. Brooks and Brooks 1940: 75. La Rocque 1953: 285.

7. FOSSARIA UMBILICATA (C. B. Adams) 1840. Brooks and Brooks 1940: 75. La Rocque 1953: 286.

8. GYRAULUS HORNENSIS F. C. Baker 1934. Brooks and Brooks 1940: 75. La Rocque 1953: 294.

9. GYRAULUS PARVUS (Say) 1817. Vanatta 1927: 114, Otter Pond near Plum Point, East Brook at St. Barbe Bay, Eddies Cove Brook. Brooks and Brooks 1940: 75. La Rocque 1953: 294.

10. HELISOMA CAMPANULATUM (Say) 1821. Brooks and Brooks 1940: 75 (H. c. minus). A synonym of the type variety, according to Baker 1928: 345.

11. HELISOMA CAMPANULATUM DAVISI (Winslow) 1926. Brooks and Brooks 1940: 75. La Rocque 1953: 288.

12. HELISOMA CAMPANULATUM FERRISSI F. C. Baker 1945: 452. La Rocque 1953: 289 (not Newfoundland).

13. HELISOMA CAMPANULATUM RUDENTIS (Dall) 1905. Walker 1918: 97. La Rocque 1953: 289.

14. PHYSA GYRINA Say 1821. Vanatta 1927: 114, Otter Pond near Plum Point, Brig Bay. Brooks and Brooks 1940: 75. La Rocque 1953: 298.

15. PHYSA HETEROSTROPHA Say 1817. Brooks and Brooks 1940: 75. La Rocque 1953: 298.

16. (PHYSA MARGARITA Lesson). Walker 1918: 112. Not listed by La Rocque (1953) and probably a synonym of another species.

17. (RADIX PEREGRA GEISERICOLA Beck). Vanatta 1925: 92-93, Junction Pond, Whitbourne. Not listed by La Rocque (1953). A misidentification?

18. (RADIX PEREGRA LACUSTRIS). Brooks and Brooks 1940: 75. Not listed by La Rocque (1953). A misidentification?

19. STAGNICOLA NEWFOUNDLANDENSIS Baker and Brooks 1935. Brooks and Brooks 1940: 75. La Rocque 1953: 279.

20. STAGNICOLA PALUSTRIS (Müller) 1774. Vanatta 1925: 93, Sandy Cove and Flower Cove (Lymnaea sp.). Vanatta 1927: 114, Cook Point, Pistolet Bay; Schooner Id.; Sandy Cove; Flower Cove; Otter Pond near Plum Point; Brig Bay; Eddie's Cove; Boat Harbour; Big Brooks; Savage Point; St. John's Id. Vanatta 1930: 134, Deer Arm, Bonne Bay; near Old Port au Choix; St. John Bay; Brooks and Brooks 1940: 75. La Rocque 1953: 280.

21. STAGNICOLA PALUSTRIS PAPYRACEA Baker and Brooks 1935. Brooks and Brooks 1940: 75. La Rocque 1953: 280.

22. STAGNICOLA PALUSTRIS PERPALUSTRIS Baker and Brooks 1935. Brooks and Brooks 1940: 75. La Rocque 1953: 280.

4. FRESHWATER OPERCULATES

23. AMNICOLA LIMOSA (Say) 1817. Brooks and Brooks 1940: 75 (A. limosa var.). La Rocque 1953: 267.

24. VALVATA LEWISII Currier 1868. Vanatta 1927: 114, Eddies Cove Brook; Brooks and Brooks 1940: 75. La Rocque 1953: 263.

25. VALVATA SINCERA Say 1824. Brooks and Brooks 1940: 75 (V. sincera var.). La Rocque 1953: 264.

26. (VALVATA TERRAE-NOVAE Férussac). Walker 1918: 131, "probably never described." The locality is not stated but the specific name indicates that this was supposedly from Newfoundland.

5. LAND GASTROPODA

27. ARION ATER (Linnaeus) 1746. Vanatta 1925: 93, Bay Bulls. Brooks and Brooks 1940: 74. Post 1959: 105. La Rocque 1953: 323.

