Whakapapa as a Māori Mental Construct: Some Implications for the Debate over Genetic Modification of Organisms

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Polynesians possess oral traditions that reveal sophisticated understandings of the world and of their place in it. These typically take the form of an elaborate cosmogony beginning with the origin of the universe and the primal parents, then continuing to trace the descent of living and nonliving, material and immaterial phenomena, including humans.

Among New Zealand Māori, such knowledge is encoded and recorded in a mental construct called whakapapa (having an underlying meaning, "to place in layers" [Williams 1975, 259]). In a commonly applied form, that of recording human descent lines and relationships, whakapapa functions as a genealogical table or family pedigree in which the lineages connect each papa or layer (a metaphorical reference to each generation of a family).

The extent to which this underlying theoretical rationale for human whakapapa applies to the nonhuman has hitherto remained unexplored, at least in the published literature. To understand the meaning of plant and animal whakapapa requires knowledge of not only plant and animal names but also their accompanying narratives. Typically, these take an allegorical form in which explanatory theories as well as moral principles are explicated. In its totality, Māori use of whakapapa and narrative creates a "metaphysical gestalt" or whole, integrated pattern, for the oral communication of knowledge (Hohepa, pers comm, 1996).

Renewed interest in whakapapa in New Zealand arises directly from recent worldwide controversy over the genetic modification (GM) of plants and animals, and, in particular, of transgenic modifications involving the

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laboratory-based transfer of genes between different species, genera, or even kingdoms, to create a genetically modified organism (GMO). Because their creation is dependent on human intervention in order to overcome the barriers that prevent such transfers by natural means, genetically modified organisms are regarded by many as "unnatural." In New Zealand, concerns expressed by the public in general and by Māori in particular led to the establishment in 2000 of a royal commission to enquire into genetic modification and its place in New Zealand society. Major Māori concerns as identified by the commission were of a cultural as well as a political nature, the latter pertaining to the Treaty of Waitangi, an agreement signed in 1840 between the British Crown and Māori that provides, in theory if not in practice, the basis for a partnership between signatories. Analysis of cultural concerns (RCGM 2001) revealed several key values and beliefs that, in the view of many Māori, are antithetical to genetic modification. Foremost among these are whakapapa and the associated metaphysical concepts of tapu—an intrinsic spiritual integrity and potentiality for power of a thing, and mauri—the elemental energy or material life force that constitutes the essential self or essence of a thing (Shirres 1997). A majority of submissions made at ten regional meetings argued that humans' mixing of genes between different species constituted an unsanctioned interference with whakapapa as well as a violation of the tapu and mauri of the organisms concerned.

Recent legislation (the Hazardous Substances and New Organisms Act 1996) contains two sections that require scientists engaging in GM research, particularly GMO development, to consult with Māori to ascertain potential risks and effects on their cultural beliefs and values, and on their relationships with their ancestral lands, valued flora and fauna, and other valued possessions (tangible and intangible). This requirement (in part II, section 6 [d] of the act) seeks to give expression to the principles of the Treaty of Waitangi (section 8 of the act).

Because whakapapa is a key focus of many Māori concerns about genetically modified organisms, the purpose of this paper is to seek an understanding of the underlying principles that inform this mental construct. Using the kūmara (sweet potato) as a case study, we attempt to clarify the rationale for the groupings and implied relationships included in this whakapapa, and what those relationships might mean in terms of the modern species concept and scientific classification of organisms. Our intention is to further inform public discussion surrounding genetically modified organisms as well as to provide decision makers with a better

understanding of a key Māori cultural concept that is central to this debate.

Cosmogonical Whakapapa

Cosmogonical whakapapa, often recited in the form of chants, describe the origins of the universe from an ultimate cause. A Hawaiian creation chant, the Kumulipo, describes this original source as Pō, a period of intense darkness devoid of matter. This is followed by the emergence of the earth from corals, after which, in an evolutionary sequence, come the "lower" sea and land plants and animals, such as mosses and shellfish, followed by "higher" creatures, for example, fishes, amphibians, birds, and human-like creatures. The second half of the Kumulipo recounts the genealogies of gods and humankind, proceeding through to a Hawaiian royal family (Beckwith 1972).

Māori inherited a similar intellectual legacy from ancestors who arrived in oceangoing canoes from an Eastern Polynesian homeland, thought by anthropologists to be located in the Society, Austral, and Cook Island groups. (It is also said by some tribes that they were always here, or came by other means; see Orbell 1991, 29–30.) Cosmogonical accounts differ between tribes. For example, some trace human descent from Tūmatauenga, others from Tāne (Shirres 1997, 36). However, while details differ, they all share the basic form of a genealogical account rooted ultimately in a common origin (see figure 1 for a generic overview, composed from several sources). In certain tribes the ultimate origin is located in a supernatural being called Io (Jones 1960). Others simply cite an origin in Te Kore or the formless void, within which mauri is located (Shirres 1997, 116–117). From there the cosmogony proceeds through space and time until the emergence of Rangi-nui (Sky) and Papa-tū-ā-nuku (Earth). These primal parents then produce many children, deified as atua or gods, who in turn act as the progenitors and personifications of all known phenomena, both living and nonliving. Important among these atua are:

Tāne = god of forest trees, birds and insects, rocks and stones, and then, in some tribal whakapapa, humans
Tangaroa = god of marine and freshwater fishes, reptiles, and other creatures
Rongo = god of cultivated foods, and also the deity of peace
Haumia = god of uncultivated or wild foods

Tawhirimatea = god of winds, rain, and clouds
Tūmatauenga = god of warfare, and in some whakapapa, progenitor of humans

From Tāne or Tūmatauenga come many generations of mythical human beings, who in turn give rise to a historical whakapapa recording the names of the captains of the voyaging canoes that brought the ancestors of the Māori to New Zealand. Given the comparatively short period of human settlement in this country (about 1,000 years), it is possible for descendents alive today to recite from memory their whakapapa back to a canoe ancestor and thence to the ultimate source. This ability reinforces the importance of whakapapa as a way of knowing, of locating a person or a thing in time and in space. Such knowledge extends to all other nonhuman phenomena, so that to "know" something is to be able to locate it within a whakapapa (Roberts and Wills 1998).

Two important points emerge from this conceptualization of an all-embracing whakapapa of the universe. First, there is no disjunction between the spiritual and material worlds. Insects and humans, fish and ferns, stars and stones all descend from the spiritual realm of the atua, and thus all possess spiritual qualities (such as mauri) in addition to their own unique material attributes. This dual inheritance applies to all things and, in this context, establishes and emphasizes complementary relationships, rather than the oppositional ones that exist between more modern juxtapositions, such as the "natural and the supernatural," the "living and the nonliving," and the "nature–culture" divide. Second, conceiving of important phenomena as godlike beings endowed with superhuman attributes emphasizes to humans the fact that their environment and its resources are both ancestors and kin. This aspect is given added emphasis in those tribal whakapapa that trace human descent from Tāne. In these accounts, humans are the teina (junior) members of the family. Thus it can be argued that, rather than a relationship of unrestrained exploitation of one's tuakana (senior) kin, a relationship based on respect and reciprocity is obligatory (Roberts and others 1995).

