

Distributional Status of an Introduced Land Snail *Discus rotundatus* (Rotund Disc, Mollusca: Discidae) in Canada

ROBERT G. FORSYTH^{1, 2, 5}, JOHN E. MAUNDER³, DONALD F. MCALPINE¹, and RONALD G. NOSEWORTHY⁴

¹New Brunswick Museum, 277 Douglas Avenue, Saint John, New Brunswick E2K 1E5 Canada

²Royal British Columbia Museum, 675 Belleville Street, Victoria, British Columbia V8W 9W2 Canada

³P.O. Box 250, Pouch Cove, Newfoundland and Labrador A0A 3L0 Canada

⁴School of Marine Biomedical Science, Jeju National University, Jeju 690-756 Republic of Korea

⁵Corresponding author: rforsyth@mollus.ca

Forsyth, Robert G., John E. Maunder, Donald F. McAlpine, and Ronald G. Noseworthy. 2016. Distributional status of an introduced land snail *Discus rotundatus* (Rotund Disc, Mollusca: Discidae) in Canada. *Canadian Field-Naturalist* 130(3): 236–247.

First collected in North America in 1937 on the Avalon Peninsula of the Island of Newfoundland, the introduced, primarily European land snail, *Discus rotundatus*, has now been recorded from the Island of Newfoundland, Nova Scotia, New Brunswick, Quebec, Ontario, and British Columbia. We review all known records from Canada, demonstrate that *D. rotundatus* is more widespread than was previously recognized on the Island of Newfoundland, and report the first record from New Brunswick.

Key Words: *Discus rotundatus*; Mollusca; terrestrial snail; gastropod; new provincial record; New Brunswick; Newfoundland and Labrador; biogeography

Introduction

Discus rotundatus (Müller, 1774), the Rotund Disc, is a distinctive land snail that is native to the Euro-Mediterranean region, where it is widespread, almost ubiquitous, and commonly synanthropic (Taylor 1909; Umiński 1962; Kerney and Cameron 1979; Gittenberger *et al.* 1984; Kerney 1999; Wiktor 2004; Welter-Schultes 2012; Wiese 2014). It reaches its eastern limit in Latvia, Belorussia, and Ukraine, including Crimea (Umiński 1962; Sysoev and Schileyko 2009). Outlying occurrences in Algeria (Umiński 1962), as well as Turkey (Örstan 2003; Örstan and Kösemen 2011), Malta (Giusti *et al.* 1995), the Azores (Backhuys 1975; Martins 1995; Cameron *et al.* 2001), and Madeira (Seddon 2008) are almost certainly introductions. In the Southern Hemisphere, *D. rotundatus* is introduced to the vicinity of Melbourne, Australia (GBIF 2015) and Western Cape province, South Africa (Herbert 2010).

In the United States, where *D. rotundatus* is also introduced, the species was first recorded in Massachusetts in 1939 (Clench and Banks 1939; Pilsbry 1948) and has since been found in Maine (Gleich and Gilbert 1976; Martin 2000), Vermont (Lee 2009), New York (Jacobson 1951; Jacobson and Emerson 1961), New Jersey (Freed 1953; Jacobson 1954; Steury and Steury 2011), Pennsylvania (Pearce 2008, 2015; Steury and Steury 2011), Washington, DC (Steury and Steury 2011), Washington state (Forsyth 2004), Oregon (Anonymous 2015), and California (Roth 1982; Hertz 1996). Dundee (1974) summarized some of the records from the eastern United States. Additional unpublished records exist for Connecticut (Carnegie Museum of Natural History

database), Ohio (GBIF 2015), Michigan (Carnegie Museum of Natural History database), Mississippi, Tennessee, Georgia, and Alabama (National Museum of Natural History, Smithsonian Institution database; Carnegie Museum of Natural History database).

In Canada, *D. rotundatus* has been found in six provinces (Figure 1). Here, we report and discuss both old and new records from Atlantic Canada, including the first record for the species from New Brunswick, and review all other Canadian records.

