

RECENT RAPID EXPANSION OF COMMON WALL LIZARDS (*PODARCIS MURALIS*) IN BRITISH COLUMBIA, CANADA

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ABSTRACT—The Common Wall Lizard (*Podarcis muralis*) has existed in southwestern British Columbia since 1967, but expanded its range rapidly in the last decade. In 2006, *P. muralis* was thought restricted to 4 populations on southeastern Vancouver Island: 3 on the Saanich Peninsula and 1 in the Triangle Mountain area. However, increased reporting and exploration led to the recognition that these populations have merged. Further, *P. muralis* have also appeared along the eastern side of Vancouver Island north to Campbell River; and on Denman Island. In 2015, *P. muralis* was also reported from two BC mainland locations: Osoyoos in the southern Okanagan, and the city of Vancouver. Introduced lacertid populations are reported to spread from their points of origin at a relatively slow rate (~1 km every 10 y), so given that *P. muralis* has been found at least 200 km north, 300 km west, and from Vancouver Island to Denman Island and the British Columbia mainland over the last 52 y, human-assisted dispersal likely contributed to its apparently rapid radial expansion in southwestern BC. As they expand into rural and protected areas on Vancouver Island, *P. muralis* may have increasing opportunities to interact with the native Northern Alligator Lizard (*Elgaria coerulea*). Where *E. coerulea* and *P. muralis* coexist on southern Vancouver Island, the latter seems more abundant, which raises concern and warrants study.

Key words: British Columbia, Common Wall Lizard, introduced species, *Podarcis muralis*, range expansion

Accidentally or purposefully, humans have introduced non-native reptiles and amphibians globally, but these introductions frequently fail to establish populations (Lever 2003). Among successful introductions to the Pacific Coast of North America are 2 lacertid lizard species in the genus *Podarcis*. One, *P. siculus*, is established in southern California (Deichsel and others 2010) and more recently, on Orcas Island, Washington (about 48.626944°N, -123.011389°W; L Hallock, pers. comm.). The second is the Common Wall Lizard (*P. muralis*), established in British Columbia (Gregory and Gregory 1999; Lever 2003; Deichsel and Schweiger 2004; Matsuda and others 2006).

Most reports describe the intentional release of 12 *P. muralis* (Fig. 1) in BC in 1970 along Rudy Road (48.553056°N, -123.457222°W), on the Saanich Peninsula north of Victoria, Vancouver Island (Bertram 2004; Deichsel and Schweiger 2004; Matsuda and others 2006; Kraus 2009). However, anecdotal evidence also exists that 2 *P. muralis* were released in the same area in 1967 (R Lessard, pers. comm.). Based on genetic sequencing and color pattern, *P. muralis* in BC are attributable to the subspecific taxon *maculiventris* from the Emilian Apennines, Italy (Deichsel and Schweiger 2004; *contra* Allan and others 1993).

Since 1967, human assistance and subsequent gradual dispersal has expanded *P. muralis*' range in BC. In 1983, 6 *P. muralis* were moved intentionally from the central District of Saanich to 2 separate gardens in Summerland (not Summerville as Burke and Deichsel [2008] stated) in the BC interior, but they failed to establish (Deichsel and Schweiger 2004). In 1986, 6 *P. muralis* from Saanich were released in a garden on Triangle Mountain in Colwood (Deichsel and Schweiger 2004), about 15 km straight-line SW of the 1967 release area. A Triangle Mountain population persists today, with *P. muralis* records spread over a 2-km² area. By 1993, the population around the 1970 Rudy Road release site appeared to have dispersed only 1.4 km. As a result, Allan and others (1993) suggested that *P. muralis* would be a poor colonizer in this area because abundant forested habitat would limit dispersal.

Various authors have opined that *P. muralis* has not expanded substantially in BC. In particular, Bertram (2004) suggested that after 37 y, *P. muralis* remained restricted to 4 known locations of introduction: 3 in Saanich, and the 1 on Triangle Mountain. Matsuda and others (2006) supported this statement, reporting that the species remained close to its point of introduction. Allan and others (2006) also suggested a basis for its limited expansion, stating that *P. muralis* would occur only in disturbed and urban environments. These his-



FIGURE 1. Gravid female (upper left), adult male (lower left), and juvenile (right) *P. muralis*, all from Durrance Road, central Saanich, Vancouver Island, British Columbia.

toric opinions led us to document the current known range of *P. muralis* in BC, and most importantly, its apparent rapid expansion since 2006.

