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Land Snails and Slugs (Gastropoda: Caenogastropoda and Pulmonata) of Two National Parks along the Potomac River near Washington, District of Columbia

Brent W. Steury

U.S. National Park Service
700 George Washington Memorial Parkway
Turkey Run Park Headquarters
McLean, Virginia 22101

Timothy A. Pearce

Carnegie Museum of Natural History
4400 Forbes Avenue
Pittsburgh, Pennsylvania 15213-4080

ABSTRACT

The land snails and slugs (Gastropoda: Caenogastropoda and Pulmonata) of two national parks along the Potomac River in Washington DC, Maryland, and Virginia were surveyed in 2010 and 2011. A total of 64 species was documented accounting for 60 new county or District records. *Paralaoma servilis* (Shuttleworth) and *Zonitoides nitidus* (Müller) are recorded for the first time from Virginia and *Euconulus polygyratus* (Pilsbry) is confirmed from the state. Previously unreported growth forms of *Punctum smithi* Morrison and *Stenotrema barbatum* (Clapp) are described.

Key words: District of Columbia, *Euconulus polygyratus*, Gastropoda, land snails, Maryland, national park, *Paralaoma servilis*, *Punctum smithi*, *Stenotrema barbatum*, Virginia, *Zonitoides nitidus*.

INTRODUCTION

Land snails and slugs (Gastropoda: Caenogastropoda and Pulmonata) represent a large portion of the terrestrial invertebrate fauna with estimates ranging between 30,000 and 35,000 species worldwide (Solem, 1984), including at least 523 native taxa in the eastern United States (Hubricht, 1985). Known extinctions of land snails are disproportionately high and there is clear evidence that over the last few hundred years snail extinctions have exceeded those known for all other animal groups combined (Lydeard et al., 2004; Naggs, 2006). Land snails are thought to have low vagility, often migrating only a few meters per year (Arnaud et al., 1999), but recent studies suggest that dispersal may be facilitated by rafting in some species that occur near rivers (Sinclair, 2010), or in the case of the Japanese snail *Tornatellides boeningi* (Schmacker & Boettger), by traveling while in the digestive tract of birds (Wada et al., 2011).

Although county-level distributions of native land gastropods have been published for the eastern United States (Hubricht, 1985), and for the District of Columbia and Maryland (Grimm, 1971a), and Virginia (Beetle, 1973), no published records exist specific to the areas inventoried during this study, which covered select national park sites along the Potomac River in Washington D.C., central Maryland, and northern Virginia. In an effort to protect better the land snail fauna of these park areas, this study sought to provide habitat, relative abundance, and site-specific location data to identify important areas for land snail conservation at these national park sites.

STUDY SITE

Inventories were conducted on lands managed by the National Park Service, National Capital Parks-East (NCPE) and the George Washington Memorial Parkway (GWMP). The survey area is encompassed by

these coordinates (WGS84 Geographic Coordinate System): N 39.007 W -77.255, N 38.667 W -77.075, N 39.006 W -77.265, and N 38.806 W -76.999. While all sites deemed to have potential snail habitat within the GWMP were surveyed, including sites in the District of Columbia (Theodore Roosevelt Island [RI]), and Virginia (Arlington Co.: Potomac Heritage Trail [PH], Roaches Run Waterfowl Sanctuary [RR]; Fairfax Co.: Great Falls Park [GF], Turkey Run Park [TR], Dyke Marsh [DM], Fort Hunt [FH], Little Hunting Creek [LH]; City of Alexandria: Daingerfield Island [DI], Jones Point Park [JP]), only portions of NCPE along the Potomac River were surveyed, including sites in the District of Columbia (Oxon Cove [OC]) and Maryland (Charles Co.: Piscataway Park [PP]; Prince Georges Co.: Fort Foote [FF], Fort Washington [FW], OC, and PP). These sites lie in the Piedmont and Coastal Plain physiographic provinces and contain a diverse array of habitats including wetlands, meadows, and calcareous and acidic, deciduous dominated woodlands. The vascular flora of these areas is correspondingly diverse with 988 taxa documented from Piscataway and Fort Washington Parks (Steury & Davis, 2003) and 1,313 taxa from the GWMP (Steury et al., 2008; Steury, 2011). The historic forts and Endicott batteries created between 1824 and 1903 at Fort Washington and Fort Hunt are located in open areas, surrounded by mowed turf grass or irregularly maintained meadows, except for Battery Emory in Fort Washington Park, which is now surrounded by second growth woodland at the crest of mature, deciduous, shell marl ravine forest. Other important sites included the narrowleaf cattail (*Typha angustifolia* L.) dominated marsh at Dyke Marsh and the pumpkin ash (*Fraxinus profunda* [Bush] Bush) swamp forest surrounding it. Important micro-habitats for snails included under or inside rotting logs, under loose bark of fallen trees, and in leaf litter.

MATERIALS AND METHODS

Surveys lasting one to five hours were conducted in 2010 and 2011 during the following months: February (2 dates), March (6), April (8), May (7), June (8), July (4), August (4), September (4), October (3), and November (2). Surveys were conducted using 3x magnifying lenses to look under woody debris, rocks, leaf litter, loose bark of rotting fallen trees, and along the bases of concrete structures. Additionally, leaf litter samples were collected by filling one to three paper grocery bags (typically 14-18 l) at most sites, and each habitat type, including talus slopes in Turkey Run Park, slopes along Difficult Run, ravine forest in Great Falls Park, shell marl forests in Fort Washington and Piscataway parks, upland woods on Theodore Roosevelt Island, and Dyke Marsh swamp. Leaf litter samples were left in paper bags until dry, sieved in a hand spun centrifuge (pore sizes 5 x 2 mm to 5 x 20 mm), and examined under a dissecting microscope. In 2010, concurrent with this study, 500 ml cup pitfall traps were set to collect ground beetles. Bycatch in these cups often included snails that were added to the records for this study. Field notes were recorded for habitat types and locations of each collection.

Voucher specimens were collected for each species observed and to document new county or state records. Shells collected at NCPE are deposited at the Museum Resource Center (MRC) in Landover, Maryland. Shells collected at GWMP are deposited at Turkey Run Headquarters in McLean, Virginia.

New county and District records were determined by comparison with data in DeWitt (1952), Grimm (1971a), Beetle (1973), Dundee (1974), Hubricht (1985), and Steury & Steury (2011). State record determinations were based on these literature reviews, plus records provided by Perez & Cordeiro (2008), and queries of collection databases at Academy of Natural Sciences at Philadelphia (ANSP), Bailey-Matthews Shell Museum (BMSM), Carnegie Museum of Natural History (CMNH), Field Museum of Natural History (FMNH), Florida Museum of Natural History (FLMNH), National Museum of Natural History (NMNH), Santa Barbara Museum of Natural History (SBMNH), The Delaware Museum of Natural History (DMNH), The Ohio State University Museum of Biological Diversity (OSM), University of Michigan Museum of Zoology (UMMZ), and Yale Peabody Museum of Natural History (YPM).

Familial nomenclature and taxonomic order follow Bouchet & Rocroi (2005), except for Cionellidae, which follows Roth (2003). Generic and species names follow Perez & Cordeiro (2008) and Turgeon et al. (1998), and are listed alphabetically.

RESULTS AND DISCUSSION

At least 64 species (ten slugs and 54 snails) in 23 families were documented from 10 national park sites along the Potomac River near Washington, DC, including 10 non-natives (7 slugs, 3 snails). All of the latter are of European origin, except for *Paralaoma servilis* (New Zealand) and *Milax gagates* (Mediterranean region). *Paralaoma servilis* and *Zonitoides nitidus* were documented for the first time from Virginia and *Euconulus polygyratus* was confirmed for the state.

Sixty new county or District records were established (Table 1), including 22 species (eight non-

Table 1. Species (n=64) of land snails and slugs found in national park sites in the District of Columbia (DC), Charles (CH) and Prince Georges (PG) counties, Maryland, and Arlington (AR) and Fairfax (FA) counties, and the City of Alexandria (CA), Virginia. New county and city records are indicated by an asterisk (*). Species newly recorded from the District of Columbia and vicinity since Richards (1934) are marked with a dagger (†). Non-native species are marked with an exclamation point (!).