This small species (diameter up to 6.2 mm in Canadian material; elsewhere to 7 mm [e.g., Umiński 1962; Wiese 2014]; or even 8 mm [*fide* Germain 1930]) is distinguished by a flattened, opaque, ribbed, grey-brown shell that is usually marked by somewhat regularly spaced, red-brown blotches (Figures 2 and 3A,B). Although Taylor (1909) reported that these blotches are occasionally absent, we have not seen any specimens from Canada or Europe that lack this characteristic. Örstan (2012) claimed that his specimen lacked spots, but unusually pale blotches are present in his figured specimen. Several other species of *Discus* occur in Canada (*D. whitneyi*, *D. catskillensis*, *D. patulus*, and *D. shimekii*), but none has red-brown blotches. The only other Canadian land snail species with a similar colour pattern is the native *Anguispira alternata*, but it is much larger (up to about 25 mm; Pilsbry 1948), with less tightly coiled whorls (Grimm *et al.* 2010). At maturity, both species have about 5½ to 6 whorls (counted by the method used by Kerney and Cameron [1979]), but *D. rotundatus* is much less than half the size of *A. alternata* even when it attains the maximum number of whorls. *Discus rotundatus* was treated comprehen-



FIGURE 1. Distribution of *Discus rotundatus*, the Rotund Disc, in North America. Shading indicates provinces and states where it has been introduced. Black circles show Canadian occurrences: 1, Vancouver; 2, Toronto; 3, Montreal; 4, Saint John; 5, Halifax; 6, Brigus, Ferryland, and St. John's. White circles show United States occurrences according to Jacobson (1951,1952); Freed (1953); Dundee (1974); Gleich and Gilbert (1976); Roth (1982); Hertz (1996); Pearce (2008); Lee (2009); Steury and Steury (2011); Anonymous (2015); GBIF (2015); database records of Carnegie Museum of Natural History, Field Museum, National Museum of Natural History (Smithsonian Institution), Royal British Columbia Museum, R. Forsyth, and R. Noseworthy.



FIGURE 2. *Discus rotundatus*, the Rotund Disc, McLarens Beach, Saint John, New Brunswick (45°14'15.2"N, 66°06'4.2"W); collected by RGF, 24 June 2015, NBM 009144. Photo: R. Forsyth.

sively by Taylor (1909), as *Pyramidula rotundata*, and was compared with other European representatives of the genus *Discus* by Umiński (1962).
The lifestyle, population dynamics, and ecology of *D. rotundatus* were described by Kuźnik-Kowalska (1999), who wrote that it was originally a woodland

species, associated with rotting wood and living in leaf litter, but that it has invaded anthropogenic habitats (such as parks and ruins). The same author confirmed its known highest altitude at 2700 m above sea level in the European Alps. Boycott (1929, 1934) described the species as a generalist, living wherever



FIGURE 3. Live examples *Discus rotundatus*, the Rotund Disc, Newfoundland and Labrador. A. Near wharf at Brigus, 10 May 2008; B. Masonic Terrace, St. John's, 22 August 2014; C. Anglican Cemetery, Brigus, 25 May 2008, with terrestrial isopods *Oniscus asellus* Linnaeus, 1758 and *Porcellio scaber* Latreille, 1804. Photos: J. E. Maunder.

there is sufficient moisture and shelter, and as one of the “forty or so [British] species to which we cannot assign specific habitats” (Boycott 1929: 213).

Materials and Methods

We consulted the following institutional collections, where material exists or was deposited: New Brunswick Museum (NBM), Saint John; Royal British Columbia Museum (RBCM), Victoria; Canadian Museum of Nature (CMNML), Gatineau, Quebec; Nova Scotia Museum (NSM), Halifax; and The Rooms Provincial Museum (formerly the Provincial Museum of Newfoundland and Labrador; NFM), St. John's. Other collections consulted, where no material exists, were Royal Ontario Museum, Toronto, and Manitoba Museum, Winnipeg. We also consulted the private collection of George P. Holm (New Westminster, British Columbia), and undertook a survey of the literature. Because of the distinctiveness of *D. rotundatus*, we did not consider it critical to verify all collections, although we did verify most (Table 1).

