Pyrgulopsis robusta (Walker, 1908) in the Columbia River: An Introduction

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There has been much concern about the introductions of *Potamopyrgus antipodarum* (New Zealand mudsnail, NZMS) in the Columbia River and elsewhere, as there should be for this extremely invasive species. Another snail thought to have been introduced in the Columbia River drainage before the NZMS is *Radix auricularia* (big-ear radix). Of course, we cannot forget *Corbicula fluminea* (Asian clam), the first introduced mollusk in the Columbia River, which was the earliest recorded introduction of this bivalve in North America (Burch, 1944). But one would be mistaken to think that the list of introduced mollusks ends with these species. One other snail, a native North American species, was also introduced in the Columbia River and thought initially to be a natural occurrence overlooked by previous surveys and a new species of *Pyrgulopsis* (Frest & Johannes, 1995; **Fig. 1**). Hershler & Liu (2004a) later placed this snail, along with the formerly federally listed endangered *Pyrgulopsis idahoensis* (Idaho springsnail) (USFWS, 1990, 2006, 2007) and *Pyrgulopsis hendersoni* (Harney Lake springsnail) as synonyms of *Pyrgulopsis robusta* (Jackson Lake springsnail). In the Columbia River *P. robusta* (*Pyrgulopsis* sp. A in **Fig. 1**) has often been misidentified as the NZMS confounding documentation of the spread of that species in the river (**Fig. 2**).

Despite earlier surveys of the Columbia having been undertaken from the late 1800s to the 1970s by several malacologists including Henry Hemphill, Junius Henderson, and Dwight Taylor, *P. robusta* had not been found in the river. Some of their surveys did include the Columbia Gorge area where this snail was eventually first discovered. However, no *P. robusta* specimens have been found in museum collections from the Columbia River collected before the 1980s.

Unlike in the extinct Lake Idaho (middle Snake River) or sediments in the adjacent Great Basin, *Pyrgulopsis* has not been found in Miocene, Pliocene or Quaternary fossil freshwater deposits in the Columbia River basin either in Washington or Oregon (Taylor, 1985).

Specimens of *P. robusta* were first found in 1988 by U.S. Fish & Wildlife Service (USFWS) personnel in dredge samples collected from the deep pools of Bonneville Dam on the Columbia River (**Fig. 1**) and sent for identification to Terry Frest at Deixis Consultants. Subsequently, in adjacent areas of the Columbia Gorge, this species was found in nearshore shallow habitats.

Surveys in the lower Columbia by Deixis Consultants (unpublished) and Neitzel & Frest (1993) found no evidence of this snail before 2002 (Frest & Johannes, 2005; **Fig. 1**). It was also not noted during surveys conducted for mollusks, or for invertebrates in general, in the most intensively studied stretch of the Columbia River, the Hanford Reach, until 2005 (Frest et al., 2008a, b; B. Tiller, personal communication, 2005; **Fig. 1**). Following establishment of the Department of Energy Hanford site, invertebrate surveys have been conducted since the 1950s in this reach (for references see Neitzel & Frest,1993 and Frest et al., 2008a, b). Battelle's Pacific Northwest Laboratory has deposited some mollusk samples collected prior to 2005 in the Hanford Reach in the Deixis collections; none includes *P. robusta*. Surveys upstream of the Hanford Reach have not found this species or NZMS as yet, nor have they been found in the only mollusk survey conducted on Wanapum Lake after an emergency draw down was necessitated by cracks discovered in Wanapum Dam (Tiller et al., 2015 and references therein).

Surveys conducted in Hells Canyon (lower Snake River) by Idaho Power (Richards et al., 2005) and Owyhee River (lower Snake River tributary) by Deixis Consultants (Frest, 2003) did not find *P. robusta*. However, a new species of *Taylorconcha*, now named *T. inseparata* (Hells Canyon snail) was found in both areas (Hershler et al., 2006), while its federally listed threatened sister species, *T. serpentincola* (Bliss Rapids snail), co-occurs with *P. robusta* upstream in the middle Snake. Thus the occurrence of *T. inseparata* in Hells Canyon indicates that suitable habitat for *P. robusta* may exist there. Nevertheless, surveys conducted by Deixis Consultants in other lower Snake tributaries such as the Salmon, Imnaha, and Grande Ronde rivers have not found *P. robusta*. All the above evidence suggests