Classification

Throughout history, various criteria have been used as a basis for classifying all living things. As a guide to grouping like with like, biologists including Aristotle (384–322 BC) relied on morphological similarities,

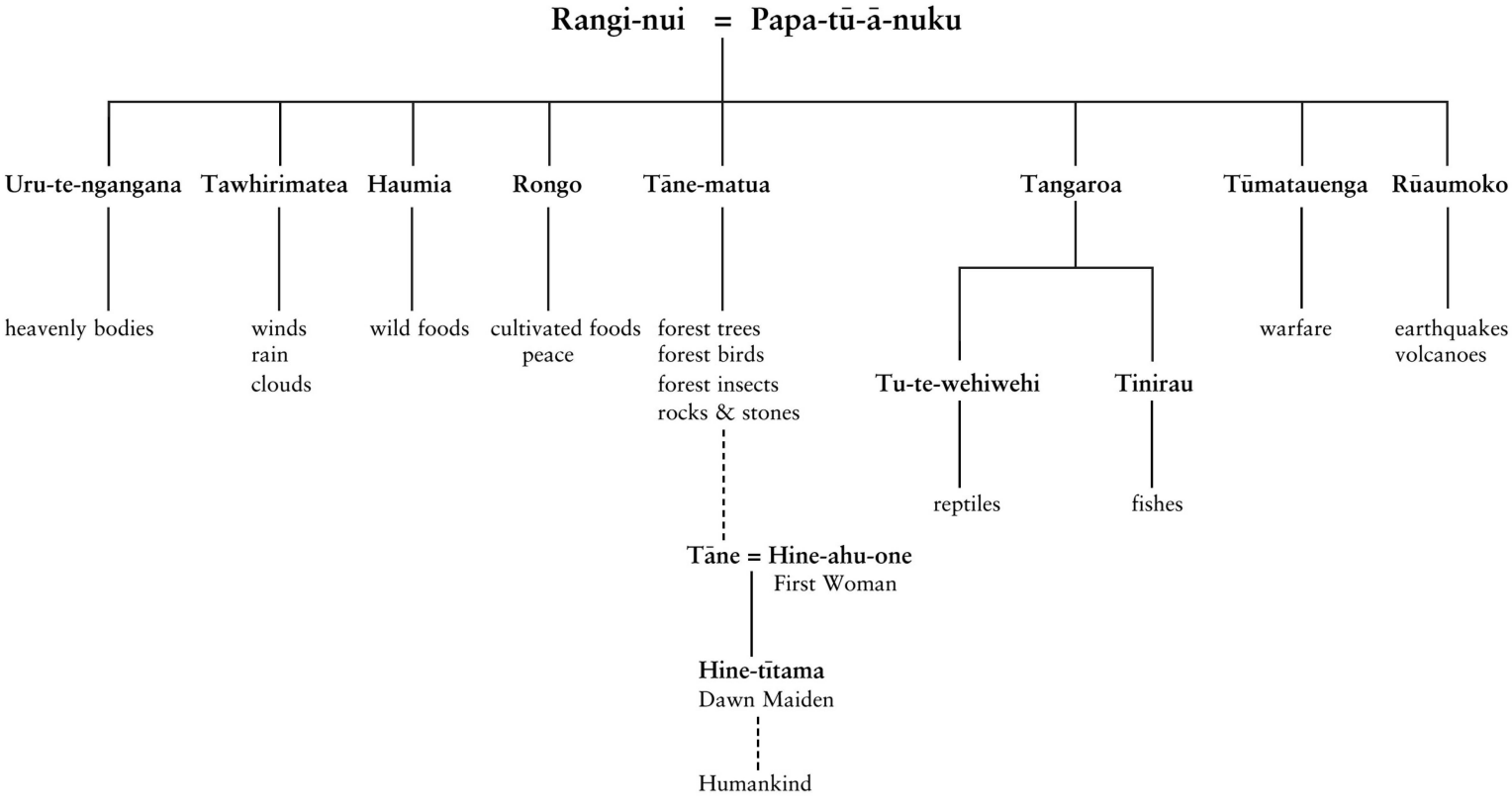

FIGURE 1. A whakapapa of the children of Rangi-nui and Papa-tū-ā-nuku.
Source: Adapted and much abbreviated from Best 1982; 1995.

complemented by anatomy and embryology. An important contribution to the science of classification was made by Linnaeus (1707–1778), who created a system whereby each organism is given two names, the first being the name of the genus and the second the name of the species; for example, *Ipomea batatas* is the binomial of the kūmara. Linnaeus also arranged the various taxa (categories or groupings of like organisms) as a hierarchy, from the smallest or lowest level (the species) through genus, family, order, class, and phylum to the highest, most all-encompassing taxon, the kingdom. This method of classification or taxonomy is now the universally accepted scientific system. A second major contribution was made by Charles Darwin (1809–1882), who in his famous book *The Origin of Species* provided both evidence and argument that "the innumerable species, genera and families . . . are all descended, each within its own class or group, from common parents" (1899, 379). Since Darwin, the goal of biologists has been to create a taxonomy that reflects evolutionary history or phylogeny (from the Greek phylon [meaning tribe] + genesis), and therefore represents a "natural" rather than an artificial construct.

All modern phylogenies are thus based on acceptance of the theory of evolution, implying the descent (by natural selection) of all living organisms from a common ancestor. Evidence for determining lines of descent and relationships, which was until recently based on comparative morphology, anatomy, embryology, and paleontology (fossil evidence), is today increasingly informed by molecular biology, especially genetics. A species, regarded by taxonomists as the most basic and only "real" or "natural" taxon, is currently defined as a population of individuals sharing a common gene pool, in theory capable of interbreeding only with each other, and hence reproductively isolated from all other species. Relationships within and between species are now increasingly determined by the number of shared homologous or "like" sequences in their DNA, the number of shared amino acid sequences in their proteins, or both of these measures. Gene technology thus enables identification of actual rather than inferred relationships, which in turn allows the construction of accurate biological "family trees" or phylogenies. So, as Darwin predicted, "our classifications will come to be, as far as they can be so made, genealogies; and will then truly give what may be called the plan of creation" (1899, 401).

