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REVIEW ARTICLE



Taramea, a treasured Māori perfume of Ngāi Tahu from *Aciphylla* species of Aotearoa New Zealand: a review of Mātauranga Māori and scientific research

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ABSTRACT

Taramea is the prized resinous exudate obtained from native *Aciphylla* plants (speargrass) identified as a taonga by Ngāi Tahu Māori in their Treaty of Waitangi tribunal claim Settlement. Ngāi Tahu recognised two types of *Aciphylla*, the larger was known as taramea and used as a fragrance, while the tap root of the smaller type, called papai, was eaten but not used as kakara (fragrance). The gum of the taramea is called 'ware' or 'wai-whenua', and was often spoken as 'ware-o-te-taramea'. Plants were traditionally tapped in the evening by cutting or using fire. In the morning the exuded resin was gathered and processed. To preserve the aroma it was saturated in hinu-weka (woodhen fat) or the fat of other native bird or animal species (tui, kiore) and worn in a pouch (hei-taramea) close to the body. Taramea was used to dress the hair and rub on the body and became a sought after trade item with northern tribes. Scientific studies on taramea plants include those relating to plant morphology, taxonomy, genetics, ecology and phytochemistry. A resurgence of interest in taramea is supporting further scientific studies to define the chemical composition of this taonga plant.

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Tēnā koutou katoa

Tuatahi, nāia te mihi ki kā tini aituā o te wā, ki a rātou kua riro ki tua o Paerau. Moe mai i ō koutou moeka roa, haere ki Hawaiki nui, Hawaiki roa, Hawaiki pāmamao, ki te hono i wairua. Āpiti hono, tātai hono, te huka mate ki te huka mate. Āpiti hono tātai hono te huka ora ki te huka ora, tihei mauri ora.

He mihi tēnei nō kā kāika o Puketeraki ki kā mauka ki uta, ki kā pukepuke ki tai, ki kā wāhi whakahirahira e tipu ai te taramea, tū mai rā, tū ake rā. He hōnore tēnei mō mātou o Puketeraki ki te tautoko i ēnei kōrero e pā ana ki tēnei taoka, ki tēnei kakara, ko te taramea. He mihi mutuka kore ki a koutou kā kaituhituhi. Nō reira, e ōku rakatira, tēnā koutou, tēnā koutou, tēnā koutou katoa.

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This article has been corrected with minor changes. These changes do not impact the academic content of the article.

Nāhaku noa

Nā Matapura Ellison

Introduction

Taramea (*Aciphylla* species) is a plant species native to Aotearoa/New Zealand (Figure 1). It is known, or has been known, by a variety of names including karamea, kurikuri, papāi (young edible root) or tūmatukuru (the larger form), wild Irishman, wild Spaniard, the bayonet plant, bayonet grass or speargrass. The origin of the name spaniard is unclear (Otago Witness 1894; Anderson 1926), while the origin of the names bayonet grass and speargrass describe the very sharp, robust leaves. The vernacular name tūmatukuru was also used in the South Island for the spiny shrub *Discaria toumatou* (matagouri).

Aciphylla is a member of the family Apiaceae (Umbelliferae); there are at least 40 New Zealand species in the genus *Aciphylla* J. R. et G. Forst. (see Scientific Investigations section below). In earlier times Ngāi Tahu (the major South Island Māori tribe) recognised two main types of *Aciphylla* (large and small), although it is unknown how these were otherwise characterised (Otago Witness 1894), and their definitions may not necessarily align with modern taxonomic delineations (Te Taura Whiri i te Reo Maori 1989). *Aciphylla* are typically found in montane to low alpine sites including rocky areas, dry grassland and tussock (Allan 1961). One of the most prized historical native



Figure 1. The large multiple rosette, large pinnae leaf *Aciphylla* species. with milky exudate (A) *A. aurea*, (B) *A. ferox*, (C) *A. horrida*, (D) *A. 'Lomond'*.

frangrances was taramea resin, which was produced in Te Waipounamu (The South Island) by Māori (Beattie 1941, 2009). Taramea use by Māori is analogous to the Middle Eastern plant-derived resins such as frankincense and myrrh that have been valued for millennia (Burridge 2020). While these Middle Eastern resins are derived from the sap of woody trees, other perennial herbaceous plants from the Apiaceae family were also prized for their perfume and medicinal properties, including galbanum resin (Burridge 2020). Recent investigations have aimed to reinvigorate the Māori cultural practice of perfume-making and explore contemporary commercial opportunities. These investigations are based on cultural authenticity and have been developed by Ngāi Tahu (see meafragrance.co.nz). Specifically, there has been an interest in the historical information associated with taramea because this could inform the appropriate manner in which the plant could be used.

