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HŌHĀ RIHA: PEST INSECT CONTROL IN MĀORI TRADITION

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ABSTRACT: Ongoing Māori connections to natural environments mean that tangata whenua 'people of the land' and mātauranga Māori 'Māori knowledge' must be key to identifying, designing and advancing national conservation strategies, including health of native species and making decisions about pest control. We revisit whakataukī 'Māori proverbs' and early ethnographic texts to explore how so-called pest insects were traditionally viewed by Māori. What species did Māori consider to be pests prior to European arrival? How were these managed? Was eradication a goal? Were insects ever considered riha 'pests' in "wild", non-cultivated environments? We review accounts of damaging insects and their management strategies, which included extraction by hand, poisons, use of karakia 'incantations', fire and even biocontrol. These findings are reported within a hōhā riha 'bothersome pests' typology, indicating degrees of "pestiness". Māori were pragmatic, turning "pests" into resources for other purposes. Māori were observers and participants in ecosystems, and many whakataukī link human behaviour to troublesome insects. We comment upon whakapapa 'genealogy' as an inclusive system of biodiversity and discuss Māori conceptions of "wilderness".

Keywords: Māori, mātauranga Māori 'Māori knowledge', pests, whakataukī 'proverbs', insects, arthropods, pest management

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Aotearoa New Zealand can boast a diverse and unique range of native insects, with most not found anywhere else in the world. These creatures were traditionally known as Te Aitanga Pepeke 'the insect world', referring to "a wide range of insects and other creatures in the Māori world that share certain features: they have four or more legs, sit in a crouching position, and some can leap or jump. Mosquitoes, butterflies and moths, spiders

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and sandflies belong to this group" (Haami 2007). Te Aitanga Pepeke thus includes insects and other invertebrates as well as arthropods such as spiders. Non-native insects introduced to Aotearoa New Zealand by Europeans added to this diversity, but some reached plague proportions in the 1860s due to the clearing of land and retreat of native birds, prompting the importation of additional insectivorous birds into the country. Today insect pests are ever-present among crops and cause NZ$1.5 billion of damage in Aotearoa New Zealand's food industry (Ferguson *et al.* 2019; Nimmo Bell & Associates 2021). The unique characteristics of flora and fauna in Aotearoa New Zealand make them vulnerable to introduced flora, mammals, insects and pathogens. Introduced species particularly concern *tangata whenua* 'people of the land, Māori' because *taonga* 'culturally treasured' species, and Māori cultural heritage, are threatened by reduced biodiversity. *Mātauranga* 'knowledge'[1] about these taonga exists in many forms, including *te reo Māori* 'Māori language', creation stories and other oral narratives. Some of this knowledge survives through transcription and publication of oral tradition. These written forms of *whakataukī* 'proverbs, ancestral sayings', *pūrākau* 'traditional stories' and *kōrero* 'myths, legends, narratives and stories', *karakia* 'incantations', *mōteatea* 'chants' and *waiata* 'songs' are often the only records we have of the eco-biological understandings of our ancient *tūpuna* 'ancestors' (Wehi *et al*. 2009).

Chambers Dictionary (2021) defines a pest as "a living organism, such as an insect, fungus or weed, that has a damaging effect on animal livestock, crop plants or stored produce". The *Oxford English Dictionary* (2021) offers "any animal, esp. an insect, that attacks or infests crops, livestock, stored goods, etc. Also (less commonly): a plant that is an invasive weed." The word pest comes from *pestis* (Latin) or *peste* (French), meaning plague, and gained prominence in the fifteenth century during the bubonic plague. The Black Death was in fact the *Yersinia pestis* bacteria, which was found in the digestive tract of fleas, then carried by rodent hosts (such as rats) into human populations (Fadler 2017: 23). "Pest" can connote a dire shared human affliction and an adversary to human activity, displaying a propensity to "attack" people and/or their agricultural pursuits.

The impacts of human arrival and settlement on biodiversity are well canvassed (see, for example, Clout and Russell 2006), but Māori, whose settlement pre-dates that of Europeans by hundreds of years, noted environmental impacts early on. The toll of invasive exotic species is documented in letters and early te reo Māori newspapers such as *Te Pīpīwharauroa*, 1899–1913. Māori noted their concern at the loss of native species as early as the 1860s:

> Kua ngaro te kiore Māori i te kiore Pākehā, te rango Māori i te rango Pākehā, te rarauhe i te koroa [roroa], waihoki e ngaaro te Māori i te Pākehā.
> The Pākehā rat has replaced the Māori rat, the Pākehā blowfly has replaced the

> Māori blowfly, the fernroot has been replaced by marrow, in like the manner the Pākehā is replacing Māori. (Kohere 1901 cited in Riley 2013: 546)[2]

A sobering parallel is drawn between colonisation of the natural environment upon which Māori relied and colonisation of Māori themselves. Māori were concerned observers of environmental changes wrought by European practices such as introduction of exotic species, clearing of land for farming and indiscriminate hunting, noting biodiversity decline over a century before government policy deemed overpredation a national priority. Conservationist Val Sanderson, who founded the Native Bird Protection Society in 1923 (forerunner to Forest & Bird), admired Māori approaches to nature conservation and noted Māori concerns for birds (Pringle 2022). Specifics such as food sources for birds were minuted in a 1951 Society meeting when Bishop Wiremu Pānapa "protested the cutting of miro trees all over the country, saying their fruits were needed for kererū ['wood pigeons']" (Pringle 2022: 39). *Rāhui* 'prohibition' was the conservation tactic most discussed in early Māori newspapers (Whaanga and Wehi 2017). Māori concerns for biodiversity remain contemporary: tangata whenua were early noticers and responders to the tree fungal diseases kauri dieback and myrtle rust (Black *et al*. 2019) and Māori scientists have developed pest control solutions from naturally occurring toxins (Ogilvie *et al*. 2019), as well as exploring novel biotechnological controls for agriculture (Palmer and Mercier 2021) and for wild environments (Dearden *et al*. 2018).

Māori language words for "pest" are mostly found in contemporary dictionaries, influenced by equivalents in the English language and reflecting Pākehā 'New Zealand European' worldviews. Māori language repository Wakareo (2021) provides *kīrearea* and *riha* as results for "pest". Other terms such as *hōhā* emerge, a term that, however, more commonly expresses annoyance, linking to human behaviour. *Orotā* is a verb meaning 'wreak havoc' (Moorfield 2021). For "pest control", *kurupēhi kīrea* and *kaipatu kīrearea* emerge more recently (Wakareo 2021). The word *pōrearea* can refer to a pest person but is commonly used as a verb of annoyance (Moorfield 2021). While these terms are readily used at present, searches in the Williams dictionary (1957) produced the terms *hōhā*, *orotā* and *pōrearea*, but none linked to the word "pest". The sole result of a search for "pest" found "Ngurengure, *n*. An insect pest that attacks kumara, larva of *Sphinx convolvuli*" (1957: 236), signalling the prominence of *kūmara* 'sweet potato' insect pests to Māori. Searches in early contributions to the *Journal of the Polynesian Society* and in the digital Aotearoa New Zealand newspaper archive Papers Past, and Māori oral histories in ethnographic records, revealed scant evidence for the terms *hōhā*, *orotā* or *pōrearea*. However, as this paper will show, many other Māori words, and importantly the use of metaphor, help to sketch out a traditional Māori view of pests.

