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Cover image: A choir from Hihifo village, Niuatoputapu competing in the national competition, 1974. Photograph: Richard Moyle.

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Paul Geraghty earned his PhD from the University of Hawai'i with a dissertation on the history of the Fijian languages. He was Director of the Institute of Fijian Language and Culture in Suva from 1986 to 2001 and is currently Adjunct Associate Professor in Linguistics at the University of the South Pacific. He is author and editor of several books, including *The History of the Fijian Languages* (University of Hawaii Press, 1983), the *Lonely Planet Fijian Phrasebook* (Lonely Planet, 1994), *Borrowing: A Pacific Perspective* (Australian National University Press, 2004) and *The Macquarie Dictionary of English for the Fiji Islands* (Macquarie Library, 2006), and articles on Pacific languages, culture and history.

Adriana Hiariej's research interests since 2012 have included studying local germplasm biodiversity, including the Tongka Langit banana (*Musa troglodytarum* L.) from the Maluku Islands, Indonesia. This includes exploration, morphological and genetic characterisation at the DNA level and product development. Since 2018 she has been a member of the Wallacea Expedition Biogeography and Biodiversity of Banana team in the Maluku islands, a collaboration between the Bandung Institute of Technology and Pattimura University Ambon.

Valérie Kagy has expertise in the study of traditional crops and particularly Pacific bananas and their role in socio-cultural life in Melanesian communities. She led a study on the genetic diversity of these bananas and has been involved in a variety

of other research projects on the genetics of traditional crops such as breadfruit and yams. She has a particular interest in the indigenous biodiversity of New Caledonia, focusing on the genetics and drought tolerance of its endemic citrus, and in this regard her work helps support food security. Since 2012, she has developed the research programme on natural substances at the Institut Agronomique néo-Calédonien (IAC), upholding the value of local biodiversity for resilient and innovative agricultural systems to protect New Caledonia's rich native Pacific ecosystem in the face of global change.

Jean Kennedy is an anthropology graduate of the University of Otago (MA Hons) and the University of Hawai'i (PhD). She specialised in Pacific and Southeast Asian archaeology before joining ANU and being drawn into New Guinea research. Her fieldwork there centred on Manus Province. She taught history and philosophy of science as well as archaeology at the University of Papua New Guinea. Since retiring to Canberra, she has returned to longstanding interests in biogeography, botany and Pacific tree crops as well as prehistory and has maintained a fondness for talking with students.

Angela Kay Kepler is an energetic "old-fashioned naturalist", having pursued a multifaceted career in ornithology, ecology, botany/ethnobotany, conservation, environmental consulting, marine biology and high-end ecotourism lecturing. She discovered five new species, notably the elfin woods warbler (*Setophaga angelae*, Puerto Rican cloud forest) and a subfossil rail (*Porzana keplerorum*, Hawaiian lava tubes). Angela has written 18 books and received several literary and photography awards, including one for *The World of Bananas in Hawai'i: Then and Now* (University of Hawai'i Press, 2011), and is currently writing a major work on Pacific fishing canoes. She holds degrees from the University of Canterbury (New Zealand), the University of Hawai'i and Cornell University, and conducted post-doctoral research at the University of Oxford.

Alan King-Hunt (Ngāti Hauā, Ngāti Te Oro) is a researcher at Te Kawa a Māui School of Māori Studies at Te Herenga Waka Victoria University of Wellington. Alan has co-authored four journal publications and is completing his master's in Māori Studies exploring Māori perspectives on biotechnological controls for introduced social wasps. Additional research projects have focused on the performance of local councils in meeting their statutory obligations to Māori, the potential of augmented reality programs as a mode for representing Māori narratives, and examining historical oral and written accounts for evidence of customary pest-control methods. Alan has a Bachelor of Arts with Honours in Māori Studies.

David J. Mabberley is a British-born Australian botanist, educator and author. He was consecutively Director of the University of Washington Botanic Gardens (Seattle, USA), Keeper of the Herbarium, Library, Art and Archives at the Royal Botanic Gardens, Kew (United Kingdom) and Executive Director of the Royal Botanic Garden, Sydney (Australia). He is now an Emeritus Fellow, Wadham College, University of Oxford (United Kingdom); Emeritus Professor, Leiden University

(The Netherlands); and Adjunct Professor, Macquarie University, Sydney. Among his varied academic interests are the taxonomy of tropical trees, notably mahoganies and citrus, and the history of science and botanical art. Internationally he is perhaps best known as author of the award-winning *Mabberley's Plant-Book: A Portable Dictionary of Plants, Their Classification and Uses*, now in its fourth edition (Cambridge University Press, 2017).