According to many cognitive psychologists and anthropologists, the ability to make sense of the world by classifying its various components (such as plants and animals) is thought to be an inherent property of the

human mind (see, eg, Atran 1993). Among traditional societies dependent on these and other environmental resources for survival, this ability has obvious advantages. Their classifications of plants and animals, known as "folk taxonomies," form the subject of a branch of systematics (the science of classification) called ethnobiology. Of interest to ethnobiologists is the nature and extent of the knowledge incorporated into a particular folk taxonomy, including its underlying framework or rationale. Researchers in this area such as Brent Berlin (1992) and Scott Atran (1993) have argued that innate pattern-recognition ability is based largely on visual detection of similarities and differences. In Berlin's words, "when human beings function as ethnobiologists . . . they do not construct order, they discern it" (1992, 8–9). Concomitant with the capacity to recognize morphological resemblances is the ability to perceive distances or gaps between two or more groups of organisms. Thus "gaps are perceptually recognised discontinuities . . . the smaller the gap between two groups (ie, the greater the similarity) the closer they will be placed in a system of classification" (Berlin 1992, 83). But cultural relativists argue that nature is a continuum made discontinuous only by taxonomists using certain culturally selected criteria (Berlin 1992, 11). According to this theory, species are products of the human mind, comparable to other social or culturally constructed frameworks.

Some support for the cultural relativists' perspective is provided by the utilitarian hypothesis, which emphasizes that usefulness and significance are of primary importance in the selection of what is included in a particular classification (Hunn 1982, 835). Others, including Ralph Bulmer (1970), have extended these hypotheses by suggesting that questions of "cultural cosmology" must also be considered when attempting to understand the rationale for a particular folk taxonomy, particularly with regard to the special status given some plants or animals.

Before attempting an analysis of the function(s) of whakapapa and its underlying rationale, including the degree to which it might serve as a "folk taxonomy," it is appropriate to mention several constraints on this research. These include the fact that in the published literature only fragments exist of what was known to be a vast collection of Māori mātauranga (knowledge) of plants and animals; that the meanings of many names in the remaining whakapapa have been lost; and that few living experts have a detailed understanding of this particular form of mātauranga of natural resources, including plant and animal life cycles, seasonal biology, habitat, ecosystem, and astronomical relationships. Our choice

of the kūmara as a case study was influenced by the fact that it is reasonably well recorded in the literature, and considerable knowledge about it, including its cultural symbolism and importance, remains extant among many Māori.

Case Study: Whakapapa of the Kūmara

Several scientific theories have sought to explain the arrival of the kūmara in Eastern Polynesia from South America (Yen 1974; Handy and Handy 1991), and its distribution further west and eventually south to New Zealand. Māori traditions about this important food source also provide a number of accounts as to its origins, handed down in the form of narrative and whakapapa. While accounts vary, all name Rongo as the origin and personification of the kūmara. One example, recorded by W E Gudgeon (1905), identifies Rongo as the third child of Rangi-nui and Papa-tūā-nuku, and the progenitor not only of cultivated foods such as kūmara and taro *(Colocasia esculenta),* but also of other vine-like plants such as aka, pōhue, and pikiarero (figure 2). Of these, aka is the most inclusive category in that it denotes vines, roots, and climbers, especially rātā (*Metrosideros* spp). Pōhue is applied to a more restricted group of vine-like plants including *Calystegia* spp, the bindweed or convolvulus; *Muehlenbeckia complexa; Passiflora tetrandra* (the native passionfruit); and *Clematis* spp (Williams 1975, 287). All but some rātā have white flowers. The name pikiarero refers to both the large flowered *Clematis paniculata* and the smaller flowered *C forsteri* (Beever 1991), although Murdoch Riley's *Maori Healing and Herbal* applies puawānanga or pōānanga to the former and pikiarero to the latter (1997, 333, 367). Clematis is an important seasonal indicator for Māori: the appearance of its white flowers in spring signals the migration of eels (*Anguilla* spp) up rivers to spawn.

A second tribal whakapapa comes from the Ngati Maru people of Thames/Coromandel (figure 3). The names were translated as follows:

Rongo-mata-aka-whau = Rongo, personification of the many vines that clasp or bind
Otaota = herbs
Tāroa, Tāmau, and Tahua = other kinds of bindweed
Aka-pōhuehue = *Calystegia sepium* (bindweed or convolvulus)
Tāwhiwhi = weeds
Aka-tāwhiwhi = *Metrosideros fulgens* (rātā vine)
Pikiarero = *Clematis forsteri*

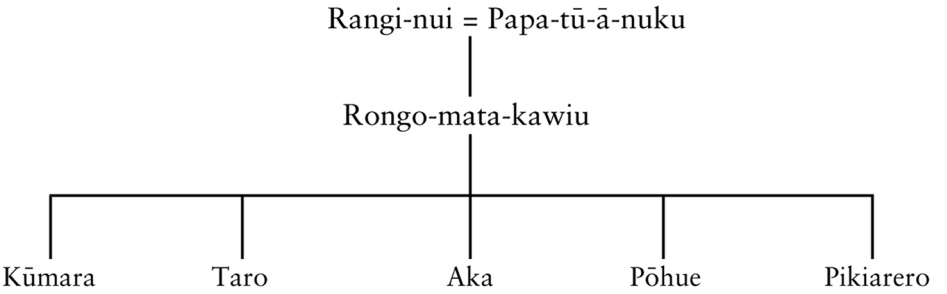

FIGURE 2. A whakapapa of Rongo-mata-kawui (Rongo of the shrunken face).
Source: Gudgeon 1905.

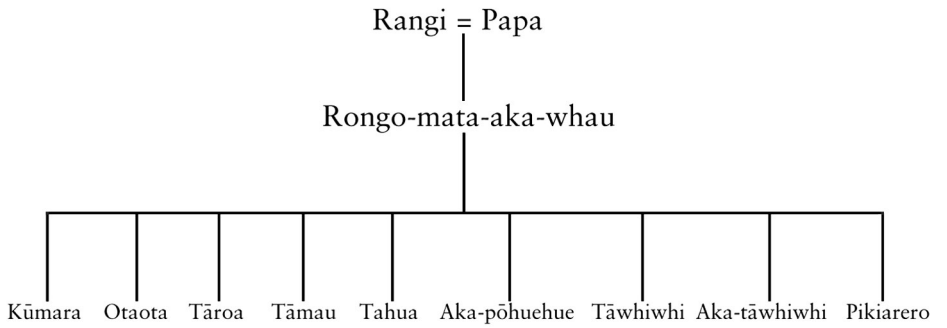

FIGURE 3. A whakapapa of Rongo-mata-aka-whau (Rongo of the many vines that clasp or bind).
Source: Paraone 1907.

Henry Williams's 1975 *Dictionary of the Maori Language* provides different translations for some of these words, but this should not imply that those given in the 1907 translation are incorrect. They are:

Tāroa = self-sown potato
Otaota = vegetation, weeds, litter
Tāmau = to fasten
Tahua = heap, or sandhill
Tāwhiwhi = *Parsonsia heterophylla* (native jasmine)

Applying the second set of translations to the whakapapa shown in figure 3 might indicate the inclusion of not only the kūmara but also the potato (the latter introduced by Cook in 1769 and quickly adopted by Māori), along with other things characteristic of kūmara mounds, which

typically incorporated sand or gravel, and the associated weeds (aka-pōhuehue or bindweed). Also included are three different kinds of vines (clematis, rātā, and jasmine).

