– RESEARCH REPORT –

A New Discovery from Māori Archaeological Sites on Coromandel Peninsula, New Zealand Reveals a Widely Distributed, Commensal Dog Parasite

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ABSTRACT

Here we present helminthological analysis of archaeological substrates and coprolites from Coromandel Peninsula. One type of helminth egg, *Toxocara canis*, was identified. The presence of a single species in numerous samples across widely separate sites dating from 1290–1665 AD suggests it was the most common New Zealand canine helminth parasite in pre-contact times. The distinctive morphology of *T. canis* eggs makes them readily identified in archaeological contexts, and more so once damaged or degraded eggs are learnt to be identified. The study illustrates the potential value of this type of analysis, and is the first multi-site, regional archaeoparasite egg study in Oceania.

Keywords: Polynesia, Ascaridida, Carnivora.

INTRODUCTION

Archaeoparasitology has long been identified as a useful tool for archaeological analysis of past diet, agricultural practices, animal domestication, migration routes, climate fluctuations, hygiene practices, cultural interactions, ethnomedicine, and the overall health status of past human societies (Reinhard 1992, Wiscovitch-Russo *et al.* 2023). It also contributes to the understanding of the co-evolution of human host-parasite interactions. Microscopic eggs of gastro-intestinal parasites (helminths) can be readily extracted from soils, sediments, and coprolites using density separation or flotation techniques (Anastasiou and Mitchell 2013; David and Lindquist 1982).

Until very recently, archaeoparasitology in Oceania has been under researched, although the specific ranges and timing of the spread of introduced commensal species have been central to archaeological debates on the spread of peoples across the Pacific region, including New Zealand (*e.g.*, Anderson and Petchey 2020; Matisoo-Smith 1994; Prebble *et al.* 2019; Walter *et al.* 2017). At the time of writing, the only examples in the entire vast region (encompassing Melanesia, Micronesia, and Polynesia) appear to have been a study in Bismark Archipelago (Horrocks, Summerhayes and Presswell 2024), and a handful of New Zealand studies, namely from northern New Zealand (Andrews 1979), Auckland Isthmus (Horrocks, Brown *et al.* 2023), Bay of Plenty (Irwin *et al.* 2004), Taranaki (Horrocks, Gibb *et al.* 2024), Palliser Bay (Horrocks, Dodd *et al.* 2024), and Shag River Mouth (Horrocks, Presswell and Smith 2024).

Between 2003–2022, a series of cultural heritage investigations at coastal lowland sites around Coromandel Peninsula in New Zealand was carried out (Horrocks *et al.* 2023b). Included in these investigations was plant microfossil analysis, to provide evidence for Māori use of indigenous and introduced plants. The results complemented recent research tracking essential plant introductions for Māori horticulture, integrated with radiocarbon chronologies (*e.g.*, Anderson and Petchey 2020, Prebble *et al.* (2019). In this study we present additional analysis of the same samples, this time for helminth eggs. The aim is to expand on the previous research, using a new line of evidence to shed light on parasites that could have adversely affected people and their commensal animals. In addition, we highlight the highly variable appearance of helminth eggs in archaeological contexts, depending on factors such as substrate type, and degree of decay and slide cover slip compression, to assist novice researchers in this field.

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STUDY AREA

The Coromandel Peninsula on the North Island of New Zealand extends 85 km north from the western end of the Bay of Plenty and is 40 km wide at its broadest point (Fig. 1). The peninsula is steeply mountainous, and largely forested. The Coromandel and Moehau Ranges form the spine of the peninsula, with the highest point at almost 900 m. While the peninsula has a steep hinterland, the coastal fringe has fertile soils and a series of large harbours. At over 1900 km² the Coromandel Peninsula is larger than most inhabited islands in Polynesia.

