Short Communication

New Zealand's forgotten biodiversity: different techniques reveal new records for 'giant' springtails

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Introduction

The subfamily Uchidanurinae Salmon, 1964 (Collembola: Neauridae) currently consists of eight genera and 15 species, all of which are locally endemic or have restricted distributions in India, Vietnam and Malaysia, Micronesia, New Caledonia, Australia, and New Zealand (Massoud 1967). They are some of the largest (up to 17 mm; M. Stevens *et al*. 2007) and most spectacular springtails recorded world-wide (Salmon 1942). In New Zealand there is a single endemic genus, with five described species: *Holacanthella spinosa* (Lubbock, 1899), *H. paucispinosa* (Salmon, 1941), *H. brevispinosa* (Salmon, 1942), *H. duospinosa* (Salmon, 1942), and *H. laterospinosa* (Salmon, 1944) (Massoud 1967). This genus is unusual, like most uchidanurines, in that it possesses brightly coloured digitations (epidermal spine-like projections) on the dorsal and lateral surfaces (See frontis piece photographs). Because *Holacanthella* are saproxylic (living within decomposing logs) they assist in nutrient uptake by plants in forests by returning nutrients from dead wood to soil (Grove 2002). They are likely to be a particularly important part of New Zealand's saproxylic fauna. Thus, they play a role in defining the composition of the saproxylic and forest community, as well as being a key component in maintaining forest health.

Although the subfamily is considered to be of conservation importance in Australia (Greenslade 1991; Greenslade *et al*. 1996), 'giant' springtails have not attracted scientific interest in New Zealand since the five species were formally described between 1899 and 1944. In general, the presence of these springtails appears to be reliant on the availability of dead wood on the forest floor – a critical habitat for these saproxylic communties; whereas their absence appears to be driven by deforestation leading to unsuitable non-indigenous habitat. Future scientific and/or conservation effort requires a greater understanding of their distribution, but with only eleven historical locality records (see Table 1; see also Stevens *et al*. 2007), determining what effect disturbances have had on these unique springtails has been problematic. Of concern is that local extinctions may be a common occurence in smaller forest fragments because these are less likely to contain ideal habitats for such highly specialised animals and they are subject to both edge effects and removal of dead wood. However, determining if an absence of a species equates to local extinction is difficult, and could be interpreted as 'species not found'.

Here, we used hand-collections, standard pitfall traps, yellow-pan traps, and a large number of flight-intercept-pitfall traps to further explore the distribution of *Holacanthella* species in the central part of New Zealand.

Materials and Methods

We targeted known localities for *Holacanthella* spp. in central New Zealand (see Table 1) by searching and hand-collecting from the underside, or from within dead wood/logs. Passive collecting, at known localities and elsewhere, was by standard pitfall traps (7.6 cm diameter, containing ethylene glycol preservative) (Boulton 2006), yellow-pan traps (17 cm diameter, 3 cm deep; containing sodium benzoate and a few drops of Triton-X),

Table 1. Distribution records of the five *Holacanthella* species throughout New Zealand.