Individually, we have made a number of new collections during general reconnaissance fieldwork for terrestrial molluscs over many years. Specimen and data collection procedures varied. Most material was collected by hand, killed in alcohol, removed and allowed to dry, and then stored as dry shells. Some of the material held at NFM has been fixed and stored in ethanol.

All known records and voucher specimens of *D. rotundatus*, from Canada, are listed in Table 1.

Results

Newfoundland and Labrador

Brooks and Brooks (1940) reported the first confirmed North American collection of *D. rotundatus*, made in 1937 from the ruins of an old Church of England church in Ferryland, on the Avalon Peninsula of the Island of Newfoundland. As a result of subsequent collecting, primarily by JEM and RGN, three general occurrence groupings are currently known in the prov-

ince, all of them on the eastern Avalon Peninsula: Ferryland (2 sites), Brigus (3 sites; Figure 4A), and St. John's (8 sites; Table 1).

Nova Scotia

Discus rotundatus was first reported from Nova Scotia in simple lists of species without supporting data, including specific locality (Davis 1990, 1992). An earlier list by the same author did not include this species (Davis 1985). The NSM does have one lot of *D. rotundatus* from Halifax, from 2000, which post-dates Davis' abovementioned publications, but no earlier-collected material is held in the collection. In 2010, DFM made one additional collection, from Halifax (Table 1).

New Brunswick

Discus rotundatus was unknown from New Brunswick until 2015 when RGF found it in Saint John (Table 1).

Quebec

Örstan (2012) reported *D. rotundatus* from Mont Royal, Quebec, a Montreal municipal park established in 1876. RGF provisionally identified material based on an image of Örstan's material (Grimm *et al.* 2010), with Örstan (2012) stating that shells lacked the characteristic reddish marks of the species. Örstan (2012) collected five shells in 2008 (live) and 2011 (fresh dead), reporting that casual searches did not reveal *D. rotundatus* elsewhere on Mont Royal. More recently, DFM collected 44 live *D. rotundatus* shells at two additional sites from under downed woody debris in mature Red Oak (*Quercus rubra* L.)–Sugar Maple (*Acer saccharum* Marshall) forest on Mont Royal during 60 minutes of searching. Each of these new sites is about 0.5 km from the site reported by Örstan (2012) and together with the ease of collection, suggests abundance, widespread occurrence, and persistence of *D. rotundatus* on Mont Royal (Table 1). Nearly all of the shells in the recent *D. rotundatus* collections from Quebec are clearly distinguished by the characteristic reddish marks of the species.

TABLE 1. Canadian records of *Discus rotundatus*, the Rotund Disc, by province. ANSP = Academy of Natural Sciences of Drexel University; CMNH = Carnegie Museum; CMNML = Canadian Museum of Nature; NBM = New Brunswick Museum; NFM-MO = The Rooms Provincial Museum [Newfoundland and Labrador]. RBCM = Royal British Columbia Museum.