The original plant microfossil study comprised 21 samples from six sites on the peninsula: Cook's Beach (T11/1050, Jones *et al.* 2021), Hot Water Beach (T11/115, Gumbley *et al.* 2018), Opu Stream Catchment (T11/51, Hoffman 2012), Whangamata (T12/3, Gumbley 2014, Gumbley and Laumea 2019), Whangapoua (T10/640, Gaylard *et al.* 2022), and Thames (T12/1412, W. Gumbley, unpubl. data) (Fig. 1). For five of the sites, ^{14}C dates range from the 14th to the mid-17th centuries AD. The remaining site, Thames, was modern. The first colonisers arrived in New Zealand in AD 1320–1350 (Walter *et al.* 2017), bringing with them with two commensal animals, the Polynesian dog (*Canis familiaris*) and Polynesian rat (*Rattus exulans*). Europeans arrived in the late 18th century. Comprehensive details of the sites and microfossil results are given in the work of Horrocks *et al.* (2023b).

METHODS

Samples were prepared for parasitological analysis by density separation (1.7–1.8 specific gravity) with sodium polytungstate (David and Lindquist 1982; Horrocks 2020),

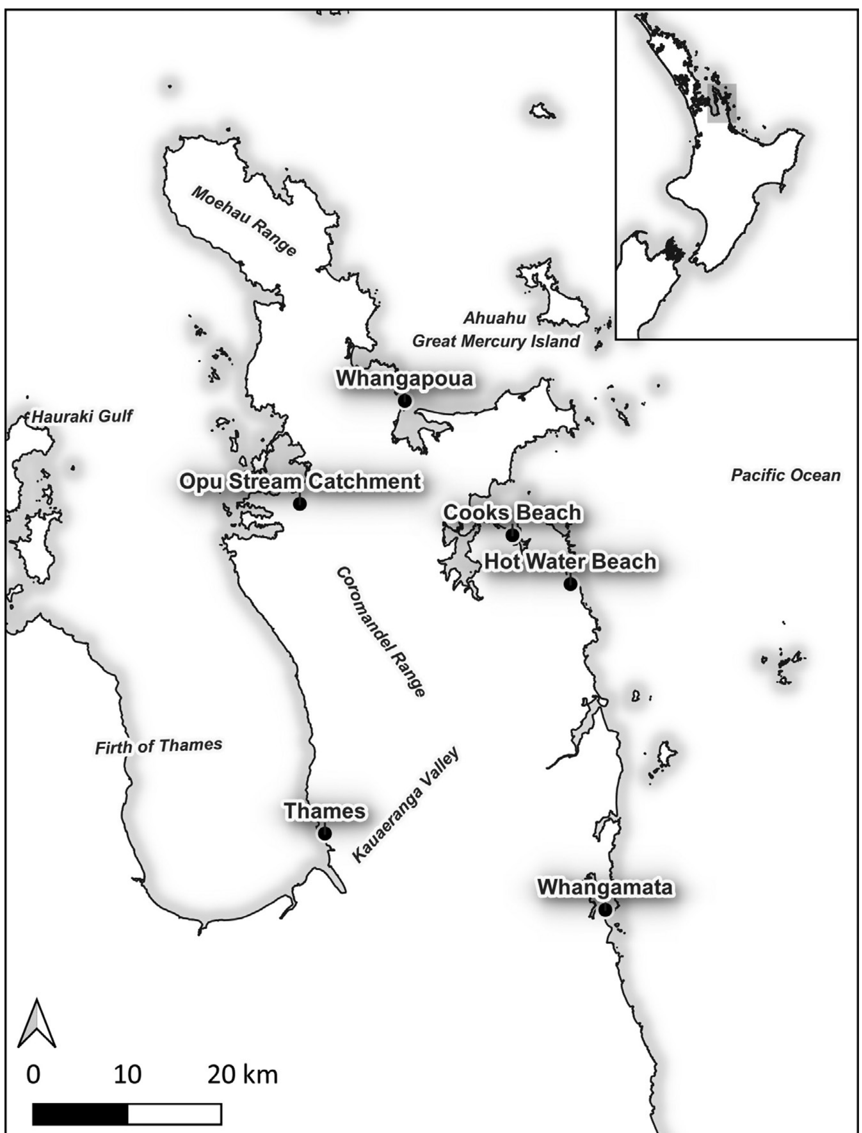

Figure 1. Map of Coromandel Peninsula showing site locations (inset: North Island and northern South Island).

