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RESEARCH ARTICLE

The rapid spread of the girdled snail *Hygromia cinctella* in New Zealand (Gastropoda: Helicoidea)

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Abstract: The girdled snail *Hygromia cinctella* originates from southern Europe but has been introduced to countries in northern Europe and, more recently, to Aotearoa New Zealand. In the latter country, the girdled snail was first noted in 2015 in Wellington, but it has since spread to other regions of the North Island. We report here the rapid spread of this exotic species in New Zealand and record its present geographical distribution using museum specimens and the community science platform iNaturalist.
Keywords: exotic species, Hygromiidae, iNaturalist, land snails, Stylommatophora.

INTRODUCTION

Hygromia cinctella (Draparnaud, 1801), known vernacularly as the girdled snail, is an herbivorous land snail originally from southern Europe and a member of the helicoid family Hygromiidae. Its native distribution encompasses countries along the Mediterranean: France (including Corsica), Italy (including Sicily and perhaps Sardinia), Slovenia, Croatia, Bosnia and Herzegovina, and Montenegro (Clessin 1887; Kerney et al. 1983; Cianfanelli & Lori 2007; Štamol 2010; Welter-Schultes 2012; Hallgass & Vannozzi 2014; van den Neucker & Scheers 2014; Dedov et al. 2015; Proćków et al. 2019). Records from Andorra and Catalonia (Spain) are likely native, though some sources consider it as introduced (Graells 1846; Vilella 1965; Puente & Prieto 1992; Cadevall & Orozco 2016); records from southern Spain are considered introductions (Jiménez & Pereira 2022).

H. cinctella naturally inhabits open areas with herbaceous vegetation and low shrubs, often close to small water bodies (Welter-Schultes 2012); however, it is also synanthropic, inhabiting open and disturbed areas, as well as cultivated ones such as urban gardens (Preece 2005; Proćków et al. 2019). These habits apparently allowed the species to colonize other European regions to the north of its natural range, primarily through human introductions: northern France (Defossez & Maurin

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1995; Vimpère 2006); Switzerland (Turner et al. 1998; Vimpère 2006); southern Germany (Falkner 1996; Kittel 1999) and soon after the rest of the country (Beckmann & Kobialka 2008; Neiber & Haack 2019); Belgium (van den Neucker & Scheers 2014; Delcourt & Vilvens 2017); the Netherlands (Neckheim 1996; Kronenberg 2006); Austria (Kwitt & Patzner 2017); Czech Republic (Říhová & Juřičková 2011); Hungary (Kerney et al. 1983); Bulgaria (Dedov et al. 2015); Ireland (Preece 2005) and the UK (Comfort 1950; Kerney 1999; Weddle 2009). It was introduced to Michigan, USA, in the 2000s but quickly eradicated (Michalak & Price 2012).

Notably, *H. cinctella* was only very recently detected in Wellington, Aotearoa New Zealand, in 2015 (Walton 2017). Since that first report, numerous other occurrences in New Zealand have been found and the species can now be considered established (see Occhipinti-Ambrogi & Galil 2004 for a review of the terminology of bioinvasions). We report here the rapid spread of the girdled snail in New Zealand in less than one decade since its first detection, and record its present geographical distribution in the country using museum specimens and the community science platform iNaturalist.

MATERIAL AND METHODS

The specimens of *Hygromia cinctella* studied herein are housed in the collection of the Museum of New Zealand Te Papa Tongarewa (NMNZ, Wellington, New Zealand): NMNZ M.318161 (Wellington, Brooklyn, May/2015; see Walton, 2017); M.324989 (same locality as the former lot, Aug/2015); and M.334245 (Manawatu-Wanganui, Maxwell/Pākaraka, William Birch Pool, Sep/2022), recently collected by the last author.

To those records, observations with photographic evidence of *H. cinctella* in New Zealand were gathered from the community science platform iNaturalist (https://www.inaturalist.org/). The methodology used herein was very similar to that of Rosa et al. (2022; see their study for a discussion on community identification on iNaturalist, quality of records, their usability, and biases), with some adjustments made due to the narrower scope of our study. We have assessed land snail records from New Zealand on iNaturalist from the past decade to determine which observations belonged to *H. cinctella*. For identification, we used specialized literature (e.g., Kerney et al. 1983; Welter-Schultes 2012) and reference specimens in the NMNZ collection. In general, the observations of H. cinctella were correctly identified as so, thanks to a small but active community of users.