We used television, newspapers, radio, and social media to solicit reports from the public, and gleaned records from iNaturalist to refine our knowledge of the distribution of *P. muralis* in British Columbia. We reviewed submitted reports and verified them either by visiting the location, from photographs, or in interviews, where we were able to determine lizard anatomy and color. We identified each site, and where possible, obtained estimates of 1st appearance of *P. muralis* there. We also solicited reports from staff from the Ministry of Environment; the Ministry of Forests, Lands and Natural Resource Operations; and the Royal BC Museum; and drew from our own personal observations. Latitude and longitude of locations (using decimal degrees to 6 decimal places) were generated using Google Earth™. In most cases, exact locations from public reports were linked to specific habitat or landscape features visible in satellite imagery, increasing confidence in the location determination.

We obtained 847 *P. muralis* reports from BC from our solicitations ($n = 781$) and iNaturalist ($n = 66$), which in itself, implies that the population has expanded rapidly in this province since 2006 (Fig. 2, Fig. 3). Of the 847 reports, 766 come from a 333-km² area from Deep Cove and Sidney at

the north end of the Saanich Peninsula, south to the Gordon Head and Oak Bay regions of Victoria, and west to the Esquimalt, Colwood, Langford, and Goldstream areas (Fig. 3). Only 40 of the 766 reports for the Saanich Peninsula come from a 62-km² unurbanized area bounded by Thetis Lake in the south, Saanich Inlet to the west to Willis Point, and from the Hartland Landfill and Prospect Lake area to the east. But where lizards exist in road cuts and disturbed habitat in this unurbanized area, they are abundant. *P. muralis* appears to be absent from an area of Saanich east of Highway 17 from Cordova Bay Road in the south, north to Mt. Newton Cross Road. The first report of *P. muralis* in Metchosin was in July 2015, and since, only 3 other reports have surfaced, all about 3.5 km west of the population in the Triangle Mountain area of Colwood. As of June 2019, the 3 separate *P. muralis* populations in the District of Saanich noted by Bertram (2004) and Matsuda and others (2006) have merged into 1 large population from the north end of the Saanich Peninsula, south across the entire peninsula to Victoria, and southwest to Metchosin (Fig. 3).

Podarcis muralis appeared in municipalities along the east coast of Vancouver Island since 2006; and by 2007, had colonized parts of Denman Island (Fig. 2). It was known since 2010 at Mill Bay, 41 km from Victoria, where it was 1st observed at a communal mailbox along Briarwood Drive (P Gregory, pers. comm.). By

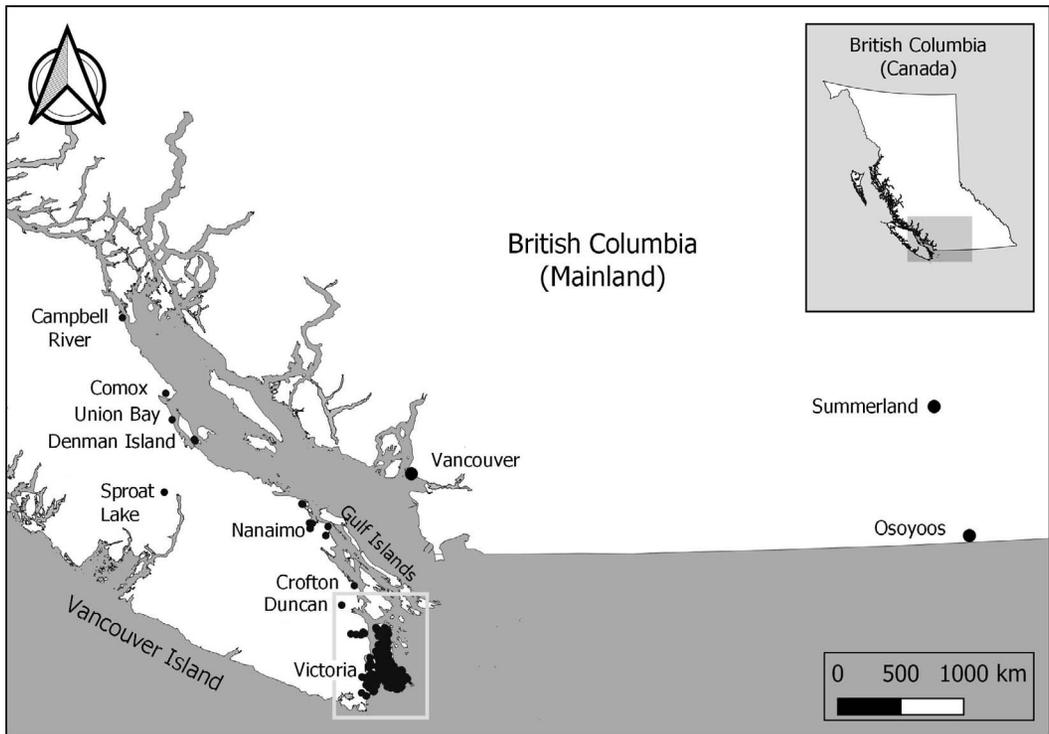


FIGURE 2. Known occurrences (black dots) for *P. muralis* in southern British Columbia (pale inset box frames area detailed in Figure 3).