and presence/absence noted. (This method also extracts starch grains and associated material such as xylem cells and calcium oxalate crystals.) Photomicrographs were taken with a Canon EOS 600D camera mounted on a Nikon 400E microscope, with a blue light filter.

RESULTS

One type of helminth egg was identified in this study, in 13 samples from four of the pre-contact sites (Table 1). This type, which is spherical, 75–90 µm in diameter, with a pitted or granular surface, and often yellow/amber/brown in colour, is consistent with those of *Toxocara canis* (Fig. 2). ^{14}C dates from these sites (see Horrocks *et al.* 2023b: Table 1) range from 1290 AD through 1665 AD (using 1σ calibrated age ranges), covering most of the first few centuries of Māori settlement (*e.g.*, Bunbury *et al.* 2022) in the Coromandel region.

DISCUSSION

Descriptions and photomicrographs of eggs of *Toxocara canis* can be found in the works of Irwin *et al.* (2004), Saari *et al.* (2018), Toxocariasis (2023), Brunanska (1997), and Prociv (1990). Eggs of different *Toxocara* species undergo similar changes in appearance as they mature. Detailed descriptions of these stages for *T. canis* and *T. pteripodis* are given in the works of Brunanska (1997) and Provic (1990), respectively. The latter is associated with fruit bats.

The spherical shape, large size (relative to other microfossil types such as most pollen grains, fern spores, and phytoliths), thick wall, pitting, and shades of yellow/amber/brown are characteristic features of *Toxocara canis* eggs from archaeological substrates (Fig. 2). The pitting can impart a dimpled or scalloped appearance, best seen around the edges in cross section. Sometimes the unhatched larval worms can be observed coiled inside the eggs (Horrocks, Gibb *et al.* 2024). Some fungal spores have a similar size and shape (notably *Palaeomycites*) to *T. canis*, although these generally lack pits, and often retain a stalk-like portion of the parent mycelium (Macphail and Stevenson 2004). Egg appearance can be variable, often highly so, depending on the degree of mechanical damage and decay, which can range from very good preservation to tearing, colour variation and loss, distortion, expansion of both egg and pits, loss of pits, and disintegration. This variation is well illustrated in our case because of the large number of samples from different contexts (i.e., different sample types and different sites). Mounting in glycerol jelly gives excellent clarity of detail of helminth eggs and larvae (as it does with pollen grains, fern spores, and starch grains and associated material) (Horrocks 2020).

Toxocara canis is a parasite of dogs and other canids. It inhabits the small intestine of the definitive host, and is usually asymptomatic, except in the case of massive infection in pups, which may be fatal. Eggs are deposited in the faeces of the dog and the worm develops within the egg, and once embryonated they become infectious. Dogs are infected when they ingest embryonated eggs from contaminated soil, or the worm larvae are directly acquired by a pup trans-placentally. In young dogs the larvae hatch out and migrate to the lungs where they are coughed up and swallowed, bringing them again to the intestine where they mature to adulthood. In dogs over three months old the larval worm either remains in the gut to mature and produce eggs for dispersal or enters the bloodstream and migrates to any organ of the body, where it will encyst in the tissues (Harris-Linton 2001). Toxocariasis is a zoonotic (transmitted between species) disease, usually acquired by children ingesting eggs from soil. Infective larvae hatch in the intestine, but the juvenile stages do not mature. Instead, they wander throughout the body for months or up to several years, damaging where they settle, and causing blindness or death in the case of ocular or neurological infections.