Discourse around Aotearoa New Zealand's unique biodiversity frequently highlights challenges faced by native birds. Invertebrates receive less attention, and not as much is known about their abundance and vulnerability to global pressures (Barnsley 2021) even as they are critical to the survival of those birds. An important reference on insects, including those perceived as pests, is David Miller's article "The Insect People of the Maori" (1952), which catalogues members of the "tribe, The Insect People (Te Aitanga Pepeke)" (p. 2). Now 50 years since Miller's article was published in the *Journal of the Polynesian Society*, our paper pays tribute to the ongoing significance of Miller's work. Interestingly, Miller was concerned about the impact of European colonisation on native insect fauna, and was looking for native biocontrols that could counter the impacts of introduced species:

> [S]o many changes have occurred in the insect fauna through the impact of European settlement that all avenues must be explored to throw light on what insects (particularly destructive ones) are native to the country, and what are introduced … especially in the field of biological control where unneedful efforts and funds can be expended in searching overseas for natural enemies of an insect that could be a native of this country. (Miller 1952: 1)

Mātauranga collated by Miller and other knowledge repositories (whakataukī and early ethnographic material) give insight into *whakaaro Māori* 'Māori philosophy' on pests. In this paper we report examples from whakataukī and early ethnographic texts that reveal early Māori conceptions of pests and methods of their control. What did Māori consider as "pests" in the insect world? What pest-control techniques were in place to deal with unwanted predation, and what was the scope of application? We then explore evidence in relation to the concept of eradication of pests, a challenging and potentially unattainable goal for insect pests (Myers *et al.* 1998) that nonetheless is seen to be achievable in this archipelago of islands for mammalian pests (Clout and Russell 2006). To understand Māori philosophical relationships with "pest" insects, the next section first describes Te Ao Māori 'Māori worldview', cosmological perspectives of *atua* 'deities/phenomenological beings', and the atua's animal and insect offspring.

CELESTIAL ORIGINS OF TE AITANGA PEPEKE, THE INSECT WORLD

Whakapapa 'genealogy' is the key organising mechanism in Te Ao Māori and links beings one to another. Creation narratives such as the separation of Ranginui 'Sky Father' and Papatūānuku 'Earth Mother' ground the relationship Māori have to the natural environment (Walker *et al*. 2019). Whakapapa can chart an individual's lineage to atua, and cosmological narratives expound human relationships with and obligations toward the

environment. Also transmitted in media such as karakia and waiata, these narratives form the basis of the Māori worldview, revealing societal norms and explaining the physical realm. Māori identity was forged over time following migration to Aotearoa. Upon arrival, Māori interrogated new surroundings and tested materials to catalogue food sources, medicines and inedibles. These are "catalogued within an entirely newly constructed whakapapa. As in Hawaiki [the ancestral home of Māori], this whakapapa had then to be given texture and meaning through story and tradition that explained relationships" (Waitangi Tribunal 2011: 33). This suggests that "atua domains" have equivalence with local ecosystems, explaining how species exist and interact, including insects.

A key narrative is the separation of Ranginui and Papatūānuku, which was conducted by one of their offspring, Tāne-mahuta 'god of the forest', to bring about Te Ao Mārama 'the world of light'. Following the separation, Tāne-mahuta was defeated in another feud by his brother Tū-mata-uenga 'god of war'. The victorious Tū-mata-uenga defeated his *tuakana* 'older brother', giving him authority to reduce the *tapu* 'sacredness' of Tāne-mahuta's offspring to *noa* 'ordinary, unrestricted'. Tū-mata-uenga applied this to Tangaroa 'god of the sea', Haumia 'god of uncultivated food', Rongo-mā-Tāne 'god of cultivated plants' (in some traditions known as Rongo-māui, Rongo-marae-roa) and Tāne-mahuta. Tāne-mahuta produced not only plants and trees but also the first woman from whom Māori people descend, and therefore, Māori today share whakapapa with plants, such as the *harakeke* 'flax' (*Phormium tenax*) (Erenora Puketapu-Hetet, in Waitangi Tribunal 2011: 35). Whakapapa is also seen to earth or ground human identity, in the literal translation "to cause/to make like Papatūānuku". Māori leader Maanu Paul explains, "my existence, my identity, my being stems from Papatūānuku" (Spraggs 2020: 80). Whakapapa links both non-human and human, establishing ongoing relationships of humans to the environment through the *tuakana–teina* 'elder–younger' dynamic (Lyver *et al*. 2019; Roberts *et al*. 2004).

Te Aitanga Pepeke is recorded in whakapapa and intertwined with cultivation traditions, specifically the kūmara. Kūmara was brought to Aotearoa on early migrations from Hawaiki and shares whakapapa with taro and *kiore* 'Polynesian rat'. These are genealogically traced back to Rongo-marae-roa, who descended from Ranginui and Papatūānuku (Best 1908; Roberts *et al*. 2004). Roskruge and Semese (2020) highlight a cosmological narrative in which the kūmara originates from the heavens where deities lived. Rongo stole kūmara seed from the bright star Whānui 'Vega', returning to earth and impregnating Pani-tinaku, who gave birth to the kūmara.[3] Rongo then cooked the kūmara to remove its tapu, making it safe for human

consumption (Roberts *et al*. 2004). In retaliation for Rongo's deceitful act, Whānui sent pests to earth, including the kūmara moth, to attack the kūmara crops (Adds 2008). Adding to this revenge is the caterpillar (larval life stage of the kūmara moth), which is the physical manifestation of Nuhe, Toronū and Moka, celestial beings whose help Whānui sought (Roberts 2012: 745). Each year Whānui's appearance in the sky before dawn signals the harvest time for kūmara (Best 1931; Roberts 2012). A whakapapa links the cultivated kūmara and the "pest" insect that feeds on it.