28. ARION CIRCUMSCRIPTUS Johnston 1828. Brooks and Brooks 1940: 74. La Rocque 1953: 323.

29. (ARION FASCIATUS (Nilsson) 1822.) Vanatta 1925: 93, Trepassey and Whitbourne. Not listed by La Rocque 1953; probably a synonym of No. 28.

30. ARION HORTENSIS Férussac 1819. Vanatta 1927: 113, Lark Harbour. Brooks and Brooks 1940: 74. La Rocque 1953: 323.

31. ARION SUBFUSCUS (Draparnaud) 1805. Brooks and Brooks 1940: 74. La Rocque 1953: 323.

32. CARYCHIUM EXIGUUM (Say) 1822. Brooks and Brooks 1940: 75. La Rocque 1953: 339.

33. CEPAEA HORTENSIS (Müller) 1774. Johnson 1906: 75, 78: Two Codroy valleys; not found on the east coast; headwaters of Robinson's River, west coast of Newfoundland; Serpentine River; East River, Hawkes Bay; Vanatta 1927: 112 (Helix), Doctor Hill and Bard Harbor Hill, Highland of St. John, St. John's Bay, Straits of Belle Isle; French Island = Tweed Island, and Lark Island, Bay of Islands. Vanatta 1930: 133 (Helix), Tucker's Head, Lord and Lady Cove, above Lomond, and Summit of Killdevil Mountain, Main Arm of Bonne Bay. Southern Arm, Bonne Bay. Deer Arm, Bonne Bay. Pointe Riche, Ingonachoix Bay. Hannah's Head, Bay of Islands. Brooks and Brooks 1940: 74. La Rocque 1953: 301.

34. CIONELLA LUBRICA (Müller) 1774. Vanatta 1927: 113 (Cochlicopa), Schooner Id.; Ha Ha Cape; Tweed Id.; Eddies Cove Brook, Eddies Cove; Back of Savage Cove; Bard Harbor Hill; Doctor Hill; Vanatta 1930: 113 (Cochlicopa), Tucker's Head, near Point Riche, Hannah's Head, and Penguin Head; Brooks and Brooks 1940: 75. La Rocque 1953: 339.

35. COLUMELLA EDENTULA (Draparnaud) 1805. Vanatta 1927: 113, Anse aux Sauvages, Sacred Id., Schooner Id., Cape Norman, Savage Point, Yankee Point, Ha Ha Cape, Doctor Hill. Vanatta 1930: 134, Tucker's Head. Brooks and Brooks 1940: 75. La Rocque 1953: 336.

36. DEROCERAS LAEVE (Müller) 1774. Vanatta 1927: 113 (Agriolimax campestris), Mauve Bay near Cape Baud, Lark Harbour, Back of Savage Cove, Ha Ha Cape, Yankee Point, Flower Cove, Doctor Hill. Brooks and Brooks 1940: 74. La Rocque 1953: 319.

37. DEROCERAS RETICULATUM (Müller) 1774. Vanatta 1927: 113 (Agriolimax agrestis), Bard Harbour Hill, Doctor Hill. Brooks and Brooks 1940: 74 (Deroceras agrestis). La Rocque 1953: 319.

38. DISCUS CRONKHITEI (Newcomb) 1865. Vanatta 1925: 93, Brig Bay (Gonyodiscus c. anthonyi). Vanatta 1927: 113 (Gonyodiscus), Anse aux Sauvages, Yankee Point; (G. c. anthonyi), Cape Norman, Ha Ha Cape, Back of Savage Cove, Bard Harbour Hill, Doctor Hill. Vanatta 1930: 133, Tucker's Head, near Pointe Riche, and Hannah's Head; (G. c. anthonyi), Pointe Riche, Grassy Id., St. John's Bay. Brooks and Brooks 1940: 74. La Rocque 1953: 321.

39. DISCUS ROTUNDATUS (Müller) 1774. Brooks and Brooks 1940: 74. Jacobson 1951: 34-35, Ferryland. La Rocque 1953: 322.

40. EUCONULUS FULVUS (Müller) 1774. Vanatta 1927: 113, Anse aux Sauvages, Schooner Id., Cape Norman, Savage Cove, Ha Ha Cape, Bard Harbour Hill, Doctor Hill. Vanatta 1930: 133, Tucker's Head and Hannah's Head. Brooks and Brooks 1940: 74. La Rocque 1953: 311.