The presence of *Toxocara canis* (from kurī dogs) in 13 of the 21 samples from four (pre-contact) of the six Coromandel sites indicates widespread prevalence of the parasite on the peninsular from early Māori settlement onwards. This parasite was one of the two dog helminth species identified in the Kohika coprolite study, the other being *Capillaria* cf. *hepatica* (Irwin *et al.* 2004). It was also one of two dog species identified at Palliser Bay, with the other being *Dipylidium caninum* (Horrocks, Dodd *et al.* 2024). The helminth species in the Auckland Isthmus midden was also *Dipylidium caninum*, although pre-European origin in that case was not definitive (Horrocks *et al.* 2023).

Table 1. *Samples with* Toxocaris canis *eggs from Coromandel Peninsula (numbers and types from Horrocks, Brown, et al. 2023b).*

Site/sample no.	Sample type
Cooks Beach	
227	soil
Hot Water Beach	
5	midden
8	midden
11	dog coprolite
Whangamata	
004	dog coprolite
147	dog coprolite
219	dog coprolite
669	dog coprolite
711	dog coprolite
735	dog coprolite
917	soil
983	sediment
Whangapoua	
	midden

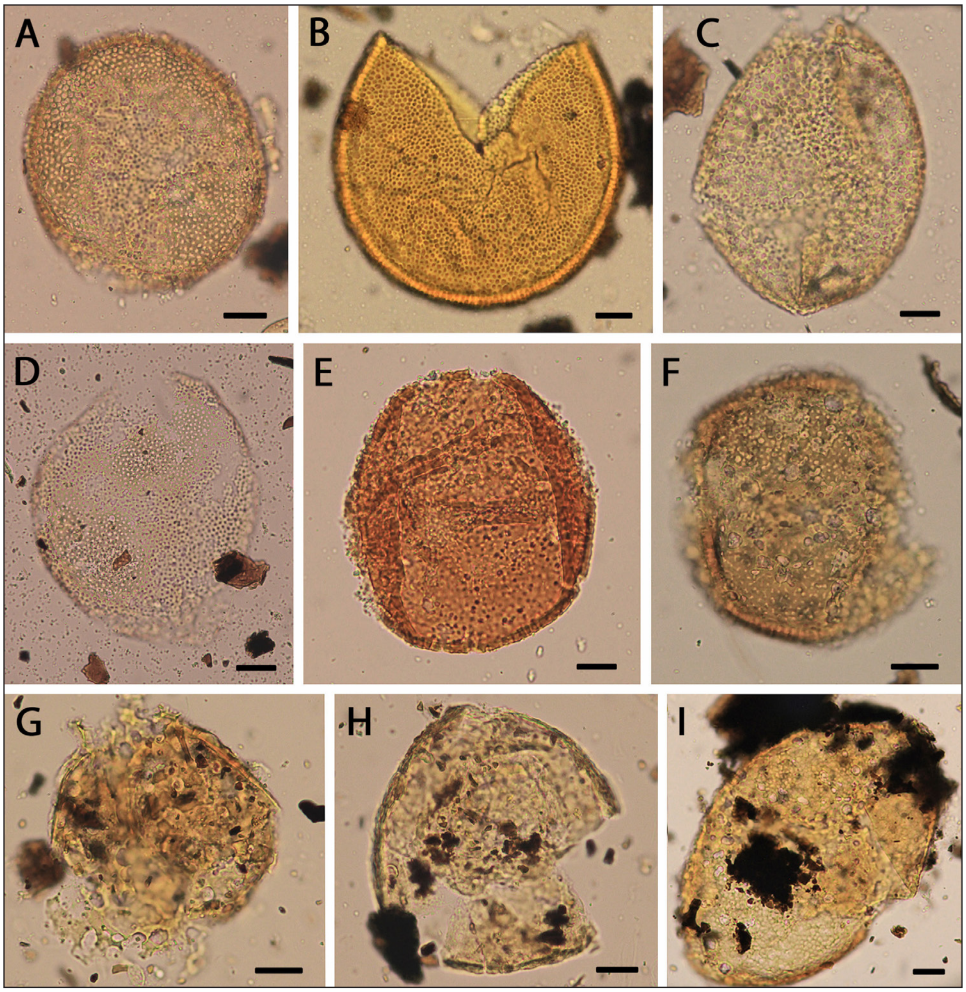

Figure 2. *Toxocara canis* eggs from Coromandel Peninsula, showing characteristic spherical shape, large size, and thick pitted wall. The colour variation depends on *in situ* conditions. Sample numbers in brackets, mounted in glycerol jelly, 400×, scale bars: 20 µm. Most are larger than fresh eggs due to slide cover slip compression and presumably preservation conditions. A–C (735, 11, 004) well preserved. B (11) damaged. D (004) colour and tissue loss. E (711) increased hue. F (669) expanded pits. G (8) disintegrated, expanded pits. H (8) pit and tissue loss. I (917) tissue loss, obscured by charred organic material.

One of the other New Zealand archaeoparasite studies was by Andrews (1979), who reported eggs of the human-specific parasite *Ascaris lumbricoides* in coprolites, dated to 150–200 BP, but similarly pre-contact origin has been considered not definitive since the timing is very close to first contact (Ferreira and Araújo 2014). *Toxocara canis* and *A. lumbricoides* eggs were also discovered, in pre-contact contexts, in northern Taranaki (Horrocks, Gibb *et al.* 2024).

Other techniques recently developed for kurī research are notably osteological and DNA studies (Greig *et al.* 2018; Grieg and Rawlence 2021; Greig and Walter 2021; Kramer *et al.* 2022; Pillay 2020). That research discussed the ecological impact of kurī, and their Māori roles as food source, food scavenger, bird hunter, clothing source, and companion prior to European arrival.