Ocean Ripeka Mercier (Ngāti Porou) is an Associate Professor at Te Kawa a Māui School of Māori Studies at Te Herenga Waka Victoria University of Wellington. Her teaching explores convergences of mātauranga Māori 'Māori knowledge' and science to support Māori resource management. Her current research examines how mātauranga and science can support environmental health in three different domains: forests, oceans and groundwater. Ocean has been a television presenter for *Project Mātauranga* and *Coast New Zealand*, and for her science communication work has received the New Zealand Association of Scientists Cranwell Medal and the Royal Society Te Apārangi Callaghan Medal.

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Gabriel Sachter-Smith is a banana farmer and researcher based in Hawai'i, USA. From the age of 13, he has been studying all aspects of bananas, and in particular diversity and breeding. He attended the University of Hawai'i where he received BS and MS degrees in agricultural production as well as plant breeding and genetics, with particular focus on how banana bunchy top virus (BBTV) affects various genotypes of banana. He runs a commercial organic banana farm on 'Oahu where he maintains over 150 varieties, as well as conducting breeding work to create new types of bananas for a variety of uses. When he is not farming, Gabe is known as a banana diversity expert of international recognition specialising in identification and taxonomy and has contributed to a number of banana-collecting and -documenting expeditions in Asia and the Pacific, including the documentation and taxonomy of wild species.

Julie Sardos is a French-born crop genetic resources scientist and plant geneticist working for the Alliance of Bioversity International and CIAT. Starting with a PhD on root and tuber crops of Vanuatu, she has spent 15 years working on Pacific Islands food crops, in the past ten years focusing on banana (*Musa* spp.) genetic resources, diversity and evolution. Since 2016 and within the framework of the International Treaty on Plant Genetic Resources for Food and Agriculture, she has organised and implemented collecting missions to assess and safeguard the endangered diversity of traditional banana cultivars and wild relatives. She has authored or co-authored more than 25 research papers published in peer-reviewed journals as well as a number of book chapters. Since 2017 she has been co-chair of the Diversity Thematic Group of MusaNet, the global network for *Musa*-related research.

Lex Thomson is a forest scientist and Associate Adjunct Professor in agroforestry and Pacific Islands agribusiness at the University of the Sunshine Coast. He has worked extensively on forestry, agroforestry and agricultural production systems in 40 tropical developing countries, including assessing the impacts of climate change on Pacific Islands forests. He has led Bioversity International's global forest biodiversity research programme, CSIRO's South Pacific Regional Initiative on Forest Genetic Resources, SPC-EU's Facilitating Agricultural Commodity Trade project and the Pacific Agribusiness Research for Development Initiative. He is an authority on Australian and Pacific Islands tree species and has published on *Acacia*, *Casuarina*, *Eucalyptus*, *Hibiscus*, *Santalum*, *Sesbania* and other plant genera and species.

Camellia Webb-Gannon is a Lecturer in the Faculty of the Arts, Social Sciences and Humanities at the University of Wollongong. Camellia is a decolonisation ethnographer focusing on the Pacific Islands region with a long-term interest in West Papua's independence movement, Australian South Sea Islander political identity, and decolonisation in Kanaky (New Caledonia). She is Coordinator of the West Papua Project at the University of Wollongong and is author of *Morning Star Rising: The Politics of Decolonization in West Papua* (University of Hawai'i Press, 2021).

William H. Wilson is a Professor of linguistics, language revitalisation and Hawaiian at the University of Hawai'i at Hilo's Hawaiian language college, Ka Haka 'Ula O Ke'elikōlani. His PhD is from the University of Hawai'i at Mānoa and focused on Polynesian historical linguistics. His early work on Polynesian possessives suggested that East Polynesia was settled from the Northern Outliers, a relationship that he has since documented with extensive data. He is best known in Hawai'i and the United States for his work in Hawaiian language revitalisation and outreach support for Native American languages.

Maurice Wong is an agronomist with expertise in agricultural research on the conservation and genetic diversity of staple food crops, roots and tubers, bananas and fehi. A member of the PAPGREN (Pacific Agricultural Plant Genetic Resources Network) in the Pacific, he is the curator of the ex-situ Pacific banana collection, hosted by Tahiti. As the Director of AGROPOL, he leads several teams working on food technology and processing, focusing on coconut, breadfruit and banana; pesticide use and a survey on residues on fruits and vegetables; rearing of insects for biological control of fruit flies, aphids and coconut pests; plant pathology, mainly banana bunchy top virus; and experiments for new vegetable varieties more resilient to pests and diseases.

