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T. J. Frest
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Prepared for the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830

Pacific Northwest Laboratory
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SUMMARY

Assessment of the beneficial uses of the Columbia River and surrounding land at Hanford is enhanced by knowing the distribution of the plants and animals that live there. Deixis Consultants conducted surveys to determine the distribution of land and freshwater molluscs (malacofauna) on the U.S. Department of Energy's Hanford Site and surrounding areas for the Pacific Northwest Laboratory. The surveys were conducted in 1992. Five species of freshwater molluscs and six species of land snails were found at 21 localities on the Site. The malacofauna of the Site is sparse in comparison to that of other areas in Washington with roughly comparable substrate and climate.

Most species found at Hanford are widely distributed forms or are introduced (nonnative) taxa. The Site does have a single endemic land snail, *Cryptomastix* n. sp., found at a single location. This species likely will be considered a candidate for federal listing. Geologic factors and human modification of spring habitats are the likely causes for the depauperate malacofauna.

ACKNOWLEDGMENTS

We thank Duane Neitzel for his interest in and encouragement of this and other mollusc studies. Gregg A. Martenson provided much needed and appreciated field support.

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INTRODUCTION

The state of Washington has a large and diverse freshwater mollusc (snail and clam) and land snail fauna, at present comprising some 120 species. Because molluscs have not been systematically collected in Washington, many new species likely remain to be discovered. Most of these are expected to be local endemics with narrow distributions and will be likely candidates for federal listing as threatened or endangered species.

Because of the state's location, its mollusc biogeography is unusually complex. Briefly, those areas west of the Cascade crest have a geologically recent, basically Asian-derived fauna. Those east of the Cascades often have Rocky Mountain ancestors but are distinct from the typical fauna of the High Rockies. At critical points in especially geologically complex areas, such as along the lower Columbia River (i. e., the Columbia Gorge), elements of both faunas mix, and local endemic speciation is especially common.

Several mollusc species with distributions centered on the Columbia Gorge area are now candidates for federal listing as threatened or endangered species. Among these are the land snail *Monadenia fidelis minor*; the freshwater snail Columbia pebblesnail *Fluminicola columbiana*, the freshwater limpet shortface lanx *Fisherola nuttalli*, and the California floater *Anodonta californiensis*. Some of these species have had status surveys conducted as long ago as 1982 and have been candidates since 1984. The two freshwater species previously known to occur in the Hanford Reach of the Columbia River have recently been the subject of a detailed survey (Neitzel and Frest 1992, 1993). A number of other Columbia Gorge taxa have also been proposed for listing. Altogether, some 9 land snails and some 18 freshwater molluscs are involved (Tables 1 and 2).

Very little systematic mollusc collecting had been done previously on the Hanford Site. What little had been done suggested that the local mollusc fauna is very similar to that of the Columbia Gorge and Yakima Canyon, and it was thus possible that some or all of the Columbia Gorge candidates could occur on the Site. The major historic references for the Hanford Site, Yakima Firing Center, and Yakima Canyon are Eyerdam (1934) and Henderson (1929, 1936). More recently, malacologists from Deixis Consultants began a systematic survey of the Yakima Canyon area for molluscs. The more modern (1988-present) Deixis records include at least one local endemic species of the land snail *Oreohelix* , whose nearest relative is an endemic Columbia Gorge species. One freshwater form, an undescribed species of the genus *Juga (Oreobasis)* ascribed by Henderson (1929, 1936) to *Goniobasis rubiginosa* Lea, formerly occurred in the vicinity of Yakima but has not been collected recently. Its nearest relative is an undescribed Columbia Gorge form. Molluscs were recently successfully collected from the Yakima area on Umtanum, South Cle Elum, and Manastash Ridges and in Taneum Canyon. These same ridges and

TABLE 1. Freshwater Mollusc Species of Concern in the Columbia Gorge Region, Oregon-Washington