FAMILY	**SPECIES**	**DC**	**MD**		**VA**		
			CH	**PG**	**AR**	**CA**	**FA**
POMATIOPSIDAE	*Pomatiopsis lapidaria* (Say, 1817)	X	X*	X*	X	X	X
ELLOBIIDAE	*Carychium exiguum* (Say 1822)		X*	X*	X	X	X
	Carychium exile I. Lea, 1842			X*			X*
SUCCINEIDAE	†*Catinella vermeta* (Say, 1824)			X		X*	X*
	†*Novisuccinea ovalis* (Say, 1817)						X*
	†*Oxyloma* cf. *effusum* (Pfeiffer, 1853)	X*	X	X*		X*	X*
	Oxyloma cf. *subeffusa* Pilsbry, 1948	X					
CIONELLIDAE	*Cochlicopa lubrica* (Müller, 1774)			X		X*	
	†*Cochlicopa lubricella* (Porro, 1838)			X*			
PUPILLIDAE	*Pupoides albilabris* (C.B. Adams, 1841)			X			
STROBILOPSIDAE	*Strobilops aeneus* Pilsbry, 1926		X	X*			X
	Strobilops labyrinthicus (Say, 1817)						X
	†*Strobilops texasianus* Pilsbry & Ferriss, 1906			X			
VALLONIIDAE	*Vallonia excentrica* Sterki, 1893			X	X		X
VERTIGINIDAE	*Gastrocopta armifera* (Say, 1821)			X*			
	Gastrocopta contracta (Say, 1822)	X		X	X		X
	Gastrocopta corticaria (Say, 1816)			X			
	Gastrocopta pentodon (Say, 1821)			X			X
	Gastrocopta procera (Gould, 1840)			X			X*
	Gastrocopta tappaniana (C.B. Adams, 1842)	X		X	X*	X*	X*
	Vertigo milium (Gould, 1840)			X*			
	Vertigo ovata Say, 1822		X*		X*	X*	X*
	Vertigo pygmaea (Draparnaud, 1801)			X			X*
HAPLOTREMATIDAE	*Haplotrema concavum* (Say, 1821)			X			X
PUNCTIDAE	†!*Paralaoma servilis* (Shuttleworth, 1852)					X*	
	Punctum minutissimum (I. Lea, 1841)		X	X	X		X*
	†*Punctum smithi* Morrison, 1935			X			X
	Punctum vitreum (H.B. Baker, 1930)		X*	X*			X
DISCIDAE	*Anguispira alternata* (Say, 1816)	X	X	X			X
	†*Anguispira fergusoni* (Bland, 1861)	X		X	X*		X
	†!*Discus rotundatus* (Müller, 1774)	X					
HELICODISCIDAE	*Helicodiscus parallelus* (Say, 1817)	X		X	X		X
	Lucilla scintilla (R.T. Lowe, 1852)			X*			X*
GASTRODONTIDAE	*Striatura meridionalis* (Pilsbry & Ferriss, 1906)			X			X
	†*Striatura milium* (E.S. Morse, 1859)						X
	Ventridens ligera (Say, 1821)	X	X	X	X	X	X
	Ventridens suppressus (Say, 1829)			X	X		X
	Zonitoides arboreus (Say, 1816)	X	X	X	X	X	X
	†*Zonitoides nitidus* (Müller, 1774)			X*		X*	
EUCONULIDAE	*Euconulus dentatus* (Sterki, 1893)						X*
	Euconulus fulvus (Müller, 1774)						X*
	Euconulus polygyratus (Pilsbry, 1899)			X*			X*
	Guppya sterkii (Dall, 1888)			X			
ZONITIDAE	*Glyphyalinia indentata* (Say, 1823)			X	X		X
	†*Glyphyalinia luticola* Hubricht, 1966			X*			X*
	†*Glyphyalinia solida* (H. B. Baker, 1930)			X			X*
	Glyphyalinia wheatleyi (Bland, 1883)			X			X*
OXYCHILIDAE	!*Oxychilus draparnaudi* (Beck, 1837)	X		X		X*	

Table 1 (continued).

FAMILY	SPECIES	DC	MD		VA		
			CH	PG	AR	CA	FA
PRISTILOMATIDAE	*Hawaiia minuscula* (A. Binney, 1841)			X			X
LIMACIDAE	†!*Ambigolimax valentiana* (Férussac, 1823)				X*	X*	X*
	!*Limax maximus* Linné, 1758			X		X*	X*
MILACIDAE	†!*Milax gagates* (Draparnaud, 1801)						X*
AGRIOLIMACIDAE	*Deroceras laeve* (Müller, 1774)	X		X	X	X	X
	†!*Deroceras reticulatum* (Müller, 1774)				X*	X*	
ARIONIDAE	†!*Arion hortensis* Ferussac, 1819					X*	
	†!*Arion intermedius* (Normand 1852)			X*			X*
	†!*Arion subfuscus* (Draparnaudi, 1805)			X		X	X
PHILOMYCIDAE	†*Megapallifera mutabilis* (Hubricht, 1951)						X*
	†*Philomycus carolinianus* (Bosc, 1802)		X	X			X
POLYGYRIDAE	*Mesodon thyroidus* (Say, 1816)	X	X	X	X		X
	Neohelix albolabris (Say, 1816)						X
	†*Stenotrema barbatum* (Clapp, 1904)			X	X*		X
	Triodopsis juxtidens (Pilsbry, 1894)	X		X	X	X	X
	Xolotrema denotatum (Férussac, 1821)		X*	X*			

native) added to the regional fauna since the work of Richards (1934). Thirty-four species were found only on the Coastal Plain as opposed to five only in the Piedmont. A total of 22 species was found only in dry to mesic upland forests, 12 only in open or forested wetlands, eight only in dry to mesic open areas, and 22 were found in more than one habitat type. Seven species (10.9%) were documented only by the presence of shells. The half life of empty shells in habitats similar to these can extend up to 11.5 years (Pearce, 2008b), suggesting recent occurrences. Fifteen species were found in the District of Columbia, 51 in Maryland (49 Prince Georges Co., 13 Charles Co.), and 56 in Virginia (19 Arlington Co., 19 City of Alexandria, 50 Fairfax Co.). Most of the new county records are probably not an indication of recent range extensions but more likely further evidence that distributions of land snails are poorly known. The historic forts and Endicott batteries at Fort Washington and Fort Hunt proved to be especially important sites for land snail species richness. The now crumbling calcareous mortar and concrete that was used to construct these sites seemed to create ideal habitat for snails preferring calcareous, mesic to xeric, open areas, while the developing, thin, soil layer over the concrete basal areas, often covered by thin leaf litter proved to be a favored habitat for many species of snails. The calcareous shell marl ravine forests of Fort Washington and Piscataway parks contained a noticeably higher density of land snails than the more acidic woodlands on the Virginia side of the Potomac, not surprisingly since snails are known to be more abundant and diverse in calcium-rich areas (Hotopp, 2002).

Several species reported here involve challenging identifications and for some the taxonomy is uncertain. Smaller zonitid, pristilomatid, and euconulid snails in genera such as *Glyphyalinia*, *Hawaiia*, and *Euconulus* possess shells that are notoriously difficult to identify. Identification of many succineid snails requires genetic analysis (Hoagland & Davis, 1987), which was not performed. The material collected during this study will serve as a baseline for future investigations into the land snail fauna of areas along the Potomac River near the District of Columbia.