A TRIBUTE TO MERVYN EVAN MCLEAN 1930–2022

Mervyn McLean. Photograph by Harold Anderson.

In 2006 Mervyn McLean published *Pioneers of Ethnomusicology*, an anthology of the discipline's multifarious influential figures and their accomplishments. Writing always with a degree of understatement no longer common in the discipline, however, he omitted any reference to himself, despite having long enjoyed an international reputation for his groundbreaking and sustained work on traditional Māori music.

Starting his fieldwork in Aotearoa New Zealand in 1958, six years before two of the four founding members of the Society for Ethnomusicology produced their seminal works—Alan Merriam's *The Anthropology of Music* and Bruno Nettl's *Theory and Method in Ethnomusicology*—Mervyn focussed on recording Māori *waiata* 'songs, chants' throughout the country, eventually recording 1,300 items at a time when few non-Māori knew of

Moyle, Richard, 2022. A tribute to Mervyn Evan McLean 1930–2022. *Journal of the Polynesian Society* 131 (2): 229–234. | https://doi.org/10.15286/jps.131.2.229-234

the existence of the many genres of sung and recited compositions. He later estimated his total distance travelled was 42,000 kilometres (1996: 5). He was, quite literally, an ethnomusicologist before the word was in common use.

An adjunct of Mervyn's fieldwork, unusual at that time, was an explicit commitment to provide singers with a copy of their recordings, and also to give younger Māori generally a free copy on request, in the interests of providing future generations with access to waiata as a teaching resource. And the desire to provide Māori with details of earlier recorded collections prompted him not just to publish annotated catalogues of collections—by the Māori Purposes Fund Board (1983), Radio New Zealand (1991) and the Museum of New Zealand (1992, with Jeny Curnow)—but also to distribute a copy free to every public library in the country.

In many of his publications, Mervyn was keen to use his knowledge and his recordings for the future benefit of Māori. The titles of the first two of his ten articles in the journal *Te Ao Hou* reflect this concern: "Can Maori Chant Survive?" (1964a) and "The Future of Maori Chant" (1964b). Subsequent journal articles contained transcriptions of waiata he had recorded. Indeed, Mervyn saw transcriptions as a very useful aid to the learning of waiata, and in 1975, together with Margaret Orbell, he published an annotated and translated anthology of 50 waiata and chants in a book format large enough to be laid flat so several students could read it simultaneously as they sang, aided, if necessary, by the inclusion of two CDs of original recordings. The volume, described by Auckland University Press as "the classic collection of Māori waiata", is still available, as an e-book.

Several of Mervyn's publications acknowledge his principal benefactor and mentor, Arapeta Awatere, and each of his books includes a long list of Māori singers and informants. Indeed, an entire book, published with Orbell, is devoted to one man, Kino Hughes, who, at age 80, "set himself the task of recording for future generations all the songs he knew" (2002: 1).

In his relentless search for published research materials in the pre-computer, pre-internet years, Mervyn confronted the many difficulties that geographical distance and slow lines of communication imposed on both his own work and the new discipline with undaunted patience and determination, methodically and painstakingly writing letters requesting photocopies, many sourced from overseas libraries, of pages from the many publications containing references to Pacific music and dance. Much of his office was occupied with the results of ten years of collecting, housed in a dozen or so filing cabinets, a process Mervyn modestly acknowledged in his 1977 *An Annotated Bibliography of Oceanic Music and Dance*: "most of the items … have been personally sighted by the compiler" (p. 7). A 1995 revised edition added a further 500 entries to the earlier 2,200.

Similar tenacity underpinned Mervyn's determination to research the *kōauau* 'Māori cross-blown flute': he personally tracked down and played

every known kōauau in museums around the world, publishing his findings in 1982 to demonstrate a chronological and geographical distribution of flute scales. His insistence that the flute was blown with the mouth, while historically correct, was not shared by a younger generation of Māori and non-Māori performers alike who preferred using the nose; such is the nature of changing attitudes to the historical model. However, something of the acknowledged breadth of his knowledge of organology more generally was reflected in the 185 entries he wrote on Oceania instruments for the *New Grove Dictionary of Musical Instruments* (McLean 1984), the greatest number of any contributor.