Species	Colour [1]	Location	Trapping method[2]	Lat (S), Long (E)	Source[3]	Date
H. spinosa	Yellow	Ohakune, NI	HC		Salmon 1942	1918
	Yellow	Kamahi Road, Mountain Road, Ohakune, NI	HC		BA Holloway	19/01/1962
	Yellow	Blyth Track, Ohakune, NI	HC	39.34172, 175.49531	M Stevens	19/12/2005
	White	near summit, Rimutaka Range, NI	HC	41.31715, 175.04690*	RK Dell	14/06/1941
		Johnstons Hill, Karori, Wellington, NI	HC	41.27459, 174.74169*	JT Salmon (TP)	16/09/1942
		Ngaio Hills (600ft), Wellington, NI	HC	41.24996, 174.76520*	Salmon 1941	01/05/1932
		Eastbourne, Wellington, NI	HC	41.29523, 174.90059*	R Forster (TP)	28/06/1942
	Yellow	Days Bay, Wellington, NI	HC	41.28138, 174.91057*	R Forster (TP)	28/06/1942
	Yellow	Westhaven, Tawa, Wellington, NI	HC	41.17368, 174.80810*	JT Salmon (TP)	15/11/1952
	White	Wellington, NI	HC		R Ordish (TP)	16/04/1954
	White	Wainuiomata, Wellington, NI	HC	41.23737, 174.96216*	R Ordish (TP)	19/10/1969
		Wellington, NI	HC		L Morrison (TP)	14/03/1952
		Mt Arthur Tableland (4500ft), SI	HC	41.18445, 172.62498*	Womersley 1937	25/11/1924
H. duospinosa	Yellow	Waitakere Range, Nihotupu Pipeline, NI †	YP	36.95001, 174.58495*	JW Early	16/01/2006
	Yellow	Horokino, near Otamaroa Stream, NI	Pitfall	38.44880, 175.48113	R Boulton	18/12/2005
		Taumarunui, NI	HC	38.88491, 175.24753*	Salmon 1942	1918
		Rotokuru Ecological Reserve, Ohakune, NI	HC	39.43477, 175.51974	M Stevens	22/04/2006
	Yellow	Atene Reserve, Whanganui National Park, NI	FIP	39.72657, 175.13886	J Campbell	08/02/2006
	Yellow	Evans Track, Golden Bay, SI	FIP	40.58576, 172.53246	H Stoffregen	12/1/2006
H. paucispinosa		Ohakune, NI			Salmon 1942	1918
	Yellow	Blyth Track, Ohakune, NI	HC	39.34172, 175.49531	M Stevens	22/04/2006
	Yellow	Holdsworth lookout track, Wairarapa, NI	HC	40.90568, 175.46729	M Stevens	30/01/2006
	Yellow	Waiohine, Wairarapa, NI	FIP	40.59409, 175.23002	M Wakelin	08/02/2006
	Red	Karori, Wellington, NI	FIP	41.17167, 174.4507	J Terry	11/01/2006
	Yellow	Catchpool, Orongaronga, NI	HC	41.33708, 174.95133	M Stevens	30/01/2006
	White	Cape Stream, Aorangi Range, Mt Ross, NI	HC	41.45224, 175.40845*	JT Salmon (TP)	06/04/1947
	Yellow	Wairau Valley , Nelson, SI	FIP	41.54284, 172.54221	D Chisnall	11/01/2006
		Maruia Valley†	HC		Salmon 1941	09/02/1940
		Mount Algidus, Rakaia Gorge, SI†	HC	43.25643, 171.37113*	Salmon 1941	
		Lake Mapourika, SI†	HC	43.32911, 170.21444*	Salmon 1941	20/02/1940
		Bold Peak (3000ft), Lake Wakatipu, SI†	HC	44.84790, 168.30248*	Salmon 1944	11/02/1943
H. brevispinosa	Yellow	Bellbird Bush, Napier, NI	FIP	39.07448, 176.484517	K Nakagawa	09/02/2006
	Yellow	Balls Clearing, Hawke's Bay, NI	FIP	39.160138, 176.49939	G Craill	13/02/2006
	Yellow	Atene Reserve, Wanganui National Park, NI	HC	39.72657, 175.13886	M Stevens	09/06/2006

	Orange	Ranui Crescent, Khandallah, Wellington, NI	HC	41.23802, 174.78314*	S Trewick	05/08/2005
	Orange, Yellow	Johnstons Hill (600-800ft), Karori, Wellington, NI	HC	41.27459, 174.74169*	Salmon 1942	13/07/1941
		Red Rocks (6ft), Wellington, NI	HC	41.35675, 174.72527*	Salmon 1942	01/06/1941
	Yellow	Cobbs lookout, Golden Bay, SI	FIP	41.06145, 172.41364	H Stoffregen	10/02/2006
	Yellow	Porika Track, Nelson, SI	FIP	41.46358, 172.370917	D Chisnall	11/01/2006
		Longwood Range (1000ft), Southland, SI†	HC	46.28324, 167.86469*	Salmon 1942	01/11/1940
		Curio Bay (100ft), Southland, SI†	HC	46.65903, 169.09858*	Salmon 1942	01/02/1941
H. laterospinosa	Yellow	Cuvier Island, Coromandel, NI†	HC	36.43704, 175.76976*	Salmon 1944	01/08/1943

[1] Colour of the cuticular pigmentation of digitations, which varies within species and is identified when possible.
[2] HC = hand collecting; FIP = flight-intercept-pitfall; Pitfall = standard pitfall traps; YP = yellow-pan traps.
[3] Source of records: TP = JT Salmon's collection housed at Te Papa Tongarewa (MONZ).
* = estimated (approximate location only) GPS coordinates for previously published records and/or museum specimens.
† = locations outside the boundaries examined in the present study. Already published locations do not appear in Figure 1.

and flight-intercept-pitfall (FIP) traps (described below). Samples were fixed in 95% ethanol, and identified (slide mounted where necessary) using original descriptions and the most recent key (Massoud 1967).