LIST OF SPECIES

CAENOGASTROPODA

POMATIOPSIDAE

Pomatiopsis lapidaria (Say, 1817) – (DM, FW [Swan Creek {SC} floodplain], JP, LH, PP [Bull Cove {BC} marsh, Accokeek Creek {AC} swamp, Wharf Road {WR} swamp], RI, RR). This is a common amphibious snail of tidal marshes, swamps, and creek banks on the Coastal Plain. It was generally found under moist logs within these habitats but one live snail was captured on 14 April 2010 in a pitfall trap in second growth woodland 25 m from the shore of Little Hunting Creek. Live animals were observed between 14 April and 18 October 2010 and as early as 19 February 2011. It was

commonly associated with *Carychium exiguum* and *Catinella vermeta*. Örstan & Pearce (2011) also recently reported it from the southern shore of Oxon Cove in Prince Georges County, Maryland. DeWitt (1952) reported this species from "Fox's Ferry," present day Oxon Cove.

PULMONATA

ELLOBIIDAE

Carychium exiguum (Say, 1822) – (DM, FW [SC floodplain], JP, LH, PP [BC, WR swamp], RR. This snail was found only in tidal Coastal Plain wetlands, under moist vegetative debris in swamps, and along marsh edges and creek banks. Live animals were observed between 18 April and 18 October 2010 and as early as 19 February 2011. On 17 July 2010, live animals were found under a moist log 0.7 m x 0.3 m at the edge of fringe marsh along Swan Creek. Also under this log were associated species *Gastrocopta contracta*, *P. lapidaria*, *Strobilops aeneus*, *Ventridens ligera*, *Vertigo milium*, and *Zonitoides arboreus*.

Carychium exile I. Lea, 1842 – (FW [Battery Emory {BE}, shell marl ravine forest {SM}], PP [SM], TR). This is an uncommon but locally abundant snail within the study area. It was found at four shady, deciduous forested sites, with seasonally moist leaf litter, on talus slopes, in upland second growth woodland, and mature forested ravines, in both the Piedmont and Coastal Plain. A common associate was *Punctum minutissimum*. A well-sorted leaf litter sample measuring 15.3 l collected on 4 August 2010, from forested talus slopes in Turkey Run Park contained at least 152 *C. exile*, 141 *P. minutissimum*, 17 *G. contracta*, 17 *Euconulus fulvus*, five *Z. arboreus*, three *Punctum vitreum*, one *Glyphyalinia indentata*, one *Punctum smithi*, one *Stenotrema barbatum*, and one *V. ligera*. Live animals were observed between 2 June and 17 October 2010. Live animals observed 4 August 2010, included juveniles of 2.5 whorls.

SUCCINEIDAE

The taxonomy of this family is not well understood and the taxon concepts presented below are based largely on those of previous studies (Grimm, 1971a; Hubricht, 1985) in the vicinity of Washington, DC. In addition to the four taxa discussed below, other species may be present in our area but could not be assigned to any known described species. Images of live animals and a comparison of shell characters are presented in Figs. 1-5.

Catinella vermeta (Say, 1829) – (DM, JP, LH, PP). This snail was found at four wetland sites on the Coastal Plain. It was common at one site in Dyke Marsh under logs in freshwater, tidal, *Typha angustifolia* marsh on 14 April 2010. One live animal was observed in freshwater, tidal, fringe marsh along Little Hunting Creek on 3 June 2010. Fourteen *C. vermeta* were found under woody debris on a tidal shore of Jones Point on 8 April 2010 and the species was observed there again on 15 June 2011. A small population was found under woody debris in freshwater, tidal, swamp forest along Piscataway Creek on 19 February 2011. Although 23 species of *Catinella* have been reported from the United States (Perez & Cordeiro, 2008), only three of these, *C. hubrichti* Grimm, *C. oklahomarum* (Webb), and *C. vermeta* have been documented from Virginia or Maryland (Hubricht, 1985; Perez & Cordeiro, 2008). Grimm (1960) provided a comparison of these three species showing a more pronounced spire in *C. vermeta* due to an additional whorl. According to Hubricht (1985), *C. hubrichti* is a snail of brackish marshes that climbs marsh vegetation and *C. oklahomarum* is found in upland pine woods. The only *Catinella* found during this survey was the higher spired, freshwater, wetland species, which was never observed climbing vegetation, and thus we attribute it to *C. vermeta* (Fig. 2).

Novisuccinea ovalis (Say, 1817) – (TR). On 17 June 2010, 34 live *N. ovalis* were found at Turkey Run Park spread over an area of 9 by 9 m located on a sandy floodplain 25 m from the bank of the Potomac River under the canopy of a large *Juglans nigra* L. Twelve snails were observed climbing the herb *Laportea canadensis* (L.) Weddell, nine were on *Asarum canadense* L., and five on *Geranium maculatum* L. Two were observed climbing the woody vine *Menisperum canadense* L. and six were observed on the woody shrub *Lindera benzoin* (L.) Blume. Associated snails at this site were *V. ligera*, climbing *Asarum canadense*, and *Mesodon thyroidus*, climbing *Lindera benzoin*. Pilsbry's (1948) description of this species as "larger and more inflated than any other (succineid) of the region" clearly diagnoses this species. Although the coloration of the animal is variable (see Pilsbry, 1948, Fig. 430a and 430b), the animals observed in this population (Fig. 3) were of a uniform pale color as shown in Pilsbry's Fig. 430a.

Oxyloma cf. *effusum* (Pfeiffer, 1853) – (DM, FW [SC fringe marsh], JP, LH, PP [BC, Accokeek Marsh], RI). This is the most common succineid found within the survey area. It occurred only in freshwater, tidal, *T. angustifolia* marshes and surrounding swamps where it

Fig. 1. From left to right: shells of *Novisuccinea ovalis* (Turkey Run Park, 17 June 2010; 18.2 mm), *Oxyloma* cf. *effusa* (Dyke Marsh, 9 September 2010; 18 mm), *Oxyloma* cf. *subeffusa* (Theodore Roosevelt Island, 15 June 2011; 11.5 mm), and *Catinella vermeta* (Dyke Marsh, 14 April 2010; 7.8 mm). Hash marks are in mm.

Fig. 2. *Catinella vermeta*, Jones Point Park, City of Alexandria, Virginia, 15 June 2011.

Fig. 3. *Novisuccinea ovalis*, Turkey Run Park, Fairfax County, Virginia, 17 June 2010.

Fig. 4. *Oxyloma* cf. *effusa*, Dyke Marsh, Fairfax County, Virginia, 15 June 2011.

Fig. 5. *Oxyloma* cf. *subeffusa*, Theodore Roosevelt Island, District of Columbia, 15 June 2011.

was easily found climbing high on the leaves and stems of *Typha* and *Sagittaria*, or under woody debris during cooler months. Live animals were observed between 14 April and 18 October 2010 and on 17 March 2011. Eggs probably hatch in late August or early September since a live animal with a 1.3 mm shell was collected on 9 September 2010. Descriptions of *O. effusum* and its habits by Grimm (1971a) fit well with observations of this species (Fig. 4) in the study area. Perez & Cordeiro (2008) reported 16 species of *Oxyloma* from the United States, including two (*O. effusum* and *O. subeffusm* Pilsbry) from Maryland and Virginia. Their inclusion of *O. retusum* (I. Lea) for Virginia is probably based in error on Hubricht's (1985) record from bordering Pendleton County, West Virginia. This is a wide-ranging species north of Virginia, extending across the northern tier of states west to California, and south to New Mexico, southern Illinois, and West Virginia, whereas *O. effusum* is a species of the Atlantic Coast from New Jersey to Florida (Hubricht, 1985; Perez & Cordeiro, 2008). Grimm (1971a) stated that records of *O. decampi gouldi* Pilsbry (synonymized with *O. retusum* by Hubricht, 1985, as suggested by Grimm, 1971a) from Maryland were based on misidentifications of *O. subeffusm* or *Catinella hubrichti* Grimm. To further complicate matters, Grimm (1981) suggested *O. d. gouldi* is equivalent to *O. verrilli* (Bland), a species Hubricht (1985) synonymized with *O. groenlandica* (Möller), which is

known from Iceland, Greenland, and Canada. Örstan (2010) stated "some uncertainty" about his record of *O. retusum* from Montgomery County, Maryland, 64.4 km north of Dyke Marsh. Although there are some similarities in the Montgomery County and Dyke Marsh *Oxyloma* populations (both apparently hatch young in late August or early September), there were also notable differences (the longest shell of any animal measured from Montgomery County was 14 mm and the longest shell found by September was 9 mm, while at Dyke Marsh, shells as long as 18 mm were observed in September). Pilsbry (1948) listed a maximum length of 16.3 mm for *O. retusum* and 19.5 mm for *O. effusum*. We believe all *Oxyloma* found in the survey area are best attributed to *O. effusum* based primarily on previously documented ranges (Hubricht, 1985) and shell length. Additionally, the broader aperture shape of Dyke Marsh *Oxyloma* more closely approximate Pilsbry's (1948) Fig. 423d of *O. effusum* from New Jersey than it does the narrower aperture of *O. retusum* from Illinois in Fig. 421a. A detailed genetic analysis of *Oxyloma* from the District of Columbia area is warranted.