Collection catalogue no.	Locality	Collection date	Collector	Latitude	Longitude	Publication	Habitat	Comments
NEWFOUNDLAND AND LABRADOR								
CMNH 149351, ANSP 169889	Ferryland: ruins of the Church of England church	1937	S. T. and B. W. Brooks	47°01'31.5"N†	52°53'05.8"W†	Brooks and Brooks (1940)		
CMNH 149352	Ferryland	July 1937	Cath Morry	47°01'31.5"N†	52°53'05.8"W†			
NFM MO-459*	Ferryland: grounds of the old, stone, Catholic church	8 August 1983	JEM and RGN	47°01'31.5"N	52°53'05.8"W		Relatively untended grassy bank, littered with old boards and stones	
NFM MO-2064*	Ferryland: grounds of the old, stone, Catholic church	23 August 1986	JEM and RGN	47°01'31.5"N	52°53'05.8"W			
NFM MO-2074*	St. John's: Waterford Bridge Road: General Protestant Cemetery	23 August 1986	JEM and RGN	47°32'40"N	52°43'29"W		Well-tended, well-treed, urban cemetery	
NFM MO-2067*	St. John's: Bowring Park, south end, near river, below old Squires property	22 August 1987	JEM and RGN	47°31'18.0"N	52°45'15.1"W		Mature, mainly deciduous woods, at the edge of an old estate, in steep valley, near small river	
NFM MO-1412*	St. John's: Bowring Park, north end, near "The Duck Pond"	8 June 1988	JEM	47°31'40.1"N	52°44'42.3"W		Variously, under wood, associated with an old concrete foundation, and on the stone abutment of an old railway bridge, all in mature, semi-open, mixed-woodland, in a large, long-established, urban park	
NFM MO-2065*	St. John's: Bowring Park, north end, near "The Duck Pond"	21 June 1988	JEM	47°31'40.1"N	52°44'42.3"W			
NFM MO-1414*	St. John's: Bowring Park, north end, near "The Duck Pond"	28 September 1988	JEM	47°31'40.1"N	52°44'42.3"W			

TABLE 1. (continued)

Collection catalogue no.	Locality	Collection date	Collector	Latitude	Longitude	Publication	Habitat	Comments
NFM MO-2072*	St. John's: near Waterford River, just south of Syme's Bridge	27 August 1988	JEM and RGN	47°32'33"N	52°43'31"W		Open, grassy, shrubby river floodplain, above usual flood level	
NBM 8354*	St. John's: near Syme's Bridge off Waterford Bridge Road	30 August 2005	DFM and JEM	47°32'37.0"N	52°43'28.2"W		Open, grassy, shrubby river floodplain, above usual flood level	
NFM MO-2073*	Brigus: near "The Tunnel"	7 October 1989	JEM	47°32'5.5"N	53°12'18.5"W			
Photos of live animals by JEM (Figure 3A)	Brigus: near government wharf	10 May 2008	JEM	47°32'24"N	53°12'24"W		Open, damp, grassy-weedy slope just above a the beach of a small, saltwater harbour	
Photos of live animals by JEM (Figure 3C)	Brigus: Anglican Cemetery	25 May 2008	JEM	47°32'05"N	53°12'23"W		Fairly well tended cemetery	
NFM MO-2070*	Brigus: small park opposite the "Bartlett Memorial"	15 June 2008	JEM	47°32'08"N	53°12'18"W		Small, shady, municipal park with mature deciduous trees	
NFM MO-2071*	St. John's: Waterford River, just south of the bridge joining Leslie Street and Blackhead Road	30 June 2008	JEM	47°32'49"N	52°43'11"W		Variously in deciduous woods, under rocks and wood, in an urban river valley	
Photos of live animals by JEM (Figure 3B)	St. John's: Masonic Terrace	22 August 2014	JEM	47°33'57.0"N	52°42'26.0"W		Under rocks and boards in a well-tended urban garden	
NFM MO-2076*	St. John's: Waterford Bridge Road	5 October 2014	JEM	47°32'30.25"N	52°43'41.0"W		Variously in deciduous woods, under rocks and wood, in an urban river valley	
NFM MO-2069*	St. John's: near Waterford River, just south of Syme's Bridge	3 June 2015	JEM	47°32'33.0"N	52°43'31.0"W		Variously in deciduous woods, under rocks and wood, in an urban river valley	

TABLE 1. (continued)