Relationships with insects reach beyond whakapapa to inform sociocultural beliefs and explain physical phenomena. *Ngārara* 'creeping things, insects' are understood in Te Ao Māori to represent atua, and sometimes act as ecological indicators or *tohu* 'signs' (Baker 2010), reinforcing environmental links to creation narratives and whakapapa. Miller (1952: 6) notes the creation of *titiwai* 'glow-worms' and *torohu* 'earthworms' result from the union of Hinetaumaunga 'Maid of the Mountains' and Tāne. Their offspring Pukupuku formed the phosphorescent entity *mokohuruhuru* 'a type of glow-worm' (Best 1976; Miller 1952). Other explanations of creatures sent as human adversaries include the battle of Tāne and Whiro 'god of darkness', which resulted in an "army of insects" including "namu poto (small sandflies), naonao (midges), rō (stick insects), peketua (centipedes), pepe-te-nuinui (butterflies), and pekepeke-haratua (hopping things of the May season), as well as birds and bats" (Haami 2007: 1). Best (1982) also notes this battle as the origin of *waeroa* 'mosquitoes'. The swarms of birds and insects were warded off by te Whanau Puhi 'the Wind Children', who captured certain species of birds only and brought them to earth (Best 1982). Tribal accounts vary; for instance, regional dialects may alter names. Nonetheless, these narratives establish genealogical links and yield taxonomic classifications of the physical world (Haami and Roberts 2002).

TERRESTRIAL ORIGINS OF TE AITANGA PEPEKE

There are accounts of accidental and deliberate introduction of insects to Aotearoa by Polynesian and Māori voyagers. In one recorded by Mohi Tūrei, Kahukura, captain of the *Horouta*, prised kūmara growing from a cliff in Hawaiki with his *kō* 'digging stick'. A soil avalanche delivered a supply of kūmara into the *waka* 'boat' (Tūrei 1912). While insects are not explicitly mentioned in any variation of this account, kiore and *pākura* 'Australasian swamphen' (*Porphyrio melanotus*) are, and both the soil and kūmara are highly likely to have contained invertebrates such as worms and larvae. Whether soil was kept on board, and what insects survived the migration to and settling in Aotearoa, are questions for archaeology. In fact, a recent study presents evidence that commensal invertebrates related to taro production were introduced with Polynesians, with detritovorous beetles, earwigs and

ants "identified in the early garden sediments after 1350 CE" (Prebble *et al*. 2019: 8829). Turi is noted as bringing *moeone* 'beetle larva' and *āwhato* 'caterpillar' aboard the *Aotea*, along with kūmara (Taylor 1855).

Whironui was said to have "landed insects and lizards from the Nukutere canoe" (Tregear 1904: 181), suggesting a deliberate introduction. An intriguing Ngāti Porou account notes ngārara were imported to an offshore island along with birds and dogs (White 1887), aboard the *Māngārara*,[4] captained by Wheketoro and others. Wheketoro's mission appears to have been to set up a sanctuary for lizards "to save his reptiles from the plundering propensity of man" (White 1887: 189). He left the *tuatara* (*Sphenodon punctatus*), varieties of *teretere* 'geckos' and *mokomoko* 'skinks' at Whanga-o-Keno (Whangaokena), an island off the East Cape, performing rituals and karakia and lighting a sacred fire for the safekeeping of the lizards. He left insects also (White 1887), including *weri* 'centipede', *whē* 'caterpillar', *wētā* 'giant cricket' and *kekere-ngū* 'black roach' (Grant 2014: 99), amongst others: these were likely to have been gathered as food sources for the lizards, for both transit at sea and settling on land.

WHAKATAUKĪ AS A SOURCE OF MĀTAURANGA

Whakataukī were a means to hold and recall mātauranga, and as such give insight into a traditional Māori worldview (Whaanga *et al*. 2018). As with creation narratives, they offer a lens on Māori understandings of physical and natural environments, social responsibility and links to the supernatural domains of Te Ao Mārama. Whakataukī contain ecological knowledge including information for taxonomic classification of (for example) native invertebrates (Haami and Roberts 2002; Miller 1952) and marine species (Wehi *et al*. 2013). The evaluation of whakataukī in the tracing of megafaunal extinction events reinforced the close relationship Māori had to their environments (Wehi *et al.* 2018). Whaanga *et al*. (2018), in their research on marine freshwater environments to inform new ways to approach policy, also demonstrate how whakataukī expound sociocultural meanings. Therefore, the applicability of whakataukī is far-reaching and can offer novel insights into contemporary problems.

Mātauranga encompasses Māori knowledge and ways of knowing, spanning technological skills, cultivation techniques and cultural heritage (Waitangi Tribunal 2011). Mātauranga contains methods consistent with modern science, suggesting that scientific investigations began in Aotearoa when Polynesians arrived (Hikuroa 2017). Drawing upon both western sciences and mātauranga for deeper understanding and broader application of local knowledge is increasingly a feature of Aotearoa New Zealand science (Mercier 2018; Ruru *et al*. 2019; Stewart 2020). A Kaupapa Māori position (Smith 2012) argues that use and revitalisation of mātauranga should be

led by Māori and recognise *tino rangatiratanga* 'self-determination' for Māori (Broughton and McBreen 2015). Adding to Māori conservation techniques are *tikanga* 'protocols' such as rāhui (Whaanga and Wehi 2017) and sociocultural and political concepts such as *mana* 'prestige' and *rangatiratanga* 'chieftainship' that apply to taonga species.

Increasingly Māori researchers are working within the wider science community to build relationships that benefit Aotearoa New Zealand's ecology (McAllister *et al*. 2019) and to promote new "biocultural" ways of interacting with environments (Lyver *et al*. 2019) that support local human–nature relationships.

METHODS

We first surveyed commonly used and contemporary *kupu Māori* 'Māori words', looking for terms that correlate to the English terms "pest" and "pest control". These kupu were used as search terms in nineteenth- and twentieth-century secondary source material containing mātauranga. We then collated materials from a broader sweep of late nineteenth and early twentieth-century references containing mātauranga on insects and compiled these in glossary form, noting bibliographical information (ethnographer, missionary or Māori composer details) in footnote citations and on EndNote. We then performed thematic analysis of these accounts, drawing out examples of Māori attitudes to insects, potential definitions of "pest" and strategies for pest insect control.

Hirini Moko Mead developed a framework of assessment based on five tests (see http://www.rangahau.co.nz/ethics/167/) to identify a Māori position, in debates on contentious issues, that engages "tikanga Māori ['Māori ritual practice'] and its knowledge base, mātauranga Māori" (2003: 335). We previously used "Test 3: the take–utu–ea test" (Mead 2003: 341) to critique the problem–solution–socialise orientation of science to new technologies in pest control (Palmer *et al.* 2020). Here we apply a related tikanga-derived analysis framework, by considering "Test 4: the precedent aspect", which asks: "Is there some event in our traditions that might help us understand the issue and help frame a response to it?" (Mead 2003: 343). We assigned the contentious issue of eradication (complete and permanent removal)[5] of pest invertebrates in Aotearoa New Zealand to the precedent aspect test.