41. HAWAIIA MINUSCULA (Binney) 1840. Brooks and Brooks 1940: 74. La Rocque 1953: 315.

42. HELICIGONA ARBUSTORUM (Linnaeus) 1758. Whiteaves 1904, Ott. Nat. 17: 192, St. John; Dall 1905: 21 (Helix). Brooks and Brooks 1940: 74. La Rocque 1953: 302.

43. HELICODISCUS PARALLELUS (Say) 1821. Vanatta 1930: 133, Hannah's Head. Brooks and Brooks 1940: 74. La Rocque 1953: 322.

44. HYGROMIA STRIOLATA (C. Pfeiffer) 1828. Brooks and Brooks 1940: 74. La Rocque 1953: 302.

45. LIMAX MARGINATUS Müller 1774. Brooks and Brooks 1940: 74 (Limax arborum). Lee 1950: 58. La Rocque 1953: 318.

46. LIMAX MAXIMUS Linnaeus 1758. BROOKS and BROOKS 1940: 74. La Rocque 1953: 318.

47. OXYCHILUS DRAPARNALDI (Beck) 1837. Brooks and Brooks 1940: 74. La Rocque 1953: 312 (O. lucidum).

48. OXYLOMA GRÖNLANDICA ("Beck" Möller) 1842. Brooks and Brooks 1940: 74. La Rocque 1953: 327.

49. OXYLOMA PEORIENSIS DECAMPII (Wolf in Walker) 1894. Brooks and Brooks 1940: 74. La Rocque 1953: 327.

50. OXYLOMA VERRILLI (Bland) 1865. Vanatta 1927: 114, Anchor Cove, Flower Cove, Bard Harbor Hill, St. John's Island. Vanatta 1930: 134, Main River and Lomond; near Old Port au Choix, St. John's Bay. Brooks and Brooks 1940: 74. La Rocque 1953: 328.

51. PLANOGYRA ASTERISCUS (Morse) 1857. Brooks and Brooks 1940: 75. La Rocque 1953: 338.

52. PUNCTUM MINUTISSIMUM (Lea) 1841. Vanatta 1927: 113, Bard Harbor Hill (P. pygmaeum Drap.). Vanatta 1930: 133, Tucker's Head, near Pointe Riche; Hannah's Head (P. pygmaeum m.). Brooks and Brooks 1940: 74 (P. pygmaeum m.). La Rocque 1953: 322.

53. PUPILLA MUSCORUM (Linnaeus) 1758. Vanatta 1927: 112, Doctor Hill; Anse aux Sauvages, near Cape Onion; Ha Ha Cape, Ha Ha Bay; Cape Norman. Vanatta 1930: 134, Tucker's Head, and near Pointe Riche. Brooks and Brooks 1940: 74. La Rocque 1953: 332.

54. RETINELLA ELECTRINA (Gould) 1841. Vanatta 1925: 93, Brig Bay (Polita hammonis). Vanatta 1927: 113, Anse aux Sauvages, Schooner Id., Cape Norman, Tweed Id., Ha Ha Cape, Bard Harbour Hill, Doctor Hill (Polita hammonis). H. B. Baker 1930: 196, (Retinella electrina). Vanatta 1930: 133, Tucker's Head, near Pointe Riche; Hannah's Head; Penguin Head; Middle Arm, Bay of Islands. Brooks and Brooks 1940: 74. La Rocque 1953: 313.

55. STRIATURA EXIGUA (Stimpson) 1850. Brooks and Brooks 1940: 74. La Rocque 1953: 317.

56. STRIATURA MILIUM (Morse) 1859. Brooks and Brooks, 1940: 74. La Rocque 1953: 317.

57. SUCCINEA AVARA Say 1824. Vanatta 1925: 93, Brig Bay and Flower Cove. Vanatta 1927: 114, Sandy Cove, Cape Norman, Yankee Point, Four Mile Cove, Big Brook, St. John's Island, Flower Cove, Back of Savage Cove, Savage Point. Vanatta 1930: 133, Tucker's Head, Pointe Riche, and Penguin Head. Brooks and Brooks 1940: 74. La Rocque 1953: 328.