Collection catalogue no.	Locality	Collection date	Collector	Latitude	Longitude	Publication	Habitat	Comments
NFM MO-2068*	St. John's: Signal Hill, just south of Gibbet Hill, overlooking the harbour	8 June 2015	JEM	47°34'11.6"N	52°41'22.5"W		Very exposed, open, grassy-weedy, rocky, meadow near an old concrete foundation	
NFM MO-2066*	St. John's: near Empire Avenue, just above Kelly's Brook, between Rennie's Mill Road and Carpasian Road	24 July 2015	JEM	47°34'23.5"N	52°42'40.8"W		Damp, sheltered gully, with open deciduous woods, above small brook; urban setting	
NEW BRUNSWICK								
NBM 009144*	Saint John: McLaren's Beach	24 June 2015	RGF	45°14'15.2"N	66°06'4.2"W		About 1 m above sea level, ≤ 3 m from high-water mark along the semi-exposed storm beach; under pieces of wood and in low vegetation which was dominated by <i>Equisetum</i> sp. and <i>Ranunculus</i> sp., on wet, cobble/gravel behind the beach ridge	
NOVA SCOTIA								
?	Unspecified					Davis (1990, 1992)		Details unknown; see text
NSM 15948*	Halifax: Waegwoltic Avenue	22 November 2000	Barry Wright	44°38'18"N†	63°35'54"W‡			
NBM 009143*	Halifax: 2720 Gottingen Street	27 August 2010	DFM	44°39'31.2"N	63°35'38.0"W		Urban, treed wasteland; few shrubs and weeds under some mature deciduous trees; a few old boards, a bit of rubbish, heavily shaded; not much ground cover	
QUEBEC								
CMNH 118700	Montréal: La croix du Mont Royal	2008 and August 2011	Aydin Örstan	45°30'30"N	73°35'17"W	Örstan (2012)	"Woods"	

TABLE 1. (continued)

Collection catalogue no.	Locality	Collection date	Collector	Latitude	Longitude	Publication	Habitat	Comments
NBM 009145	Montréal: Parc du Mont Royal: 0.42 km north-northwest of Chalet du Mont Royal	16 November 2015	DFM	45°30'20.4"N	73°35'31.4"W		Under woody debris in mature Sugar Maple–Red Oak parkland	
NBM 009146	Montréal: Parc du Mont Royal, adjacent to chemin Olmsted	17 November 2015	DFM	45°30'14.7"N	73°35'08.1"W		Under woody debris in mature Sugar Maple–Red Oak parkland	
ONTARIO								
CMNML 91756*	Toronto: south Rosedale	30 November 1953	D. Montgomery Wood	—	—			
CMNML 59922*	Toronto: north slope of Rosedale Ravine at Glen Road footbridge	14 October 1970	F. Wayne Grimm and J. Cavanaugh	43°40'23"N [§]	79°22'30"W [§]			
NBM 8729*	Toronto: Rosedale Ravine, north side of Rosedale Valley Road	20 September 2007	DFM	43°40'22.6"N	79°22'21.4"W		Deciduous forest, Norway Maple, <i>Fagus</i> , Red Oak, sparse understory except along verge; Japanese Knotweed, Virginia Creeper, and <i>Solidago</i> sp. <i>Discus rotundatus</i> ubiquitous under old cardboard and discarded clothing	
NBM 8735*	Toronto: Rosedale Ravine, north side of Rosedale Valley Road	20 September 2007	DFM	43°40'17.4"N	79°21'53.7"W		Open deciduous woods, some areas with a carpet of English Ivy and knotweed stands	
NBM 8740*	Toronto: Rosedale Ravine, south side of Rosedale Valley Road	20 September 2007	DFM	43°40'23.2"N	79°22'43.1"W		Open area with <i>Rhus</i> , <i>Solidago</i> , and Japanese Knotweed	
	Toronto: western beach, Bluffers Park	19 April 1994	Frederick W. Schueler	43°42'15.0"N	79°14'19.1"W	Karstad (1995)	Shell in beach drift	
BRITISH COLUMBIA								
CMNML 97166*	Victoria	Before 1940	Not recorded	—	—			Hanham collection; see text

TABLE 1. (continued)