Central to this review is whakataukī, including the more than 5,000 from Riley (2013) and 2,669 from Mead and Grove (2001), from which we identified 28 and 11 relevant whakataukī respectively. Grant (2014) provided other relevant material including a karakia recorded by White (1887) and narratives and waiata collected by Grey (1857), Smith (1895), Best (numerous), Taylor (1855) and Tregear (1888). Another key reference is Miller's article "The Insect People of the Maori" (1952), which records

Māori names for invertebrates and includes discussion on pest insects. Miller references Ngata's 1928 collection of traditional Māori songs and chants, *Nga Moteatea*, for nuisance behaviours of insects, specifically numbers 68, 158 and 175. To this we add 170 and 180, identified by McRae and Jacobs (2011: 59).

A NOTE ON NGĀ PEPEKE KIKINO—"EVIL INSECTS"

Grant (2014) meticulously collated names of insects and categorised them, including a group that she names "Ngā pēpeke kikino: the insect pests" or literally 'bad/evil/corrupted insects'. Pests were categorised by ethnographers based upon European assumptions of their pestilence, and early ethnographic material documents insect nomenclature. Grant notes that ethnographer Polack recorded Māori names for insects with a focus on those with human nuisance value:

> That these insect names rose to historical prominence is only by virtue of their nuisance value because they were all considered pests. The names recorded by Polack (1838/1974, pp. 319–320) were *namu* (sand-fly), *waiwai roa* (mosquito), *kikārāru* (cockroach), *keha* (flea) and *kutu* (lice). Such records also reflect what appears to be a common human response to record negative interactions, before registering a positive reaction, and in this case, towards insects. (Grant 2014: 18)

The human response to emphasise the negative may reflect the ethnographer's interest and focus, with ethnographic texts thus limited in both their content and expression. Best, for example, translates line 28 of a Ngāti Manawa *kaioraora* 'cursing song', written by Kaupoke, thus: "Ko tona taina te kutu, te riha: he is the brother of the loathsome parasites" (1902: 151): another translation would be "his younger brother is the louse, the louse egg". The latter translation relates Tama-i-Arohi to the louse and its egg. This is not a flattering comparison but allows room for other, more positive views of lice, discussed below. Drawing on evidence such as whakataukī with a critical eye on given translations may allow clearer interpretations of how tangata whenua viewed insects.

HŌHĀ RIHA—DEGREES OF NUISANCE

Of the whakataukī, 40 are cautions or cast the influence of insects on Māori life in a negative light, but only 10 of these were concerned with problematic damaging insect characteristics. We categorise these as *hōhā riha* 'pest annoyances'. *Riha* means 'louse egg' as well as 'pest', its double meaning allowing us to turn this phrase to 'insect pest annoyances'. We discuss these by severity of nuisance and threat.

Of Nuisance to Humans

Observations of pests experienced as a physical nuisance to humans, by virtue of unwelcome presence and persistence, are documented in many places, for example, "nga kutu o te upoko o Rehua—the lice from the head of Rehua" (Miller 1952: 21). *Kutu* meaning 'vermin' could be applied to several ailments early Māori may have dealt with. However, Miller understands Elsdon Best as taking this to mean "a figurative expression meaning the fruits of the forest" (p. 21), given that the star Rehua 'Antares' has celestial oversight of the forest domain (Best 1982). The star Matariki is wife to Rehua (see Matamua 2017), highlighting a nexus of Māori cosmology, that of Papatūānuku (where crops can be grown) and Ranginui (where celestial activity influences harvest yields). Interestingly, the persistence and pervasive presence of kutu is positively likened to bounty within the forest.

Fleas were also a nuisance—"E! Ka pōrangitia ahau i te tuiau nei! O! This flea could drive me mad!" (Mead and Grove 2001: 28)—but were compared favourably to human behaviour: "Ka tohe puruhi te tangata nei—the man is persistent as a flea" (p. 190). What were considered annoying traits could conversely be considered a model for humans facing challenges. "He namu pea ahau—perhaps I will be a sandfly" refers to the sandfly's determination, required when someone wants to attempt something ambitious (p. 101; Grey 1857).

The cicada (*Amphipsalta zelandica*) is recognised in many whakataukī, its appearance an important seasonal and ecological indicator, for example, "Mehemea ka tae ki te waru, ka piri taua iwi, te kihikihi, ki to ratou tupuna ki a Tane … When the eight month (December) arrives that tribe, the cicadas, cling to their ancestor Tane (trees)"[6] (Miller 1952: 16). Contrasting with this are less flattering comparisons between the loud sound of cicadas and complainers, such as "E kitā nei hoki te terakihi—said of a hungry man when food is scarce" (Mead and Grove 2001: 29), and the sound of the English language, "He reo kihikihi—The cicada language" (Miller 1952: 16). While cicadas do not inflict physical damage, their distinctive stridulation is likened to annoying humans.

Much less pleasant were the parasitic worms: *engaio*, *iro*, *iroiro* 'threadworm', *ngoiro* (Miller 1952) and *ngaio* 'horsehair worm' (found in freshwater fish, *kōkopu*). Ngaio also afflicted *kākā* 'forest parrot' (*Nestor meridionalis*), which was discovered when the birds were cooked, as well as *īnanga* 'whitebait' and wētā. Andrews (1976) notes that no human worm parasites were recorded prior to introduction by Europeans, which at the time suggested worms only colonised non-humans, although further study is needed. *Ngaio* has etymological similarities with terms for worms that did infect humans in other parts of the Pacific. These include *kaio* (Marquesas: 'very small worm or grub') and *naio* (Hawai'i: 'pinworm', found in the rectum and in faeces).

Of Danger to Humans (Not Just Nuisances)

In some instances, whakataukī cautioned people to have a healthy respect for members of Te Aitanga Pepeke. For example: "Ko te rite o te tau, kai te katipo e haurangi nei … The kapito [*sic*] is to be regarded at all seasons as either angry, mad, or drunken" (*Otago Daily Times* 1930: 27) This saying gave a stern warning to people regarding the *katipō* spider (lit. 'night stinger'). Experience had taught Māori that a katipō bite brought on convulsions, abdominal cramps and even death. If the bite was life-threatening, one belief was that the "victim" would have to catch the perpetrating katipō and burn it in order to recover (Riley 2013: 513). This suggests killing was appropriate punishment for the offending spider, but we find no suggestion of widespread or even localised katipō eradication to remove the danger. Best (1905) notes the treatment for katipō bites was a method called *whakapua*, in which the victim rested near open fire and inhaled smoke.

Of Nuisance to Wild Taonga or Resource Species

Were there animal species on behalf of which Māori intervened, to reduce their predation by other animal species? Or natural enemies that were encouraged? We did not find many leads or evidence regarding this. However, wild *tāwhara*, the prized and tasty fruit of kiekie (*Freycinetia banksii*), was protected from kiore by tying the leaves over the bracts and fruit (Best 1908).

Other plants harvested from the wild were also cultivated and grown near settlements. Māori had plantations of harakeke and in some cases *tī kouka* 'cabbage tree' (*Cordyline australis*), the leaves of which were indispensable to weaving and construction. Grant assigns the general terms *tāwhanawhana* 'looper caterpillar' or *pepe tāwhanawhana* 'flax looper moth' to insects that eat holes in both the harakeke and tī kouka leaves (Grant 2014: 51). An overabundance of these insects would cause intolerable damage of leaves, where both length and strength were needed.