Mervyn's family's obituary in the *New Zealand Herald* identified his most enduring achievement and legacy: the founding and directing of the Archive of Maori and Pacific Music at the University of Auckland. Funded from the Department of Anthropology's annual grant throughout his 23-year tenure as director, the archive progressed from a collection of tapes in a technician's workshop in a villa in Symonds Street to customised premises next to a language lab in the then newly built Human Sciences Building. Largely through Mervyn's tireless advocacy among his colleagues, the archive grew within two decades to house the world's largest recorded collection of traditional music from the Pacific. More recently, the change of name to the Archive of Māori and Pacific Sound acknowledges the many spoken and orated assemblages of Pacific-wide material included in its holdings. Originally a repository of material for largely academic use, the archive is now a specialised collection unit within the University of Auckland Library, with greatest use by Māori and Pasifika themselves.

In 1983 in cooperation with an international team, Mervyn led the Archive in co-ordinating a UNESCO-funded Territorial Survey of Oceanic Music, inviting established scholars to apply to survey the music of nominated parts of the Pacific experiencing rapid culture change. Ten surveys were undertaken in what was the first such project within Pacific ethnomusicology to incorporate the training of local co-workers in recording and documentation, as well immediate repatriation of copies of the recordings.

Mervyn once said that he wrote his autobiography *Tō Tātau Waka: In Search of Maori Music 1958–1979* (2004) in a matter weeks, and that he was delighted that Māori descendants of his informants, when contacted for photographs of their *koro* and *kuia* 'elderly male and female relatives', readily supplied them for inclusion. Such was the enduring high reputation of his fieldwork, and such was the growing public interest in things Māori within the country. The book was Auckland University Press's best-selling volume for that year.

Ethnomusicology was and is a relatively small subdiscipline within Anthropology at Auckland University, residing collegially but always competitively with archaeology, social anthropology and biological anthropology. During Mervyn's time, Māori studies and linguistics were also

part of the department, which as a whole was solidly focussed on Aotearoa New Zealand and the Pacific. It was pure luxury to be able to get an instant expert opinion on practically any aspect of Polynesian society or culture simply by walking along the corridor and knocking on the appropriate door. Many of Mervyn's publications acknowledge such collegial cooperation.

Mervyn edited or co-edited the *Journal of the Polynesian Society* (*JPS*) from 1968 to 1976. As M.P.R. Sorenson noted in his centennial history of the Polynesian Society (1992: 124–26), Mervyn arrived at a time when *JPS* was running six issues behind, his co-editor having left for overseas fieldwork. By prioritising the journal and even sacrificing part of his leave, he brought the issues up to date. Indeed, Sorenson characterised his five-year period of sole editorship as of "a meticulous standard". In 1977, the Polynesian Society honoured Mervyn with the award of the Elsdon Best Memorial Medal, in recognition of his outstanding scholarly contributions to Māoridom and the Pacific.

Mervyn made only two significant departures from a focus on Māori music. One was a period of fieldwork on Aitutaki and Mangaia, the other a chapter on the structure of Tikopian music in Raymond Firth's monograph *Tikopia Songs* (1990).

In 2007 the Department of Anthropology published *Oceanic Music Encounters: The Print Resource and the Human Resource; Essays in Honour of Mervyn McLean*. A presentation copy was given to Mervyn at an Auckland restaurant, together with pre-recorded tributes from the 15 contributors. A comprehensive list of his publications was included in that volume.

During his "retirement", Mervyn continued to be active, broadening the scope of his publications even as his colleagues were tending to narrow their own research focus. Geographical diffusion of singing styles and musical instruments came under his scrutiny. He first presented his accumulation of knowledge of the Pacific in *Weavers of Song: Polynesian Music and Dance* (1999), a major work unlikely to be repeated by a sole author. He further extended the scope of his Pacific research to embrace Polynesian origins and languages in his final major work, *Music, Lapita, and the Problem of Polynesian Origins* (2014), incorporating data from linguistics and archaeology. By all measures, this was a remarkable achievement for any author, but an achievement made more poignant by a statement appearing at the very end of the 231-page document: "Because the writer is now blind, this book has been necessarily dependent on the help of many people."

Moe mai, moe mai rā e te rangatira.

Richard Moyle
University of Auckland

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SOVEREIGNTY AND THE LIMITS OF INDIGENOUS RIGHTS IN WEST PAPUA

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ABSTRACT: This article examines an apparent political paradox facing Indigenous West Papuans as they grapple with the issue of how to represent themselves to the outside world in order to ensure their survival and protect their dignity: that is, they must simultaneously present as one body and as many—as a unified nation deprived of and legitimately entitled to a state, and as a multiplicity of diverse Indigenous peoples requiring the protection of Indigenous rights to safeguard their cultures. Echoing the perspectives of prominent West Papuan rights advocates, this article argues that Indigenous rights alone are insufficiently comprehensive and powerful in their ability to protect the lives, livelihoods and cultures of West Papuans. To be effective, Indigenous rights for West Papuans must follow the actualisation of sovereignty—specifically, the Westphalian-influenced notion of sovereignty implied in the right to self-determination enshrined in the 1966 United Nations International Covenant on Civil and Political Rights and International Covenant on Economic, Social and Cultural Rights. West Papuans must first be recognised as a singular body politic, a pan-Papuan nation with an attendant right to statehood, before they can live safely and fully as Indigenous peoples.