Research into the historical uses and associated traditions of taramea ensures that important knowledge that has been gained over centuries will be documented for future generations. This article reviews the historic material published on taramea as a prelude to our detailed scientific studies into the infraspecific phytochemical variation within some of the New Zealand *Aciphylla*.

Mātauranga Ngāi Tahu/ traditional knowledge

The natural resource

Taramea has been identified as a taonga in New Zealand law under the Ngāi Tahu Treaty of Waitangi Tribunal (1991) claim and subsequent Ngāi Tahu Deed of Settlement and Ngāi Tahu Claims Settlement Act (1998). This recognises both the historical and the cultural significance of the resource for Ngāi Tahu and ensures recognition of the relationship of Ngāi Tahu to the preservation of taramea for the enjoyment of future generations. The locations where taramea plants are consistently stated to grow are in the sub-alpine regions. For Ngāi Tahu, taramea plants were located on the East Coast from the Kaikōura mountain ranges south to Murihiku (Southland) and Karamea on the West Coast (Figure 2). Favoured sites were Kairuru (Kaikōura), Waimakariri (mid Canterbury), Hakataramea (Waitaki Valley), Uretane (or more correctly Urutāne, near Waimate), Hikaroroa (inland of Waikouaiti), and Maungaatua (inland South West of Mosgiel) (Beattie 1941).

Traditionally, Ngāi Tahu identified two types of *Aciphylla*. The larger type was known as taramea and was used only as a kakara (fragrance) (Beattie 2009). In contrast, the tap root of the smaller type, known as papaī was eaten. The gum of the taramea is called 'ware' or 'wai-whenua', and was often spoken as 'ware-o-te-taramea' or 'the-gum-of-the-taramea'. It is a resinous substance and can take a long time to collect, so in order to speed up the process, harvesters would 'tahu te taramea' or set the plant on fire. This was apparently done in various ways, for example, by setting alight tussock or dry vegetation either underneath, or on top of the plant. This had the effect of stressing the plant and the heat would then draw the resin out of it. This procedure would often occur during the hours of dusk. Then early the next morning the ware was collected by young women. During the night they had to sleep 'moe-tuturika' or 'koromuke' (doubled up), since it was thought if they slept 'moe-whārōrō' (straightened out), the gum would not run correctly (Beattie 2009). It was believed that it would run down

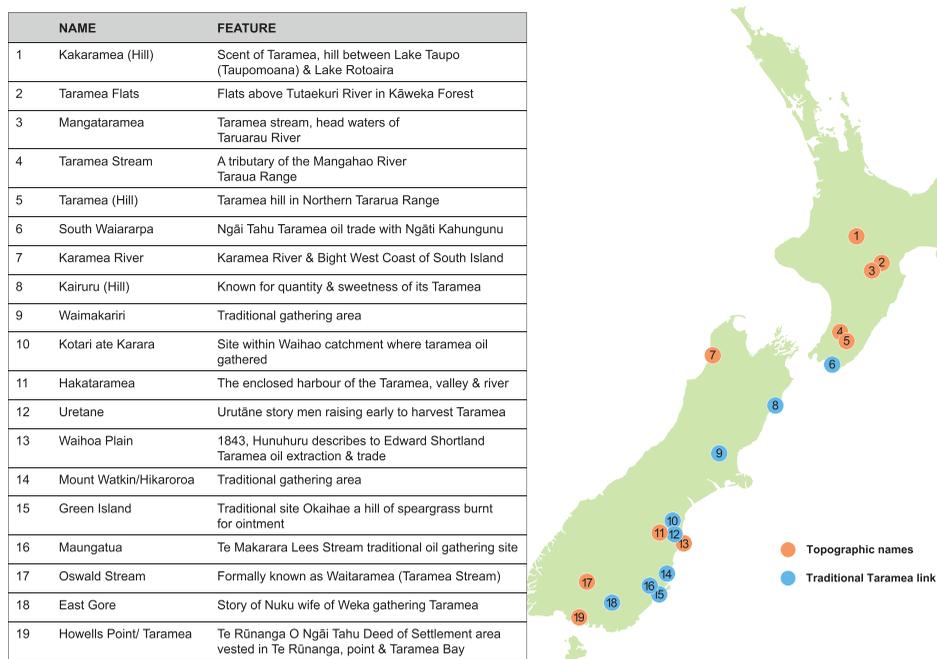


Figure 2. Historically recognised taramaea locations within Aotearoa New Zealand.