On the contemporary side, Māori agriculturalist Nick Roskruge and Saii Apang Semese from Papua New Guinea (Roskruge and Semese 2020) explain the value of natural enemies in the *māra* 'garden', noting the beneficial qualities of certain organisms in competing with insects that would otherwise be detrimental to crops. Parasitoids such as wasps (Hymenoptera order) or flies (Diptera order) are natural enemies to common pests of the kūmara plant (Roskruge and Semese 2020). Another example cited is the endemic tiger beetle (*Neocicindela tuberculata*; syn. *Cicindela tuberculata*), which has several Māori names, indicating strong historic significance: moeone, *pāpapa* (adult), *hāpuku*, *kapuku*, *kui*, *kurikuri* and *muremure* (larvae) (Roskruge and Semese 2020). Adults are ground predators, as are their larvae. Moeone may live for several years in a hole in the ground and grab and eat passing insects, but it also eats kūmara and is considered a pest insect (Grant 2014: 68–69).

Of Nuisance as Consumers/Spoilers of Crops

Household nuisances, such as the fly, liken spoiling of food to wasted opportunities in whakataukī: "He rango takakino kai, he tangata ware moumou taonga, kai rānei—a blowfly spoils food, a thoughtless man wastes possessions, or food" (Best 1915); or more forthrightly expressed as "he uri nā te rango moumou kai—a descendant of the food-wasting fly" (Best 1915).

Slugs (invertebrates but not insects) are identified in this whakataukī: "Ekore e ngaro, he puia taro nui, ngata taniwha rau. You cannot readily destroy a large clump of taro roots, nor hundreds of devouring slugs … So it is with a large tribe, it is difficult to destroy them all" (Riley 2013: 61). There are 22 native species of slugs in Aotearoa New Zealand, with several English pest slugs being introduced during European settlement (Burton 1962). Miller (1952) notes Māori names for slugs: *hātaretare*, *ngata*, and *putoko*. They eat and damage kūmara plant leaves and tubers (Roskruge and Semese 2020). Several European slug species remain costly to agriculture today (Ferguson *et al*. 2019).

The caterpillar was significantly detrimental to kūmara plantations. Roskruge and Semese (2020) detail numerous[7] present-day pest threats, or pōrearea, to kūmara cultivation. Older literature refers to caterpillars by many names, most prominently the *āwheto* or *āwhato*—the convolvulus hawk-moth or Sphinx caterpillar (*Agrius convolvuli*) (Best 1931; Makereti 1938), and sometimes called *hotete or ngurengure*, by Ngāti Porou, in its larval state (Miller 1952). *Āwhato* was a name applied to the parasitised fungal form of these grubs (*Ophiocordyceps robertsii*). Murdoch Riley attributes *āwheto*, *āwhato* and *mokoroa* to the vegetable caterpillar (*Cordyceps robertsii*), in an undated entry: "In olden days the Āwheto was regarded by the Maoris as sacred, and it was sometimes eaten as a special delicacy" (Riley 1994: 123). Miller (1952) provides an extensive catalogue of names for *Agrius convolvuli* caterpillars including (but not limited to) *anuhe*, *awato*, *hawato*, *haurangi*, *kauwaha*, *moka*, *moko*. Additionally, mokoroa, the grub stage of anuhe, can be eaten by humans, alongside *ngutara,* likely the caterpillar (*Charagia virescens*) (Miller 1952). Best (1931) adds East Coast Māori taxonomic references as *torongu* and *tupeke*.

The prevalence and impact of caterpillars on agriculture is captured in several oral traditions including waiata, whakataukī and karakia. Makereti (1938) and Best (1931) describe them as being well known to take over gardens in large numbers. Hargreaves (1963: 102) calls the large caterpillar the "[t]he only pest that seems to have beset the Maori agriculturalist". Best (1905) recalls chiefs that faced kūmara crops decimated by vermin such as the āwheto—and in one example compounded by *pūkeko* 'Australasian swamphen' (*Porphyrio melanotus*)—requiring a special karakia to the atua Maru (another name for Tū-mata-uenga) to assist in better crop yields.

White (1887: 1) recorded a karakia for planting kūmara that foregrounds the magnitude of this pest: "I hara taua, koia Ru, koia Whe, koia potipoti—My enemies are these: the earthquakes, and the caterpillar, and all devouring insects." Caterpillar infestation is a crisis akin to a natural disaster in this incantation. Miller (1952) surfaces the following extract from song 158 (Ngata 1928) about the *muharu* or *muwharu* 'caterpillar, grub':

> *Mahi atu taua ki te tukou no kai, e nohoia mai ana e te muharu; mahi atu taua ki te tokou* [*sic*] *no Rongo, e nohoia mai ana e te hotete.*—We grow the *kumara* for food, the devouring grub occupies it; we cultivate the *kumara* for Rongo, but the caterpillar settles on it. (Miller 1952: 27)

Ngāti Ruanui are similarly documented to have loathed caterpillar infestations in a lament: "*Ka hinga te kaua, ka hinga te moeone, ka hinga awhato*—Then fell the *kaua*, fell the *moeone*, destroyed was the *awhato*" (Miller 1952: 14). In this composition, according to Miller (p. 14), kaua, awhato and moeone are all insects; moeone is particularly regarded as "a pest in the kumara fields" (Miller 1952: 23). As noted above, *Te Aka Māori Dictionary* (Moorfield 2021) lists *moeone* as 'the tiger beetle larva', endemic to Aotearoa New Zealand. In its larval state it was considered a pest, while in its adult state it eats other pest insects.

Caterpillar eating habits feature in well-known whakataukī, often with reference to poor human behaviour, a common example being: "Awhato ngongenga roa!—Ugly great caterpillar! Always slowly nibblin [*sic*]" (Colenso 1879: 121). Variations of this whakataukī, e.g., "edge-cutting caterpillar!", are recorded by Riley (2013: 30), Brougham and Reed (1963: 45) and Mead and Grove (2001: 367). All denote a fussy or gluttonous person who picks at their food as the caterpillar nibbles at leaves. Picky eating may bring offence to hosts whose *manaaki* 'hospitability' is undermined. The whakataukī compares the frustration caused by the āwhato caterpillar that eats the kūmara leaves to a human with poor etiquette. The prominence of caterpillars in various oral histories makes clear that they were a pest to Māori, but what tools were available to manage them?

