

Independent introductions of hedgehogs to the North and South Island of New Zealand

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Abstract: According to the most recent (2005) compendium on the history of the European hedgehog (*Erinaceus europaeus*) in New Zealand, this small insectivorous mammal was first brought from Europe to the South Island in the 19th century. This introduction has been presumed to be the source of hedgehogs that subsequently spread to the North Island. This view was informed by the absence of hedgehogs in the North Island throughout the 19th century and no evidence of direct shipments of hedgehogs from overseas to the North Island. Molecular data have challenged this view and suggested that not only was the North Island colonised independently from overseas, but hedgehogs also first became established in the North rather than in the South Island. If true, this finding indicates that the historical record collected by previous researchers might be incomplete. In the present study, based primarily on newspaper articles, we fill this gap by documenting four pre-1900 shipments of hedgehogs to the North Island, thereby confirming the independent colonisation of the North Island. However, we also report on several relocations from established populations in Canterbury (South Island) to regions on the North Island, and none in the opposite direction. We illustrate the importance of linking observational and molecular data with historical records when interpreting the introduction pathways of introduced species.

Keywords: invasion, New Zealand, shipping, historical records

Introduction

New Zealand is the only country in the world where European hedgehogs (*Erinaceus europaeus* L.) have successfully established in the wild outside their native range (Brockie 1975; Long 2003). Hedgehogs were shipped to New Zealand by acclimatisation societies three times between 1869 and 1885, but the number of survivors was low (only six in total), and the only documented releases during that time were two males from the last shipment (Thomson 1922; Brockie 1975). Further, private efforts followed; the earliest animals found in the wild are reported from the 1890s (Thomson 1922; Brockie 1975; King 2005). Hedgehogs were brought over to New Zealand as pets but also disseminated throughout the country. This was done at least partly in the hope that they might control insect and mollusc pests (Brockie 1975; Long 2003). While they failed in this task, their voracious appetite for endemic skinks and eggs of ground-nesting birds has made them a significant threat to the native fauna (Jones & Sanders 2005; Jones et al. 2005).

The general consensus from historical records is that hedgehogs were first introduced to the South Island in the

19th century, and were absent on the North Island before the 20th century when they were thought to have been transported there from the South Island (Thomson 1922; Wodzicki 1950; Brockie 1975; Long 2003; King 2005). A recent study based on microsatellite and mitochondrial molecular data (Bolfíková et al. 2013) has questioned this view. Approximate Bayesian computation models supported only scenarios with colonisation of the North Island directly from the source population in Great Britain, and indicated that hedgehogs first became established in the North rather than in the South Island. Bolfíková et al. (2013) suggested that ancient southern populations might have been replaced by the invasion waves from the North Island. Another possibility is that the historical record, as collected by Brockie (1975), is rather incomplete and that hedgehogs appeared on the North Island much earlier than previously thought.

Here we re-examine the introduction history of the European hedgehog to New Zealand by using primary sources of information, original documents of acclimatisation societies and, mainly, newspaper articles, which proved to be a reliable (Pawson & Quigley 1982), and thanks to recent digitalisation (<https://paperspast.natlib.govt.nz>), also a very powerful resource (Star 2014; Pipek et al. 2015a,b, 2019; King 2017a,b).

Methods

We collected information from published annual reports and unpublished minute books of acclimatisation societies in New Zealand and newspaper articles stored in the Papers Past archive (paperspast.natlib.govt.nz) published from 1850 to 1940. In the newspaper archive we used the search query: hedge*hog + hedge*hogs, which enabled any combination of the following strings, “hedge hog”, “hedge-hog” or “hedgehog” in singular as well as plural form. We also explored less commonly used terms, hedge*pig and urchin, but this did not lead to the discovery of new articles.

We double checked this information with data included in George M. Thomson’s monograph on plant and animal introductions (Thomson 1922) and other resources addressing the naturalisation of hedgehogs and other animals in New Zealand (Wodzicki 1950; Brockie 1975; Long 2003; King 2005). As George Thomson lived in Otago and took care of the survivors of the only shipment of hedgehogs of the Otago Acclimatisation Society in 1885, we consider his data (about presence, not absence) from this region, and also from Canterbury, as trustworthy.

Results

The geographic distribution of the earliest records of hedgehogs, combined with knowledge of individual shipments, strongly support the hypothesis that the first introductions were in

Canterbury (Fig. 1; See Appendix S1 in Supplementary Materials). We tracked down 10 shipments of hedgehogs, six to the South Island (1869–1894) and four to the North Island (1883–1896; Table 1). The mortality during shipping (when reported) was high (ranging from 50 to 97%, median 91%). Some hedgehogs must have been shipped without being noticed (or documented) by newspapers, and then released, either deliberately or accidentally, as in case of pets (Drummond 1911). Several releases, not reported by contemporary newspapers, were noted in hindsight (Table 1; Appendix S1).