Keywords: West Papua, sovereignty, human rights, Indigenous rights, nation-statehood, UNDRIP, right to self-determination

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Under conditions of globalisation, the status of nation-states as the paramount *actants* in international relations is under question (Appadurai 1996). In addition, the so-called postcolonial international political community appears increasingly reluctant to sanction the creation of new states (Habermas 2001), and political and academic wisdom encourages "peoples" seeking self-determination to pursue non-statist forms of sovereignty (Buchanan 1997). In such circumstances, the question of why West Papuans relentlessly and uncompromisingly envisage decolonisation from Indonesia in the form of nation-statehood rather than through alternative avenues of autonomy—in particular, through asserting Indigenous rights (see Bertrand 2011: 852)—bears scrutiny. This article argues that West Papuans have indeed attempted to claim Indigenous status and attendant rights but have largely been unsuccessful under Indonesia's reign of violence and that state's refusal to acknowledge the existence of Indigenous peoples at all within its borders.

Webb-Gannon, Camellia, 2022. Sovereignty and the limits of Indigenous rights in West Papua. *Journal of the Polynesian Society* 131 (3): 235–260. | https://doi.org/10.15286/jps.131.3.235-260

For these reasons, West Papuans have felt compelled to pursue a state of their own as well as seeking recognition as Indigenous peoples. They hope that through achieving the former, the latter will also be realised.

When considering the following command from Bambang Soesatyo, speaker of the Indonesian People's Consultative Assembly (MPR), to the Indonesian military in April 2021, a primary rationale for Papuans' insistence on their own state—survival—becomes clear: "Just eradicate them. Let's talk about human rights later" (CNN Indonesia 2021). The "them" to whom Soesatyo refers are the Indigenous peoples of the contested Indonesian provinces of Papua and West Papua (known collectively by Papuan activists as "West Papua"[1]) who are fighting for their independence—that is, most of the Indigenous population (Elmslie *et al*. 2021; Robinson 2010). Given, as is evident from this statement, the lack of esteem in which the Indonesian government holds West Papuan individuals' human right to life, what hope is there, West Papuans might justifiably ask, for Papuans' more specific Indigenous group rights (for example, those expounded in the Universal Declaration on the Rights of Indigenous Peoples (UNDRIP—United Nations 2006))—rights that clearly depend on the right to life—to be upheld under Indonesian rule? For if Indigenous Papuans cannot assume that, in the view of the Indonesian government, they have a right to simply exist as "a people" (or as people more generally), then they certainly cannot count on their right to exist as *Indigenous peoples*. It is this logic that has led many West Papuans to contend that the pursuit of Indigenous rights is futile until they have acquired their own independent state—a state under which their human right to life is not subject to ad hoc decrees of state politicians (Forkorus Yaboisembut, pers. comm., 2 Dec. 2008, Jayapura).

This article examines what appears to be a political paradox facing Indigenous West Papuans as they consider how best to represent themselves to the outside world to ensure their survival and protect their dignity. It asks, how do West Papuans simultaneously present as one body and as many—as a unified nation deprived of and legitimately entitled to a state of its own, and as a multiplicity of diverse Indigenous peoples[2] requiring the protection of Indigenous rights to safeguard their cultures? Echoing the perspectives of prominent West Papuan rights advocates, this article argues that Indigenous rights alone are insufficiently comprehensive and powerful to protect the lives, livelihoods and cultures of West Papuans. To be effective, Indigenous rights for West Papuans must follow the actualisation of sovereignty—specifically, the sovereignty of statehood as implied in the right to self-determination enshrined in the International Covenant on Civil and Political Rights (ICCPR—United Nations 1966a) and the International Covenant on Economic, Social and Cultural Rights (ICESCR—United Nations 1966b) rather than the more limited sovereignty articulated in the

UNDRIP. West Papuans must first be recognised as a singular body politic, a pan-Papuan nation with an attendant right to statehood, before they can live safely and fully as the approximately 300 Indigenous groups (Franklin 2019), each with different languages, cultures and relationships to land, that they comprise.