PEST CONTROL METHODS

Soil Preparation and Maintenance

Insects that, alongside bacteria and fungi, are key to putrefaction of organic and non-organic matter (Goff 2010) play a role in soil renewal. "Hei o moku ka kimi ai au / I te whatu i te one, ka rewa ko te iho … For sustenance was what I sought / In cultivating the soil; but useless germs remain" (Smith 1905: 148–49). This lamentation excerpt reveals the impact on a kūmara plantation after a season of drought and insect pestilence. Establishing

healthy and fertile soil was important to mitigate against crop failure. It was common for Māori to utilise wood ash for fertiliser (Hargreaves 1963), well known today as a source of potassium and phosphate (Erich 1991). The specific supplements to maintain soil nutrients varied depending upon local conditions and geology, suggesting knowledge exchange and experimentation. The craft of cultivation no doubt developed over time, but oral histories and various implements record tested and working practices.

Grant speculates that it is "unlikely that [Māori] knowledge of insects extended to an extensive understanding of the various de-compositional roles played by them" (2014: 221). However, this seems unlikely given that Māori had intimate knowledge of agricultural soils, and archaeologists have demonstrated how Māori augmented soils by adding gravels, charcoal and/or shell to improve productivity. What little we found is suggestive or generalised to *huhu* 'grubs, worms'. Oral narratives make links between decomposition in horticulture and human death. Hine-nui-te-pō is remembered to have said "Me matemate-a-one … let man die and become like soil" to demigod Māui, illustrating the life cycle that returns people to land (Harmsworth 2020: 31). "Mā iro e kite. He will be found by the maggots" (Mead and Grove 2001: 278) indicates the connection between insects and decomposition. A recurring phrase in six whakataukī connected huhu to *popo* 'rot' and *hanehane* 'decay'. "E mau koe ki tai ki noho, he huhu, he pōpō, he hanehane", which translates into "[hold] true to the tide of the sit-still (peace), and obtain the grub, decay and rottenness" (Riley 2013: 76). A full life cycle that ends in decay was seen as a natural, preferred state of living, as opposed to war.

In soil, one linguistic coincidence found was *wharu* 'mud, quagmire, bog, mire' (Moorfield 2022), but also *wharu* (*Rhododrilus edulis*), a large worm found in loamy soil that was "stripped with the fingers [to remove soil] before being prepared for eating" (Miller 1952: 53). The story of Rata's tree (see Haami 2007) infers that Māori recognised the importance of insects, along with birds, in ecological regeneration.

Repellents

Various insect repellents were developed by early Māori. Riley (1994) notes the repellent qualities of ngaio (*Myoporum laetum*), mānuka (*Leptospermum scoparium*) and kawakawa (*Macropiper excelsum*). Ngaio is noted as a popular and versatile repellent, with almost all aspects of the tree being useful including the bark, leaves (Burton 2012) and shoots (Riley 1994). Tītoki (*Alectryon excelsus*) and miro (*Prumnopitys ferruginea*) oil and *kōkōwai* 'red ochre' (Riley 1994) were rubbed on the skin and used as personal insect repellents.

Fire and Smoke

The physical properties of fire were a major element in "hands-on" insect control among early Māori. Best (1931) claims it was not unusual to see burning fires placed at strategic points in a cultivation. The light of small fires inside dwellings enticed nocturnal insects to their ends. In some instances, burning kawakawa leaves would deter pests. Kawakawa has bioactive properties and the toxicity of its smoke makes it well suited to pest control (Brooker *et al*. 1987 cited in Hodge *et al*. 1998). Mānuka and ngaio wood or leaves were also known to be burnt for insect repellent qualities (Riley 1994). Similarly, Te Tai Tokerau (Northland) Māori placed fires around gardens, but instead used gum of the kauri tree (*Agathis australis*) to produce a repelling smell (Best 1931). That knowledge of these techniques survives through the generations suggests they were practised habitually, probably effective at controlling pests, and a good use of resources available at the time.

Karakia and Chants

Regular efforts to stave off pests through rituals such as naming, carving and blessing agricultural implements such as kō were exercised to prepare and protect crops from harm. *Tohunga* 'spiritual adepts' were tasked with agricultural protection, warding off pests through karakia (Best 1931). As in the aforementioned karakia "I hara taua, koia Ru, koia Whe, koia potipoti", potential crop devastation required divine entreaty.

Ahi tapu 'ceremonial practices involving fire' were associated with the management of staple crops like kūmara. Ceremonies called *ahi torongu* are documented by Best (1924, 1931), in which karakia were performed over a fire with the aim of controlling *torongu* 'greasy cutworm' (Grant 2014), which infests kūmara gardens. Fire was originally the sole domain of the deity Mahuika until her grandson Māui-pōtiki stole fire from her and cast it into the forest, where it was cached in holes left by mokoroa or anuhe, the grub of the pūriri moth, ghost moth or pepe tuna (*Aenetus virescens*). Incidentally these holes are often occupied by wētā. While fire released from Mahuika brought it into the domain of common knowledge, assisted by insects, the fire and karakia used in ahi tapu practices were performed to channel atua power to diminish the impact of caterpillars on plantations.

Carving and Other Rituals

Pātaka 'storehouses' contained food and were elevated to protect contents from rats. Ornate traditional carvings on pātaka celebrated human figures, ancestors chosen to uplift tribal mana, but may also have provided spiritual protection for pātaka contents. Carving styles included *whakaironui*, or carving that mimics the burrowing of *iro* 'maggots' through wood, and

pūwerewere or *pūngāwerewere* 'spider', which was noted to be spiderweb-like with patterns radiating from a central motif (Witehira 2013).

Insects held continuing associations with atua and thus supernatural powers. In one account, the *ngaro tara*, which Grant identifies as "*Protohistricia alcis* and *Helophilus trilineatus*" (Grant 2014: 113), "is not a blow-fly; it would not alight on food-matter" (Tregear 1904: 510). Because food has power to move something from a state of tapu to noa, this avoidance of food may suggest ngaro tara is a tapu insect. Someone wanting to oppose the powers of a particular tohunga, such as their *makutu* 'curse', could form a mound of soil into the likeness of the tohunga, then create a hole in this golem while chanting the person's name. If a ngaro tara entered the hole and was subsequently trapped inside, this would avert makutu by bringing misfortune or death to the tohunga.

Turning Pest into Produce

Whakataukī codify observations and lived experience with the natural environment into key messages or reminders of best practice, whether it be social norms or enhancing day-to-day activities. Caterpillars are frequently recorded as pests, but also serve for food, for medicine and in artistic expression. "Kohi āwhato te mara o Te Tahuri—Gather caterpillars from the gardens of Te Tahuri" (Riley 2013: 453).[8] Here, the āwhato (*Cordyceps robertsii*) that thrived in the kūmara gardens of the Waiōhua tribe (present-day Mount Eden, Auckland) is remembered for its medicinal properties. Chief Te Tahuri was charged with caring for her tribe's kūmara gardens and made use of the pest by manually collecting the āwhato and burning them, then mulching them into a powder and making use of the resulting substance for people suffering from asthma (Davies 1871: 27; Fuller *et al*. 2005). A similar recipe involved āwheto, the fungus growing from caterpillars, which, when mixed with bird fat, was the source of black ink for *tā moko* 'traditional tattooing' (Robley 1896 cited in Baker 2010). While regarded as a pest, caterpillars were also clearly harnessed for practical uses in day-to-day and ceremonial life. Some worms, too, served a purpose, aiding in hunting efforts. *Herehere-tuna* was literally "a bunch of worms for catching eels" (Miller 1952: 10), sometimes making use of mokoroa or huhu (see Grant 2014: 62). The *kurekure* (*Notoscolex esculenta*, *N. sapida*) and wharu earthworms were edible (Miller 1952: 17, 53).