Flight-intercept-pitfall trapping

Flight-intercept-pitfall (FIP) trapping was carried out as part of a large-scale invertebrate survey within native forest in central New Zealand. Sixty five traps were set in the southern half of North Island and north of Kaikoura in South Island (Fig. 1). Each FIP trap consisted of a pitfall trap with a flight-intercept fitted above it (Fig 2), as used previously by Ewers *et al*. (2002) and Ewers and Didham (2004). The pitfall portion of an FIP trap consisted of a green funnel (22 cm diameter) with half the nozzle cut off to leave an opening 3 cm in diameter. The nozzle was inserted into and attached to the lid of a 500 ml (c.a. 13 cm high, 8 cm diameter) collection jar. A 1 cm overflow hole, covered with fine nylon mesh, situated c.a. 9 cm above the base of the collection jar allowed excess rainwater to drain out. The flight-intercept portion comprised two clear polypropylene sheets (60 cm high, 23 cm wide) slotted together to form four fins. This was rebated into the top of the funnel and tied to it. A green or grey plastic cover (40 cm x 40 cm) tied over the top of the fins reduced the amount of rain and debris falling into the trap (Fig. 2). The funnel of each trap fitted tightly into an aluminium cylinder set in a suitably deep hole. The rim of the aluminium cylinder was slightly elevated above ground level and flush with soil that was carefully packed around it to allow small invertebrates to enter. The cylinder allowed the

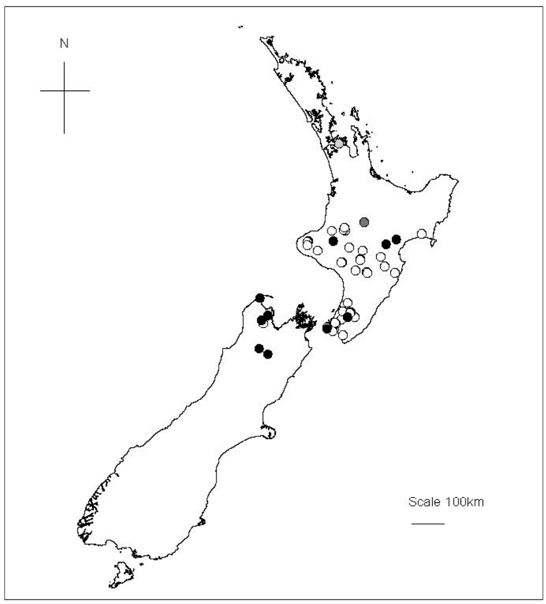

Figure 1. Distribution of *Holacanthella* species from flight-intercept-pitfall (FIP) trap survey in central New Zealand. ● present in FIP traps; ○ absent from FIP traps; ● present in pitfall trap; ● present in yellow-pan trap.

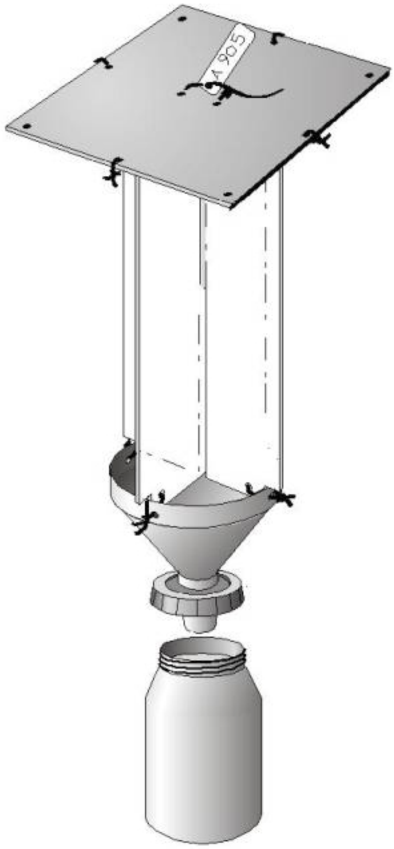

Figure 2. Flight-intercept-pitfall trap used to collect invertebrates (figure by Chris Edkins).

trap to be easily removed and replaced, and formed a solid foundation – independent of the trap itself – around which soil was packed. This method helped avoid gaps forming between the ground and the trap over time, and facilitated the consistent capture of small invertebrates. Care was taken to avoid damage to the surrounding vegetation and minimise the area of disturbed soil when the traps were being installed.