Collection catalogue no.	Locality	Collection date	Collector	Latitude	Longitude	Publication	Habitat	Comments
CMNML 91841*	Esquimalt, Vancouver Island	20 December 1954	D. Montgomery Wood	—	—			Data presumed to be wrong; see text
Holm collection, CM106205	Vancouver: Queen Elizabeth Park: close to Cambie Street/ West 35th Avenue	5 March 2010	George P. Holm	49°14'26"N†	123°06'51"W†	Holm (2010)	Under fallen branches and decaying leaves at side of wooded trail (Holm, personal communication)	
RBCM 015-00492-002*	Vancouver: Queen Elizabeth Park, sunken garden at base of waterfall	28 December 2010	Patrick and Chloë Williston	49°14'33"N**	123°06'50"W**	Forsyth and Williston (2012)	Mature urban gardens of native and exotic trees and shrubs; deep litter and quantities of dead wood debris	
RBCM 015-00491-001*	Vancouver: 515 East 31st Street	11 May 2010	Patrick and Chloë Williston	49°14'35.1"N	123°05'37.6"W	Forsyth and Williston (2012)	Urban garden and adjacent alleyway; on asphalt and soil beneath lavender shrubs; on soil between cobbles; on stone retaining wall	
RBCM 015-00493-002*	Vancouver: Little Mountain: Queen Elizabeth Park, upper edge, Sunken Garden	26 September 2013	RGF	49°14'33.8"N	123°06'52.1"W		Mature, rocky garden of mature native and exotic trees and shrubs; under dead wood	
Holm collection	Vancouver: Everett Crowley Park, along middle east-west trail	5 April 2012	George P. Holm	49°12'38"N†	123°02'11"W†	Holm (2012)	Under branches and pieces of wood (Holm, personal communication)	
RBCM 015-00494-005*	Vancouver: Champlain Heights Park, along Butler Street	25 September 2013	RGF	49°12'48.8"N	123°01'59.1"W		“Islands” of native trees and shrubs, with introduced weeds surrounded by lawn; under dead wood	

*Material examined.
†Subsequently derived herein; used same geoposition as recorded by later collectors.
‡Subsequently derived herein and approximate; geoposition taken at mid-point along the length of the road.
§Subsequently derived herein and approximate; geoposition taken at Glen Road bridge over Rosedale Ravine.
*Subsequently derived herein and approximate.
**Approximate centre of area searched (Forsyth and Williston 2012).

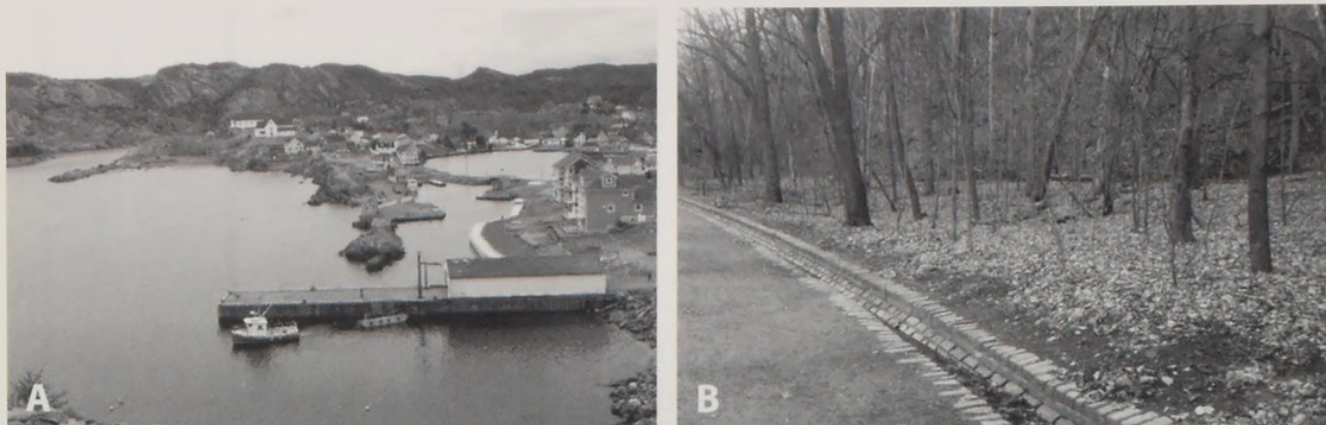


FIGURE 4. Examples of the varied habitat of the Rotund Disc, *Discus rotundatus*, in Canada. A. Brigus, Newfoundland and Labrador; B. Mont Royal, Montreal, Quebec. Photos: J. E. Maunder (A) and D. F. McAlpine (B).