the plant instead of collecting in balls at the top. This time-honoured traditional procedure was to ensure good processing and a resultant good perfume. In 1843, Huruhuru described to Edward Shortland how the leaves were held over a fire until an oil exuded and this was collected in a gourd. He also outlined the importance of the oil as barter and as a gift between Māori chiefs living on the southern coast of the North Island and those of the South Island (Shortland 1851).

It pays to be cautious about accounts that it was the work of the women to prepare the ware-o-te-Taramaea in this traditional way. Many of these views conform to the stereotypes of nineteenth century Victorian English society. In those times rigid gender roles were expected and thus the information collected often conformed to the writer's own cultural norms. However, in early Māori society there were no such strict divisions between gender roles (Williams 2010).

Taramaea has a history of traditional uses. Ware-o-te-Taramaea was gathered in rourou (flax plates) or ipu (vessel) and often saturated with hinu-weka (woodhen oil) plus the fat of other bird or animal species (tui or kiore) and this was said to preserve its odour (Beattie 1941, 2009). The resultant perfume was stored in a tahā (gourd), the shell of the kina (sea urchin) or pāua (abalone). The kakara (fragrance) was used to dress the hair and rub on the body. There are also accounts of the infused hinu being used to adorn tūpāpaku (corpses) of important people (Beattie 2009). Another way of wearing this kakara was as a hei-taramaea (fragrance bag), around the neck (Stevenson 1947; Brunner 1952; Karaitiana 1965; Beattie 2009). The hei-taramaea commonly comprised a woven sachet containing muka/ whītau (flax fibre) saturated in taramaea resin, or infused in oil. When cold, the perfume would harden. However, the heat of the body

caused the scent to melt and be released. An important factor in its trade value was that processed sachets of taramea resin were small, light and highly valued. Therefore, they were easily transported and extremely attractive as a trade item. The Māori process of preserving the perfume of taramea is akin to the *enfleurage* process developed by French perfumers—the extraction of essential oils and fragrances from flowers using low odour animal or vegetable fats (Guenther 1948). Solid state perfumes and colognes are modern equivalents of this concept that is currently gaining in popularity (M. Sly, personal communication).

Taramea is a hidden gem and perhaps that is a reason for its absence from the current cosmetics market. It is vital that the protection of this important plant resource is ensured, and a sustainable harvesting practice is adopted to avoid over-exploitation of this taonga.

Māori occupation

The absence of large-scale archaeological evidence of land occupation by Māori in the interior of Southern Aotearoa/New Zealand when the Pākehā settlers spread through it in the late 1850s and early 1860s, is not a fair reflection of the importance of the land to Ngāi Tahu (Evison 1997); the interior land was in fact an integral and necessary part of the traditional economy of the early nineteenth century (Beattie 1941). Many of the early Pākehā explorers were actually guided by Ngāi Tahu people, for example Nathaniel Chalmers was guided by rangatira (chief) Reko from Tūtūrau (Beattie 1947).

Within Te Ao Māori, the Māori view of the land and its resources could be perceived as tribal territory, as being in common ownership between tribes, and as a series of annual ranges where customary harvesting of resources occurred in the course of their yearly economic activities (Evison 1997). The timing, frequency and distance of Māori seasonal mobility varied according to the availability of resources within an area. But in general there was a pulse of migration during the late spring to autumn period. This was usually followed by retreat to a long-term settlement in the winter and early spring (Anderson 1983). These mahinga kai (food gathering site) trails were amplified within the Southern District because of the inability to grow kūmara (sweet potato) in permanent gardens in the colder climate south of Horomaka (Banks Peninsula).

Seasonal expeditions often occurred over considerable distances, for example, expeditions into the distant western lakes of Manuherehia (Otago) and Te Anau (Southland). It is known from local sources that Te Matehaere of the Ngāti Huirapa subtribe of Ngāi Tahu, annually migrated with his people from his East Otago base into the Manuherehia. These expeditions may have extended over more than the typical summer season (see Beattie 1920 for an account of a weka (woodhen) hunt through the inland Southern South Island) and some settlements there may have been more or less permanent (Anderson 1983). The creation of preservation techniques such as drying or packing in fat meant that more permanent settlements could be established and maintained elsewhere (Beattie 1941).