The data of each observation (locality, coordinates, and date) was extracted from iNaturalist (on 07/Nov/2022) and used alongside the NMNZ specimen records to construct a distribution for *H. cinctella* in New Zealand. The map was created with QGIS software (https://QGIS.org/) using map data from Natural Earth (https://naturalearthdata.com/).

RESULTS AND DISCUSSION

In total, we located 39 records of *Hygromia cinctella* in New Zealand, 36 of which are from iNaturalist (Table 1). The species' current distribution (Fig. 1) shows that it has rapidly spread across the North Island of New Zealand. Most records are from the city of Auckland and its surroundings, showing the species is well-established in the area and that the Auckland population might predate the Wellington one. There are also further records from the Wellington region, including one from Porirua, indicating that the girdled snail is spreading in this region as well.

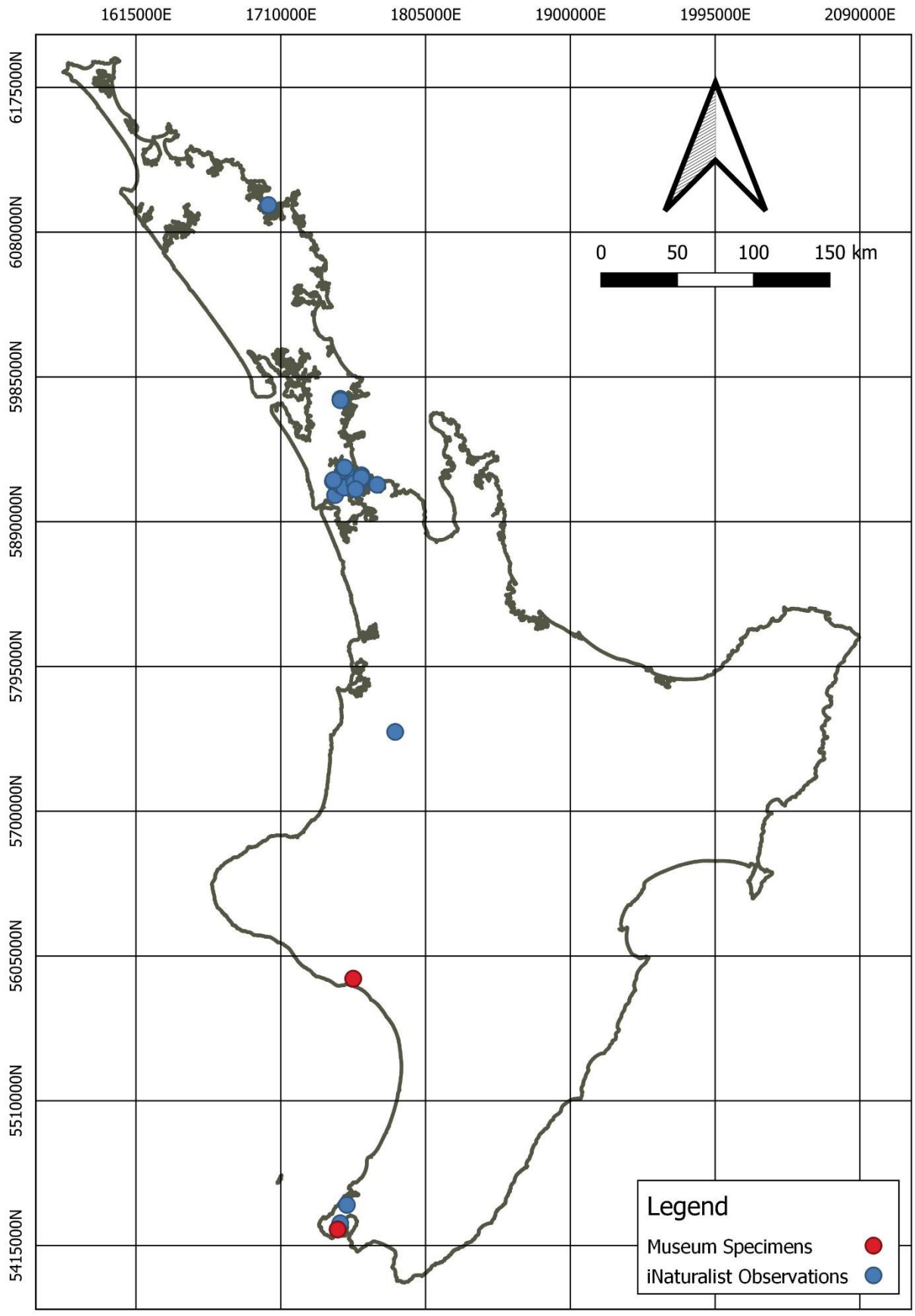

Figure 1. Distribution of *Hygromia cinctella* in New Zealand.