Oxyloma cf. *subeffusa* Pilsbry, 1948 – (RI). This snail was observed only on Theodore Roosevelt Island on 24 March and 15 June 2011, scattered under moist woody debris in a tidal swamp and moist woodland between a small marsh and the Potomac River. Although Grimm (1971a) described the ground color of *O. subeffusa* as pale gray, Pilsbry's (1948) description of its ground color as very pale gray or faintly yellowish better describes the specimens from Theodore Roosevelt Island. The form, color, and size of the shell, and the pattern and color of our material (Fig. 5), match exactly Fig. 418a of Pilsbry (1948). Both Grimm (1971a) and Hubricht (1985) mentioned that *O. subeffusa* does not climb vegetation, which is consistent with our observations. *O. subeffusa* is a globally rare (G3) snail found only along the Atlantic Coast from southern Virginia to New Jersey (Hubricht, 1985). It is ranked as an S1 "extremely rare and critically imperiled" species in Virginia (Roble, 2013). Pilsbry (1948) mentioned a collection from Washington, DC without citing a specific locality. Theodore Roosevelt Island would be the westernmost site known in the distribution of *O. subeffusa*.

The only other succineid species previously reported for Maryland and Virginia are *Succinea campestris* Say, a species associated with dry, beach dune grasses, and *S. wilsoni* I. Lea, a high-spired species of brackish marshes. Additionally, *S. indiana* Pilsbry, a species of dry, sunny, bare ground, has been recorded from Maryland, but not Virginia. Non-indigenous succineid species, such as *Oxyloma salleana* (Pfeiffer) from the Mississippi River drainage or the European *Succinea putris* (L.) which has been reported from sites as near as northern Pennsylvania (Pearce, 2008a), potentially could also occur in the survey area. Reports of the federally threatened *Novisuccinea chittenangoensis* (Pilsbry) from southwestern Virginia, in Tazewell County, by Hubricht (1985) and cited by Perez & Cordeiro (2008) were refuted by Hoagland & Davis (1987) and upheld by Niver (2010).

CIONELLIDAE

Cochlicopa lubrica (Müller, 1774) – (FW [Battery Humphries {BH}, Battery Wilkin {BW}], JP, OC). Live snails were found between 17 April and 15 June in dry to seasonally mesic, sunny, open locations with little or no vegetation on thin calcareous soils over concrete and often under shallow leaf litter and rarely on moist tidal shores. The two *Cochlicopa* species found during this inventory have been shown to be distinct in Europe based on allozyme patterns and shell variables (Armbruster and Schlegel, 1994; Armbruster, 1995). Until North American forms are similarly studied, we accept the separation proposed by Armbruster (1995) of mature shells with a maximum shell diameter < 2.2 mm to be *C. lubricella* and shells with a diameter > 2.3 mm to be *C. lubrica*. A shell was found in a mouse nest on a capped landfill on the northern shore of Oxon Cove, a few meters from the District of Columbia line. The Oxon Cove and Jones Point shells were larger (5.9-6.2 mm long, 2.6-2.7 mm wide) than any shell found at Fort Washington (largest 5.1 mm long, 2.4 mm wide). Grimm (1971a) stated that this species is synanthropic east of Garrett County, Maryland.

Cochlicopa lubricella (Porro, 1838) – (FW [BW]). Shells were found only at Battery Wilkin in association with the more common *C. lubrica*.

PUPILLIDAE

Pupoides albilabris (C.B. Adams, 1841) – (FW [BE, Battery Meigs {BM}, BW, Fort Washington {fw}]). This snail was observed only on the Coastal Plain where it preferred dry to seasonally mesic, sunny, open locations with little or no vegetation on thin circumneutral soils over concrete and often under shallow leaf litter. It was common only at Battery Wilkin (live snails on 17 July 2010), uncommon at Battery Meigs, and rare at Fort Washington and Battery

Emory. Shells found at Battery Emory were in shady, second growth forest.

STROBILOPSIDAE

Strobilops aeneus Pilsbry, 1926 – (DM, FW [BE, BW, SC floodplain forest], GF, LH, PP [AC swamp, SM], TR). This was a common snail within the survey area generally found under loose bark of fallen trees in woodlands or swamps, but also occasionally found in leaf litter. Shells were rarely found at dry, open sites. Live snails were observed between 5 March and 13 November.

Strobilops labyrinthicus (Say, 1817) – (LH). The lone animal was found on 3 June 2010 in a moist log on the bank of Little Hunting Creek in association with *S. aeneus*. Hubricht (1985) recorded it mostly from western Virginia, and Grimm (1971a) documented it in Maryland only from three northwestern counties, but Norden (2008a) added Montgomery County. It is likely rare on the Virginia Coastal Plain.

Strobilops texasianus Pilsbry & Ferriss, 1906 – (FW [BM, BW]). This is a rare snail in the survey area (only shell material was found), recorded only on the Coastal Plain at dry, open sites associated with historic Endicott batteries and forts. The shell sculpture differences between *S. texasiana* and *S. labyrinthicus* are subtle. Pilsbry (1948) separated them by the coarseness of the ribbing, calling *S. labyrinthicus* "finely ribbed" and *S. texasiana* "coarsely ribbed," and noted that *S. labyrinthicus* matures at 1.7-1.8 mm high while *S. texasiana* may be as high as 2.0 mm. Burch (1962) was slightly more specific, and referred to ribbing on the base of the shell as "absent or poorly developed" in *S. labyrinthicus* and "well developed" in *S. texasiana*. Our specimen of *S. labyrinthicus* measured 1.8 mm high and had 41 ribs on the base that became almost obsolete near the aperture, while our most characteristic *S. texasiana* specimen was 1.9 mm high, had 31 ribs on the base, and possessed noticeably higher ribs on the spire.

VALLONIIDAE

Vallonia excentrica Sterki, 1893 – (FH, FW [BH, BM, BW, fw], RR). This is a locally common snail typically found in dry to mesic, open, grassy, sometimes mossy, sites on the Coastal Plain along the base of concrete or mortared walls of historic forts and batteries. It was the most commonly observed snail at the base of the walls of Fort Washington. A shell was found at the edge of a marsh at Roaches Run. Live snails were observed only on 17 April 2010.

VERTIGINIDAE

Gastrocopta armifera (Say, 1821) – (FW [BW, fw]). This is the largest of the *Gastrocopta* species found during the survey. It occurred at only two sites (both on the Coastal Plain) in dry to seasonally mesic, sunny, open locations with little or no vegetation, except turf grass or moss, on thin calcareous soils, often over concrete and under shallow leaf litter. Live snails were found between 17 April and 17 July 2010.

Gastrocopta contracta (Say, 1822) – (DM, FF, FH, FW [BE, BM, Battery Smith {BS}, BW, fw, SC floodplain forest, SM,], Gulf Branch [GB], GF, RI, TR). This is by far the most common *Gastrocopta* species documented within the study area. It was found at nearly every site and in a wide variety of habitats from dry, sunny, open sites, to leaf litter in shady ravine forests, and under loose bark of logs in swamps, on both the Coastal Plain and Piedmont. Live animals were observed between 17 April and 7 October 2010.

