

## Note

### First recorded co-occurrence of *Valvata lewisi* Currier, 1868 and *Valvata lewisi ontariensis* Baker, 1931 (Gastropoda: Valvatidae) from Alberta, Canada, with notes on morphometric and genetic variability

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#### Abstract

Sympatric populations of Loosely Coiled Valve Snail (*Valvata lewisi ontariensis* Baker, 1931) and Fringed Valvata (*Valvata lewisi* Currier, 1868) are documented from Alberta, Canada, for the first time. Both forms have been identified concurrently in aquatic invertebrate survey samples collected from three wetlands in northeastern Alberta by the Alberta Biodiversity Monitoring Institute. Molecular analysis (DNA barcodes) indicates that there is no genetic distinction between *V. lewisi* (*sensu stricto*) and *V. lewisi* var. *ontariensis*. Morphometric measurements show that the degree of open coiling, the character that defines *V. lewisi* var. *ontariensis*, is highly variable in Alberta specimens. Our findings confirm that *V. lewisi* var. *ontariensis* is a phenotypic morph of *V. lewisi*.

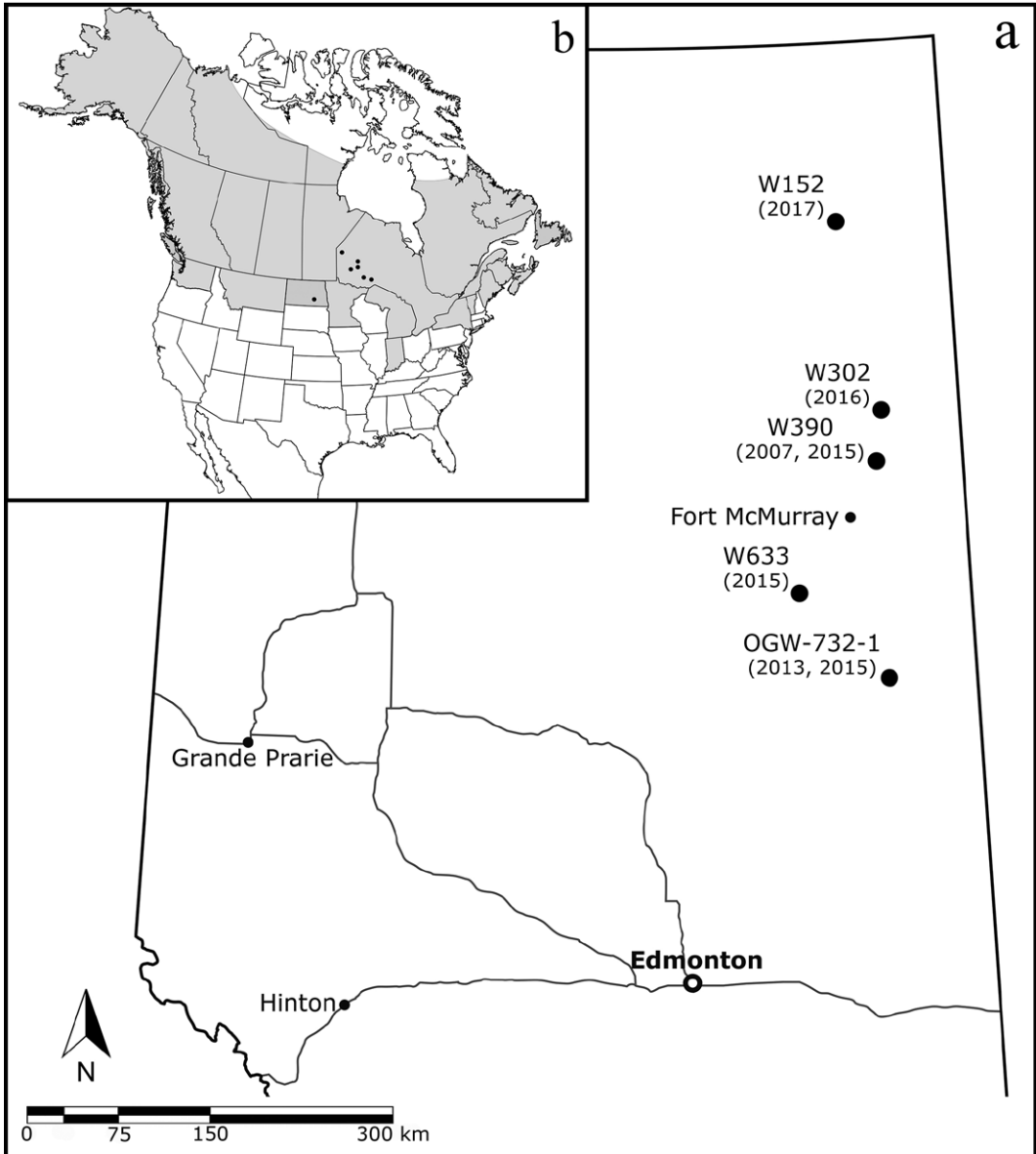
Key words: Distribution; range extension; Alberta; Valvatidae; *Valvata*; *Valvata lewisi*; *Valvata lewisi ontariensis*; Alberta Biodiversity Monitoring Institute; ABMI