Biocontrols

Birds were known to be kept by Māori as pets and for other purposes. There are several accounts of kākā being trained to act as decoys or lures when trapping birds (Ranapiri and Smith 1895; Shortland 1856; Tregear 1888). The tūī (*Prosthemadera novaeseelandiae*) is noted by Andersen (1946) as

being trained to speak, to welcome visitors (Tregear 1904). The pūkeko is also said to have been kept as a "comical pet" that was "destructive in the garden" (Andersen 1946: 157). Best (1931) observed the installation of fences by Māori to contain the pūkeko. Today, pūkeko are regarded by some as a pest due to the damage they cause to crops (Parshotam 2018). The relationship with avian species is also documented by Cowan and Pōmare (1987), citing a commemorative connection between Te Arawa people and *tarāpunga* 'seagulls' (*Chroicocephalus novaehollandiae scopulinus*), noting the birds represent the spirits of ancestors and therefore should never be targeted for food.

Early Māori pest management strategies may have included birds as biocontrol agents, that is, other fauna deployed to keep pest numbers down. As noted above, Māori are recorded by early ethnographers as capturing and training birds for different purposes, such as the *tōrea* 'oystercatcher' and *karoro* 'black-backed gull', which were "caught young and fed by hand" (Tregear 1904: 180). Hargreaves (1963) and Best (1931) note Māori tamed bird species for caterpillar extraction in kūmara fields. While historical account is brief in both cases, Best (1931) cites missionary William Colenso as having witnessed seagulls being put to work in the gardens for the purpose of clearing out insects. Hargreaves (1963) mentions this phenomenon in passing, making reference to letters between missionaries Dandeson Coates and Rev. Richard Davis. This unpublished manuscript (cited as Davis to Coates, Nov. 10, 1826) is held in the Hocken Library at the University of Otago. Colenso also notes that in about 1846, when he'd been living in Hawkes Bay a few years,

> the tribe of the late chief Karaitiana, who lived near me, had their large kumara plantation regularly set upon by those immense larvae [i.e., anuhe, awhatō, hawato, hotete, as per list on 1880: 11]. The chiefs borrowed all my turkeys, which were put into their kumara plantation, and in a short time they cleared the whole ground of those destructive creatures. (Colenso 1880: 12)

Interestingly, Roskruge and Semese (2020) recommend attracting carnivorous birds to the māra as a modern pest management strategy.

ERADICATION AND WILD ENVIRONMENTS?

Early Māori conceptualisation of pests and evidence of pest control methods specific to invertebrates may provide useful insight into current and future pest management challenges. Contemporary conservation and biosecurity efforts are captured in movements like the government's Predator Free 2050 initiative, concerned with eradication of pests at a landscape scale in wild environments, areas relatively unmodified by humans. Thus far we have considered precedents in Māori tradition that reveal the species regarded as

pests and control interventions. Is there a precedent for "landscape-scale" intervention and control in traditional practice? Asking such a question highlights the complexity of this contemporary scenario and brings into focus the philosophical differences between Te Ao Māori and contemporary lay public conceptions of "wilderness". Cultivated food is under the domain of Rongo-mā-tāne and is symbolised by kūmara. Food from the "wild" was acquired under various atua domains: Tangaroa for fishing, Tāne for snaring and hunting, and Haumiatiketike for gathering uncultivated food, symbolised by *aruhe* 'fernroot' (*Pteridium*). In environmental philosophy, wilderness is understood as a place without human presence, and is demarcated from settlement and industry. However, Indigenous interactions with nature are wide-ranging and more integral to Indigenous identity, society and culture. Landscapes, even those not visited, are imbued with names, personality, sacredness and values, extending the domain of Indigenous governance well beyond their more permanent places of abode.

A predator-free Aotearoa New Zealand would require eradication everywhere—across offshore islands as well as the mainland, in urban, rural and wilderness areas. From the research gathered here, it seems eradication, to the extent of that required to become predator-free, was never conceived of, let alone considered, by Māori in pre-European times. Apart from the disappearance of some notable groups such as moa, the environment was relatively abundant and biodiverse, and when scarcity was noticed, *rāhui* 'ban on harvest' was imposed (Whaanga and Wehi 2017). Rāhui is a hands-off environmental recovery mechanism that does not respond to plenty or overpopulation so much as it does to scarcity.

The control of caterpillars in kūmara plantations is the most prominent example of traditional Māori pest management, and thus the best precedent for comparison. These efforts involved localised control using several techniques, such as fire and smoke, manual extraction, spiritual intervention and potentially biological controls, although the effectiveness of these methods is unclear. Consequently, there is no precedent for landscape-scale eradication evident in the oral traditions gathered here, although local and seasonal elimination was a continual goal. Furthermore, we see admiration for pests, and entomorphisation of humans, likening persistent and greedy humans to sandflies and caterpillars. We see a keen interest in the suppression of pests, but also opportunistic use of pests as a resource and indeed even medicine. Accordingly, more work is required to inform views on permanent pest control through a Māori lens.

A predator-free environment would mean the eradication of Aotearoa New Zealand's most damaging invasive species. These animals originated outside of Aotearoa and therefore sit outside whakapapa which home endemic species. They also sit outside a whakapapa which encompasses

Polynesian imports, often denoting resources of value brought deliberately to Aotearoa. Traditionally a tropical tuber, all imported kūmara varieties required adaptive and innovative agricultural techniques to grow in Aotearoa, pioneered by early Māori (Yen 1961). Archaeological sites of kūmara fields and storage pits have been located throughout Aotearoa (Law 1969), showing the widespread reliance on the food source and the research, development and technology behind adaptation of kūmara cultivation across the country (Anderson and Petchey 2020). Given how vital the kūmara was to Māori, its prominence in ceremonies and whakataukī is understandable. It encapsulates local cultural heritage even though it arrived from lands other than those occupied by tangata whenua: the whakapapa is enduring and traceable. Despite its importance in whakapapa, the kūmara is not from Aotearoa, making it an intriguing point of reference. It may be non-native in strictly biogeographic terms, but for Māori its whakapapa connects Aotearoa and Hawaiki. Politically, the kūmara is regarded as a taonga to Māori, featuring in the Waitangi Tribunal claim WAI 262 (Waitangi Tribunal 2011). This taonga has been under *kaitiakitanga* 'guardianship' by Māori, who for generations have ensured its prosperity and protection, through ongoing measures such as pest control. Māori also developed and cultivated new varieties of sweet potato (Yen 1974).