Name	Occurrence	Ecology	Suggested Status
Juga (Juga) hemphilli hemphilli (Henderson, 1935)	WA, OR; W-central Gorge	small-medium streams	Endangered
Juga (Juga) hemphilli dallesensis (Henderson, 1935)	WA, OR: central Gorge	small-medium streams	Endangered
Juga (Juga) hemphilli maupinensis (Henderson, 1935)	OR: Deschutes R.	large streams	Endangered
Juga (Juga) hemphilli n. subsp.	WA, OR; W. Gorge	small-medium streams, springs	Endangered
Juga (J.) n. sp. 1	WA, OR; W. & central Gorge	small streams, springs	Endangered
Juga (J.) n. sp. 2	WA, OR; E. Gorge	springs	Threatened
Juga (J.) n. sp. 3	OR; W. Gorge	small-medium streams	Endangered
Juga (J.) n. sp. 4	OR; E. Gorge	springs	Endangered
Juga (Oreobasis) bulbosa (Gould, 1847)	OR; Deschutes R.	large streams	Endangered
Juga (O.) n. sp. 1	WA; central & E. Gorge	medium-small streams, springs	Threatened
Juga (O.) n. sp. 2	OR; central & E. Gorge	springs	Threatened
Juga (O.) n. sp. 3	OR; Deschutes R.	springs	Endangered
Juga (O.) n. sp. 4	OR; Deschutes R.	springs	Endangered
Lyogyrus cf. *greggi* n. sp.	WA, OR; central & E. Gorge	springs	Endangered
Vorticifex neritoides (Hemphill, 1890)	WA, OR; lower Columbia R.	large rivers	Endangered
Anodonta wahlametensis Lea, 1838	WA, OR, CA	large rivers	Threatened
Physella (Physella) columbiana (Hemphill, 1890)	WA, OR; lower Columbia R.	large rivers	Endangered
Fluminicola columbiana Hemphill, 1899	WA, OR: whole Gorge	large-medium rivers	Endangered[a]
Fisherola nuttalli nuttalli (Haldeman, 1841)	WA, OR: whole Gorge	large-medium rivers	Threatened[a]

(a) These are current candidates for federal listing.

TABLE 2. Land and Snail Species of Concern in the Columbia Gorge Region, Oregon-Washington

Name	Occurrence	Ecology	Suggested Status
Oreohelix variabilis Henderson, 1929	OR; E. Gorge	basalt talus	Threatened
Oreohelix aff. *variabilis* n. subsp.	OR; Deschutes R.	basalt talus	Endangered
Vespericola columbiana columbiana (Lea, 1838)	WA, OR; lower Gorge	Forested outcrops, bottomland forest	Endangered
Vespericola columbiana depressa (Pilsbry & Henderson, 1936)	OR: E. Gorge	basalt talus & springy areas	Threatened
Vespericola columbiana n. subsp.	OR; Deschutes R.	basalt talus & springy areas	Endangered
Monadenia fidelis columbiana Pilsbry, 1939	OR, WA: W. Gorge	forested areas	Endangered
Monadenia fidelis minor (Binney, 1885)	OR, WA; E. Gorge	basalt talus & springy areas	Endangered[a]
Hemphillia malonei Pilsbry, 1917	OR; W. Gorge	forested areas	Endangered
Cryptomastix hendersoni Pilsbry, 1928	WA, OR: E. Gorge	basalt talus, springy areas	Threatened

(a) This is a current candidate for federal listing.

associated canyons extend eastward from the Yakima River to the Columbia River, crossing the Yakima Firing Center and, in some cases, the Hanford Site.

Assessment of the beneficial uses of the Columbia River and surrounding land is enhanced by knowing the distribution of these species. Therefore the U.S. Department of Energy, Richland Field Office, requested that the Pacific Northwest Laboratory conduct surveys for land and freshwater molluscs. This report describes the surveys conducted in 1992. Species that have been confirmed or reported to occur in the Yakima Canyon to date are listed in Table 3. The survey project is far from complete, but the early indications are that both the Yakima Canyon and surrounding areas, including the Hanford Site, do indeed have both a land and freshwater mollusc fauna very similar to that of the Gorge, and do share at least some of the candidate species. Both the Columbia pebblesnail and shortface lanx, for example, have long been known to inhabit the Columbia River in the Hanford Reach. Also, at least some of the species now known to occur in the Yakima Canyon area are either present or potential candidates for listing (Table 3).