2012, *P. muralis* had appeared in Nanaimo, 110 km NW of Victoria, initially in the Starks-Cinnabar Valley region, and by July 2019, detected at an additional 46 locations in that city (D Veljacic pers. comm.). In 2014, *P. muralis* appeared at the north end of Shawnigan Lake, 45 km NW of Victoria, and at the former Esquimalt and Nanaimo Railway station (now Cowichan Valley Museum) in Duncan, 61 km from Victoria. Repeated surveys in Duncan failed to reveal additional individuals. In 2016, the species was reported from Nanoose and Campbell River, respectively, 136 km and 265 km NW of Victoria. In Campbell River, *P. muralis* presently occurs only along Colwyn Street (50.019167°N, -125.244444°W), just south of Phoenix Middle School. One bright green adult *P. muralis* was also detected on a rock wall at the south end of Sproat Lake (49.258611°N, -124.925833°W) in 2018, 213 km NW of Victoria. In 2019, *P. muralis* was reported in Comox, Union Bay and Crofton, respectively, 224, 203, and 73 km NW of Victoria.

A few reports of *P. muralis* exist for the BC mainland (Fig. 2), but none have led to established populations. In 1983, 2 attempts to introduce *P. muralis* to Summerland failed (Burke and Deichsel 2008; Deichsel and Schweiger 2004). Another *P. muralis*, verified from a photograph, was found in downtown Osoyoos in autumn 2015 in a shipment of grapes from Vancouver Island (O Dyer, pers. comm.). This animal died in captivity in April 2016. We received report of another *P. muralis* from the Caulfield area of Vancouver (49.345278°N, -123.261944°W) in May 2015. This animal was described as a green lizard with a smooth back, and had a neonate garter snake in its jaws (P Akerhielm, pers. comm.). We did not collect the Vancouver animal, but lack of later reports suggests that *P. muralis* had not established there. As of June 2019, no further reports of *P. muralis* on the BC mainland have appeared.

As Hedeem (1984) suggested for *P. muralis* in Cincinnati, their success in BC likely reflects a combination of the mild southern Vancouver Island climate and the lizard's adaptability to

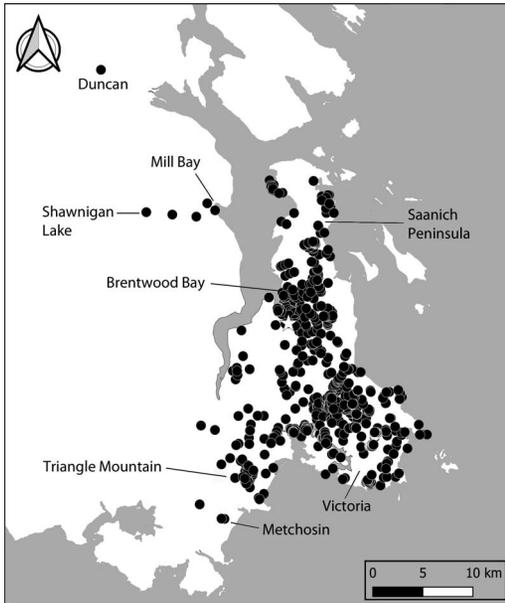


FIGURE 3. Occurrences (black dots) for *P. muralis* across the Saanich Peninsula southwest to Metchosin, on southern Vancouver Island (framed by a pale inset box in Figure 2; white star indicates initial release site from 1967).

anthropogenic environments. *Podarcis muralis* is widespread in Europe, from northern Spain to southern Belgium and the Netherlands, east to Romania, and south to the Balkans and southern Italy, with northernmost populations at 50°N latitude (Arnold and others 1978; Salvi and others 2013). Beyond this range, multiple introductions have taken place in Germany and the United Kingdom (Michaelides and others 2015; Schulte and others 2012, 2013). The species can endure short-term exposure to sub-zero temperatures and tolerate having up to 28% of their body water frozen (Claussen and others 1990). Besides freeze-tolerance, *P. muralis* can hibernate intermittently, and even in northern parts of its European range, is active on sunny days in winter (Claussen and others 1990; Rugiero 1995). On Vancouver Island, freeze tolerance is unstudied, but we have observed *P. muralis* active in winter during sunny weather in Victoria and on the Saanich Peninsula.

In Europe, *P. muralis* can occur at high densities (up to 6000 ha⁻¹) with mean densities (excluding hatchlings) of 531/ha in a cemetery in southern France (Barbault and Mou 1988).