Table 1. Records of *Hygromia cinctella* in New Zealand including museum specimens (NMNZ collection) and iNaturalist observations. The iNaturalist observation number must be added to the end of the command 'https://www.inaturalist.org/observations/' to become a functioning URL for accessing each observation.

Museum spm.	Location	Date	Latitude	Longitude
NMNZ M.318161	Reuben Avenue, Brooklyn, Wellington	25/05/2015	-41.308664	174.760382
NMNZ M.324989	Reuben Avenue, Brooklyn, Wellington	01/08/2015	-41.308664	174.760382
NMNZ M.334245	William Birch Pool, Maxwell/Pākaraka, Manawatu-Wanganui	01/09/2022	-39.824578	174.841081
iNaturalist obs.	**Location**	**Date**	**Latitude**	**Longitude**
21294478	Warkworth, Auckland	13/02/2019	-36.398012	174.663371
28757803	Auckland, Auckland	13/07/2019	-36.865602	174.834648
41653990	Fitzherbert Terrace, Thorndon, Wellington	08/04/2020	-41.271686	174.779171
65703754	Opanuku Walkway, Henderson, Auckland	28/11/2020	-36.882452	174.620177
66148544	Opanuku Walkway, Henderson, Auckland	06/12/2020	-36.881740	174.626492
66853799	Western Road, Laingholm, Auckland	06/12/2020	-36.967879	174.636326
70582594	Rhinevale Close, Henderson, Auckland	05/03/2021	-36.886823	174.618395
71076841	Opanuku Walkway, Henderson, Auckland	13/03/2021	-36.882467	174.620708
72961367	Oakley Creek Walkway, Point Chevalier/Waterview, Auckland	05/04/2021	-36.880453	174.704105
73060830	Mount Eden, Auckland	06/04/2021	-36.878105	174.762455
73467795	Tawa, Wellington	10/04/2021	-41.162422	174.828481
73568154	Cockle Bay, Auckland	11/04/2021	-36.902360	174.944953
75095735	Margan Avenue, New Lynn, Auckland	25/04/2021	-36.912888	174.679275
75901625	Opanuku Walkway, Henderson, Auckland	01/05/2021	-36.882303	174.620570
78944385	Birkdale, Auckland	14/05/2021	-36.804397	174.702274
82106292	Newmarket Park, Parnell, Auckland	08/06/2021	-36.865160	174.783547
92851748	Birkdale, Auckland	29/08/2021	-36.804391	174.703064
95903753	Donovan St, Blockhouse Bay, Auckland	24/09/2021	-36.922620	174.702583
99159009	Warkworth, Auckland	04/10/2021	-36.406482	174.663297
100907644	Onehunga, Auckland	12/11/2021	-36.922072	174.794476
106794328	Opanuku Stream Walkway, Henderson, Auckland	16/03/2021	-36.879623	174.623070
106794329	Opanuku Stream Walkway, Henderson, Auckland	16/03/2021	-36.879623	174.623070
106794330	Opanuku Stream Walkway, Henderson, Auckland	16/03/2021	-36.879623	174.623070
106794333	Opanuku Stream Walkway, Henderson, Auckland	16/03/2021	-36.879623	174.623070
106794334	Opanuku Stream Walkway, Henderson, Auckland	16/03/2021	-36.879623	174.623070
106794335	Opanuku Stream Walkway, Henderson, Auckland	16/03/2021	-36.879623	174.623070
106794337	Opanuku Stream Walkway, Henderson, Auckland	16/03/2021	-36.879623	174.623070
106794338	Opanuku Stream Walkway, Henderson, Auckland	16/03/2021	-36.879623	174.623070
108464780	Greenlane Train Station, Greenlane/Remuera, Auckland	13/03/2022	-36.889303	174.797333
109524241	Michael Joseph Savage Memorial Park, Orakei, Auckland	26/03/2022	-36.847803	174.827476
112480589	Russell, Northland	23/04/2022	-35.257420	174.119541
113055713	Te Kuiti, Waikato	17/04/2022	-38.360820	175.118502
120609339	Green Lane West, Epsom, Auckland	07/06/2022	-36.893365	174.777046
126028387	Mission Bay, Auckland	13/07/2022	-36.859894	174.830713
129073089	Orakei, Auckland	01/08/2022	-36.861309	174.827231
140723298	Onehunga Mall, Onehunga, Auckland	01/11/2022	-36.931055	174.786967