In addition, this article documents the various grievances and strategies that inform West Papuans' bifurcated political project of gaining national self-determination *and* ensuring Indigenous cultural preservation. Such twin ambitions, rarely held by Indigenous peoples in settler-colonial states of the global "north", who have tended to pursue the latter rather than the former (Niezen 2003: 51), are not so uncommon for Indigenous groups in the global "south", many of whom experienced immediate recolonisation under the imposition of postcolonial successor states which have sought to annihilate their identities (p. 72). First, this article outlines the development of a pan–West Papuan national identity—one that incorporates elements of many of West Papua's Indigenous cultures and that establishes West Papuans as a unified people entitled, under international law, to a state. Second, it chronicles the trajectory of hopes raised and then dashed in relation to participation in the global Indigenous rights movement as an opportunity to simultaneously promote the nation and protect Papuan Indigenous rights. Third, it examines the Indonesian state's attempts to manage West Papuan claims of indigeneity, at times showing motions of accommodation and at other times denying the existence of such rights, ultimately moving to quash Papuan nationalist *and* Indigenous political aspirations. Finally, it details how West Papuans have incorporated Indigenous identity expression(s) as a means of pursuing a nation-state envisaged as a pan-Papuan-Indigenous-influenced national culture but not an ethnic- or Indigenous-only state. Most Papuan leaders realise that a monoethnic state is impossible in a globalised world, but that a state with a dominant West Papuan cultural nationalism will offer Indigenous West Papuans their best chance of achieving Indigenous cultural preservation and sovereignty. It concludes by demonstrating how West Papuans are practising political self-determination despite the absence of recognition from Indonesia of their right to do so either as a nation or as Indigenous people.

THE BIRTH OF THE INDIGENOUS WEST PAPUAN NATION AND PAN-PAPUAN INDIGENOUS IDENTITY

When Indonesia won its independence from the Netherlands in 1949, it asserted sovereign claims to West Papua, a territory that had also been a Dutch colony, but which had been administered separately to the Dutch East Indies (now Indonesia). The Dutch, however, had different plans for West Papua, the territory comprising the western half of the island of New

Guinea (the eastern half of which is now the sovereign state of Papua New Guinea) and began to prepare West Papuans, whom they contended were ethnically and culturally different to other Indonesians (Elmslie 2002: 11), for independent nation-statehood. On 1 December 1961, the Dutch-supported New Guinea Council selected a national anthem, a national flag and a name for their nation—West Papua (King 2004: 49). Arguably, then, it was the Dutch who encouraged West Papuans to pursue a state of their own, and initially set West Papuans on the path to developing a formal nationalism. But the character of that nationalism, which is both pan-Melanesian and Indigenously inflected, was endogenously inspired. In response to Papuans' December 1 actions, the Indonesian government sent its military to invade the territory, beginning a process that some scholars proffer could constitute genocide under international law (Brundige *et al*. 2004; Kirksey 2012: xi). A Cold War–era deal between Indonesia, the Dutch and the USA, known as the 1962 New York Agreement, handed the administration of West Papua to the United Nations (UN) and then Indonesia. In 1969, the UN oversaw the so-called Act of Free Choice, a referendum in which West Papuans were to vote either for independence or for continued integration with Indonesia. The UN turned a blind eye to the farcical plebiscite in which Indonesia hand-picked less than one percent of the West Papuan population to vote and threatened the participants with violence if they did not vote for annexation to Indonesia (see Budiardjo and Soei Liong 1983: 31). Deprived of the opportunity for self-rule in 1962 and again in 1969 and conscious of the international movement towards decolonisation (Kluge 2020: 1160), Indigenous West Papuan activists began in earnest to fight, through guerrilla warfare and international diplomacy, for independent nation-statehood (Ondawame 2010: 65–93) whilst simultaneously building an ardent nationalism. "During the coming decades of Indonesian occupation," Eben Kirksey reports, "thousands of indigenous Papuans were killed in bombing raids, displaced by military operations, subjected to arbitrary detention, executed, or 'disappeared'. Forced sterilization campaigns and neglect of basic public health programs resulted in slower, perhaps more insidious, declines in West Papuan populations" (Kirksey 2012: xi). As Indonesian rule in Papua revealed itself as endlessly brutal and destructive, the push for a state became as much about West Papuans' survival as it was about decolonising in a way similar to other former Pacific and African colonies (Webb-Gannon *et al*. 2019: 189).