Some traditional stories and place names identify where taramea plants were harvested or processed (Figure 2). In the story of the weka hunter, Beattie (1920) recounts that ‘... Nuku busied herself gathering taramea (speargrass) and extracting the kakara (scent) on the hills on which East Gore is now built’. At Hakataramea, the large valley

of speargrass was also known as Te aka taramea by Teone Pukurakau (Beattie 1930). The Hakataramea river is said to commemorate a dance that took place where the dancers would wear sachets made from the skins of whēkau (laughing owl) filled with taramea resin (Karaitiana 1965). Beattie (2009), reports a story of the people of Te kai-a-te-Atua Pa at Willowbridge who had travelled to Waimatamate (now named Waimate), where in the evening the women singed the taramea, but on their return in the morning could not find any sap. The men as a joke had risen earlier than the women and removed it all. The collection site is a hill on the south east side of the Kapua-Hurihia gorge at Waimate, known as Urutāne (men's gathering or collecting). On the West Coast of the South Island, Kakara Taramea (fragrance of taramea) is a non-official locality synonymous with Karamea the town, river and bight. The contraction of the name occurred prior to the Heaphy and Brunner exploration of the West Coast in 1843 (Nelson Examiner 1846) and was recognised in the 1880 Ngāi Tahu map (Tairaroa) (Te Taura Whiri i te Reo Maori 1989).

Several mountains in Manuherekia (Central Otago) are said '*to have given to the breezes in summertime a pleasant and distinctive aroma*' (Beattie 1941). When considering Māori migration across extensive land areas, the question arises of why the migration occurred. What resources were so special that Māori put all that effort into travelling across the harsh environment to obtain them? The obvious answer was to harvest the pounamu (greenstone). However, there were extensive areas of land between the permanent sites of settlement on the East Coast and the pounamu resources on the West Coast where hidden treasures awaited. One of the most prized historical native fragrances came from taramea plants (Beattie 1941), and was collected by Ngāi Tahu Māori. Traditional products such as these fragrances entered an extensive trade system which spread throughout the land of Ngāi Tahu, and further afield to include North Island tribes (Beattie 1941).

Importance of place names

Knowledge of the whenua (land) was gained through repeated travel. Māori had no written language before 1820, so they had to come up with other ways in which to store information (Roberts and Wills 1998). The reiteration of toponyms/place names was a technique they used to store historic information of the whenua (Roberts and Wills 1998), so that they could accurately recall different areas and their topographic features (Brailsford 1981, 1984). It was also used as a medium in which to store historical traditions and history of their iwi (people). This technique relied heavily on the oral transmission of these place names, for the information to be passed on through generations. Therefore, travelling the whenua reinforced the histories of the people and kept them connected to the whenua (Roberts and Wills 1998). Historic place names of significance and discussed below are presented in Figure 2.

Knowledge of significant people and events was included within the naming of the whenua. The term '*singing the trail*' explains how Māori told the stories of their tūpuna (ancestors) through the medium of oral maps. When someone who held the knowledge of these place names made their way along particular ara (trails), many memories and old stories associated with the area were recalled and could be shared with descendants. In this way, place names could unlock knowledge of histories and of the stories of tūpuna.

Historical place names preserve traditional knowledge/information associated with particular localities. In recognising this, early ethnographers, Beattie and Roberts, compiled extensive lists of Māori place names (Beattie 1941) from Ngāi Tahu sources. They travelled extensively to speak to the elders who still held this information, to record it so that it was not lost. Today, many of these names are rapidly being forgotten because the European names are more commonly known and used. However, a new initiative of Te Rūnanga o Ngāi Tahu–Kā Huru Manu is bringing old names back into new usage and is a resource pool of nomenclature within Te Wai Pounamu. From the 1880 Kahu and Taiaroa lists, 28 high country sites were recognised as being important for sourcing taramea and 26 sites recognised for their importance as a source of papai (Williams 2004). Currently a number of geographical locations officially preserve the taramea name (Figure 2). They are Howells Point (Taramea) at Riverton, and the bay that protects the entrance to Jacobs River Estuary, unofficially known as Taramea Bay. The second is Taramea (hill) and associated Taramea Stream which are features located in the north of the Tararua Range, in the Manawatu-Wanganui District (Te Taura Whiri i te Reo Māori 1989). The Taramea Flats are located on the eastern slopes of the Kaweka Ranges and the Mangataramea Stream, located on the eastern slopes of the Tahuhunui Range Hawkes Bay district. The kakara taramea (fragrance of taramea) is also preserved in several contracted names of features. Karamea, mentioned above, Kakaramea one of the three volcanic cone hills between Lake Taupo (Taupomoana) and Lake Rotoaira; and the name of a small rural town in south Taranaki.