The recently collected specimens (M.334245) are from an anthropicized area in the Manawatu-Wanganui region, albeit far removed from any major urban centres. Likewise, there is a single iNaturalist record from the general area of Te Kuiti, a largely deforested area in the Waikato region (observation #113055713; the precise locality was obscured by the user). Finally, there is a single iNaturalist record from the Northland region (observation #112480589), which is far removed from other occurrences and from major urban centres, a fact that was also noted by the iNaturalist user who posted it. That user says that the Northland observation was made on a property belonging to a person from Auckland; the user had previously recorded *H. cinctella* in the property of that same person in Auckland (observation #66853799) and, so, hypothesized that the person inadvertently transported the snails from Auckland to Northland.

The spread of *H. cinctella* within countries in Europe has also been rapid (e.g., Dedov et al. 2015; Delcourt & Vilvens 2017; Neiber & Haack 2019). Its notable movement northwards and eastwards in Europe is mostly due to human activity (imports), particularly along railways and waterways, although natural/active expansion of the snail populations is also considered to be involved in some cases, (Defossez & Maurin 1995; Wimmer 2006; Beckmann & Kobialka 2008; van den Neucker & Scheers 2014). Furthermore, the species' expansion is also potentially aided by increasing annual temperatures, especially in the past two decades (Peltanová et al. 2012), though the models of Proćków et al. (2019) predict that *H. cinctella* will not benefit much from increasing temperatures in terms of future distribution.

Outside its native distribution, *H. cinctella* seems to favour anthropically modified habitats (e.g., gardens) (Preece 2005; Proćków et al. 2019). Such places will also typically have more amenable microclimatic conditions than natural areas in most invaded countries (Peltanová et al. 2012), though adult girdled snails have been shown to survive the cold winters of Eastern Europe (Říhová & Juřičková 2011). The species, like many other introduced snails, is prone to dispersal by trade, particularly via horticultural activities (e.g., on plants, on tools and equipment, or as eggs in the soil) and timber and other construction materials (Neckheim 1996; Preece 2005; Říhová & Juřičková 2011; Dedov et al. 2015). Furthermore, its eggs are resistant to fluctuations in humidity, which could aid its spread (Wimmer 2006).

Collection data for the NMNZ specimens and the comments of users on the records they posted on iNaturalist, shows that the girdled snail in New Zealand is typically found in gardens, on trees and foliage close to roads, in the vicinities of streams, and other disturbed microhabitats (e.g., on walls). Considering its present distribution in New Zealand (Fig. 1), *H. cinctella* is already established in the country and can be considered a naturalized species. There is ample possibility for the girdled snail to rapidly spread further in New Zealand along major urban hubs of the North Island (e.g., Tauranga) and to the South Island, e.g., the urban centres of Christchurch and Nelson. One important point of entry to the South Island is Picton, a small town that receives the ferries coming from Wellington. Considering that *H. cinctella* can survive Eastern European winters (Říhová & Juřičková 2011), its survival in the mild climate of most of New Zealand (mean annual temperatures are circa 10°C in the south and 16°C in the north; Mackintosh 2001) is almost a certainty.

The girdled snail is herbivorous and does not appear to pose a threat to any crops or ornamental cultivars. Likewise, it is not known to be a threat (either directly or indirectly through competition) to any other terrestrial gastropods. As such, as already suggested by Walton (2017), likely *H. cinctella* will not have any significant negative effects on the native snail fauna. Considering that the girdled snail is not expected to spread far from modified environments, its impact on the native flora is also expected to be minimal.

CONCLUSION

The establishment of the girdled snail in New Zealand is the first of this species outside of Europe (the population in the USA was eradicated; Michalak & Price 2012). As such, it is expected that this snail will appear in other countries before long (Proćków et al. 2019).

As argued by Welter-Schultes (2012), the distribution of *Hygromia cinctella* in Europe is likely underestimated, because researchers rarely study the fauna of disturbed and urban areas. The same is true for New Zealand, where directed collecting activities now mainly take place in reserves or remote areas. On the contrary, the observations on iNaturalist are heavily biased towards those organisms that people find (and photograph) in urban settings, e.g., close to their homes, or in parks

and other recreational areas (Rosa et al. 2022). As such, the potential of iNaturalist for the study of exotic species cannot be overstated, from those already established to the rapid detection of new arrivals (Rosa et al. 2022). The platform will be a major source of data going forward and will be important in understanding how species and populations will respond to new challenges and opportunities, particularly as temperatures increase and habitats change.

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