Despite incomplete knowledge of the meanings of all names, it seems clear that these two whakapapa function as a folk taxonomy in that both incorporate two major kinds of plants. The first consists of the root crops and contains two distinct "folk generics" (Berlin 1992, 21–24): kūmara and taro. Of kūmara, Māori knew at least eighty-two named varieties, of which only three survive today. Similarly, there were at least twenty different named varieties of taro (Best 1976 [1925]). Of interest in these two whakapapa is the absence of the third major root crop, uwhi or yam (*Dioscorea* spp), which arrived with the kūmara and taro in the founding canoes. Yams are thought to have marginally survived only in the warmer and more sheltered regions of the North Island (Leach 1984); their absence might indicate that they were never grown in the tribal areas from which these whakapapa originated, or that they became extinct there and thus over time were lost from memory and from the whakapapa.

The second kind, the vines, appears to consist of two subgroups: "aka," the more inclusive word used for roots, vine-like plants, and climbers (lianes); and "pōhue," a name restricted to *Calystegia* spp possibly because of their close resemblance to the kūmara plant (an observation supported by the narrative of Marama, referred to later). Aka and pōhue, like kūmara and taro, might also qualify as "folk generics." This categorization presumes that the genus is the most immediately recognizable biological category or taxon, by virtue of its particular and unique configuration, including morphological, behavioral, and ecological features. (Atran has suggested "folk" genus and species be combined into a single "generic-specieme," as in many cases the genus is represented by only one species, and because it is often difficult or impossible for anyone except an expert to accurately distinguish species within a genus [1993, 5, 6]). Inclusion of root crops and vines in the same whakapapa appears to be explained by the strong morphological similarity between the extended vine-like branches of the kūmara plant and the other vines or climbers, and possibly also the fact that white flowers are prevalent among them all.

A third composite whakapapa is illustrated in figure 4. It combines information from several tribal areas on the East Coast of the North Island including Whanau a Apanui (Delamare, pers comm, 1999); Ngati Awa and Tūhoe (Best 1977 [1925]). Māori names of the insect pests are taken from David Millar's *Common Insects in New Zealand* (1971).

This whakapapa includes the uwhi. In addition, a fourth food plant that

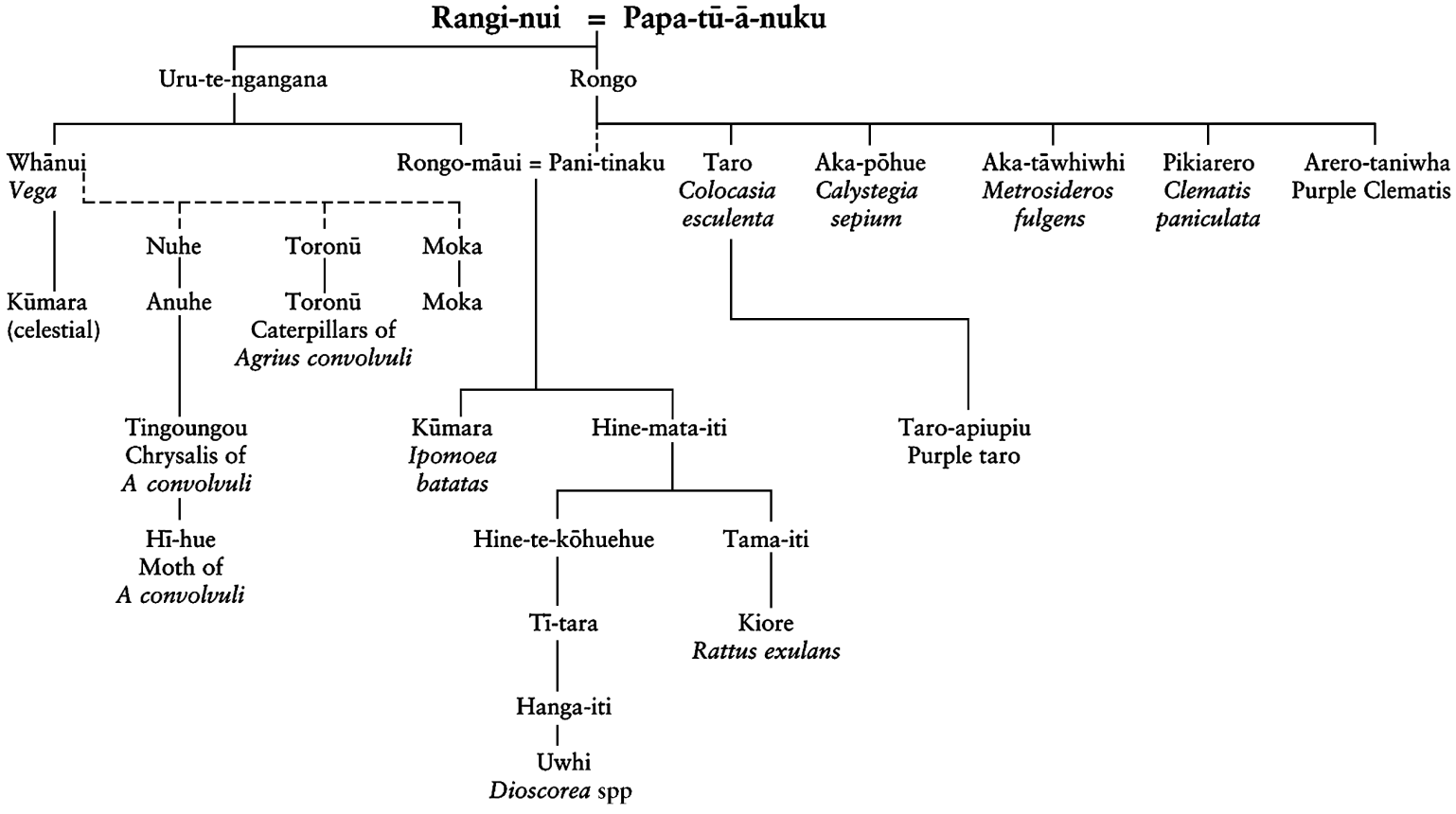

FIGURE 4. A composite whakapapa of Rongo.
Source: Best 1908; 1977; Miller 1971; and Delamare pers comm 1999.

came in the ancestral canoes, namely the hue or bottle gourd *(Lagenaria siceraria),* which like the kūmara is thought to have originated in South America (Whistler 1991, 52), may be represented in this whakapapa. If kōhuehue, which translates as "fat," refers to the gourd, Hine-te-kōhuehue could be the personification of the hue. Tī-tara (literally, "framework of sticks") might then refer to the structure on which the vines and fruits (gourds) were grown (Williams 1975, 424). Some support for this suggestion is provided by comparative linguistics. In Western Polynesia, reflexes of the (reconstructed) Proto-Polynesian word "*fue" (from which the Māori word "hue" is derived) denote creeping, vine-like plants of the convolvulus and other families, but in Eastern Polynesia (from Hawai'i to New Zealand) they refer primarily to the bottle gourd. Hue has morphological similarities to kūmara and most other plants included in this whakapapa in that it is a vine-like climber with white flowers. Perhaps for these reasons the Hawaiians included both kūmara and hue under Lono (= Rongo [Handy and Handy 1991, 16]). But there are important differences. Unlike the vegetatively propagated root crops, hue grows from seed. This fact and the importance of the hue as a food crop and container for multiple purposes may have provided a reason for some tribes to discern a separate descent from Tāne via Pū-te-hue [Best 1976, 245]); its own origin stories (Orbell 1985, 116); and an explanation of how the different shaped varieties of hue came to be (Reedy 1997, 93–97).