From the early 1970s and through the 1980s, in the decades following the failed Act of Free Choice, internal and external negotiations for West Papuan sovereignty were influenced primarily by the emergence of Westphalian-style postcolonial nation-states in Africa, Asia (Kluge 2020) and the Pacific (Webb-Gannon *et al*. 2019). During these years, West Papuan

leaders were concerned with constructing a pan-Papuan nation that was inclusive of all West Papua's Indigenous peoples and cultures, one that could account for a history of internecine violence and still convince the world that the Indigenous peoples of West Papua were a polis of sufficient unity, a nation-of-intent (see Webster 2002: 509). An obvious way of doing this was to interweave elements of West Papuans' myriad Indigenous cultures that together could be considered Melanesian, as distinct from Asian Indonesian cultures. That West Papuans' cultural nationalism took on Melanesian rather than Asian dimensions was not simply a product of Papuans' opposition to Indonesian rule. Rather, it was shaped by pre-colonial Asian–Melanesian antagonisms (Webb-Gannon 2021: 78) as well as cultural similarities (concepts of time, spiritual and cosmological beliefs, agricultural practices and social relationships and structures) with other Melanesian peoples (Moore 2003: 11).

A critical part of the nation-making process involved building infrastructure and networks through which geographically dispersed West Papuans could rally around Indigenous West Papuan–Melanesian symbols of identity. These symbols included Papuan songs and dances (Smythe 2013), consumption of sago (a starchy staple consumed in parts of Melanesia) rather than "Asian" rice, and apparel such as the *koteka* 'penis gourd' and feathered headdresses. Biak anthropologist and musician Arnold Ap was an early architect of such infrastructure. He envisioned a homeland for West Papuans in which its Indigenous peoples could express their cultural identity freely without fear of Indonesian army reprisals (Webb-Gannon 2019: 123). When Cenderawasih University in Jayapura opened a cultural museum in 1973, Ap was appointed its curator. He travelled widely throughout West Papua, documenting traditional music, dances, stories, art and architecture (Buttry n.d.; see also Glazebrook 2004). In 1978, he formed the band Mambesak with his friend Sam Kapissa and several of their peers, performing original compositions and traditional songs, and recounting jokes and humorous stories collected during Ap's travels through Papua (Ibrahim 2021). Mambesak also hosted a weekly radio show that broadcasted cultural items from around Papua (Ibrahim 2021). The show and Mambesak's live performances and recordings (released on cassette) were wildly popular (Smythe 2013), and understandably so when considered in the context of the cultural erasure to which West Papuans had been subject since Indonesian occupation. Indeed, not long after the Indonesian takeover, reported human rights activist Carmel Budiardjo, Indonesia gathered Papuans from diverse geographical locations to witness a mass burning of Papuan cultural artefacts, symbolising a "burning of 'their colonial identity'" (cited in Ibrahim 2021). Despite Mambesak's songs containing few explicitly political lyrics, Indonesian authorities recognised

the inherently subversive nature of Ap's work. Ap celebrated West Papuan cultures (rather than one "Indonesian" culture) and in doing so—through travel, live performance and radio—helped to create out of numerous Indigenous expressive practices a unifying spirit of West Papuanness, as opposed to Indonesianness, across the territory. The capacity of performance to build identity, including political identity, is a characteristic of Melanesian cultures (as it is of other Pacific cultures and Indigenous cultures elsewhere). One *becomes* West Papuan and can even experience a transitory freedom from Indonesian rule through participating in communal song and dance (Smythe 2013). Ap's nation-building work, intertwining performance elements of various West Papuan Indigenous cultures to bring the peoples of the territory together, was so potent that he was imprisoned and executed by the Indonesian military in 1984.

While Ap was reclaiming vestiges of vanishing Indigenous West Papuan cultures for national posterity, the iconic West Papuan rock-reggae fusion band the Black Brothers, formed in 1974 in Jayapura, West Papua, was making waves across West Papua and throughout the Pacific, stirring nationalist sentiment via what James Clifford terms the phenomenon of "indigènitude" (2013: 16). Indigènitude, according to Clifford, is an identity politics formed out of "a concatenation of sources and projects" that draw on local Indigenous traditions as well as a more generalised, transnational idea of indigeneity (p. 16). The Black Brothers, whose songs called for independence from Indonesia, made use of indigènitude's "symbolic repertoire" (p. 16), signalling in performances and album artwork, through warrior stances and adornment in body paint, batik tunics, feather headdresses and shell and beaded necklaces, both a pan-Melanesian and a pan-Indigenous identity. The Black Brothers' portrayal of themselves as Indigenous folk warriors, as nostalgic representatives of a prelapsarian primordialism (Niezen 2003: 11–13) (the Black Brothers also drew on elements of the global négritude movement to galvanise black solidarity from around the world), operated politically to unite West Papuans through popular music and an identity in which they could recognise fragments, or echoes, of their own Indigenous cultures. While contributing to a burgeoning West Papuan national identity by practising strategic indigènitude, the Black Brothers, who gained international acclaim in the 1980s, were also positioning West Papuans as part of a global Indigenous movement which was beginning to gain traction in international fora such as the United Nations and to find appeal among a Western public partial to the broad romanticisation of indigeneity (Niezen 2003: 52).