Ontario

Discus rotundatus was first found in Ontario by D. M. Wood and associates. Material in the CMNML collection is from the Rosedale Ravine and was collected in 1954 and 1970. Recently, DFM re-collected the species from this ravine, where it is widespread and abundant (Table 1). The discovery of this species in beach drift at Bluffers Park, Toronto, was noted by Karstad (1995).

The late F. W. Grimm (Grimm 1996; Grimm *et al.* 2010) reported this species from Ottawa. RGF has reviewed Grimm's collections, now in CMNML (including those in the backlog, as well as his final collection donated to the museum after his death) and has not located any *D. rotundatus* material from that city.

British Columbia

Discus rotundatus was undetected in British Columbia for many years, and even extensive surveys in urban areas of Vancouver and Victoria by Forsyth (1999) failed to find it. Forsyth (2004) included it in the province based on an unpublished museum lot (CMNML 91841) purportedly collected at Esquimalt (a suburb of Victoria), Vancouver Island, on 20 December 1954. However, Forsyth and Williston (2012) contacted the collector of this material, D. M. Wood, who was adamant that he could not have collected those specimens on Vancouver Island at that time (D. M. Wood, personal communication). Assuming that the date and collector's name are correct, those specimens seem contemporaneous with others collected by D. M. Wood in Toronto the preceding year; thus, it is possible that they were also from Toronto and that the locality data were incorrect. We suspect, then, that this series of specimens and the data have become wrongly associated.

However, there is also a single specimen of *D. rotundatus* (CMNML 097166) from "Victoria" (with no additional data). Presumably this material is from the A. Hanham collection and, if correct, would seem to pre-date the discovery of this species in Newfoundland, because Hanham died in 1944 after dispersing his mollusc collection in 1940 (Drake 1963). However, it is

also possible that this specimen was wrongly labelled at some time, as is often the case in old shell collections. Although these two records provide the tantalizing possibility that *D. rotundatus* is, or was, present on Vancouver Island, this species remains unconfirmed from there.

Discus rotundatus is, however, present in the City of Vancouver. From Queen Elizabeth Park, Holm (2010) reported the first recent, confirmed records from British Columbia. Forsyth and Williston (2012) independently found the species in the same park and at another site, on East 31st Street, about 1 km away. Since then, two additional sites (at least 5.5 km southeast of the East 31st Street site) were found in two adjoining parks, Everett Crowley Park (Holm 2012) and adjacent Champlain Heights Park, with collection sites probably less than 500 m apart (Table 1).

Discussion

Although long known to be introduced in North America since at least the first records from Newfoundland in the 1930s (Brooks and Brooks 1940), *D. rotundatus* has not yet become as generally widespread and common as certain other introduced European snails, such as *Oxychilus* spp., and occurrences — as far as we know — still seem to be clustered. Given the frequency of interceptions of *D. rotundatus*, by the United States Plant Protection and Quarantine Division (1.08% of all interceptions between 1993 and 1998; Robinson 1999), it is surprising that the species is not much better established on this continent.

In Newfoundland, *D. rotundatus* has persisted for at least 79 years. However, it remains restricted to just three clusters of occurrences: at Ferryland; in Brigus (Figure 4A), where it is generally common; and in St. John's.

In British Columbia, fieldwork by RGF in urban areas of Vancouver and Victoria and their suburbs (Forsyth 1999) failed to locate this species until recently, and then only at two sites in Vancouver. We do not expect that these occurrences represent recent introductions, but rather that the species was missed in prior

years. *Discus rotundatus* is not uncommon at Queen Elizabeth Park, but was not found during multiple visits to a different area of the same park while looking for *Aegopinella nitidula*, another introduced snail (Forsyth *et al.* 2001). If *D. rotundatus* were more generally distributed, it would have been encountered along with the dozen introduced species of snails found in British Columbia over the last couple of decades (including some new provincial, Canadian, or North American records; e.g., Forsyth 1999, 2008; Forsyth *et al.* 2001). Here, as perhaps elsewhere in Canada, this species may have a very local distribution, perhaps confined to a few hundred square metres.