A similar journey to Aotearoa was shared by the kiore, which is often lumped in with later arrivals and pests the Norway rat (*Rattus norvegicus*) and ship rat (*Rattus rattus*). But can kiore be considered a pest? Roberts *et al*. (2004: 14) differentiates caterpillars from kiore in that kiore ate *uwhi* 'yams' and *hue* 'gourds' while sharing whakapapa, whereas the caterpillars consumed leaves of plants for which there was no whakapapa, thus reinforcing its status as foreign. In a traditional narrative caterpillars and related pests are said to have been sent by an atua named Ruakapunga in retribution for the failure to recite karakia upon travels that carried the kūmara between Hawaiki and Aotearoa (Waitangi Tribunal 2011: 132). This reinforces the importance of tikanga as guidance on human conduct. These oral histories remain relevant today, with whakapapa helping to determine "pest" and taonga relationships in Te Ao Māori. More recently imported exotic and invasive species have no whakapapa and are not accounted for in oral traditions.

Māori were expert agriculturalists, aware of detrimental species, and engaged in methods to control them. These localised activities are similar to the present day in which pest impacts are amplified in areas where humans have greatly disturbed native ecosystems, through land-use changes to accommodate humans and agricultural businesses. Wild environments contain areas of uncultivated food and resources, with their management subject to boundaries, including tribal. These areas were known, named,

visited and harvested for resources such as timber, construction, weaving and dyeing materials, medicine and food. Techniques such as rāhui signal that a "hands off, nature will heal" approach was the most frequently and widely used control method in Tāne and Haumiatiketike domains. Future work could reveal examples of early Māori applying pest control methods in non-cultivated environments. However, further exploration must acknowledge that there is a potentially unresolvable tension between controlling non-wild and wild populations, and control over and between the various domains mediated by different atua.

CONCLUDING THOUGHTS

Māori versions of the term "pest" had certain equivalences to the English, and some customary methods correspond to today's pest control strategies. Manual practices, such as when people picked āwheto off kūmara leaves, are the most used strategy for rat and possum trapping. Insect repellents for the skin and the production of smoke from burning kawakawa and ngaio work like today's natural deterrents such as citronella. Fires to attract and burn up fleas and moths have modern-day equivalents in lures and "zap traps". Encouraging birds to pick out and eat pest caterpillars from cultivations would make birds Aotearoa New Zealand's first tool for biocontrol, and tangata whenua its first agent. English- and Māori-language terms may resonate, and even translate quite directly; however, the underlying meanings and philosophies distinguish Māori views on "pests". We could not find a pest that was "all bad", "all of the time". Indeed pests sometimes had divine origins. Pests were a reminder of historic *hara* 'violation of tapu', and pest–human relationships maintained these histories and connections.

Mātauranga Māori broadens the perspective of many disciplines and potentially contains environmental solutions for all Aotearoa New Zealanders (Ataria *et al*. 2018). The mātauranga gathered here grounds our nationwide conversation on pests in a deeper history, one in which our tūpuna paid considerable attention to pests and their management. Māori have faced and confronted a range of pests and inconveniences, in particular insects that had negative impacts on agricultural activities and staple crops. Pest control techniques were developed to combat invertebrates like the āwhato. The narratives collated in this paper illustrate Māori engagement with pest control is an age-old activity that was necessary for maintaining economic and food sovereignty. This effort continues, albeit using different controls, as today invasive predation continues to harm food production practices. It is also killing taonga species such as birds, mobilising the efforts of iwi, researchers, media, Crown agencies, local governments and the public.

The control of invasive predators also has potential to revitalise Māori community connections to place and enhance cultural heritage. Recalling

the old saying from the 1860s, republished in *Pīpīwharauroa* (Kohere 1901), Māori had long noted the deleterious effects of colonisation, both on people and the environment. With a shared understanding of this degradation, establishing stable populations of threatened native species through the eradication of pests may represent an opportunity to work to shared concerns, as Tiriti 'Treaty of Waitangi' partners. Pest elimination means *mauri* 'life force' will probably be enhanced and perhaps even restored entirely to some domains, enhancing biodiversity and cultural prosperity. However, we found no precedent for complete eradication in traditional Māori society. Instead, pests were used productively, in legend, in metaphor and in practice—from Tāne, who made a home on earth for the insect army sent by Whiro, to our gardening tūpuna, who collected āwheto and turned them into dyes. To agree upon elimination, and appropriate strategies for eradication, requires a shared understanding of these historic pest control approaches and the values that underpin them.

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NOTES

1. In this manuscript we use *mātauranga* to denote *mātauranga Māori* 'Māori knowledge', for efficiency, but also in line with trends in literature.
2. An earlier version of this Māori saying is recorded in a letter from Julian von Haast to Charles Darwin, later published by Hooker in 1864 (see Riley 2013: 865).
3. Haami and Roberts (2002) expand this narrative to include Māui surreptitiously witnessing Pani giving birth to kūmara after having consumed them, an event which prompted Māui and his brothers to leave for Aotearoa, and Pani's relocation, in shame, to Mataora 'the underworld'.
4. Haami (2007) offers this spelling of the waka name as an alternative to White's, who interprets *Manga-rara* as meaning 'dry twig'. Grant (2014) expands on the potential significance of *Māngarara* as signifying 'branch or family of creeping creatures', although this explanation is not corroborated by any Ngāti Porou accounts, who prefer the non-macronised *Mangarara*.
5. Eradication would need to take place not just in sanctuaries, or haloes, but wilderness areas, key habitat for native birds. Examining whakataukī and early ethnographic sources highlights the importance of whakapapa, and ecological interconnectedness, when considering if human intervention in Te Wao Nui a Tāne 'Tāne's forest wilderness' was ever part of Māori thinking and practice.
6. Hakikea is the traditional name for the lunar month closest to December in the Gregorian calendar.

7. Roskruge and Semese (2020) list kūmara moth, aphids (*Aphis gossypii*, *Macrosiphum euphorbiae*, *Myzus persicae*), sweetpotato leaf miner (*Bedellia somnulentella*), greasy cutworm (*Agrotis ipsilon aneituma*), soybean looper (*Thysanoplusia orichalcea*), tropical armyworm (*Spodoptera litura*), pasture wireworm (*Conoderus exsul*), white-fringed weevil (*Naupactus leucoloma*), black field cricket (*Teleogryllus commodus*), tomato and potato psyllid (*Bactericera cockerelli*), garden symphylid (*Scutigerella immaculata*), black lawn beetle (*Heteronychus arator*), nematodes (*Meloidogyne* spp.) and detritus moth (*Opogona omoscopa*).
8. Riley cites Davies (1871) but has modified the whakataukī to the form cited here.

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