TABLE 3. Mollusc Species Previously Reported from the Yakima Canyon Area

Species	Comments	Suggested Status
Terrestrial		
Anguispira kochi eyerdami Clench & Banks	Type and only reported locality: ridge above Satus Creek Regarded as a synonym of *A. kochi occidentalis* by Pilsbry (1948).	Endangered
Oreohelix strigosa strigosa (Gould)	Reported from Yakima Canyon (Henderson, 1929)	Uncertain
Oreohelix n. sp. cf. *variabilis* Henderson	Found in Yakima Canyon area in 1988.	
Oreohelix cf. *junii* Pilsbry	Found in Yakima Canyon area in 1990. May be new species.	Endangered
Vespericola columbiana pilosa (Henderson)	Found in Yakima area (Eyerdam ,1934; confirmed from Yakima Canyon 1989).	None
Cryptomastix mullani olneyae (Pilsbry)	Found in Yakima area (Eyerdam, 1934; confirmed in Yakima Canyon 1989).	Uncertain
Cryptomastix hendersoni (Pilsbry)	Found in Yakima Canyon (Pilsbry, 1940; confirmed in 1989)	Uncertain
Allogona ptychophora (Brown)	Found in Yakima area (Eyerdam, 1934).	None
Oxyloma nuttalianaum Lea	Found in the Yakima area (Eyerdam, 1934)	None
Succinea gabbi Tryon	Found in the Yakima area (Eyerdam, 1934)	None
Aquatic		
Juga rubiginosa (Lea)	Reported from Ahtanum Creek near Yakima by Henderson (1929): only definite site known at present. Northernmost known site for the genus, and likely represents an undescribed subgenus.	Endangered
Gyraulus (Torquis) parvus (Say)	Found in the Yakima area (Eyerdam, 1934)	None

METHODS

A total of 21 sites were examined in detail for land snails and aquatic snails (Figure 1). The 21 sites were chosen according to the likelihood of occurrences of land snails and aquatic snails. Sites were chosen that appeared to have soil types, vegetation, and water suitable for habitat. Other sites had been surveyed more casually in previous trips. The survey of the Hanford Site concentrated on the areas lying near the southwest, east, and northwest borders. Most sites were on the Emerson Nipple, Riverland, Snively Basin, Savage Island, and Iowa Flats USGS 7.5' topographic quadrangles (see Appendix). All springs and permanent streams on the Hanford Site not previously evaluated were surveyed. Most sites were concentrated in the Arid Lands Ecology Reserve and in the area in and adjoining the Wahluke Wildlife Refuge on the east side of the Columbia River. Major land forms that were surveyed were Rattlesnake Mountain, White Bluffs, and Umtanum Ridge (Figure 1). Major drainages covered were Cold Creek Valley, Dry Creek, and Rattlesnake Creek. Other sites that looked worthwhile on the maps (e.g., surface water was available) were reconnoitered but not surveyed either because habitat was entirely unsuitable (e.g., Doke Spring), or because of access problems. Significant features of the geology and flora were noted (see Appendix).

The field survey was conducted between August 17 and 20, 1992. The survey was conducted by walking out onto the chosen sites and, based on the previous snail habitat encountered, examining the surroundings (looking at the vegetation, under rocks, etc.) The occurrence or nonoccurrence of species was based on these examinations. Final laboratory analysis of the samples was completed by August 25, 1992. The survey team had two members, Terrence J. Frest and Edward J. Johannes. Gregg A. Martenson (Pacific Northwest Laboratory) assisted in the field August 17 to 19. Generally, sampling required at least 1 hour per site.

Hand-collected snails were placed in marked, water-filled bottles to which finely crushed menthol crystals were added. Relaxation occurred in 8 to 12 hours for freshwater forms and 24 to 36 hours for land snails. Relaxed snails were fixed with 5% formalin for 1 to 2 days, then transferred to 50% isopropyl alcohol. In the laboratory, the snails were transferred to 70% ETOH-15% glycerin for long-term storage. All snails were identified to species, and vouchers will be reposited in appropriate museum collections.