Whakatauki/Waiata

In addition to the naming of places, Māori also stored important information in karakia (prayers), whakatauki (proverbs), waiata (songs) and kōrero tuku iho (oral traditions). These other forms make it easy for rangatahi (young people) to learn through repetition.

Ancient wisdoms and truths can guide and help us. Taonga tuku iho (valued Māori items/activities handed down from earlier generations) are a connection to the past that is about protection and guidance for the future. Many important values and knowledge are inherent in these.

Taku hei piripiri
 Taku hei mokimoki
 Taku hei Tawhiri
 Taku Kati Taramea!
 My little neck-satchel of sweet-scented moss
 My little neck-satchel of fragrant fern
 My little neck-satchel of odoriferous gum
 My sweet-smelling neck-locket of sharp-pointed taramea!

This waiata aroha (song of love) reported by Colenso (1891) was often used, hummed or sung by a mother to a child to express delight and satisfaction. The word ‘kati’ is used to indicate the excessive sharpness and the consequent pains, with loss of blood, attending the collecting of its prized gum, thus enhancing its value.

Kōrero tuku iho

One of the earliest traditions of taramea recorded, is preserved in the story of Tamanuiaraki (Tama) reclaiming his wife Rukutia after she was taken by Tutekoropaka (White

1887). In the legend Tutekoropaka brought all noxious plants from Hawaiki (Beattie 1941) and he used these to obstruct the progress of Tamanuiaraki (Tama) in his journey to reclaim his wife:

Tutekoropunga said to the children of Tama “Stay here with your father. Should he pursue me he will not be able to overtake me. There will be much to obstruct him on the land and ...”. He then departed, taking with him the wife of Tama.

... The day following his arrival at home, he (Tama) said to his children, “Stay here while I go in search of your mother.” He then attired himself in the mats he had received from his ancestors, and over these he wore some poor and dirty ones, so that he might not be recognized. He took a maipi (shark’s-tooth weapon) and some obsidian with him, and went on his journey chanting this incantation:

*E pa, e pa maunga e tu mai ra
Tu ki tahaki,
Kia atea au te whanatu.
Tu-maire-toro. —
Kia atea au te whanatu, —
Tu-maire-toro. —
Te ara i awei, ra toro. —
Te ara i a Tama, —
Tu-maire-toro.*

*O obstructing mountain!
Thou, now standing yonder,
Stand aside,
That now I may,
With path all clear,
Travel on,
With song resounding—
That now I may,
With path all clear,
Travel on,
With song resounding,
Along the road
Which echoes still.
The path of Tama
Still vibrates
With song resounding.*

On he went and came to a bramble: this he cut with his maipi. He next came to the barbs of a tumatakuru (Discaria toumatou): these he cut and cast aside. Next he came to a tara-mea (Aciphylla squarrosa): this he pushed aside with his maipi, but cut it with his obsidian. Having got out on a plain (White 1887)

In White’s (1887) recount of this legend, once Tama gets into the house of Tutekoropaka he opens a calabash filled with a sweet perfume so that Rukutia would recognise him.

The above traditional tale tells us that the taramea plants are inland and on the mountain ranges (tū whenua; tū maunga). It also tells us what tools were used to gather it; the māipi (shark tooth weapon) and the tool most commonly used for cutting and scraping, sharp flakes of matā (obsidian). Both these tools were usually gathered from the

coastlines. It also tells us that through strenuous work, obstacles can be overcome and taramea can be gathered.