Gastrocopta corticaria (Say, 1816) – (FW [BE, fw]). This was the rarest *Gastrocopta* within the survey area, documented only by two shells. Both were found at calcareous Coastal Plain sites created by the presence of forts or Endicott batteries constructed between 1824 and 1903. Typically thought of as a forest species found on logs or tree trunks, the presence of a shell at the base of a wall of Fort Washington, an open, dry to mesic, calcareous, area surround by turf grass, is uncharacteristic for this species (Norden, 2007), which may indicate that it was moved to this location.

Gastrocopta pentodon (Say, 1821) – (FH [Battery Robinson {BR}, Battery Sater {BSa}], FW [BE, BW]). This snail was uncommon but locally abundant. Typical habitat included dry, open, sunny sites such as Battery Robinson, which was completed in 1904. Live snails were observed between 18 July and 17 October 2010. Some forms of the shell of this species can closely approximate those of *G. tappaniana*. The methods of Pearce et al. (2007) and Nekola & Coles (2010) were used to distinguish between them. However, within the survey area, *G. pentodon* was found only in dry to mesic upland habitats, and resembled *G. p.* form *gracilis* Sterki of Vanatta & Pilsbry (1906), which has five teeth and is subcylindric, whereas *G. tappaniana* was typically found in wetlands, is broader, and always has more than five teeth.

Gastrocopta procera (Gould, 1840) – (FH [BSa], (FW [BH, BM, BW, fw]). This species was found only in association with forts and batteries on the Coastal Plain and always in low abundance. It was most common at Battery Humphries where three shells were found. Live snails were observed between 17 April and 16 June 2010, climbing on concrete and mortared stone walls.

Gastrocopta tappaniana (C.B. Adams, 1842) – (DM swamp, FW [BW], JP, LH, PP [AC swamp, WR swamp], RI, RR). This species was uncommon within the survey area, generally found under moist logs in swamps on the Coastal Plain, however two shells were found at a dry upland site at Battery Wilkin. Live snails were found between 19 February and 7 October. For identification notes, see *G. pentodon*. Juveniles with developing dentition were found on 7 October 2010 in Dyke Marsh Swamp. The angulo-parietal and columellar lamellae are the first to form in this species. It was associated with *Vertigo ovata* at Dyke Marsh.

Vertigo milium (Gould, 1840) – (FW [BE, BM, BW, SC floodplain], PP [WR swamp]). This tiny snail was found in a variety of Coastal Plain habitats, including second growth woodland, dry, open sites, swamps, and shores. It was most common in second growth woodland at Battery Emory where 68 shells and a few live animals were found on 17 October 2010 in a leaf litter sample measuring 17.85 l.

Vertigo ovata Say, 1822 – (DM, JP, PP [BC]), RR). Live specimens were found under loose bark of rotting, fallen trees, under wood debris, climbing moist, shaded, fallen logs, and in wet leaf litter. Collection dates ranged from 17 March to 7 October.

Vertigo pygmaea (Draparnaud, 1801) – (FH [BSa], FW [BM, BW]). This species was found (mostly as shells) only on the Coastal Plain at dry, open Endicott battery sites. A live immature snail was found in Fort Hunt Park at Battery Sater on 16 June 2010.

HAPLOTREMATIDAE

Haplotrema concavum (Say, 1821) – (Claude Moore Farm, FW [BE, SM], GF, PP, TR). This uncommon, omnivorous snail was found at both Piedmont and Coastal Plain sites but was most numerous in shell marl ravine forest on the Coastal Plain, where the only live animal was found on 19 September 2010 under a rotting log.

PUNCTIDAE

Paralaoma servilis (Shuttleworth, 1852) – (JP) (Fig. 6). During 1.5 hours of search effort on 17 March 2011, 23 live snails and eight shells were found under woody debris deposited by storm tides along the western shore of Jones Point. Associated species included *C. exiguum*, *C. vermeta*, *Deroceras laeve*, *Deroceras reticulatum*, *P. lapidaria*, and *V. ligera*. This species is native to New Zealand (Brooks, 1999) and possibly Australia (Price & Webb, 2006) but has been introduced to North and South America, Europe, and the Pacific Islands. In western North America it was long mistaken as a native species described as *Punctum conspectum* (Bland) (Pilsbry, 1948). It is easily distinguished from the *Punctum* species in the survey area by its larger size (almost twice the diameter) and higher, more irregularly spaced ribs on the last whorl. This is the first record for Virginia and to our knowledge the first published record for the eastern United States (Dundee, 1974; Robinson & Slapcinsky, 2005; Perez & Cordeiro, 2008). It was also recently collected in Washington, DC outside the study area (CMNH 121988, "across street from 4100 Cathedral Ave.", Pearce, 8 March 2012).

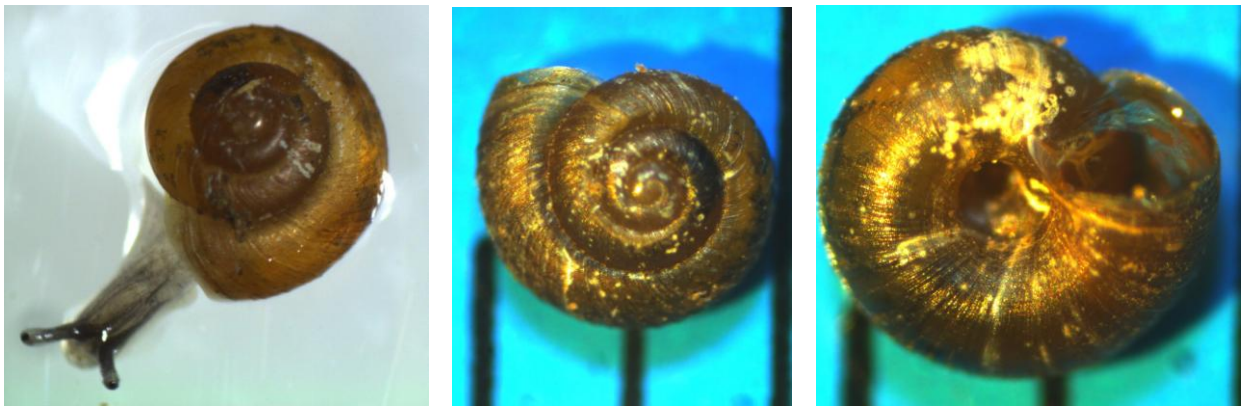

Fig. 6. *Paralaoma servilis*. Left to right: Live specimen, 17 March 2011, Jones Point Park, City of Alexandria, Virginia; dorsal view of empty shell; ventral view of empty shell. Hash marks are in mm.

Fig. 7. *Punctum* species found in the study area from left to right, *P. minutissimum* (Fairfax County, VA, Turkey Run Park, 4 August 2010), *P. smithi* (Prince Georges County, MD, Fort Washington, 19 June 2010), and *P. vitreum* (Prince Georges County, MD, Fort Washington, 17 October 2010).

Punctum minutissimum (I. Lea, 1841) – (FW [BE, SM], GF, PH, PP, TR). This is probably a very common snail in the survey area but due to its minute size it was detected only in moist leaf litter samples from deciduous woodlands on both the Coastal Plain and Piedmont. Live animals were observed on 19 June and 4 August 2010 and 17 March 2011. The three *Punctum* species found during this survey are fairly distinctive when compared side by side (Fig. 7). *P. smithi* is the smallest at maturity, possesses at least one lamella on the base inside the aperture, and has the palest and most transparent shell. *P. minutissimum* lacks lamellae and has closely spaced and regularly occurring riblets of equal height, and *P. vitreum* is the darkest in life and possesses higher major riblets interspaced with 4 to 8 minor riblets.