We do not have much data on *D. rotundatus* from Ontario or the other provinces where it has been found, but it is noteworthy that, although several collectors have been active in Ontario over many years (F. W. Grimm, F. W. Schueler, Michael J. Oldham, and RGF) and together have examined at least several hundred sites, the species has not been found outside Toronto and the Rosedale Ravine. Although Grimm said that he had found it in Ottawa, we found no evidence supporting this claim. Our new record of *D. rotundatus* from Halifax, Nova Scotia, suggests that the species could be more generally spread, especially if Davis' earlier mention of the species from Nova Scotia represents one or more undocumented finds from the province.

The mode and source of terrestrial mollusc introductions are little known (Grimm *et al.* 2010), but *D. rotundatus* has likely been introduced to North America on a number of occasions. All three occurrence clusters in Newfoundland are closely associated with saltwater harbours, which at least in years past have received significant trans-Atlantic sea traffic. Transportation via ships' ballast material is possible. In this respect, Lindroth (1957) reported *D. rotundatus* at ship ballasting places at Dartmouth, England.

However, the plant trade is recognized as a major vector for introductions of terrestrial snails (Bergey *et al.* 2014), and in southwestern British Columbia cities, Forsyth (1999) noted considerable localized transport of snails (although not *D. rotundatus*) in garden waste, soil, rock, wood, and other debris that was dumped in vacant lots and undeveloped parks. Some New York occurrences of *D. rotundatus* were apparently associated with outdoor, ornamental plantings or greenhouses (Jacobson 1954; Karlin and Naegele 1960). Vancouver's Queen Elizabeth Park, the site of a former quarry, is planted with a variety of native and exotic trees, shrubs, and garden plants. In Newfoundland, the main nucleus for the St. John's *D. rotundatus* occurrences is almost certainly Bowring Park, a long-established urban park planted with numerous, mainly imported, tree species, as well as many imported garden plants. This park also happens to be a short distance (3–4 km) upstream from the city harbour, near the upper reaches of the sheltered Waterford River Valley, along the whole length of which *D. rotundatus* also commonly occurs.

In Canada, *D. rotundatus* is found in habitats (Figure 4A,B) almost as varied as those in Europe, confirming Boycott's (1929, 1934) view that it may live anywhere there is shelter and moisture.

Acknowledgements

George Holm (New Westminster, British Columbia), Frederick Schueler (Bishops Mills, Ontario), and Patrick Williston (Smithers, British Columbia), as well as John M. C. Hutchinson and Heike Reise (Senckenberg Museum für Naturkunde Görlitz), shared data and/or specimens with us or collected specimens. Nathalie Djan-Chékar (The Rooms Provincial Museum), Jean-Marc Gagnon (Canadian Museum of Nature), Heidi Gartner (Royal British Columbia Museum), Andrew Hebda (Nova Scotia Museum), Robert Hershler (National Museum of Natural History, Smithsonian Institution), Janis Klaphecki (Manitoba Museum), Timothy Pearce (Carnegie Museum of Natural History), Mary Sollows (New Brunswick Museum), and Maureen Zubowski (Royal Ontario Museum) provided information on, access to, or assisted in depositing specimens into the collections under their care. We thank them all for their assistance. We are especially grateful to Timothy Pearce for sharing unpublished records from his private collection (now in the Carnegie Museum of Natural History) and D. Monty Wood (Ottawa, Ontario) for discussion of the Esquimalt, British Columbia record. Finally, we thank the two reviewers, Jochen Gerber and Timothy Pearce, for their valuable comments on the manuscript.

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Received 8 December 2015

Accepted 18 April 2016



Forsyth, Robert G. et al. 2016. "Distributional Status of an Introduced Land Snail *Discus rotundatus* (Rotund Disc, Mollusca: Discidae) in Canada." *The Canadian field-naturalist* 130(3), 236–247.

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