Landscape modification

At the estimated time of arrival (~1280 AD) of the Polynesian ancestors to Aotearoa New Zealand (Wilmshurst et al. 2008), the land below 1200 m was all forested (Anderson 1983). Grasslands were relatively restricted, but included floodplains and moist regions of the Central Otago and Mackenzie Country in the South Island (Walker et al. 2004). By the end of the pre-European era, a large proportion of the eastern interior and coastal districts of the South Island was reduced to tussock grassland and dry scrub (Perry et al. 2014). This recession of the forests was due to climatic changes, and in particular to the increased incidence of burning which in turn affected the geographic distribution of taramea plants (see Scientific Investigations section below). In New Zealand only a few of the native plant species show any real adaptation to fire and the increase in fires from anthropogenic sources that accompanied human settlement, resulted in a widespread shift in the biodiversity and function of the landscape (Perry et al. 2014). Another contributing factor to the changing environment in the South Island was the unusually slow rate of forest regeneration (see below), which can be attributed to the cooler, drier climate compared with the North Island. Ngāi Tahu attributed these fires to ancestors named Te Rapuwai and Waitaha, who were said to have ‘*made the land open*’ (Beattie 1941). As the forests retreated and consequent moa (large, now extinct flightless bird) populations dwindled, southern Māori turned away from the once-great hunting ground of their ancestors, and looked to exploit the resources of the sea, coastal plains and hills more extensively (Anderson 1983). With a change in landscape, different food sources gained greater importance in daily life.

The arrival of European settlers in the early 1800s further transformed the landscape. The introduction of pigs, rats and other mammals had a huge effect on the biodiversity of Aotearoa, which had evolved in isolation from the threat of terrestrial mammals (Evison 1997). Post-colonisation restrictions for Māori access to traditional migration routes, hunting grounds and resources (Beattie 1941) meant that knowledge of these traditional routes, harvesting practices and other associated tikanga were lost or forgotten. All these factors combined to make it very difficult to maintain traditional practices. The impact was greatest on the inland districts, where settlements declined/disappeared because of neglect of inland trails.

Retaining ownership and access to the land could have allowed Ngāi Tahu the opportunity to develop certain traditional resources (Waitangi Tribunal 1991), examples of which include the sweet smelling highly prized kakara (fragrant) taramea.

Scientific investigations

Morphology, taxonomy and ecology

The first species of *Aciphylla* to be collected by European naturalists was at Queen Charlotte Sound (Marlborough) by the Forsters (father and son), on James Cook’s second voyage to New Zealand in 1773 (Oliver 1956). The Forsters named this species

A. squarrosa in 1776. The genus *Aciphylla* J.R. Forster & G. Forster is a member of the carrot (Apiaceae) family and comprises 42 species, two (*A. simplicifolia* and *A. glacialis*) of which are found in Australia (APNI 2020), with the remainder endemic to New Zealand (Schönberger et al. 2020). In New Zealand, *Aciphylla* are distributed from the coast to predominant montane regions, especially in Te Wai Pounamu (the South Island) (Allan 1961).

As mentioned above, landscape modification affected the distribution and potential speciation of *Aciphylla*, particularly in the South Island where the relatively low rainfall and desiccating westerly winds were conducive to natural fires during arid conditions (Perry et al. 2014). This combined with sporadic deforestation and vegetation burning by people resulted in rapid changes in plant diversity which favoured the growth of recolonising plant species such as *Aciphylla* that were tolerant to drought (McGlone and Moar 1998) and could re-sprout after fire (Payton and Pearce 2009).

There have been a series of taxonomic studies (e.g. Dawson 1968; Dawson and Le Comte 1978; Mitchell et al. 1998, 1999; Radford et al. 2001), since the last taxonomic revision (Oliver 1956), but a comprehensive update is needed. This is because of the complexity of *Aciphylla*, an example of recent species adaptive radiation (Mitchell et al. 1998 and see further discussion in Meudt et al. 2009), and observations of geographic variation (subspecies) necessitating further collections and data analysis (D. Glenny, personal communication). Furthermore, reports of hybridisation between species and even genera have the potential to add further uncertainty to taxonomic considerations (Le Comte and Webb 1981; Webb and Druce 1984).