The Role of Narrative

In all societies, particularly those with a strong oral tradition, narrative discourse plays a major role in transmitting knowledge. Patu Hohepa described Māori narrative as providing the "flesh" (meaning) to the "bones" of a particular discourse (pers comm, 1996). This is true of the whakapapa of the kūmara, which includes entities whose presence gains intelligibility only by way of the accompanying narrative. One version of a kūmara narrative presented here with reference to figure 4 begins with Uru-te-ngangana, tutelary deity of celestial bodies including stars. Also of importance to this story is Whānui (the star Vega), who is the elder brother of Rongo-māui, a small star close to Whānui. Rongo-māui's wife Pani-tinaku (tinaku = to germinate, sprout, conceive) was the foster mother of the five Māui brothers, who were fishermen. (One of these, the well-known Polynesian hero Māui-tikitiki, fished up the North Island of New Zealand.) When the brothers reproached Rongo-māui for his indo-

lence in failing to procure food supplies, he set off to obtain the celestial kūmara held in the care of Whānui. When Rongo-māui ascended to the heavens and asked his brother Whānui for the precious food, Whānui refused. So Rongo-māui descended out of sight, then crept back and stole the celestial kūmara and brought them back to earth. By this act, theft also entered the world. Rongo-māui, who carried the tubers in his scrotum, then impregnated his wife Pani and told her to go to the Wai o Mona-Ariki (the waters or stream of Mona-Ariki) and give birth to their offspring, the earthly form of the kūmara. (The underwater birth of the kūmara is "re-enacted" in the practice of placing stored tubers in water to stimulate the sprouting of shoots prior to planting.) Pani's children—Nehutai, Pātea, Waihā, Pio, Matatū, Pāuārangi, Toroa-māhoe, Anurangi, and Aka-kura—are all different varieties of kūmara.

Rongo-māui then told Pani to cook this food in order to remove the tapu inherited by their celestial origin from atua. Her foster sons, the Māui brothers, partook of her cooked kūmara and, preferring it to fish, asked Pani how she had obtained it. Pani was silent, so Māui-tikitiki followed her during the night and watched as she gave birth to more kūmara, then informed his brothers they were being fed on the impurities of Pani. This troubled them and caused them to migrate to far-off lands. Some came to New Zealand to settle.

When Pani realized she had been observed giving birth to the kūmara, she fled in shame down to Mataora (an underworld located in the ancestral homeland), taking along her youngest daughter Hine-mata-iti, who became the ancestor of the kiore (*Rattus exulans* or Pacific rat). These small, nocturnal creatures still follow the ways of their ancestor Rongo-māui by stealing the kūmara offspring of Pani while they are in underground storage pits during the winter.

When Whānui looked down and saw men busy attending to their kūmara plantations, he realized that Rongo-māui had stolen some of his tubers and was angry, because they were intended as food of the atua. He therefore sent for Nuhe, Toronū, and Moka, three ancestors who live in the sky, and asked them for help in punishing Rongo for his theft of the kūmara. And so anuhe (who bears the tattoo marks of Nuhe on his sides), toronū (also known as torongū), and moka descended from the heavens to attack the leaves of the kūmara crop. Every summer they continue to rain down from the sky with their sudden appearance in great numbers on damp nights (Best 1908, 238, 241, 256; Miller 1971, 11–13). These caterpillars *(Agrius convolvuli),* which feed on the leaves of the kūmara on

summer nights, were a well-known scourge to Māori, who had many different names for each state of the life cycles (Miller 1971, 11–13).

Mātauranga Provided by the Narrative

Māori mātauranga (knowledge) of seasonal cycles essential to the successful cultivation of the kūmara is evidenced by the inclusion of the star Whānui in this whakapapa, and by the status given him in the narrative. Despite his anger at the theft of his celestial tubers, Whānui continues to look after the earthly descendents. His rising in the morning above the eastern horizon during autumn signals the time for the kūmara harvest, an important occasion in the Māori economic cycle and one greeted with considerable ritual. Habitat and ecosystem relationships observed between the kūmara, its predator the kiore, and the insect pests anuhe, torongū, and moka, would appear to provide the rationale for the inclusion of otherwise unrelated folk generics in this whakapapa, while the narrative account provides the culturally appropriate explanations for these relationships. The ecosystem relationship between the kiore and the kūmara is depicted in the whakapapa through lineages linking them by descent from Pani. It is then explained metaphorically in the narrative by Pani's flight to the underworld (a place of darkness) where her daughter Hinemata-iti (Hine of the small face) gives birth to Kiore. This particular name of Hine, an apparent reference to the physical features of the kiore, is also given to a small star near Whānui (which is sometimes difficult to see). This close astronomical relationship may be a reflection of their tuakana–teina relationship as described in the narrative (Delamare, pers comm, 1999).

Kiore are also shown in the whakapapa as closely related by descent to the uwhi and (if this interpretation is correct) to the hue, both of which are eaten by kiore. In folk taxonomic terms this particular line of descent and grouping might be described as "the plants that are devoured by rats." It is notable that Māori distinguished the caterpillar pests, which are diurnal and consume leaves rather than tubers, by providing them with a lineage separate from the other organisms in this whakapapa. That Māori also had detailed knowledge of the life cycles, behavior, and habitat of both the kiore and these caterpillars has been recorded by Brad Haami (1994) and David Miller (1971), respectively.

Recognition of the distinctive "folk generic" status of taro based on its morphological distinctiveness from the vine-like plants and method of cultivation no doubt accounts for its separate descent line (see figure 4).

But it may also reflect the ancestral status of taro in Eastern Polynesia, where it was more important than the kūmara (Handy and Handy 1991, 14–16).

These whakapapa clearly act at one level as folk taxonomies of the root crops and of vine-like species morphologically similar to kūmara. They also contain a wealth of information about the biology and habitat of the kūmara, including predator, pests, and an environmental indicator of its time of harvest. A "genealogical" framework then acts as a convenient mnemonic for the storage and recollection of this knowledge.