Punctum smithi Morrison, 1935 – (FW [BE, SM], GF, PP [SM], TR). The habitat and distribution of this species were the same as for *P. minutissimum* but it was slightly more common in shell marl forest on the Coastal Plain than in the Piedmont. It was also found on hummocks in Great Falls Swamp. These two species were often found together, but rarely in equal numbers (e.g., Fort Washington Park leaf litter sample: 124 *P. smithi*, 4 *P. minutissimum*,; Turkey Run Park leaf litter sample: 141 *P. minutissimum*, 1 *P. smithi*). Live animals were observed on 19 June and 4 August 2010.
A previously undescribed growth form (Fig. 8) was found at three sites in Fort Washington Park occurring with typical *P. smithi*. It is easily distinguished from typical *P. smithi* by possessing two lamellae within the aperture, one at the normal position and a more interior one. Although variation in the dentition of *P. smithi* has been noted (Hubricht, 1951), it has been in reference to the length and shape of a single basal lamella rather than the number of lamellae. The type description for this species (Morrison, 1935), and others since that time (Pilsbry, 1948; Burch, 1962; Hubricht, 1974), mention only one basal lamella just inside the aperture. Collections of *P. smithi* at Fort Washington Park indicate that 5.8% of the population is the bidentate form.

Fig. 8. *Punctum smithi*, form with two lamellae, found at three sites in Ft. Washington Park, Prince Georges County, Maryland. Arrows indicate locations of two lamellae.

Punctum vitreum (H.B. Baker, 1930) – (FW [BE], PP [SM], TR). This was the least common of the *Punctum* species in the survey area. It was more common on the Coastal Plain but found at only 3 forested sites in leaf litter. Live animals were observed on 17 October and 13 November 2010. In the Piedmont, it was represented by 3 empty shells found in leaf litter from forested talus slopes in Turkey Run Park.

DISCIDAE

Anguispira alternata (Say, 1816) – FW [BE, BS, Battery White {BWh}, fw, SM], GF, PP, RI). Found at most woodland sites in the Piedmont and Coastal Plain sections of the survey area and also in dry, open areas at historic batteries. It was most common in shell marl ravine forest in Fort Washington Park. All of the shells within the survey area have a low spire and angular periphery characteristic of Pilsbry's (1948) form *angulata*. By comparison, Norden (2008a) reported that only 40% of *A. alternata* shells on Plummers Island, Maryland, on the opposite shore from the study area, exhibited an angular periphery. Animals of this species have orange mucus.

Anguispira fergusoni (Bland, 1861) – (GF, PH, PP, RI, TR). Surprisingly, this species was scarcer on the Coastal Plain than in the Piedmont area of the survey. Hubricht (1985) asserted that *A. fergusoni* is an inhabitant of the Atlantic Coastal Plain that has followed floodplains up into the Piedmont region. Pilsbry (1948) described it as being found on the Coastal Plain but as being most common at or near the Fall Line. The only Coastal Plain animals found during this survey were on Theodore Roosevelt Island, just below the Fall Line, on 31 March 2010, and in shell marl ravine forest in Piscataway Park, where it was associated with the typically montane species *Xolotrema denotatum*. It was much more common in the Piedmont, in shady, oak dominated woodland, usually under stones or fallen limbs. On 22 June 2010, one snail in Great Falls Park was found climbing the trunk of *Carpinus caroliniana* Walt. to 3 m along the River Trail south of Sandy Landing. The periphery of this shell is rounded and the mucus is clear.

Discus rotundatus (Müller, 1774) – (OC). This introduced European snail was documented only on a landfill at Oxon Cove in the District of Columbia (Steury & Steury, 2011). Three shells and 51 live snails were found.

HELICODISCIDAE

Helicodiscus parallelus (Say, 1817) – (FH, FW [BE, BWh, fw, SM], GF, LH , PH, PP [AC swamp, SM], RI). This species was widespread but uncommon in the study area. The most shells found at one site was seven in a 13.77 l leaf litter sample from shell marl forest in Fort Washington Park. It seems to be a habitat generalist occurring in forests, swamp hummocks, and drier, open sites, under bark, and in leaf litter. Live animals were observed between 16 June and 17 October 2010 and on 5 March 2011.

Lucilla scintilla (R.T. Lowe, 1852) – (FH, PP [SM]). *Lucilla inermis* H.B. Baker was recently synonymized with *L. scintilla* (Horsák et al., 2009). This was a rare snail in the survey area, represented only by single shells found at Battery Sater in Fort Hunt Park and in mature shell marl ravine forest along Accokeek Creek in Piscataway Park. *Hawaiia minuscula* is similar in appearance, but these species can be distinguished under magnification by differences in shell sculpture, (uneven, distinct, growth wrinkles in *H. minuscula* compared to the smooth, paraffin or porcelain-like surface of *L. inermis*, which may have a few growth wrinkles near the aperture). We used Horsák et al. (2009) to distinguish *L. scintilla* from *L. singleyana* (Pilsbry), which has been documented from near the study area.

GASTRODONTIDAE

Striatura meridionalis (Pilsbry & Ferriss, 1906) – (FW [BE], GF, PP [SM], TR). This was a widespread but uncommon snail found at four sites in leaf litter of deciduous woods and also on hummocks in Great Falls Swamp.

Striatura milium (E.S. Morse, 1859) – (GF, TR). This snail was found only in the Piedmont section of the survey area in leaf litter in deciduous forested ravines. It is rare (S1S3) in the Commonwealth (Roble, 2013). These sites are near the southernmost known for this species. Live snails were observed on 19 September 2010. The embryonic whorl of *S. milium* lacks the spiral lirae of *S. meridionalis*.

Ventridens ligera (Say, 1821) – (DI, DM, FF, FW [BE, BH, BM, BS, BW, BWh, fw, SC floodplain, SM,], GF, JP, LH, OC, PH, PP, RI, TR). This snail and *Zonitoides arboreus* are the most easily found snails within the survey area. It occurred at most upland sites in both moist and dry situations, and rarely in wetlands. One individual was found at the top of a *Pycnanthemum tenuifolium* Schrad., 80 cm above the sandy substrate, at Sandy Landing, in Great Falls Park.

Ventridens suppressus (Say, 1829) – (FH, FW [BE, BM, BW, fw], GF, LH, PH, TR). This was a widespread but uncommon snail within the survey area. Solitary individuals were typically found at the base of large rocky outcrops or boulders in deciduous woods, but an aggregation of 21 shells and nine live animals was found at Battery Wilkin, a dry open site, on 17 April 2010. Eight of these shells were adults with one denticle and 22 were multi-denticled juveniles. A live snail was also found on a hummock in Great Falls Swamp. Live snails were observed between 17 April and 19 September 2010. *Ventridens virginicus* (Vanatta), a similar species that has been reported from just west of the survey area, differs from *V. suppressus* in having two denticles at maturity, one (usually bifid) along the columellar margin and the other lamella relatively high on the palatal margin. At maturity, *V. suppressus* has one uncleaved denticle located at the base of the columellar margin, and subadults have a lamella relatively low on the palatal margin. There was no evidence of *V. virginicus* within the survey area.

Zonitoides arboreus (Say, 1816) – (DM, FF, FH, FW [BE, BM, BW, BS, fw, SM, SC floodplain], GB, GF,

Fig. 9. *Zonitoides nitidus*, live specimen, 17 March 2011, Jones Point Park, City of Alexandria, Virginia.

JP, LH, PH, PP, RI, TR). This is the most commonly observed snail within the survey area. It is found in all habitats (deciduous forests, swamps, and dry open sites) under logs, loose bark, and in leaf litter, but it is probably most common in upland deciduous woods.

Zonitoides nitidus (Müller, 1774) – (DI, JP, PP [WR floodplain forest]). This snail (Fig. 9) was found at three sites during the survey, including a live adult and two live juveniles found on 28 July 2010 along the bank of the Potomac River under woody storm debris left by high tides near a small freshwater marsh on Daingerfield Island. On 19 February and 17 March 2011, it was found in very similar habitat near Wharf Road at Piscataway Park and at Jones Point, respectively. Other records of this snail along the Potomac River, from the northwest, are limited to Garrett County, Maryland, a distance of 273 km. Richards (1934) reported a collection from Baltimore, 64 km northward. The largest shell measured 6.7 mm at the largest diameter. In comparison to Z. *arboreus*, *Z. nitidus* is larger at maturity (6-7 mm), has a higher spire, possesses a more convex base and rounder aperture, and lacks spiral striation on the shell. In life, *Z. nitidus* is darker, and the shell is more transparent and amber colored. This is the first record for Virginia and the Maryland site is the southernmost record for the East Coast of North America.