Loosely Coiled Valve Snail (*Valvata lewisi ontariensis* Baker, 1931; common name from Clarke 1981) is a tiny, enigmatic freshwater gastropod that has rarely been collected since first being described by Frank Collins Baker in 1931. Originally thought to be confined to a few locations in western Ontario, Canada (Baker 1931; Clarke 1973; Figure 1), similar specimens have since been collected as Pleistocene fossils or empty shells in Manitoba, Canada (Clarke 1973), and Minnesota, USA (Bright 1981), with the only other confirmed record of living specimens from the Cottonwood Lake Study area in North Dakota, USA (Hanson *et al.* 2002; Figure 1). Here, we report on the first sympatric collections of *Valvata lewisi* (*sensu stricto*) and *V. lewisi* var. *ontariensis* from Alberta, Canada, and provide notes on morphometric and genetic variability.

In contrast to the distribution of *V. lewisi* var. *ontariensis*, *Valvata lewisi* Currier, 1868 (Fringed Valvata, according to Turgeon *et al.* 1998) is commonly found across the prairie, parkland, and boreal regions of Canada from Newfoundland to British Columbia,

north into the Yukon and Alaska, and south into the northern United States (Clarke 1981; NatureServe 2017; Figure 1). *Valvata lewisi* is a small freshwater snail that seldom exceeds 5 mm in diameter and has a depressed spire, multi-spiral operculum, and bi-pectinate gill (Clarke 1973; Burch 1982). Shell sculpting consists of fine striations on the first one and a half to two whorls, which develop on subsequent whorls into axial lamellae that are usually elevated and blade-like, but may be reduced to coarse collabral threads (Clarke 1973). In comparison, *V. lewisi* var. *ontariensis* exhibits the same characteristics, but, unlike *V. lewisi* (*sens. str.*) where the body whorl directly contacts the preceding whorl, *V. lewisi* var. *ontariensis* exhibits open coiling in which the last one to one and a half whorls are separated (Baker 1931; Figure 2).