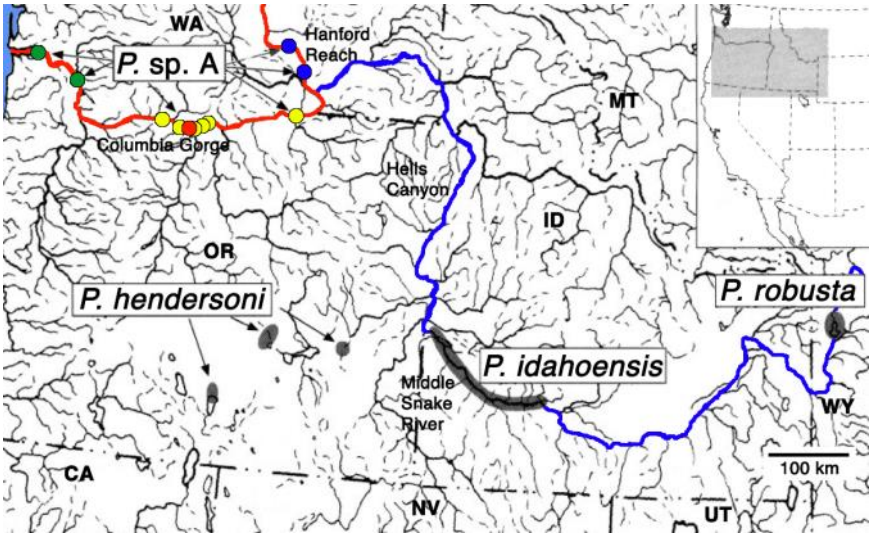

Figure 1. *Pyrgulopsis robusta* (referred to as its junior synonyms) sites in the Snake River (blue), Columbia River (red), and adjacent internal basins. Red dot –1988, yellow dots – 1994-95, green dots – 2002-03, blue dots – 2005. Note large gaps in distributions, especially in the lower Snake River. Map modified from Hershler & Liu (2004a). States: CA – California, ID – Idaho, MT – Montana, NV – Nevada, OR – Oregon, UT – Utah, WA – Washington, WY – Wyoming

that *P. robusta* has been recently introduced in the Columbia River. DNA evidence (Hershler & Liu, 2004a, b) further strengthens this conclusion. It indicates that the closest congeners of Columbia River populations are from Polecat Creek, Wyoming, in the upper Snake River drainage (**Fig. 1**), not the geographically closer middle Snake River populations. This further supports introduction in the Columbia as the most likely possibility (**Fig. 3**).

Why *P. robusta* does not occur in the Hells Canyon portion of the Snake, despite a high chance of being swept into this area from upstream populations, is a mystery. The Snake formerly flowed west through Oregon, hence explaining *P. robusta* occurrences in the Great Basin of eastern Oregon (*P. hendersoni* sites in **Fig. 1**), but was later captured by headwater erosion in Hells Canyon before the early Pleistocene, becoming a Columbia River tributary (Wheeler & Cook, 1954; Taylor, 1985). This is not the only snail with a distribution reflecting this former drainage divide. *Valvata utahensis* (desert valvata), *Stagnicola hinkleyi* (rustic pondsnail), and *Vorticifex effusa* (Artemesian rams-horn) are among those also absent in Hells Canyon despite their presence just upstream in the Snake (Taylor,1985; Frest & Johannes, 1995; Richards et al., 2005). *Vorticifex effusa* also occurs in the Columbia but probably arrived via a short-lived connection between the Klamath and Deschutes drainages (Taylor, 1985). *Pristinicola hemphilli* (pristine pyrg), a Columbia basin snail, also has its furthest upstream site on the Snake in Hells Canyon. However, Hells Canyon is not a total barrier to freshwater snail migration. Species of *Fluminicola* were present in the Columbia in the Miocene (Taylor, 1985) and probably arrived there by a different route, but the distribution of *F. fuscus* (ashy pebblesnail) and an unidentified species of *Fluminicola* in the Columbia and Snake indicates that these snails went through Hells Canyon (Liu et al., 2013). Only *Fisherola nuttalli* (shortface lanx) is known to have crossed this former divide by moving upstream from the Columbia (Taylor, 1985). Despite all this activity, *P. robusta* remains stubbornly in place in the middle Snake River, even though it has shown the ability to expand elsewhere in the Columbia and in the past in the Snake.

R. Hershler photos

Figure 2. *Pyrgulopsis robusta* (left) and *Potamopyrgus antipodarium* (right). Shell height: 6.0 mm for *robusta*.

Pyrgulopsis robusta was introduced into the Columbia River nine years before the NZMS. In 2015 both essentially covered the same stretch of the Columbia River, from the mouth to the Hanford Reach. *Pyrgulopsis robusta* took at least 27 years while NZMS took 18 years to cover the same stretch of river, about 380 miles (612 km). How *P. robusta* was introduced into the Columbia River from Polecat Creek or nearby populations is unknown. One possibility is human-mediated transfer with fish. A possible introduction source, the Jackson National Fish Hatchery, is several miles down-stream from Polecat Creek in the upper Snake River basin and has been in operation since the 1950s. A U.S. National Museum of Natural History online collection record identified specimens occurring in a spring creek feeding hatchery as *P. robusta* but this was found to be a misidentified *Colligyrus* species (R. Hershler, pers. comm., 2014). Making this source even more unlikely, the hatchery distributes trout only in western Wyoming and eastern Idaho; supposedly none has ever been sent to the Columbia River.