Typical characteristics of *Aciphylla* include rosettes of rigid fibrous leaves tipped by sharp spines, and large numbers of reduced compound umbels arranged into narrow elongate inflorescences (Dawson 1971). The New Zealand *Aciphylla* can be separated into at least nine broad groups based on genetics, geographic distribution, morphology and leaf exudates (clear or milky), with the majority of plants being easy to cultivate (D. Glenny, personal communication). The occurrence records for the large *Aciphylla* species (which were most likely those targeted by Māori for taramea resin collection) were obtained from the Global Biodiversity Information Facility (GBIF 2020) which has enabled the distribution boundaries to be mapped. A table of several key features of the New Zealand *Aciphylla* species (Cockayne 1906; Dawson 1979, 1980; Breitwieser et al. 2010–2020) are provided in the Supplementary Material section. A notable feature is the large diversity in size and form of the different species, which is not uncommon in other endemic herbaceous plants, particularly those from islands (Biddick et al. 2019). The focus of this work (and subsequent studies) is on taramea plants that were harvested by Māori and the most likely botanical source of the plant material, i.e. the large *Aciphylla* species that were/are now the most widespread and accessible. The distributions of the mainland large species are depicted in Figure 3 (clear exudates) and Figure 4 (milky exudates). Nonetheless, it should be noted that the current plant distribution patterns are not likely to be the same as those accessible by Māori in times before European arrival. *A. 'Lomond'* is a long-recognised, but informal taxon (Mark 2012), distinguished from *A. aurea* by its much wider pinnae (Figure 1). Within its range it generally occupies higher altitude areas than *A. aurea*. However, it does hybridise with *A. aurea* where the two meet, which is a source of confusion (D. Glenny, personal communication). The majority of *Aciphylla* species are smaller high-altitude species.

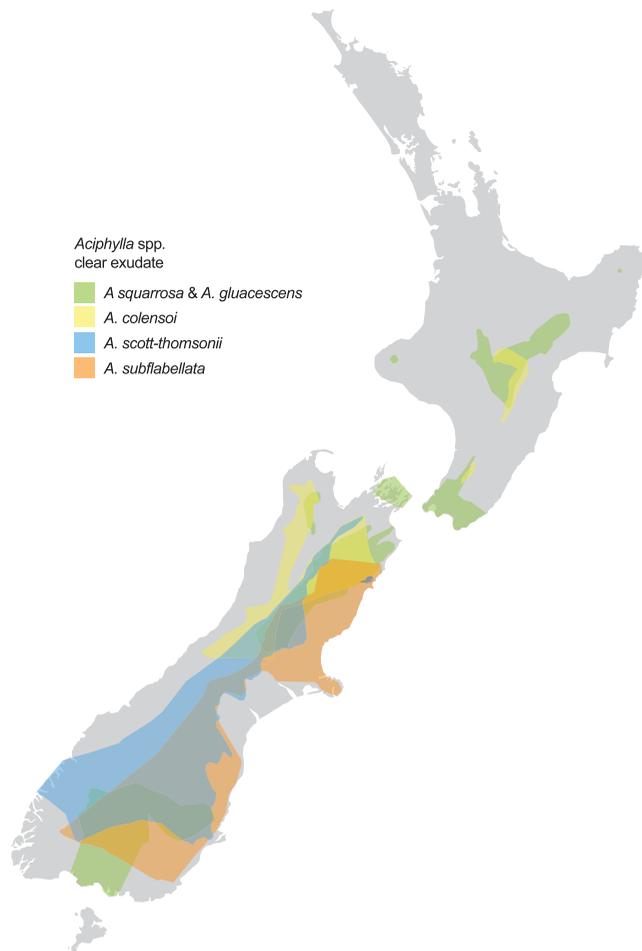


Figure 3. Distribution map of large taramea plant species, *A. squarrosa* and *A. glaucescens* (GBIF-a 2020); *A. colensoi* (GBIF-b 2020); *A. scott-thomsonii* (GBIF-c 2020); *A. subflabellata* (GBIF-d 2020) with clear exudates within Aotearoa New Zealand.

However, the larger species in flower are conspicuous by their inflorescences, resembling ‘great golden candles’ (Moore and Irwin 1978). The plants are pollinated by insects and are dioecious (separate male and female plants) with various and synchronous reproduction (Campbell 1981). *Aciphylla* plants are a unique feature of the alpine flora of New Zealand. The closest related genus *Anisotome*, has a form that is more traditionally associated with Apiaceae species, lacking the sharp spines (Mitchell et al. 1998, 1999). Plants from the Apiaceae family are well known for their aromatic and fragrant properties, as both culinary herbs and for their volatile essential oils (Guenther 1950). In New Zealand, examples include the native *Gingidia* species, many of which are characterised by their strong aniseed aroma (Sansom et al. 2013).

The uniqueness of plant architecture and growth has led to much speculation about biological and ecological roles of *Aciphylla* and its associated biological interactions. The outwardly pointing spines radiating from a central crown could be expected to offer maximum protection from mega-herbivore predation (Clark and Burns 2015).