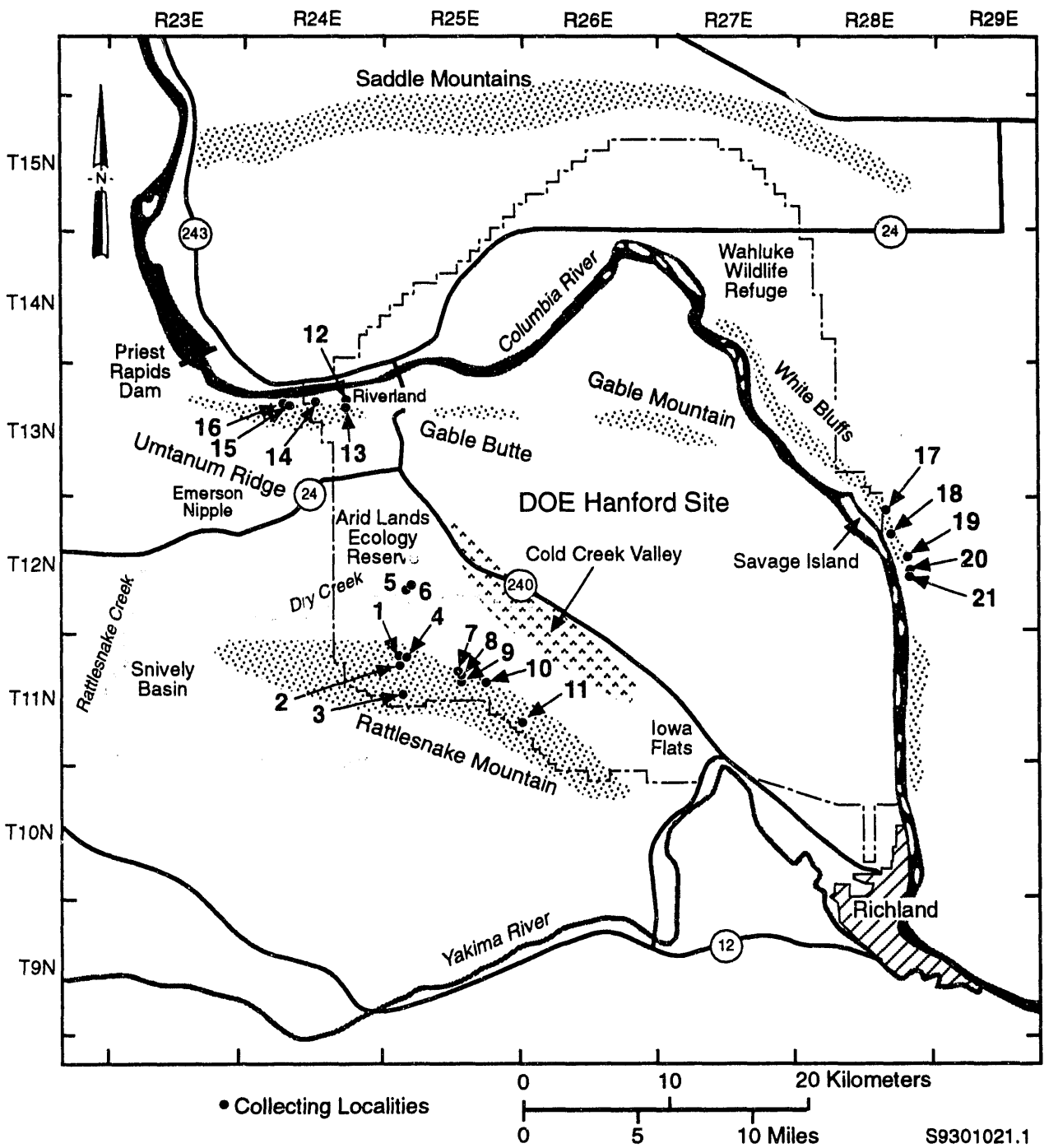

FIGURE 1. Map of the Hanford Site Showing Collecting Localities. Base map modified from National Park Service (1992). Numbers refer to site descriptions in the Appendix.

RESULTS

A total of five freshwater mollusc taxa and six land snail taxa was collected from the sites (Appendix). Of the 21 localities surveyed, only 9 (6 on the Hanford Site) had live molluscs. Many other sites previously selected from the maps were examined briefly. Most of these were clearly unsuitable and were not surveyed. The most common problem was human alteration of spring habitats, often resulting in dry springs.

No candidate, endemic, or rare freshwater species were found aside from the two (*Fisherola nuttalli* and *Fluminicola columbiana*) already known to occur on the Hanford Site [in the Hanford Reach of the Columbia River (Neitzel and Frest 1992)]. Most species encountered are widely distributed and are pollution- and disturbance-tolerant forms, such as *Physella gyrina*. The freshwater mollusc fauna is extremely sparse compared to that of the Columbia Gorge and somewhat depauperate as compared to that of the Yakima Canyon. One introduced taxon, *Radix auricularia*, was present at several sites.

No additional candidate land snail taxa were encountered during the survey. One of the species found, *Philomycus carolinianus*, was likely introduced. Most of the taxa are relatively widespread species. However, one new land snail species, *Cryptomastix* n. sp., was found at a single site. It is very likely closely related to *C. hendersoni*, another taxon suggested for candidate status (Table 3) and most likely should itself be considered a probable candidate for listing and Hanford Site endemic. Live specimens were not collected: a formal description of this species will require live collections. From past experience, attempts to resample the site should be made either in early spring or in late fall. Most land snails in semiarid regions aestivate in hot dry weather and hibernate in cold weather. Thus they are difficult to find live most of the year.

DISCUSSION

The majority of the Columbia Gorge endemics prefer certain habitats that also are present in Yakima Canyon and the Hanford Site. Most of the freshwater taxa are restricted to permanent springs in rocky areas, often narrowly localized to the spring source or to strongly spring-influenced flowage. A few species, such as *F. nuttalli*, *F. columbiana*, and *Anodonta californiensis*, are river endemics. The common rocky substrate in the Columbia Gorge is basalt, as it is in both the Yakima Canyon and Hanford Site. In some instances, basalt taluses, particularly those that are north- or east-facing, will have land snails even in the absence of springs. For both land and freshwater spring-associated taxa, the common occurrence is as locally abundant small colonies often separated by large intervening stretches totally lacking molluscs.