Toxocara canis eggs are not common in archaeological studies worldwide but have been found in canid coprolites at a Lapita site in Bismarck Archipelago (Horrocks, Summerhayes and Presswell 2024), Paris (11th to 16th centuries) (Bouchet 1995), and Brittany, France (300,000–500,000 years ago) (Bouchet *et al.* 2003), and Peru (700–1476 AD) (Richardson *et al.* 2012). The Brittany example suggests an evolutionary history of the species in canids that pre-dates the relationship of dogs and humans, although human remains were found at the same site, indicating that palaeohyena or wolf may have competed for dwelling space in the area (Bouchet *et al.* 2003).

CONCLUSIONS

Archaeoparasitology complements recent osteological and DNA techniques developed for kurī dog research showing the early arrival of dogs in the Coromandel region and their spread across the peninsula during the next few centuries. In this study, the presence of only one egg species, *Toxocara canis*, and in numerous samples from widely separated sites, suggests that it was the most common pre-contact Māori canine helminth parasite in New Zealand, possibly adversely affecting people and their dogs. The distinctive morphology of *T. canis* eggs makes them readily identified in archaeological substrates and coprolites, and more so once damaged or degraded eggs are learnt to be identified. The study illustrates the potential value of this type of analysis in Oceania for those islands where commensal animals were introduced, tracking the impacts of humans on endemic species, and tracing subsequent human-environmental interactions. This is the first multi-site, regional archaeoparasite egg study in Oceania. The identification of *T. canis* and other parasite species in well-dated archaeological contexts elsewhere could significantly improve our understanding of the co-evolution and effects of human-host-parasite interactions. Remote Oceania is well placed for this type of research because, being the last habitable region that humans colonised, from c. 3000 BP to 630–600 BP (Bedford 2023, Walter *et al.* 2017), unlike most of the rest of the planet it potentially provides records that have not been obliterated by scores of millennia of human activity.

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