Moral Imperatives Provided by the Narrative

Traditional narratives include among their several functions that of imparting moral rules or guidance. One analysis of the similarities and differences between indigenous knowledge systems and modern or "western" science notes that while science purports to be value free, indigenous knowledge systems, being typically rich in narratives, are deliberately value-laden. That is, in addition to providing knowledge about the world, they also seek to provide moral rules and ethical guidelines that dictate proper conduct toward one another and one's environment (Roberts 1998, 66, 67).

But deeper layers of meaning can also be embedded in narratives. As the example outlined above demonstrates, they may seek to ascribe origins, explain relationships, and tell why things came to be the way they are. Such explanations provide an opportunity to establish or reinforce tikanga and ritenga (the ethical values and the rules for proper conduct). Within this particular narrative are several moral lessons about the consequences of right or wrong actions. These include the theft committed by Rongo (an act punished by the advent of insect and rat pests) and the spying of the Māui brothers on Pani (an act which forced them to emigrate). On the other hand, Rongo rightly observed the correct ritual of tapu removal by cooking the celestial tubers, thus making this food available to humans.

Other traditional narratives relate a different, earthly origin for the kūmara by recounting its importation to New Zealand from Eastern Polynesia. One of these stories (briefly mentioned earlier) tells how Marama, junior wife of Hoturoa, the captain of the Tainui canoe, brought with her several precious plants from the homeland. Because she engaged in immoral behavior with a slave shortly after her arrival, when she planted her kūmara they turned into the pōhue or bindweed *(Calystegia sepium)*. This weed is a scourge of the kūmara garden, strangling and smothering

the plants, while its roots, inferior in size and bitter in flavor, have a purgative effect when eaten. Similarly, Marama's hue seeds turned into māwhai *(Cassytha paniculata),* a vine-like plant that smothers low vegetation and has small spiny fruits. Her aute (paper mulberry, *Broussonetia papyrifera,* from which tapa cloth was made) grew into the endemic whau tree *(Entelea arborescens),* whose bark is used to make an inferior substitute for tapa. In contrast, the kūmara, taro, and hue plants brought by Hoturoa's senior wife, Whakaotirangi, all flourished because she did not commit any moral indiscretion and she observed the correct protocol on arrival by planting them in soil brought from the homeland (Jones and Biggs 1995, 52; Orbell 1985, 46–47).

Discussion

As a case study, the whakapapa of the kūmara enables us to make some preliminary generalizations as to the major characteristics and functions of this construct in traditional Māori society, and to ask whether and how these might inform contemporary debates about genetically modified organisms. What seems clear from the above is that whakapapa provides a cognitive template of great utility in an oral society. To this template are added layers of information and meaning in the form of mātauranga of plant and animal names, biology, and ecosystem relationships with animate as well as inanimate things. Further layers of meaning are provided by accompanying narratives, which not only provide explanations for why things came to be the way they are, but also moral guidelines for correct conduct. Whakapapa thus enable a wealth of knowledge to be conveniently situated, memorized, recalled, and transmitted. Collectively, this information provides the necessary sources of meaning and understanding required for a variety of different purposes. In what follows, we first discuss the several functions whakapapa appear to have played in traditional society. Following that, we ask how might the knowledge they contain, including that within their accompanying narratives, inform the debate on genetic modification.

Whakapapa as Folk Taxonomy

As the most prized cultivated food crop of Māori, the kūmara is elevated to a status whereby it is personified as Rongo, the central focus of the whakapapa in figure 4. All other things within this realm, terrestrial and celestial, are in some way associated with the kūmara in terms of origin, morphology, or biology (including habitat and seasonal cycle). This strongly

suggests an underlying utilitarian rationale for the creation of the whakapapa of Rongo, which is not surprising, given the considerable effort that had to be expended by each tribe to ensure the kūmara's survival in a marginal habitat, well south of its usual, more tropical distribution.

Raymond Firth applied the term "economic lore" to such pragmatic knowledge of natural resources, yet he did not posit a solely utilitarian explanation:

> Knowledge is the essential preliminary to effective use. The Māori of olden times were remarkably well-versed in all matters pertaining to their natural surroundings. The term "economic lore" may be used to denote this knowledge as applied to the solution of his economic problems . . . [Further,] it is doubtful if this interest of the Māori in his surroundings was solely a matter of economic or practical utility. [While] it is unquestionable that the greater part of the fund of information pertaining to birds, plants and minerals was accumulated directly on this basis of economic interest . . . at the same time it is not inconsistent with a certain desire to obtain knowledge for its own sake, to observe and describe with accuracy, and with the object of better classification. (1973, 58–60)

Support for a utilitarian hypothesis is provided by whakapapa of two other root crops traditionally important to Māori: aruhe (the rhizome of *Pteridium esculentum* or bracken fern) and tī or cabbage tree (*Cordyline* spp), which ranges in size from a shrub to a palm-like tree. One species, tī pore *(C fructicosa)* was transported to New Zealand in the ancestral canoes along with the above-mentioned root crops, while five other species are endemic. Both aruhe and the native tī grew wild, but they were also semicultivated—aruhe by burning off regenerating forest cover at regular intervals to encourage its growth, and tī by cutting and replanting the stems, which, along with the rhizomes, were harvested and eaten. Both were important year-round sources of starch, particularly in southern latitudes where kūmara, taro, and uwhi could not be grown, and during winter, the traditional time of warfare. Indeed, aruhe was regarded as "te tūtanga tē unuhia" (the staple that can never fail) until its eventual replacement by the European-introduced potato (Hiroa 1950, 93).

Neither aruhe nor tī is included in the whakapapa of the kūmara, and several reasons can be advanced for their absence. First, they are both morphologically distinct from the other plants in this whakapapa, and unlike the cultivated root crops, neither were dependent on vegetative propagation, being first and foremost "wild" foods. But it may have been the association of aruhe with war that provided a more important cultural rational for their exclusion. Cultivation of kūmara was so intensive and

laden with ritual that it was necessarily a peacetime activity; thus, Rongo was also regarded as atua of peace. Aruhe, on the other hand, was regarded as one of the children of Tūmatauenga, the tutelary deity of warfare, and thus was incompatible with the children of Rongo. Therefore, aruhe was never stored or cooked with kūmara (Andersen 2000, 5; Riley 1997, 249, 391). It may be for all of these reasons that aruhe was excluded from the realm of Rongo and placed instead in the realm of Haumia-tiketike, another child of Rangi-nui and Papa-tū-ā-nuku. Oral tradition records Haumia as having at one time clung to the back of the Sky-father as hair. But when the parents were separated, he hid in the bosom of the Earth-mother. However, the hair of Haumia remained visible as fronds of the bracken fern, and it is by this means that aruhe is discovered by humans, dug up, and eaten (Riley 1997, 389).

As for the origins of tī, one whakapapa of this plant has been described and explained in considerable detail by Philip Simpson (2000), based on information provided by Hohepa Delamare. This extraordinary genealogy traces an origin (from several children of Rangi-nui and Papa-tū-ā-nuku, including Haumia) and descent including at least fifteen generations, most of which occur in the celestial realm. It is here that all the important morphological, anatomical, reproductive, ecological, medical, and nutritive attributes of the earthly tī are imparted and fixed in this plant and its descendents.