The relatively sparse land and freshwater snail fauna of the Hanford Site likely results from several factors. First, the area is relatively arid, even as compared to the eastern part of the Columbia Gorge and to the Yakima Canyon. Second, and surprisingly, spring modification such as diversion, addition of pipes, bulldozing, and excavation were nearly universal on the Hanford Site. Only one site lacked such modification. From our past experience, such modification frequently impacts both the land and freshwater native mollusc fauna, frequently resulting in their elimination (Frest and Johannes 1992; Boler and Frest 1992).

The small number of permanent streams on the Hanford Site could be a third factor. The limited number of streams in this large area likely has inhibited dispersal and site reoccupation within the last 10,000 years. Note that a larger freshwater and land snail fauna is known to occur along the Columbia River to the north of the Hanford Site as well as in the Hanford Reach of the Columbia River itself (freshwater only), Columbia Gorge, Yakima Canyon, and Washington Snake River areas.

The depauperate nature of the Hanford Site malacofauna cannot be ascribed to the more notorious human usages of the Site unless some spring diversion was connected to this. Some of it certainly occurred before DOE acquisition of the area; however, PVC piping in some springs must be of relatively recent vintage. Springs on the east side of the Columbia River are clearly impacted substantially by irrigation and fish hatchery usage. Such usage has repeatedly been observed to endanger or threaten all or a substantial portion of the native mollusc fauna.

The Hanford Site retains three rare mollusc species, one of which appears to be a new and endemic taxon. *Cryptomastix* n. sp. is very likely closely related to the Columbia Gorge endemic *C. hendersoni* [those reported in Pilsbry (1939-1948) from other areas appear to belong to other species].

The new species has not been found in Yakima Canyon. Areas to the north of the Hanford Site and across northern Washington also seem to lack this species. In this genus, only *C. mullani olneyae* and *C. mullani mullani* have been found in these areas to date.

No species in the freshwater genera *Juga* or "*Bithynella*" or the land snail genus *Oreohelix* occurred on the Hanford Site. This was somewhat surprising, as all three occur in the Yakima Canyon area. Their equivalents are also found in the Columbia Gorge and in certain other areas in Washington, such as the Grand Coulee. The limited survey period and the factors mentioned previously are likely responsible. The few streams in a large area with few continuous or seasonal connections likely resulted in a sparse mollusc population. This coupled with streams being used for irrigation during the earlier part of the twentieth century may have caused these species to go extinct on the Hanford Site. Very likely, species belonging to these genera extend from the Yakima Canyon area into the Yakima Firing Center, but only *Cryptomastix* seems to survive onto the Hanford Site.

There are plans to sample an additional 20 sites in spring 1993. The results will verify the existence, or lack thereof, of species in the freshwater genera *Juga* or "*Bithynella*" or the land snail genus *Oreohelix* on the Hanford Site.

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APPENDIX

LOCALITIES

APPENDIX

LOCALITIES

Site coordinates are derived from the most recent USGS 7.5' quadrangle. Taxonomy used for freshwater mollusc species is that of Burch (1989) for gastropods and Clarke (1981) for pisidiids. Landsnail taxonomy follows that of Pilsbry (1939-1948), except that *Cryptomastix* is regarded as a full genus, as is now well established (e.g., Webb 1970; Emberton 1988). Abbreviations for collectors are as follows:

TF- Terrence J. Frest
EJ- Edward J. Johannes
GM- Gregg A. Martenson

1. Lower Snively Spring. SW1/4 SW1/4 NW1/4 NW1/4 sec. 8, T11N R25E, Snively Basin quad., Benton Co., Washington. Lower Snively Spring on W. side of dirt rd., Snively Gulch, Snively Basin, N. side of Rattlesnake Hills, Arid Lands Ecology Reserve, Hanford Site. Basalt substrate. Elev. 1280'. Spring with considerable human modification. Shallow spring with *Rorippa*, *Urtica*, *Sambucus*, *Rosa*, and *Salix*. Gravel substrate. Live specimens of *Gyraulus (Torquis) parvus* (Say, 1817) and *Pisidium (Neopisidium) insigne* (Gabb, 1868) were found. Collected by hand. 8/17/92 TF, EJ, GM.