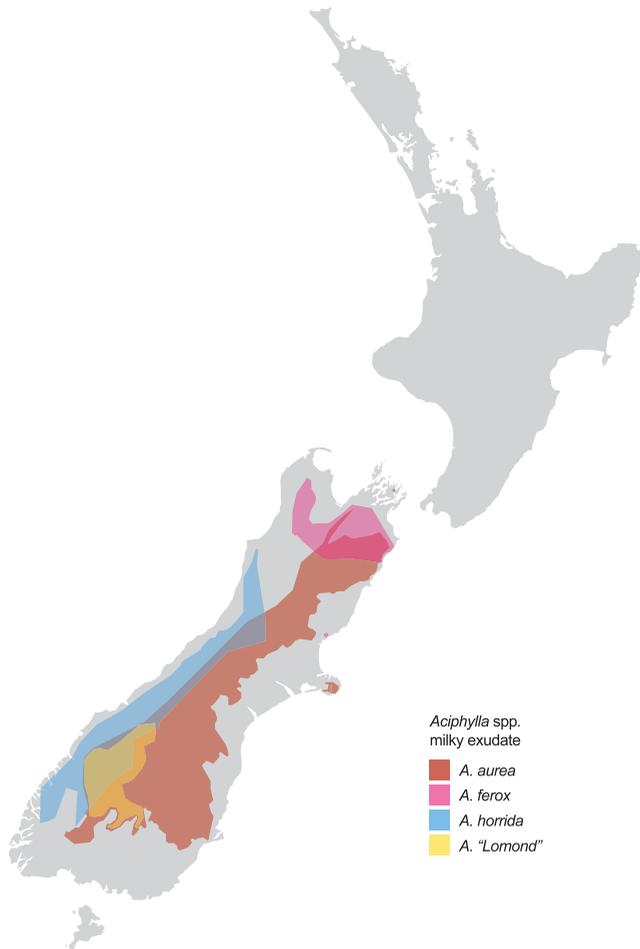


Figure 4. Distribution map of large taramea plant species, *A. aurea* (GBIF-e 2020); *A. ferox* (GBIF-f 2020); *A. horrida* (GBIF-g 2020); *A. Lomond*, (SCD 2020) with milky exudates within Aotearoa New Zealand.

The plants generally increase their investment in spine production as they mature, an example of progressive heteroblasty (Burns 2016). This is rare in other New Zealand Apiaceae, but found in a small range of other native species (Burns 2016). Several studies have examined flowering and resource allocation in *Aciphylla*, both in terms of the carbon and energy cost of reproduction (Hogan et al. 1998), and the influence of resources and pollen on fruit set (Brookess and Jesson 2007). Insect associations include: the rare herbivorous weevil genus, *Hadramphus* (Fountain et al. 2016) and the endemic aphid *Schizaphis* (Podmore et al. 2019).

Phytochemistry

Early phytochemical investigations of New Zealand *Aciphylla* species revealed the presence of the triterpene β -sitosterol in *Aciphylla colensoi* (Cambie and Parnell 1969). Bloor

(1995) included several species of *Aciphylla* in his screen of biological activity of New Zealand plants, but none had significant bioactivity. A unique polyacetylenic compound was found from *A. scott-thomsonii* (Perry et al. 2001). This species, plus *A. aurea*, *A. dieffenbachia*, *A. similis* and *A. subflabellata* also contained the well-known, non-volatile polyacetylene faltarindiol (Zidorn et al. 2002). More recently, Weston reported steam-distilled volatiles, including heptanal and octanoic acid, from seeds of *A. aurea* and three other *Aciphylla* species (Weston 2010). Various essential oil components have also been documented in patent literature (Ellesmere-Sly et al. 2009) for the commercial extraction of taramea plants. In our ongoing research we are examining in detail the phytochemical variation in chemical composition of taramea essential oils and resins, in plants collected from diverse geographic regions of the South Island, publication of which is in preparation.

Conclusions

There is no doubt of the importance of taramea as a resource in early Māori society. Its significance is recognised in the oral traditions of Ngāi Tahu and more recently in the Ngāi Tahu Claims Settlement Act (1998). The record of drying and packing in fat to preserve samples is analogous to the French enfleurage process used to capture fragrances from plants, and may have practical implications for the development of commercial taramea-based fragrance products. Our research on taramea, both Mātauranga Māori and Western science, further defining its biological and chemical properties, is on-going.

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