Pyrgulopsis idahoensis was originally listed under the Endangered Species Act (ESA) with four other middle Snake River snails: *Valvata utahensis* (desert or Utah valvata), *Physa natricina* (Snake River physa), *T. serpenticola*, and *Idaholanx fresti* (Banbury Springs lanx) [both *I. fresti* and *T. serpenticola* are the only mollusks among a handful of animals listed under the ESA before being scientifically described] (USFWS, 1990). There has been a concerted effort by many parties in Idaho to have these five snails expunged from the ESA list. It is no surprise therefore that *P. idahoensis* was removed as a result of being synonymized with *P. robusta* (Hershler & Liu, 2004a). Morrison et al. (2009) cited this as one of few examples of a decrease in the conservation status of a species as a result of taxonomic change. Like *P. idahoensis*, *Physa natricina* was placed as a junior synonym under *Physella acuta* based on shell and soft tissue study done by Rogers & Wethington (2007). But a later DNA study (Gates et al., 2013) overturned their conclusions by showing that the genetic divergence between *Physa natricina* and other Physidae are almost twice those cited by Wethington et al. (2009) for a new species of Physidae they described. Additionally, *Physella acuta* has not been reported in the middle Snake River as pointed out by Gates et al. (2013). Fortunately this species was not removed from the ESA list before the Gates et al. (2013) paper was published.

The range increase that resulted from lumping several *Pyrgulopsis* species into *P. robusta* (**Fig. 1**) was the major justification given by USFWS (2006, 2007) for delisting *P. idahoensis* (this reason was also given for the delisting of *V. utahensis* (USFWS, 2010)). Supposedly the range extension has secured its future survival. But the knowledge that the Columbia River populations are introductions could possibly have resulted in a different outcome, the listing of *P. robusta* in place of *P. idahoensis*.

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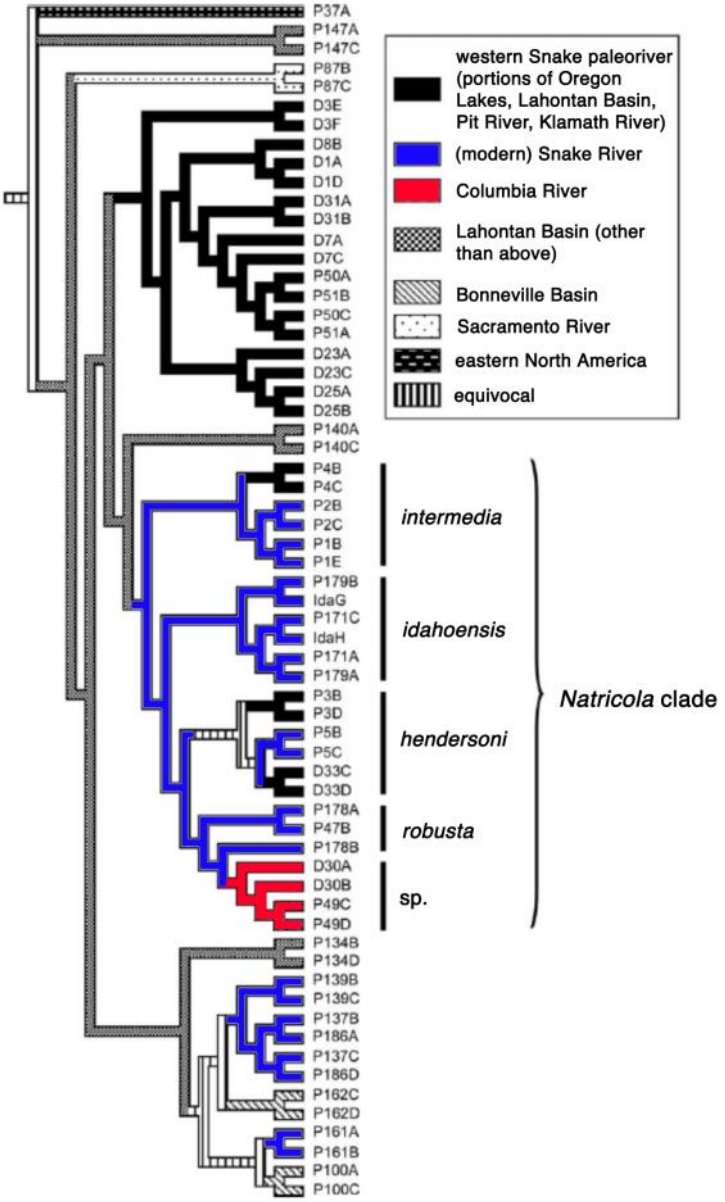

Figure 3. Phylogenetic reconstruction of drainage occurrences showing that *Pyrgulopsis robusta* (from Polecat Creek) is the closest congener to the Columbia River populations. Figure modified from Hershler & Liu (2004b), based on fig. 2 therein.

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