EUCONULIDAE

Euconulus dentatus (Sterki, 1893) – (FH [BR], GF). This snail was found at only two sites, including a dry open site on the Coastal Plain (1 shell) and a small colony on 15 September 2010 in the Piedmont in moist leaf litter near the mouth of an unnamed drainage leading to Difficult Run. This species is easily distinguished from the next two, by possessing a few, low lamellae, elongate in a radial direction, in the base of the last whorl.

Euconulus fulvus (Müller, 1774) – (TR). This species was found only in leaf litter on a forested talus slope in the Piedmont, the easternmost known locality in Virginia. J. Slapcinsky identified these specimens through comparisons with material at FLMNH, noting the larger and relatively flatter, more loosely coiled species as *E. fulvus*. A genetic study of *Euconulus* is desirable because the shells and genitalia are relatively simple and their small size makes detailed anatomical work difficult.

Euconulus polygyratus (Pilsbry, 1899) – (FW [SM], GF, PP [SM]). This species was found in both the Piedmont and Coastal Plain at a total of three sites. All collections were from leaf litter, including two sites in shady, deciduous forested ravines. At Great Falls it occurred in association with *E. dentatus*. Three additional lots of *E. polygyratus* from Fairfax County were found at FLMNH (299067 & 299088; Popes Head Road at Popes Head Creek and Occoquan Regional Park, both J. Slapcinsky) and CMNH (85289; Mt. Vernon, G.H. Clapp).

Hubricht (1985) and Perez & Cordeiro (2008) did not list *E. polygyratus* from Virginia, but Beetle (1973), without citing specific specimens or localities, recorded this species from Alleghany and Pulaski counties. Specimens identified as *Euconulus chersinus* (Say), a species with shell morphology very similar to that of *E. polygyratus*, were located at FMNH, collected by L. Hubricht between 1945 and 1972 from western (Giles Co.) and southern (Pittsylvania and Sussex counties), Virginia. However, these records did not appear in the mapped distribution of this species he compiled (Hubricht, 1985). In that paper, Hubricht placed more than 440 km between his records of *E. polygyratus* in Frederick County, Maryland, and *E. chersinus* and *E. trochulus* (Reinhardt) in northeastern Tennessee and southwestern Virginia, respectively.

Guppya sterkii (Dall, 1888) – (FW [SM], PP [SM]). This minute species was represented within the survey area by one live snail collected from leaf litter on the north side of Fort Washington Park on 17 October 2010 and by five live animals found along Accokeek Creek on 30 April 2011.

ZONITIDAE

Glyphyalinia indentata complex (Authors) – (FW [BE, BH, SM], GF, LH, PH, PP, RR). This species complex

was found throughout the survey area (all shells except one live snail on 24 August 2010) in upland leaf litter or under rotting logs, but not in high abundance. Two shells were found on hummocks in Great Falls Swamp. In dry to mesic, upland, shell marl forest in Piscataway Park, shells with forms attributable to this group ranged in color from transparent pinkish or pale brown, to clear (when young), to opaque and yellowish brown. The degree of spiral striation was also variable. This taxon complex is actually a series of undescribed anatomical species, with few or no shell differences (Hubricht, 1985). Of *Glyphyalinia* species having a minute umbilicus, *G. cryptomphala* can be separated by having a tongue-shaped callus covering the umbilicus. Five species (*G. junaluskana* [Clench & Banks], *G. sculptilis* [Bland], *G. pecki* Hubricht, *G. picea* Hubricht, and *G. latebricola* Hubricht) can be separated by having more numerous radiating grooves, 43-82 grooves on the last whorl. *Glyphyalinia luticola*, with 20 grooves on the last whorl, can be separated from the remaining species by shell color and habitat. We group the remaining six species, with 26-38 grooves on the last whorl, in the *G. indentata* complex (*G. carolinensis* [Cockerell], *G. indentata* [Say], *G. ocoae* Hubricht, *G. praecox* [H.B. Baker], *G. rimula* Hubricht, and *G. umbilicata* [Cockerell]). Three of these species (*G. carolinensis*, *G. indentata*, and *G. praecox*) have been reported from the vicinity of Washington, DC. In addition, any similar-looking undescribed species mentioned by Hubricht (1985) would be in this complex.

Glyphyalinia cf. *luticola* Hubricht, 1966 – (DM, PP). Shells were found in both cat-tail marsh and the surrounding swamp forests and a live animal was found in floodplain swamp along Piscataway Creek on 19 February 2011. This species was separated with difficulty from specimens in the *G. indentata* complex following the recommendations of Hubricht (1966) that shells found in marshes and swamps, with a coppery color and smaller umbilicus are *G. luticola*. The transverse grooves on the four specimens attributable to *G. luticola* were more widely spaced at nearly four whorls, especially near the aperture, than in *G. indentata* from upland sites.

Glyphyalinia cryptomphala (Clapp, 1915) – (FW [BM], TR). One shell was found at each of two sites in the survey area, in deciduous forest and a dry, open site. At maturity, this species is distinguished from *G. indentata* by its closed umbilicus, or a tongue-shaped, calcareous flap over the umbilicus. We follow Turgeon et al. (1998) in treating *Glyphyalinia solida* (H.B. Baker) as a synonym of *G. cryptomphala*.

Glyphyalinia wheatleyi (Bland, 1883) – (FW [SM], GF, PP [SM], TR). This species was regularly found in low numbers in leaf litter on the Coastal Plain and in the Piedmont. It was found alive on 19 September and 17 October 2010. *Nesovitrea electrina* (Gould), a similar species that reaches its southern Coastal Plain limits in northern Virginia but not recorded during this study, differs from *G. wheatleyi* in its smaller size at maturity (to 5.2 mm), preference for wetter habitats, smoother shell nearly lacking radial grooves, and especially by its rounder aperture.

OXYCHILIDAE

Oxychilus draparnaudi (Beck, 1837) – (JP, OC). This introduced European snail was found on a landfill site at the border of the District of Columbia and Prince Georges County (Steury & Steury, 2011). A live animal was found in the City of Alexandria on 8 April 2010 under a concrete slab.

PRISTILOMATIDAE

Hawaiia minuscula (A. Binney, 1841) – (DM swamp, FF, FH, FW [BE, BH, BM, BS, BW, fw], PP [SM, WR swamp]). This species was found only on the Coastal Plain, where it was most common at historic batteries and forts surrounded by turf grass. It was also found in historically similar areas with concrete or mortar that have succeeded to second growth woodland (Battery Emory) or even at sites that are now mature forest (where it was found in leaf litter) such as the rifle butts along the river trail at Fort Washington Park and shell marl ravine forest in Piscataway Park. It was the most common snail found at Fort Hunt Park. Live snails were observed between 17 April and 16 October 2010. Hubricht (1985) described its habitat as bare ground on floodplains, meadows, roadsides, and waste ground in urban areas, noting that he had never found it in leaf litter. However, Baker (1939) described its habitat as woodlands of oak, hickory, and sycamore. Within the study area, seven live snails with shell form and sculpture seemingly identical to *H. minuscula* were found in swamp habitats (under loose bark of a fallen tree in Dyke Marsh swamp on 18 October 2010, with *Vertigo ovata*, and on 5 March 2011, under loose bark in a remote swamp at Accokeek Creek). Both of these populations differed slightly in life (yellowish tan bodies visible through the transparent shell) from *H. minuscula* found in open grassy areas (shells occasionally tinted yellow instead of the more common transparent or opaque white color, but the paler animals give the transparent shells a whiter appearance). A shell

found in a swamp at Wharf Road was likely attributable to river drift. Shells from open grassy areas of juvenile animals up to 3.5 whorls are usually transparent and become opaque white at maturity or with shell aging after death. A more thorough examination of the swamp *Hawaiia* is warranted to determine whether habitat or diet could account for the different body coloration or if it may prove to be a different or new species.