South Island

The efforts of the acclimatisation societies of Canterbury and Otago were apparently limited and contributed only marginally, if at all, to the successful establishment of hedgehogs. In all documented cases, only a few individuals were imported (Table 1), well below the number usually needed for starting a viable population of mammals (Forsyth & Duncan 2001; Blackburn et al. 2015; Gonzalez-Suarez et al. 2015). Hedgehogs imported by the Canterbury Acclimatisation Society in 1869 and 1871 were kept in confinement and likely not liberated; the doubts about the utility of hedgehogs as biocontrol agents (The Star 1869; Hursthouse 1871; Press 1871) prevailed around 1870, and in 1876 it was even suggested (but not supported) in Parliament to include hedgehogs in the Noxious Animals Prohibition Act, 1876 (see: www.nzlii.org/nz/legis/hist_bill/napb18761391327) to prevent them from being introduced (Grey River Argus 1876). The Acclimatisation Society of Otago, in its first and only attempt, released one

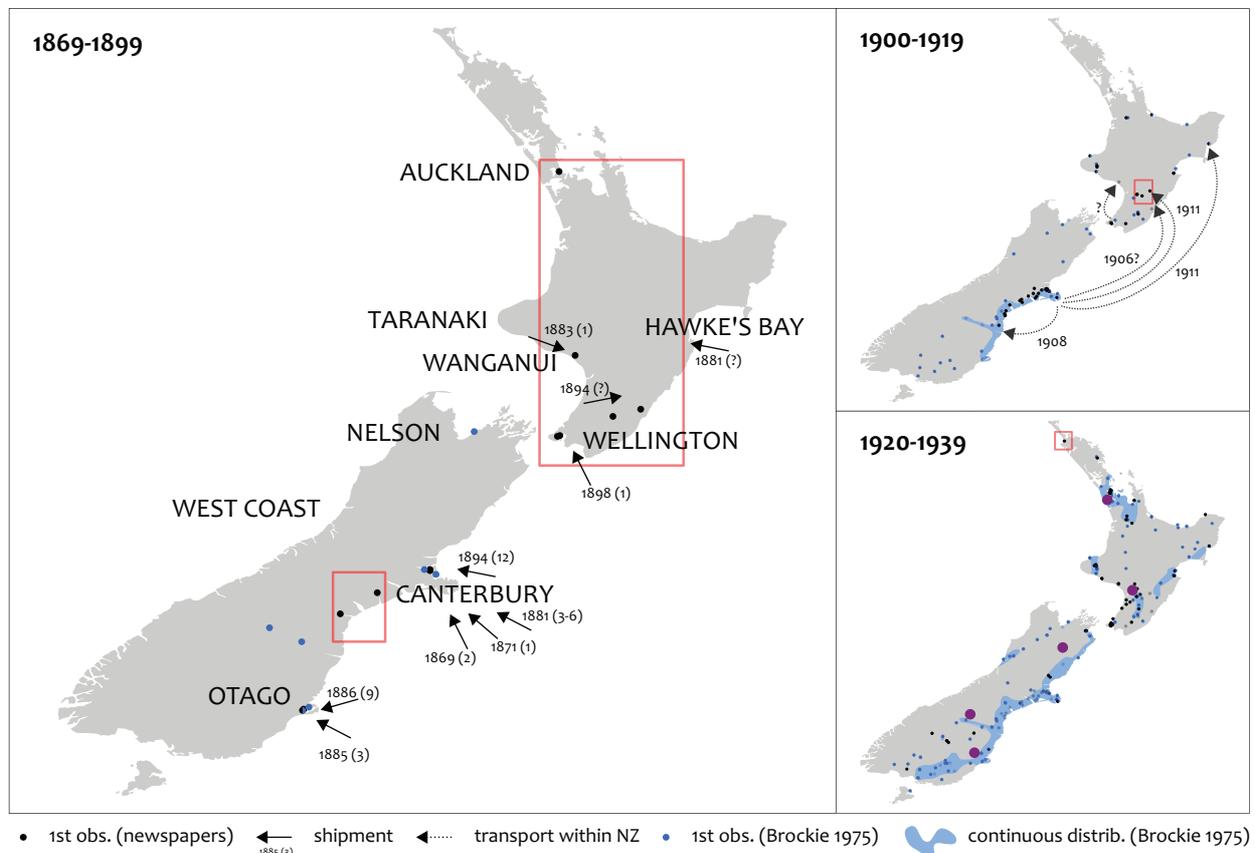


Figure 1. First observations / liberations as inferred from newspapers (black, see Appendix S2 in Supplementary Materials) and as presented in Brockie (1975) (blue). The localities of DNA collection as in Bolfiková et al. (2013) are in purple. The red rectangles highlight additional information not included in Brockie (1975). The arrows indicate shipments, the dotted arrows translocations.