Population growth can be rapid in favorable conditions (Dexel 1986). Allan and others (1993) estimated densities of 2 to 3 *P. muralis*/m² at Rudy Road in Saanich, excluding addition of young-of-the-year later in the season. We have seen similar densities in urban and suburban environments across the Saanich Peninsula and south to Victoria where adequate cover exists. Homeowners commonly report estimates of 30 or more lizards per suburban garden, with some estimating 1000+ lizards on larger properties in the central District of Saanich.

Our observations in the Hillside, Fairfield and Cedar Hill regions in Victoria suggest that more young-of-the-year occur at the periphery of each population, implying that young lizards disperse away from adults and their established territories. Based on our annual visual surveys of rock walls for *P. muralis* presence in these suburban environments since 2004, this unassisted range expansion seems to have occurred radially at about 40–70 m annually. Allan and others (1993) recorded one adult lizard that moved 100 m in the north Saanich region, but other adults in their study moved only a few meters a year.

In Ohio, Common Wall Lizards can produce up to 3 clutches of 4–5 eggs in a warm year (Kwiat and Gist 1987). Matsuda and others (2006) stated that *P. muralis* produces 2 clutches (of 3–8) annually in the Victoria region, as in southwestern France (Barbault and Mou 1988); though Allan and others (2006) found no evidence of multiple clutching in BC. In contrast, *E. coerulea* produces one litter of 3 to 6 each year (Vitt 1971; Bertram 2004; Matsuda and others 2006), which may place it at a selective disadvantage reproductively to *P. muralis*. Moreover, because introduced lizard populations tend to lose their native parasites, a condition shown for *Podarcis* introduced to North America (Burke and others 2007), this invasive lizard’s body condition and reproductive rate may be further enhanced on Vancouver Island.

Allan and others (1993) and Bertram (2004) suggested that *P. muralis* presence does not affect *E. coerulea*, but anecdotal observations imply otherwise. According to B Wolff’s account (in Deichsel and Schweiger 2004), *E. coerulea* disappeared when *P. muralis* appeared; no mention was made of any recolonization and subsequent coexistence. In addition, biologists L Ramsay

and D Fraser (pers. obs.) consistently observed *E. coerulea* on their property for the last 19 years, but not in 2017. This lack of detection followed the appearance of *P. muralis* on their property in 2013, with an increase in *P. muralis* detections by 2016. Two other reports from 2014 from K Lamb (pers. comm.) in the Beaver Lake-Elk Lake region in the District of Saanich also inferred that *E. coerulea* initially vanishes when *P. muralis* increase in number, but in these cases *E. coerulea* reappeared in about 3 y. As of 2017, both species occurred on Mount Tolmie, toward the southern end of the District of Saanich. The 2 species coexist today on Vancouver and Denman Islands, but *P. muralis* is more abundant in all observed cases, so concern exists for the long-term trajectory of *E. coerulea* where both species are present.

Besides the reproductive potential of *P. muralis* compared to that of the native *E. coerulea*, the small body size of *P. muralis* (mean adult SVL at 45 mm for males and 47 mm for females; Allan and others 2006) will permit it to reach age at 1st reproduction earlier and numerically outpace the larger *E. coerulea* (mean adult SVL about 90 mm; McBrayer and Anderson 2007), particularly if the more numerous *P. muralis* exploits the same food resources. Further, the active body temperature of European populations of *P. muralis* in summer averages 33.6°C (Avery 1978), about 5°C warmer than the mean body temperature of *E. coerulea* (Bennett 1980), so rising ambient temperatures associated with climate change may favor *P. muralis*.

Given the broad distribution and often high local densities of *P. muralis* in BC, the potential for its reintroduction by lizard enthusiasts, and the fact that many property owners protect lizards on their land, *P. muralis* is unlikely to be eradicated from Vancouver Island. For these reasons, it is critical that we study the biology of this exotic, and evaluate risks it may pose to the native fauna of southern BC.

Acknowledgements.—Thanks to Habitat Acquisition Trust staff P Erickson-McGee and A Nasadyk for fielding many phone calls and emails. Thanks to L Hallock, Washington Department of Fish and Wildlife for information on *P. siculus* from Orcas Island, P Karsten for information from Denman Island, P Gregory for at Mill Bay observations, R Lessard for the report of two *P. muralis* released in Saanich in 1967, D Veljacic for multiple observations and specimens from Nanaimo, O Dyer for information on the Osoyoos

P. muralis, P Akerhielm for the Vancouver *P. muralis* sighting, L Ramsay, D Fraser, and K Lamb for information on *E. coerulea* presence relative to *P. muralis* and H Gartner for assistance with manuscript preparation. Thanks to all the people who reported their sightings and submitted their observations to iNaturalist, and for their patience with our enquiries; too many exist to name individually here. Many thanks to R Anderson and C Rombough for reviews that significantly improved this manuscript.

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