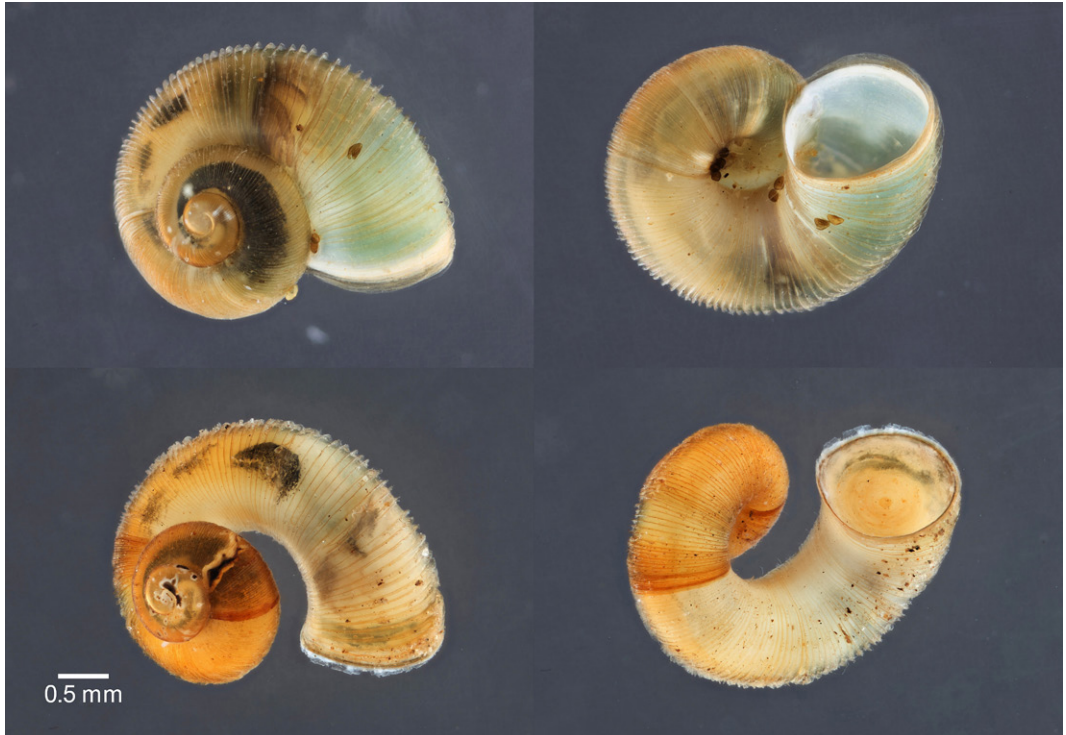
*Valvata lewisi* var. *ontariensis* has been detected at five wetlands in Alberta, Canada, through the ongoing activities of the Alberta Biodiversity Monitoring Institute (ABMI). The ABMI collects biological information on a wide range of terrestrial and aquatic organisms across the province using



**FIGURE 1.** a. Alberta Biodiversity Monitoring Institute wetland site locations where specimens of *Valvata lewisi* var. *ontariensis* have been documented in Alberta (large solid circles, collection years in parentheses). Inset map b. shows known range of *Valvata lewisi* (*sensu stricto*) in North America (shaded area) with historical collection records of *V. lewisi* var. *ontariensis* (solid circles).

standardized, publicly available methods (e.g., ABMI 2015, 2018). During routine taxonomic analysis of aquatic invertebrate samples collected by the ABMI in 2007, we detected 12 *V. lewisi* var. *ontariensis* specimens in samples obtained from a permanent wetland in the northeastern part of the province (ABMI site W390; 57.26899°N, 110.72157°W; Figure 1). Following this initial detection, several

additional *V. lewisi* var. *ontariensis* specimens were subsequently recovered from ABMI samples collected from the initial detection site and four additional wetlands in the same region—W152 (58.78107°N, 110.86238°W), W302 (57.80382°N, 110.65305°W), W633 (55.97079°N, 112.23922°W), and OGW-732-1 (55.25222°N, 110.91161°W; Figure 1)—for a total collection of 75 specimens. This sampling effort also



**FIGURE 2.** Dorsal and ventral views of *Valvata lewisi* (top) and *Valvata lewisi* var. *ontariensis* (bottom). Photos: Robert P. Hinchliffe.

revealed the co-occurrence of *V. lewisi* var. *ontariensis* and *V. lewisi* (*sens. str.*) at sites W390, W633, and OGW-732-1. Voucher specimens have been preserved in 80% ethanol and deposited in the invertebrate zoology collection at the Royal Alberta Museum in Edmonton, Alberta, Canada (ABM.I.A.91, ABM.I.A.5396, ABM.I.A.11900, ABM.I.A.15382, ABM.I.A.18222, and ABM.I.A.30673).

Morphometric analyses of *V. lewisi* var. *ontariensis* revealed considerable variation in the degree of open coiling in Alberta specimens. Measurements showed a clear gradation in the ratio of open-coiled gap to aperture diameter in specimens from both W390 (0.04:1 to 0.22:1, mean 0.10:1,  $n = 16$ ) and OGW-732-1 (0.02:1 to 0.41:1, mean 0.13:1,  $n = 18$ ), a pattern also noted, although not directly measured, by Baker (1931) when examining western Ontario specimens.