Table 1. Historical records of hedgehog shipments with details of the year, the ship, the number transported, the region of arrival (SI – South Island, NI – North Island), the number surviving and whether or not they were released.

Year	Ship	Port of origin	Destination Region	Number loaded	Number survived	Released	Source	Notes
1869	Hydaspes	London	Canterbury (SI)	4	2	Likely not	Thomson 1922, Colonist 1869	
1871	Robert Henderson	Glasgow	Canterbury (SI)	20-24	1	Likely not	Thomson 1922, Canterbury Acclimatisation Society 1872	
1881	Waimate	London	Canterbury (SI)		3-6	Yes	Lyttelton Times 1881, Wilkin 1883	Newspapers in 1881 report three individuals, but, more likely, three pairs were imported, as the importer lately claims he released six of them.
1883	Huia	England	Whanganui (NI)	8	1	Was sick – might have become a museum specimen	New Zealand Herald 1884, Wanganui Herald 1883, Manawatu Standard 1883, Nelson Evening Mail 1885	According to trade imports and exports, eight hedgehogs were imported to New Zealand in 1883, we assume that this refers to the shipment by the vessel 'Huia'
1885	Tainui	London	Otago (SI)	100	3 (2 males 1 female)	To gardens, female died	Press 1885, Otago Daily Times 1886, Thomson 1922, Otago Acclimatisation Society (unpubl.)	Given to the care of G. M. Thomson.
1886*	Ionic	Plymouth	Otago (SI)		9		Otago Daily Times 1887, Otago Acclimatisation Society (unpubl.)	Hedgehogs were offered by Charles Bills, however, the acclimatisation society could not afford to pay for them
1894			Merivale, Canterbury		12	Escaped	Thomson 1922, Hutton 1897	
1894	Langstone	Liverpool	Wairarapa (NI)		Few	Yes	Evening Post 1894	
1896			Hawke's Bay (NI)			Likely purchased	Daily Telegraph 1896, Feilding Star 1896	
1898	Ionic		Wellington (NI)		1		Marlborough Express 1898	

*According to James Drummond (Drummond 1914), hedgehogs first came to Otago along with robins and nightingales in 1855. The early date is likely a typographical error and should be 1885. The combination of Otago, robins, nightingales, hedgehogs, Shaw & Savill company fits quite nicely to the vessel 'Ionic', which departed in 1885 (New Zealand Herald 1885, Otago Daily Times 1887). Furthermore, Shaw & Savill only started to operate as a company in 1859.

female and two males in its gardens in 1885, however the female died soon after and one of the males disappeared. In 1887 the society was not in a financial position to purchase the hedgehogs brought to New Zealand by the vessel 'Ionic' (Otago Acclimatisation Society, unpubl. report).

Initially hedgehogs were probably released on the South Island in the 1880s (Lyttelton Times 1881): six in 1881 in Christchurch (Wilkin 1883), four more around 1886 in Ashburton (Ashburton Guardian 1905) and 12 in Merivale, Christchurch in 1894 (Thomson 1922). In 1899, one hedgehog was confined in the gardens of the Canterbury Acclimatisation Society (Canterbury Acclimatisation Society 1899). Around 1909 (Ashburton Guardian 1915) or possibly sooner (Ashburton Guardian 1914), two or three were released in the Rangitata region in South Canterbury.

In 1907 (Otago Daily Times 1907) and 1908 (North Otago Times 1908) at least seven hedgehogs were transported from Canterbury to Otago. The translocation from Canterbury also contributed to the establishment of hedgehogs in Nelson (Manawatu Standard 1917).

North Island

Hedgehogs on the North Island were observed before any of the tracked overseas shipments transporting hedgehogs reached the region: in the 1880s, escaped pets were reported from Auckland (Auckland Star 1880) and Wellington (Evening Post 1885).

The local acclimatisation societies were less active than their southern counterparts, none of the tracked shipments identified in newspapers were organised by them, even though the acclimatisation society of Wellington wanted to import hedgehogs from overseas as early as in its first year of establishment in 1871 (Lyttelton Times 1872).