2. Snively Spring. SW1/4 SE1/4 NE1/4 SW1/4 sec. 8, T11N R25E, Snively Basin quad., Benton Co., Washington. Snively Spring, W. side of dirt rd. in Snively Gulch, S. of Snively Ranch, Snively Basin, N. side of Rattlesnake Hills, Arid Lands Ecology Reserve, Hanford Site. Basalt substrate. Elev. 1480'. Spring shows signs of pre-Site human modification. Sparse *Rorippa* and *Urtica*; water shallow, rather warm. Collected at spring source. No molluscs seen. 8/17/92 TF, EJ, GM.

3. Upper Snively Spring. Cen. SW1/4 SW1/4 NW1/4 sec. 20, T11N R25E, Snively Basin quad., Benton Co., Washington. Upper Snively Spring in unnamed tributary canyon to Rattlesnake Cr., N. side of Rattlesnake Hills, within the Arid Lands Ecology Reserve, Hanford Site. Basalt substrate. Elev. 2100'. Spring human modified (old wooden pipe). Collection attempted near spring source. Shallow spring with *Urtica*. Cobble and mud bottom. No molluscs seen. 8/17/92 TF, EJ, GM.

4. Snively Gulch. Cen. NE1/4 SW1/4 NW1/4 sec. 8, T11N R25E, Snively Basin quad., Benton Co., Washington. E. -facing basalt talus on W. side of dirt rd. in Snively Gulch, Snively Basin, N. side of Rattlesnake Hills, Arid Lands Ecology Reserve, Hanford Site. Elev. 1340'. Basalt talus with *Clematis* and *Rosa*. Specimens of *Vallonia cyclophorella* (Sterki, 1892) were found live, recently dead, and long dead. Land snails hand collected. 8/17/92 TF, EJ, GM.

5. Rattlesnake Spring. NE1/4 NE1/4 NW1/4 NE1/4 sec. 29, T12N R25E, Riverland quad., Benton Co., Washington. Rattlesnake Spring in a deep ravine cut by Dry Cr. in unconsolidated sediments, Arid Lands Ecology Reserve, Hanford Site. Elev. 700'. Spring not in good shape; comparatively warm. USGS map says dry. Abundant *Lemna minor*; *Salix*, *Urtica* common; some *Prunus*, *Sambucus*, and *Solidago*. Mud bottom; 12-15" depth. No molluscs seen. 8/18/92 TF, EJ, GM.

6. Dry Creek. SW1/4 NE1/4 SE1/4 SE1/4 sec. 20, T12N R25E, Riverland quad., Benton Co., Washington. Dry Cr. behind Radioecology Field Lab Building 646, Arid Lands Ecology Reserve, Hanford Site. Elev. 690'. Common *Rorippa*, *Urtica*, *Salix.*, *Solidago*. Gravel bottom with sand patches. Depth 6" or less. Live and recently dead specimens of *Physella (Physella) gyrina* (Say, 1821) were found. Live specimens of *Radix auricularia* (Linne, 1758) were found. Molluscs collected by hand and dip net. 8/18/92 TF, EJ, GM.

7. Unnamed spring west of Benson Spring. SE1/4 NE1/4 NE1/4 SE1/4 SE1/4 sec. 10, T11N R25E, Snively Basin quad., Benton Co., Washington. Unnamed spring in tributary canyon W. of Benson Spring, N. side of Rattlesnake Hills, Arid Lands Ecology Reserve, Hanford Site. Basalt substrate. Elev. 1440'. Spring piped below collecting site. Common *Urtica*, *Salix*, and *Prunus*. Mud bottom, 2" or less depth. Cold spring, but comparatively warm water. Live, recently dead, and long dead specimens of *Pisidium (Neopisidium) insigne* (Gabb, 1868) were found. Hand and dip net collection. 8/18/92 TF, EJ, GM.

8. Benson Spring. NW1/4 SW1/4 NW1/4 SW1/4 SW1/4 sec. 11, T11N R25E, Snively Basin quad., Benton Co., Washington. Benson Spring at canyon divide, N. side of Rattlesnake Hills, Arid Lands Ecology Reserve, Hanford Site. Basalt substrate. Elev. 1660'. Spring piped. Fairly large spring with basalt cobbles and mud bottom. Epiphytic algae, *Urtica*, *Rosa*, *Salix*, and *Cicuta*. *Rorippa* and *Solidago* below collecting site. Depth 4" or less. No molluscs seen at source. 8/18/92 TF, EJ, GM.