LIMACIDAE

Ambigolimax valentiana (Férussac, 1823) – (Collingwood Picnic Area, JP, RR). Five of these introduced slugs, native to the Iberian Peninsula of Europe and previously placed in the genus *Lehmannia*, were found after dark on the curb of a parking lot near the Potomac River on 11 June 2011. Three days later, a colony of nine slugs was found under moist debris in swamp forest and the next day, one slug was found in similar habitat at Jones Point. This species was previously unrecorded from any county in the survey area.

Limax maximus Linnaeus, 1758 – (DI, FW [SM], GF, JP, TR). This large introduced European slug was uncommon in the survey area. It was typically found in woodlands under logs.

MILACIDAE

Milax gagates (Draparnaud, 1801) – (TR). Eleven of these introduced slugs native to the western Mediterranean and Canary Islands were found along the concrete base of an office building in Turkey Run Park on 19 June 2011.

AGRIOLIMACIDAE

Deroceras laeve (Müller, 1774) – (DM, JP, PP [WR swamp], RI, RR). This native slug occurred only in wetlands (e.g. under logs in a cat-tail marsh [9 September 2010; n = 2]; wet leaf litter in swamps [7 October 2010; n = 2]). It was found on the shore of Jones Point on 3 March 2011, and as early as 19 February, in swamps at Wharf Road.

Deroceras reticulatum (Müller, 1774) – (JP, PH). Thirteen of these introduced European slugs were found on the western shore of Jones Point under woody debris on 3 March 2011 and one was observed at a culvert outfall on the bank of the Potomac River along the Potomac Heritage Trail on 17 June 2011. The population at Jones Point is highly variable in color, ranging from a dark gray to a pale cream background with variable amounts of dark reticulations. When disturbed, this slug secretes a milky mucus diagnostic for the species (McDonnell et al., 2009). This species was previously unrecorded from any county in the study area.

ARIONIDAE

Arion hortensis Férussac, 1819 – (DI). This introduced European slug was found under a log along a wooded bank of the Potomac River. This taxon concept was expanded by Davies (1979) to include three similar species (*A. distinctus* Mabille, *A. hortensis*, and *A. owenii* Davies). Pearce & Bayne (2003) determined the first two of these occur in the eastern United States. The key provided by McDonnell et al. (2009) suggests that the population on Daingerfield Island is *A. hortensis*, having sides below the lateral bands contrasting and pale, no break in right mantle band above the pneumostome, and tentacles that are faintly reddish rather than dark blue-black. Dissection of the larger of our two specimens, although immature, revealed two elongated structures (not fully developed) oriented perpendicular to the epiphallus duct, which is closer to the anatomy of the verge in *A. hortensis* than *A. distinctus*.

Arion intermedius (Normand, 1852) – (FW [SC floodplain], GF). This introduced European slug was found within the survey area at only two sites (one each in the Piedmont and Coastal Plain), including under a rotting log on a slope above Great Falls Swamp on 24 August 2010, and under logs along the bank of Swan Creek on 17 July 2010.

Arion subfuscus (Draparnaud, 1805) – (DI, FW [SM], GF, TR). This introduced European slug was the most commonly observed slug within the survey area, recorded at nearly every wooded site sampled, generally under logs or loose bark.

PHILOMYCIDAE

Megapallifera mutabilis (Hubricht, 1951) – (GF, TR). This uncommon slug was found only in the Piedmont section of the survey area, typically in rotting logs. It was observed between 21 April and 24 August 2010. Two entwined slugs were observed inside a standing rotting tree in Great Falls Swamp on 24 August 2010.

Philomycus carolinianus (Bosc, 1802) – (GF, PP). An uncommon but widespread slug within the survey area, it was observed at only four sites between 21 April and 13 November 2010, and on 5 March 2011, under rotting

logs or loose bark of fallen trees. A population in Johnson's Gulley in Piscataway Park contained melanistic individuals.

POLYGYRIDAE

Mesodon thyroidus (Say, 1816) – (DM, FF, FH, FW [BE, BW, fw, SM, SC floodplain], GF, OC, PH, PP, RI, TR). This snail possesses the second largest shell of any species found within the survey area. It is a common and widespread species found at nearly every site, but is most common in calcareous woodlands such as shell marl forest. This species was commonly observed climbing the trunks of smooth barked trees such as *Asimina triloba* (L.) Dunal and *Carpinus caroliniana* Walter to a height of 2 m in mid-summer but was never observed climbing in the spring. A live animal was found under a log in Dyke Marsh on 9 September 2010. On 17 July 2010, one snail had climbed a *Lindera benzoin* to a height of 1 m and appeared to be feeding on a bird dropping on the middle of a leaf. Nearly all (98%) mature shells possessed a parietal denticle. The largest shell measured 26 mm at its widest diameter.

Neohelix albolabris (Say, 1816) – (GF). This was a very rare snail in the survey area, documented by only three live juveniles and three adult shells found in a forested ravine, under loose bark of a large fallen tree, near the center of Great Falls Park. This is the largest species in the survey area; the largest specimen measured 28 mm at its widest diameter. We believe that the snails from the *N. albolabris* group collected in the Piedmont are *N. albolabris* rather than its Coastal Plain congener *N. solemi* (Emberton, 1988). Örstan (1999) confirmed *N. albolabris* from near this latitude in Montgomery County, Maryland by dissection. Juveniles of *N. albolabris* can be distinguished from those of *M. thyroidus* by having a thinner shell at a similar diameter and thinner lip over the umbilicus without a smooth edge.

Stenotrema barbatum (Clapp, 1904) – (FW [BE, SM], PH, TR). This was an uncommon snail found at only four sites in leaf litter in deciduous woodland. This species was reported for Prince Georges County by Grimm (1971a) but the record was not included by Hubricht (1985). Of ten mature shells found in shell marl forest at Fort Washington Park, 40% lacked the parietal denticle and instead possessed a shiny callous thickening in the parietal area. Shell diameter (8.8 - 9.1 mm) and density of periostrical hairs (<4 per mm) on these shells indicate they are more like *S. barbatum* (> 8 mm; 4 periostrical hairs per mm) than *S. hirsutum* (6 - 8 mm; 5 - 6 periostrical hairs per mm) (Grimm, 1971b; Perez, 2011).

A juvenile shell of 2.3 whorls with appressed pubescence found in moist leaf litter at the base of a southeastern facing slope along Difficult Run in Great Falls Park may be attributable to *S. barbatum* or possibly *S. hirsutum* (Say, 1817). It differed from other juvenile shells of *S. barbatum* of the same size by having appressed pubescence rather than stiffly erect hairs.

Triodopsis juxtidens (Pilsbry, 1894) – (FW [BM, BWh, SM], GF, JP, LH, PH, PP, RI, TR). This is a widespread, but never abundant, species of woodland sites nearly always in or under moist rotting logs. Live snails were found between 2 April and 24 August 2010. Broken shells of this species and *Anguispira alternata* found between stones in the walls of Battery White 1.5 m above the ground may have been placed there by rodents.

Xolotrema denotatum (Férussac, 1821) – (PP [SM]). This typically montane species was found at two sites on the Coastal Plain in shell marl ravine forest in Piscataway Park on 30 April 2011. Nine live juveniles and one juvenile shell were found under loose bark of fallen trees along Accokeek Creek, and one fresh, mature shell and one live juvenile were found in Johnson's Gulley. Juveniles are easily distinguished from other species with periostrical hairs that could occur in the area such as *Stenotrema* or *Euchemotrema* by their larger nuclear whorl and shell diameter. The flora of these calcareous areas also contains a number of species more typically associated with sites in western Maryland and Virginia (Steury & Davis, 2003). These are the southernmost Coastal Plain sites on the East Coast.

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