Traps were set with 100-200 ml of 40% propylene glycol in each collection jar as a temporary preservative. They were then inserted into the aluminium cylinders and secured with four guy ropes running from the upper rain cover to pegs in the ground. The traps were opened on 14-16 December 2005 and left open for a total of eight weeks and invertebrates were collected at four-weekly intervals by straining the propylene glycol through squares of fine mesh cleaning cloth (Chux multicloth, Chux®). This usually involved several rinses of the collecting containers to ensure that all invertebrates were collected. The cloths were transported to the laboratory in individual labelled jars containing c.a. 50 ml of 70% ethyl alcohol. In most cases, the ethyl alcohol was replaced with fresh 70% ethyl alcohol for storage.

Results and Discussion

Hand-collections detected *Holacanthella* individuals at only nine separate locations, despite the large number of locations and search hours (mostly unrecorded). Yellow-pan traps also revealed a single location in North Island. *Holacanthella* were collected from a further nine locations in 15% of the FIP traps distributed widely over the central part of New Zealand (Fig. 1). It was not possible to determine the relative efficiency of the three types of traps because the true proportion of *Holacanthella* caught per trap was not recorded (Boulton 2006). The flight-intercept component of the FIP traps is unlikely to contribute to the collection of *Holacanthella*, because this genus lacks the furcula (i.e., jumping organ) (Massoud 1967), and would most likely have been trapped only by falling into the FIP directly. Clearly, however, *Holacanthella* can be collected in all three trap types.

Indeed, the new records reported here increase the ranges of three of the five species when compared to all known records (see Table 1, see also Stevens *et al*. 2007). For example, Golden Bay is the first confirmed location for *H. duospinosa* in South Island, and four other records (Waitakere Range, Horokino, Ohakune, and Whanganui National Park) all increase the known distribution range of this species in North Island which was previously restricted to a single location at Taumarunui. Likewise, *H. brevispinosa* was found in South Island traps at Golden Bay and Nelson, and in North Island traps from Napier, Hawke's Bay, and Wanganui National Park (Table 1). These records all represent new localities and increase the known distribution range of this species.

The most revealing results were from the FIP traps located in the Wellington region. Wellington and its surrounding forests have been intensively explored in the past, and there are a comparatively large number of historical records for two of the five species (*H. spinosa* and *H. brevispinosa*) (Table 1). Although the forests in this region have suffered extreme deforestation and fragmentation, recent hand-collecting revealed the presence of *H. brevispinosa* (Table 1). However, neither the hand-collecting nor the use of FIP traps described here produced any evidence that *H. spinosa* remains in the Wellington region even though records show it was present from 1932 to 1969. Surprisingly, *H. paucispinosa* was found in a FIP trap at Karori, near where *H. brevispinosa* and *H. spinosa* were recorded previously (Table 1). This is the first record for *H. paucispinosa* within the Wellington region. The localities closest to Wellington where this species was recorded are Orongaronga, Aorangi Range, Waiohine and Holdsworth lookout track (Wairarapa) (Table 1). *Holacanthella paucispinosa* was also identified from traps in Wairau Valley (Nelson), the first record of this species in the northeast of South Island (Table 1).

Holacanthella was found in diverse, mature forest types, such as Beech (*Nothofagus menziesii, Nothofagus fusca, N. solandri* var. *cliffortiodes*), Totora (*Podocarpus totara*), Titoki (*Alectryon excelsa*), Kohekohe (*Dysoxylum spectabile*), Tawa (*Beilschmiedia tawa*), Rimu (*Dacrydium cupressinum*) and Kamahi (*Weinmannia racemosa*) (I. Stringer unpub. data). However, the habitats where *Holacanthella* were not collected in FIP traps (Fig. 2) seem equally diverse. Furthermore, FIP traps that contained *Holacanthella* in one collection period did not necessarily contain *Holacanthella* in the other collection period so few direct conclusions can be made with respect to habitat preference. However, these springtails appear particularly susceptible to habitat modification and are likely to be highly specialised to New Zealand's indigenous forests as they have never been recorded from any other forest type (Salmon 1941, 1942, 1944; M. Stevens *et al*. 2007).

The sampling described here, using a diverse range of techniques, indicates that a combination of hand-collecting and one of three trapping techniques (standard pitfalls, yellow-pan, flight-intercept-pitfall traps) can lead to greater success in detecting the presence of 'giant' springtails. Although the study is qualitative, it does indicate that these trapping methods could potentially be useful for passively monitoring such log-dwelling (saproxylic) invertebrates. The likely ecological importance and vulnerability of *Holacanthella* to the impacts of deforestation and the clearing of dead wood (Grove 2002) suggests they should be considered in future land management and conservation plans. However, this can only occur once we gain an understanding of their true biodiversity, distribution and vulnerability – essential criteria for conservation biodiversity (Whittaker *et al*. 2005).

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