9. Unnamed spring south of Benson Spring. SW1/4 SW1/4 SW1/4 SW1/4 SW1/4 sec. 11, T11N R25E, Snively Basin quad., Benton Co., Washington. Unnamed spring on W. wall of tributary canyon S. of Benson Spring, N. side of Rattlesnake Hills, Arid Lands Ecology Reserve, Hanford Site. Basalt substrate. Elev. 1520'. Pre-Site human modification to spring. Almost no vegetation; scattered *Rorippa* below site, *Prunus* above spring. Very shallow spring (depth less than 1"). No molluscs seen. 8/18/92 TF, EJ, GM.

10. Unnamed spring east of Benson Spring. NW1/4 NW1/4 NE1/4 SE1/4 SE1/4 sec. 11, T11N R25E, Snively Basin quad., Benton Co., Washington. Unnamed spring in E. branch of a small canyon S. of Benson Spring, N. side of Rattlesnake Hills, Arid Lands Ecology Reserve, Hanford Site. Basalt substrate. Elev. 1300'. *Rorippa* small and rare; common *Prunus*. Mud substrate, shallow depth of 1" or less. No molluscs seen. 8/18/92 TF, EJ, GM.

11. Rattlesnake Mountain unnamed spring. NE1/4 NW1/4 NW1/4 SW1/4 SE1/4 sec. 30, T11N R26E, Iowa Flats quad., Benton Co., Washington. Unnamed spring E. of radio tower, N. side of Rattlesnake Mt. (Rattlesnake Hills), Arid Lands Ecology Reserve, Hanford Site. Basalt talus. Elev. 3160'. Spring completely diverted and piped. Live and long dead specimens of *Vallonia cyclophorella* (Sterki, 1892) were found. Land snails hand collected. 8/18/92 TF, EJ, GM.

12. Juniper Springs (lower). SE1/4 NW1/4 SE1/4 SW1/4 NE1/4 sec. 14, T13N R24E, Emerson Nipple quad., Benton Co., Washington. Juniper Springs (lower spr.) just W. of peach orchard, W. of dirt access rd., above the Columbia R., E. end of Umtanum Ridge on the N. side, Hanford Site. Basalt substrate. Elev. 560'. Spring is dry or completely diverted into peach orchard. One *Prunus* still survives on the spring site. No snails seen. 8/19/92 TF, EJ, GM.

13. Juniper Springs (upper). SE1/4 SW1/4 SE1/4 SW1/4 NE1/4 sec. 14, T13N R24E, Emerson Nipple quad., Benton Co., Washington. Juniper Springs (upper spring) above peach orchard, W. of dirt access rd., above the Columbia R., E. end of Umtanum Ridge on the N. side, Hanford Site. Basalt substrate. Elev. 640'. Almost all the spring water has been diverted into abandoned peach orchard. Broken wooden pipe runs through the site. Dry spring. *Prunus*; *Rhus*, *Equisetum* in upper part of spring (basalt ledge); common *Prunus*, *Clematis* below. Specimens of *Pisidium (Neopisidium) insigne* (Gabb, 1868) were found recently dead and long dead. Specimens of *Vallonia cyclophorella* (Sterki, 1892) were found recently dead. Live, recently dead, and long dead specimens of *Succinea gabbi* Tryon, 1866 and *Cryptomastix* n. sp. were found. Land snails collected by hand. 8/19/92 TF, EJ, GM.

14. Umtanum Ridge above China Bar. SW1/4 SW1/4 NW1/4 NE1/4 NW1/4 sec. 15, T13N R24E, Emerson Nipple quad., Benton Co., Washington. Basalt talus below small cave, above China Bar, along the Columbia R., E. end of Umtanum Ridge on the N. side, Hanford Site. Elev. 580-600'. Dry basalt talus with very little vegetation (burned sage scrub). Snails not seen. 8/19/92 TF, EJ, GM.

15. Umtanum Ridge cave west of China Bar. SW1/4 NW1/4 SE1/4 SW1/4 SW1/4 sec. 9, T13N R24E, Emerson Nipple quad., Benton Co., Washington. Cave and adjoining talus in basalt cliff above abandoned railroad grade, W. of China Bar, along the Columbia R., E. end of Umtanum Ridge on the N. side. Elev. 490'. Cave served as a Native American shelter and has a small midden (*Margaritifera falcata*). Site disturbed by artifact collectors. Dry cave with wind blown sediments covering the floor. Small patches of *Prunus* on both sides of the cave. No snails seen. 8/19/92 TF, EJ, GM.

16. Umtanum Ridge west of China Bar. SE1/4 NW1/4 SW1/4 SE1/4 SE1/4 sec. 8, T13N R24E, Emerson Nipple quad., Benton Co., Washington. N. -facing mossy basalt talus above abandoned railroad grade, W. of China Bar, along the Columbia R., E. end of Umtanum Ridge. Elev. 470'. Mossy basalt talus with little vegetation. No snails seen. 8/19/92 TF, EJ, GM.