All three whakapapa—of kūmara, aruhe, and tī—demonstrate the importance of pragmatic as well as cultural considerations in their creation. Another illustration can be found in Hawaiian cosmological genealogies, where, from a solely genetic or biological point of view, groupings appear strikingly capricious. Here the Sky-father (Wākea) and Earth-mother (Papa) produce four children. Kāne (Tāne), the firstborn primary deity, gives rise to taro (the most highly valued food, reserved for chiefs), sugarcane, bamboo, and then humans. Kanaloa (Tangaroa) produces the banana and marine life; Kū (Tū) the coconut and breadfruit; and Lono (Rongo) the kūmara, gourd, and pig (Handy and Handy 1991, 15).

Whakapapa as Phylogeny

Modern classifications based on the underlying concept of phylogeny or evolutionary history aim first to name and assign all living things to a species, regardless of their cultural importance or utility. Second, they systematically group species into more inclusive, higher taxonomic categories, culminating in a kingdom. Third, they attempt to reflect the phylog-

eny of all organisms so that, ideally, members of a kingdom are genetically related and can trace descent from a single common ancestor. (Note that differences of opinion exist among proponents of cladistics, which emphasizes genetic relatedness as being of primary importance in classifying organisms, and phenetics, whose supporters argue that a "good" taxonomy should incorporate the greatest amount of biological—including ecological—information, and thus serve a more utilitarian purpose.)

Similarities and differences between Māori and modern scientific systems of classification in terms of the above aims are both demonstrated in figure 4. The ability of Māori to perceive underlying patterns in nature and to group these into the most intuitive and basic of all classifications—that is, the "folk genus" of Berlin (1992), or "generic-specieme" of Atran (1993)—is clearly present. Kūmara, taro, uwhi, kiore, pōhue, and aka all appear to be such taxonomic categories. Extension of this ability to distinguish species at the subgeneric level is also evidenced by Māori recognition of two closely related plant species, pikiarero (white clematis) and arero-taniwha (purple clematis), and of the three caterpillars anuhe, torongū, and moka—although science recognizes only one extant insect species that consume the kūmara leaves: *Agrius convolvuli* (Scott and Emberson 1999; formerly *Sphinx convolvuli* [Millar 1971]). But a major difference between the systems occurs above the level of "folk genus" in that higher order taxonomic categories such as family, order, class, phylum, and kingdom are absent from these whakapapa. Any superficial similarity between Rongo and the other environmental realms (such as Tāne, Tangaroa, and Haumia) and the kingdom taxon must be dismissed on the basis that modern classifications require all organisms to be descended from only one common ancestor at the kingdom level; in other words, the phylogenetic basis of modern scientific classifications does not provide for multiple membership in several kingdoms. In contrast, membership in the realms constructed around the children of Rangi and Papa is not exclusive. "Kinds" of organisms, for example, "plants" or "insects," can claim membership in more than one realm, as do the plant, insect, and other animal species found within Tāne, Tangaroa, Rongo, and Haumia. Furthermore, as figure 4 demonstrates, membership may extend to nonliving entities, such as the star Whānui. (In a study of the classification of aquatic animals in Waya Island, in the Yasawa Group in Fiji, Andrew Pawley also noted, "Above the genus and species level . . . folk and scientific classifications have major differences" [1994, 88].)

With regard to the third aim of scientifically based classifications, obvi-

ous—but analogous—similarities exist between phylogeny and whakapapa. Both are concerned with understanding origins, descent lineages, and relationships. Among Māori, this is most clearly demonstrated in human whakapapa, as one's personal identity and place in society is traditionally reliant on possession of knowledge of genealogical links to one's ancestors and living relations.

Given the above, it would seem that a more accurate interpretation of Rongo is as an environmental realm representing the ecosystem of important cultivated foods; that is, it includes those other living and nonliving entities that have some historical and/or extant association with the kūmara. In positing the importance of ecosystem relationships as providing the logic for this whakapapa, we depart from a second claim by Pawley, that "the higher the level . . . the less natural [in terms of morphology, behavior or ecological adaptation] the categories" (1994, 88). On the other hand, we find agreement with Atran's statement concerning the criteria for "life-form" status: "Size alone may not be as important as a place in human ecology; that is, the life-form divisions seem to be made on the basis of those habits of life that determine the place of each being in that local environment pertaining to man's everyday life" (1993, 37).

In sum, there are some intriguing similarities and differences between plant/animal and human whakapapa and modern scientific classifications based on the concept of phylogeny. All three share a similar concern with attempting to identify descent from a common ancestor (or ancestors). But human whakapapa involve only a single species and therefore are more closely allied in terms of their underlying philosophy to modern phylogenetic classifications in their presumption of relationships based on genetically inherited characteristics; thus both can lay claim to being genealogies. This presumption of genetic relationships (increasingly confirmed by modern genetics for human as well as nonhuman genealogies) differs from what we believe to be the underlying rationale of those plant and animal whakapapa exemplified by that of the kūmara. Here there is a similar emphasis on identification of relationships, but these are based on spatial and temporal associations (which may include both inanimate and animate things) as well as morphological resemblances (which may include quite different species). Another distinguishing aspect (not covered here due to space considerations, because it requires a comparative analysis) is that all plant and animal whakapapa are specific to place, and will therefore vary from region to region depending on, among other things, climate and biophysical resources. For all of these reasons, few nonhuman

whakapapa can claim to be genealogies in the sense that all of the things they encompass possess a closely shared genetic inheritance. (Exceptions include the whakapapa of an important resource involving only one genus or species, such as the tuna [eel].)

Instead, the primary purpose of plant and animal whakapapa such as that depicted in figure 4 appears to be that of making sense of the surrounding environment by functioning both as a "folk taxonomy" of important resources, and as a "mind map" of a particular ecosystem.

How Might Knowledge of Whakapapa and Narratives Inform the GMO Debate?

It has been said that Māori are a people who walk backwards into the future, a reference to the importance placed on seeking guidance for future actions from the wisdom of the past deeds of ancestors and mythical heroes. It is therefore of interest to reflect on the knowledge embedded in whakapapa and their accompanying narratives in an attempt to draw some conclusions of relevance to contemporary concerns about genetically modified organisms.

One conclusion explicit in the kūmara narrative is that Rongo-māui was a risk taker. Strict social constraints were imposed on tēina (in this case Rongo-māui) in interactions with tuākana (in this case Whānui) in that junior relations are supposed to show the utmost respect to senior family members. Yet Rongo-māui flouts these rules and engages in disrespectful conduct by stealing Whānui's tubers. He then further insults the mana of Whānui by cooking the kūmara in order to lift their celestial tapu so that humans may eat them. In traditional Māori society, such transgressions invite a reciprocal response in order to restore balance, in this case, to reassert the mana of Whānui. However, although Rongo-māui's wrongdoing does not go completely unpunished, it could be argued that the eventual benefits (a valuable new food crop) outweigh both the risk and the subsequent penalty.