Our examination of intra- and inter-specific variability associated with the DNA barcode markers cytochrome c oxidase 1 (COI) and internal transcribed spacer 2 (ITS2) for *V. lewisi* (*sens. str.*) and *V. lewisi* var. *ontariensis* specimens from sites W390 and OGW-732-1 indicated no genetic distinction between the two morphs. For COI, the mean interspecific variation ( $\pm$  SD) was  $0.17\% \pm 0.13$  with intraspecific genetic distances at  $0.16\% \pm 0.12$  for *V. lewisi* (*sens. str.*;

$n = 12$ ) and  $0.16\% \pm 0.14$  for *V. lewisi* var. *ontariensis* ( $n = 28$ ). For ITS2, the mean interspecific variation ( $\pm$  SD) was  $0.07\% \pm 0.14$  and the intraspecific genetic distance of *V. lewisi* (*sens. str.*;  $n = 10$ ) was  $0.03\% \pm 0.07$  and of *V. lewisi* var. *ontariensis* ( $n = 23$ ) was  $0.11\% \pm 0.17$ . DNA barcoding was conducted by the Canadian Centre for DNA Barcoding in Guelph, Ontario, Canada. Genetic sequences have been submitted to GenBank (COI: MK721872 to MK721913, ITS2: MK721934 to MK721969).

Our detections of *V. lewisi* var. *ontariensis* constitute the first record of this morph in Alberta, Canada, and the first explicitly documented instances of co-occurrence of *V. lewisi* var. *ontariensis* with *V. lewisi* (*sens. str.*). Clarke (1973: 229) noted that loosely coiled specimens seemed to “occur also (rarely) in some apparently normal populations”, but neglected to provide references or observational evidence for this statement. Furthermore, he suggested that the specimens he examined were uniform as all one morph or the other. Other published reports on this species do not make any mention of co-occurrence of the two morphs.

The taxonomic status of *V. lewisi* var. *ontariensis* as a valid subspecies has historically been uncertain (see Baker 1931; Clarke 1973, 1981; Burch 1982).

The working definition of a subspecies is two or more populations of the same species from separate geographic locations with one or more distinguishing characters (Mayr 1942, 1982). The initial Ontario collections identified by Baker (1931) and later expanded on by Clarke (1973) were originally thought to be an isolated and distinct population of the open-coiled morph. Our concurrent collections of *V. lewisi* (*sens. str.*) and *V. lewisi* var. *ontariensis* clearly show that the two morphs can occur in the same water body. This, in addition to the lack of a CO1 or ITS2 barcode gap between the two morphs, supports the conclusion that *V. lewisi ontariensis* is a phenotypic morph of *V. lewisi*.

Despite the broad and common distribution of *V. lewisi* (*sens. str.*), the open-coiled morph has, thus far, been collected in only three isolated regions of North America. Given the widely spaced and seemingly isolated locations where *V. lewisi* var. *ontariensis* has been collected, it is possible that the open-coiled morph is the result of some unknown and possibly localized environmental factor. However, it is also possible that *V. lewisi* var. *ontariensis* is more common than collection records indicate and is simply difficult to detect during routine aquatic invertebrate surveys because of its small size and propensity to burrow into the upper layer of soft substrates (R.P.H. pers. obs.). Targetted sampling in other regions is needed to more fully understand the complete distribution of *V. lewisi* var. *ontariensis*. We recommend that future collections of open-coiled *V. lewisi* specimens be identified and labeled as *V. lewisi* var. *ontariensis* to allow for better tracking of the localities where this morph occurs and perhaps yield additional clues as to the possible source of open coiling.

### Author Contributions

Writing—Original draft: R.P.H.; Writing—Review & editing: R.P.H., C.T. and T.P.C.; Visualization: R.P.H.; Conceptualization: R.P.H. and T.P.C.; Investigation: R.P.H. and C.T.; Resources: C.T.; Formal analysis: R.P.H.

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