58. SUCCINEA OVALIS Say 1817. Dall 1905: 58, Balaena Bay. Vanatta 1925: 93, Flower Cove. Vanatta 1927: 114, Lark Harbour, Savage Cove, Flower Cove, Eddie's Cove, St. John's Island, Bard Harbour Hill, Doctor Hill. Vanatta 1930: 133, Tucker's Head, Lomond, and Hannah's Head. Brooks and Brooks 1940: 74. La Rocque 1953: 329.

59. VALLONIA ALBULA Sterki 1893. Vanatta 1930: 134, Tucker's Head, near Pointe Riche, and Penguin Head. Brooks and Brooks 1940: 75. La Rocque 1953: 337.

60. VALLONIA EXCENTRICA Sterki 1893. Brooks and Brooks 1940: 75. La Rocque 1953: 337.

61. VALLONIA PULCHELLA (Müller) 1774. Brooks and Brooks 1940: 75. La Rocque 1953: 338.

62. VERTIGO ALPESTRIS Alder 1838. Brooks and Brooks 1940: 74. La Rocque 1953: 332.

63. VERTIGO ELATIOR Sterki 1894. Vanatta 1927: 113, Schooner Island (V. ventricosa e.). Brooks and Brooks 1940: 75. La Rocque 1953: 334.

64. VERTIGO GOULDII Binney 1843. Brooks and Brooks 1940: 74. La Rocque 1953: 334.

65. VERTIGO GOULDII BASIDENS Pilsbry and Vanatta 1900. Vanatta 1927: 113, Ha Ha Cape, Bard Harbour Hill. La Rocque 1953: 334.

66. VERTIGO GOULDII COLORADENSIS Cockerell 1891. Vanatta 1930: 134, Tucker's Head and Hannah's Bay. La Rocque 1953: 334.

67. VERTIGO GOULDII PARADOXA Sterki 1900. Brooks and Brooks 1940: 74. La Rocque 1953: 334.

68. VERTIGO MODESTA (Say) 1824. Vanatta 1925: 93, Brig Bay and Flower Cove (V. hoppii). Vanatta 1927: 113, Anse aux Sauvages, Sacred Island off Cape Onion, Brig Bay, Ha Ha Cape, Yankee Point, Savage Point, Back of Savage Cove, Sandy Cove = Poverty Cove, Bard Harbour Hill, Doctor Hill. Vanatta 1930: 134, Tucker's Head; near Pointe Riche. Brooks and Brooks 1940: 74. La Rocque 1953: 335.

69. VERTIGO MODESTA CASTANEA Pilsbry and Vanatta 1900. Vanatta 1927: 113, Brandy Id. = Schooner Id.; Pistolet Bay; Cape Norman; Flower Cove. Brooks and Brooks 1940: 74. La Rocque 1953: 335.

70. VERTIGO MODESTA PARIETALIS (Ancey) 1887. Vanatta 1927: 113, Anse aux Sauvages, Sacred Id., Ha Ha Cape. Brooks and Brooks 1940: 74. La Rocque 1953: 335.

71. VERTIGO PERRYI Sterki 1905. Brooks and Brooks 1940: 74. La Rocque 1953: 336.

72. VITRINA LIMPIDA Gould 1850. Vanatta 1927: 113, Anse aux Sauvages, Sacred Id., Cape Norman, Ship Cove, Ha Ha Cape, Flower Cove, Bard Harbour Hill, Doctor Hill. Vanatta 1930: 133, near Pointe Riche. Brooks and Brooks 1940: 74. La Rocque 1953: 317.

73. ZONITOIDES ARBOREUS (Say) 1817. Vanatta 1927: 113, Burnt Cape, Pistolet Bay; Bard Harbour Hill; Doctor Hill. Vanatta 1930: 133, near Pointe Riche; Hannah's Head. Brooks and Brooks 1940: 74. La Rocque 1953: 316.

74. ZONITOIDES NITIDUS (Müller) 1774. Brooks and Brooks 1940: 74. La Rocque 1953: 316.

75. ZOÖGENETES HARPA (Say) 1824. Vanatta 1927: 113, Ship Cove, Sacred Bay; Anse aux Sauvages; Deer Pond Brook; Bard Harbour. Brooks and Brooks 1940: 75. La Rocque 1953: 338.

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