Similar messages are inherent in the actions of the Māui brothers who, because they spy on Pani in an attempt to discover the procreative source of the kūmara, are then forced to depart for foreign lands. Numerous other stories about the youngest Māui brother, the celebrated Māui-potiki, tell of how he also defies social rules of conduct in order to provide some new innovations for humankind (Grey 1885). Thus the Māui stories also highlight two recurring themes in Māori traditions: that of a younger person seeking to outsmart an elder, and that of a trickster/hero who under-

takes dangerous missions on behalf of his people in order to bring new knowledge or technology into the world.

Because the story of Marama's serious transgression of social conduct, outlined earlier, involves the transformation of one species into another, it is of particular interest here. During the ongoing GMO debate, many Māori have voiced the opinion that transmutation of one species into another (including humans into other animals) occurs only in the realm of the atua. In other words, while it is possible for gods to perform such actions, it is not appropriate for humans to attempt the same by moving genes between species. However, Marama and her plants are located in historical time. But it would be unwise to interpret this as evidence in support of transgenic modification. It seems more likely that this story simply seeks to explain why and how Māori were forced to adapt to local and sometimes inferior plant species (pōhue, māwhai, and whau) in place of those (kūmara, hue, and aute, respectively) brought from Eastern Polynesia. All three narratives involving Rongo-māui, Pani, and Marama support the comments made by Gregory Schrempp in his study of Māori cosmogony: "There are a number of stories dealing with the problem of getting central cultural and ritual goods—such as the *kūmara,* ritual knowledge, and the gods themselves—to the new locale. The particularly recurrent patterns in these stories are the tendency of these goods of themselves to revert to their original home, and the overcoming of these tendencies through combinations of theft, the use of certain rituals that fix goods in new contexts, and appropriation of powers belonging to the female line" (1992, 103).

One might therefore conclude from these stories that normally prohibited actions are justifiable if the cause or purpose is correct (tika) or worthy and the potential benefits appear to outweigh the risks. Furthermore, although adherence to tikanga reduces the risks to both individuals and society from abnormal behavior or wrongdoing, sometimes it is only through deliberately flouting culturally embedded norms that important and beneficial changes to society are brought about. However, in all activities involving risk taking, following proper process—including respecting and adhering to appropriate tikanga and ritenga—provides an essential safeguard particularly when embarking on a new venture. Rongo-māui took such precautions by ensuring that the tapu of the celestial kūmara was removed by cooking. This Māori "precautionary principle" is often expressed in the saying, "Kia tūpato": Be careful.

Conclusion

This case study of the kūmara demonstrates that whakapapa and narrative serve important and legitimate cultural functions, such as making sense of a complex world, imparting moral guidance concerning risk-taking activities and their consequences, and reaffirming deeply held cultural beliefs. Because good risk management involves making decisions in which societal values as well as biophysical knowledge must be considered, it would seem important for all who engage in this debate to know more about the whakapapa and narratives of plants and animals, and to discuss how this knowledge might inform the genetic modification of organisms in New Zealand.

Because a major aim of this research is to enable all New Zealanders, and in particular Māori, to engage more fully in the GMO debate, we hope to have demonstrated that an informed understanding of nonhuman whakapapa and their narratives can make an important contribution to this discussion. We also suggest that use of the same word for both human and nonhuman whakapapa can be unhelpful to an understanding of the implications of transgenic modification. For example, it is often claimed by those opposed to genetically modified organisms that moving genes between different species of plants and animals constitutes a violation of whakapapa. When questioned further it is evident that many who advance this claim assume—incorrectly—that nonhuman whakapapa are based on the same underlying assumptions as human whakapapa, in other words, that they all contain things that are closely related genetically. Yet as this case study of the kūmara demonstrates, one whakapapa can involve many, quite different species of plants and animals, including insects and a rat. This begs the question: is it or is it not acceptable to move genes between the different species contained within this one whakapapa? We do not presume to have the answer to this question, but our research suggests that the conflation of attributes of human and nonhuman whakapapa is one source of confusion in the discussion of the impacts of transgenic modification.

It must also be noted that this paper deals almost exclusively with biologically based information and argument. But as mentioned in the introduction, Māori concerns about genetic modification have not only a material but also a spiritual basis, involving, for example, the concepts of tapu, mana, and mauri. Because these beliefs are central to concerns about the

perceived adverse effects of transgenic modification, any informed consideration of the impacts of genetic modification on whakapapa must take them into consideration.

Our primary purpose has been to suggest that traditional whakapapa and narrative-based knowledge has much to offer Māori who are interested in understanding more about the genetic modification of plants and animals and the potential effects this practice might have on Māori cultural values and beliefs. This knowledge should also be of interest to decision makers, who we suggest need to have an understanding of different epistemologies and the criteria each use for justifying claims about the rights and wrongs of this technology. Only with such understanding will an informed conversation be possible. Narrative-based explanations as well as empirical evidence are both important in reasoned debate in which the merits of each can be assessed according to the function they are asked to serve.

An equally important aim motivating this research on whakapapa is to enable and encourage modern Māori to learn about their rich scientific heritage, including traditional ways of classifying and understanding the world. Knowing about these whakapapa and narratives is surely sufficient reward in itself.

* * *

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Abstract

The use of whakapapa by New Zealand Māori is most commonly understood in reference to human descent lines and relationships, where it functions as a family tree or genealogy. But it also refers to an epistemological framework in which perceived patterns and relationships in nature are located. These nonhuman whakapapa contain information concerning an organism's theorized origins from supernatural beings, inferred descent lines, and morphological and ecological relationships. In this context whakapapa appear to function at one level as a "folk taxonomy," in which morphology, utility, and cultural considerations all play an important role. Such whakapapa also function as ecosystem maps of culturally important resources. More information and meaning is provided by accompanying narratives, which contain explanations for why things came to be the way they are, as well as moral guidelines for correct conduct.

Renewed interest in the whakapapa of plants and animals has arisen from concerns raised by Māori in regard to genetic modification, particularly the transfer of genes between different species, as this concept is frequently invoked by those who oppose transgenic biotechnology. Informed dialogue on this subject requires an understanding of the structure and function of nonhuman as well as human whakapapa and their underlying rationale, as well as the nature of the relationships among the things included in nonhuman whakapapa. Of additional interest and relevance is the relationship of whakapapa to modern scientific concepts of taxonomy based on phylogeny and the species concept.

In this paper we describe and interpret the whakapapa of an important food plant, the sweet potato or kūmara, in terms of its apparent functions and underlying rationale. We also discuss how the whakapapa and its associated narratives might contribute to the current debate on genetically modified organisms in New Zealand.

KEYWORDS: whakapapa; folk taxonomy; ethnobiology; Māori narratives; genetically modified organisms; kūmara (sweet potato).