17. Unnamed springs east of Savage Island. SW1/4 NW1/4 SW1/4 sec. 2, T12N R28E, Savage Island quad., Franklin Co., Washington. W. -facing springs above irrigation wasteway WB5K in canyon along the Columbia R., E. of Savage Island, White Bluffs, just outside the Wahluke Slope Habitat Management Area. Elev. 580-600'. Springs are largely or entirely irrigation recharge. Shallow seep slope (mostly under 1" depth) and basal ditch (up to 16" depth). Collection from *Rorippa*-covered slope and adjacent ditch with *Typha*, *Salix* and *Prunus*. No molluscs seen. 8/19/92 TF, EJ, GM.

18. Unnamed springs east of the south end of Savage Island. NW1/4 NE1/4 NW1/4 sec. 14, T12N R28E, Savage Island quad., Franklin Co., Washington. W. -facing springs above access rd. along the Columbia R., E. of the S. end of Savage Island, White Bluffs, Wahluke Slope Habitat Management Area, Hanford Site. Elev. 480-490'. Springs are mostly or entirely irrigation recharge. Shallow seep slope (mostly under 1" depth) with thick secondary calcium carbonate accumulation. Live and recently dead *Physella (Physella) gyrina* (Say, 1821) and *Oxyloma nuttalianum* (Lea, 1841) specimens were found. Live *Stagnicola (Hinkleyia) caperata* (Say, 1829) specimens were found. Hand and dip net collection from *Rorippa*-covered slope and adjacent ditch with *Typha*, *Cicuta*, and *Salix*. 8/19/92 TF, EJ, GM.

19. Unnamed springs north of the Ringold Fish Hatchery. NE1/4 SE1/4 SW1/4 SW1/4 NW1/4 sec. 24, T12N R28E, Savage Island quad., Franklin Co., Washington. W. -facing springs above access rd. along the Columbia R., N. of the Ringold Fish Hatchery, White Bluffs, just outside the Wahluke Slope Habitat Management Area. Elev. 490'. Springs are entirely or heavily influenced by irrigation recharge. Obvious secondary calcium carbonate (travertine) accumulation. Abundant mosses, *Typha*, and *Cicuta* in ditch; *Typha* and *Rorippa* on slope. Live and recently dead specimens of *Physella (Physella) gyrina* (Say, 1821) and *Radix auricularia* (Linne, 1758) were found. Live, recently dead, and long dead specimens of *Oxyloma nuttalianum* (Lea, 1841) were found. Live specimens of *Deroceras laeve* (Müller, 1774) and *Philomycus carolinianus* (Bosc, 1802) were found. Dip net and hand collection. 8/19/92 TF, EJ, GM.

20. Ringold North springs. NE1/4 SE1/4 SW1/4 NW1/4 sec. 24, T12N R28E, Savage Island quad., Franklin Co., Washington. W. -facing springs to E. of Ringold Hatchery, near N. end of hatchery, near check gate, White Bluffs, just outside the Wahluke Slope Habitat Management Area. Elev. 420'. Common calcium carbonate deposition on slope. Abundant *Rorippa*, common *Typha* and *Scirpus* on slope, *Typha*, *Scirpus*, and *Cicuta* along ditch. Depth in ditch to 28". Live and recently dead specimens of *Physella (Physella) gyrina* (Say, 1821), *Stagnicola (Hinkleyia) caperata* (Say, 1829), and *Oxyloma nuttalianum* (Lea, 1841) were found. Recently dead specimen of *Radix auricularia* (Linne, 1758) was found. Dip net and hand collection. 8/20/92 TF, EJ.

21. Ringold South springs. NE1/4 SW1/4 NE1/4 NW1/4 SW1/4 sec. 24, T12N R28E, Savage Island quad., Franklin Co., Washington. W. -facing springs to E. of Ringold Hatchery, near N. end of hatchery, near check gate, White Bluffs, just outside the Wahluke Slope Habitat Management Area. Elev. 420'. Common calcium carbonate deposition on slope. Abundant *Rorippa*, common *Typha* on slope; *Typha*, *Rorippa*, *Scirpus*, and *Cicuta* along ditch. Live, recently dead, and long dead specimen of *Physella (Physella) gyrina* (Say, 1821) was found. Live and recently dead specimens were found of *Radix auricularia* (Linne, 1758) and *Oxyloma nuttalianum* (Lea, 1841) were found. Depth in ditch to 16". Hand and dip net collection mostly from slope. 8/20/92 TF, EJ.

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