The sole surviving hedgehog (of eight) shipped to Whanganui in 1883 (Manawatu Standard 1883), was followed 11 years later by a few individuals shipped to Wairarapa (Evening Post 1894). Two years later an unknown number were transported to Hawke's Bay (Daily Telegraph 1896) and finally one individual hedgehog was conveyed to Wellington (Marlborough Express 1898).

Apart from the direct shipments from Europe described

above, some hedgehogs were imported from the South Island. In 1906 (presumably – the date relates to the Christchurch exhibition), several hedgehogs were transported from Canterbury to the Manawatu-Whanganui region (Manawatu Standard 1918) and in 1911, another five followed (Manawatu Standard 1911a; Woodville Examiner 1911; New Zealand Times 1911). Also in 1911, eight hedgehogs were transported from Canterbury to Poverty Bay (Poverty Bay Herald 1911).

Finally, there was also some movement of hedgehogs within the North Island: a pair or two were transported from Wellington to Whanganui (Opunake Times 1927) and a pregnant female from Whanganui to the Taranaki region (Stratford Evening Post 1926).

Discussion

By analysing the newspaper archive, we improved significantly the knowledge of the history of hedgehog introductions in New Zealand. While some overseas shipments to the South Island were recorded by Brockie (1975), we managed to track yet unknown overseas shipments to the North Island. The list is nevertheless still not exhaustive; some hedgehogs appeared as pets in areas where no previous shipment was noted, i.e. in 1880s in Auckland and in Wellington. Overall, newspapers were especially valuable in capturing the early occurrences of hedgehogs on the North Island, which were missed by Brockie (1975). In later years, the data in Brockie (1975) and in newspapers correspond well. It is understandable that Brockie (1975) missed information on early occurrences because a substantial part of his data comes from questionnaires undertaken by Wodzicki (1950) and people remembering the early spread might have already passed away by that time. He also did not have the advantage we have in digitised newspaper articles.

Newspaper records support some, but not all, findings from molecular data (Bolfiková et al. 2013). Although some early shipments are untraceable, hedgehogs were introduced independently to the North Island of New Zealand well before the 20th century with at least four shipments from Europe. Some hedgehogs were also relocated in the 20th century from Canterbury (South Island) where they first became abundant

(Fig. 1, Table 2). Support for this high rate of translocation of hedgehogs in New Zealand stems from genetic data that show no evidence of populations being isolated by distance (Bolfiková et al. 2013).

By contrast, our data do not support the most likely molecular genetic scenario (Bolfiková et al. 2013) that the establishment initially occurred in the North Island from where hedgehogs independently colonised other regions in the North as well as the South Island. According to newspaper articles, hedgehogs were already abundant in the South Island, especially around the big cities (Christchurch, Timaru, Dunedin) by the time they had just begun to be recorded in the North Island (Fig. 1, Appendix S1).

Our study demonstrates that thorough historical analysis can still add new insights into a relatively well studied species in New Zealand (Jones & Sanders 2005), and can assist future studies aiming at clarifying the history of animal introductions and spread in New Zealand. Genetic studies might benefit from improved historical record, that can help to select the most appropriate set of introduction scenarios for rigorous testing (e.g. ABC analysis), and develop a balanced sampling design, based on the documented species spread, by collecting the material from likely sources of early introductions as well as from more distant sites.

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Table 2. Historical records of hedgehogs being moved from one part of New Zealand to another.

Year	From	To	Number	Released	Source	Notes
Ca. 1906	Christchurch (Canterbury)	Ashhurst, Palmerston North (Manawatu-Whanganui)	Several	Yes	Manawatu Standard 1918	Woman / girl brought (at the time of Christchurch exhibition) several hedgehogs from Lyttleton and some of them escaped in Ashhurst, the rest might have escaped in Palmerston North
Before 1908	Christchurch (Canterbury)	Oamaru (Otago)	6	?	North Otago Times 1908	
1911	Christchurch (Canterbury)	Waerenga-A-Hika (Poverty Bay)	8	Yes	Poverty Bay Herald 1911, Manawatu Standard 1911b	
1911	Christchurch (Canterbury)	Palmerston North (Manawatu-Whanganui)	5	Likely	Manawatu Standard 1911a, Woodville Examiner 1911, New Zealand Times 1911	Given by Mr. Heaven to the Council for liberation in Reserves
?	Wellington	Whanganui	2 or 4		Opunake Times 1927	Made appearance in Whanganui only within last few years, thought to be descendants of a pair or two transported from Wellington

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Supplementary material

Additional supporting information may be found in the supplementary material file for this article:

Appendix S1. Hedgehog timeline: releases, observations and other items concerning hedgehogs.

Appendix S2. First occurrences in a region (as noted by newspapers) that underpin the figure 1.

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