AN INDIGENOUS NATION WITHOUT A STATE: COULD INDIGENOUS RIGHTS OFFER A PATHWAY TO STATEHOOD OR EVEN NEGATE THE NEED FOR A STATE?

Through the efforts of culture bearers and producers such as Ap and the Black Brothers and Indigenous West Papuan politicians swelling the ranks of the Organisasi Papua Merdeka (OPM—Free Papua Movement), which used guerrilla tactics and diplomatic methods to fight for independence from Indonesia, the nascent West Papuan nation born at the end of the Dutch administration came of age. Crafted from elements of Indigenous cultures from around West Papua and a creative deployment of indigènitude and promulgated through popular culture and media, West Papuan nationalism was also fuelled by the systemic violence of Indonesian occupation. Unable to assert legitimacy by quashing West Papuan cultures and imposing its own (through transmigration; see, e.g., Gietzelt 1989; Kymlicka and Straehle 1999: 74), Indonesia governed Papuans through repression, using techniques of political imprisonment, torture, mass killing, starvation and a ubiquitous military presence (Brundige *et al*. 2004). Between 1970 and 1980, the colonised territories of Melanesia (excluding West Papua and French-occupied Kanaky) were realising statehood (Fiji in 1970, Papua New Guinea in 1975, Solomon Islands in 1978 and Vanuatu in 1980). West Papua anticipated its turn. Resource rich—West Papua is home to the world's largest gold and copper mine (Leith 2002)—and therefore capable of being economically self-sufficient, politically organised through the OPM (Ondawame 2010), skilled in international diplomacy (Kluge 2020) and claiming a vast territory as their own (Webster 1999: 1), West Papuans awaited only international recognition of their sovereignty to secure their statehood. However, several factors conspired against Papuans in this quest. First, the United Nations considered the outcome of the 1969 sham Act of Free Choice to be enshrined in law[3] and gave no indication it would revisit its decision. Second, West Papuans struggled to gain support from likely allies among the former colonies-turned-states of Africa and Asia due to Indonesia's influential and powerful position among a group of 49 African and Asian states that had participated in the 1955 Bandung Conference. This conference founded the movement of Third World non-alignment and pursued an agenda of anticolonialism and anti-interventionism in state sovereignty (Burke 2006). Indonesia's leadership role in the movement served to obfuscate its own colonisation of West Papua. As well, many of the territories closer to home in the Pacific that had been fellow states-in-waiting with West Papua but had by now become sovereign states had doubled down on domestic political agendas to shore up their own state sovereignty and deal with the teething problems inherent in inceptive state-making and thus had little time to focus on unfinished decolonisation further afield (Webb-Gannon 2021: 154).

The rise of global neoliberal capitalism in the 1980s and 1990s signalled the decline, it seemed at the time, of ethnonationalist-state claim-making (Guéhenno 1995; Kymlicka and Straehle 1999: 67; Nimni 2010: 22). In literary and political theory, the world was largely, although prematurely and confusedly (Shohat 1992: 103), considered "postcolonial" (Xie 1997: 8). Correspondingly, in the 1980s and into the 1990s, several powerful West Papuan activists had become disillusioned with what appeared to be the futile quest for nation-state sovereignty and began to turn their attention to the relatively new global Indigenous rights movement. Indigenous internationalism was a social movement that emerged from this increasingly globalising world, a world reluctant to recognise new states but willing to accord significance, and political power even, to sub- and supra-national groups posing little threat to the status quo of the extant international system of states. Ronald Niezen posits that following World War II, two main categories of "peoples" whose "unfulfilled yearnings for self-determination and whose ambitions at some level involve a rejection of the multicultural projects proposed by states" were identifiable: ethnic peoples and Indigenous peoples (2003: 7). Ethnonationalist groups'/peoples' goals frequently take the form of a nation-state, writes Niezen (p. 8). Only a state, for these groups, will satisfy their longing for equality with other nations, offer them collective security and allow them to freely express their collective identity (pp. 8–9). Indigenous groups, on the other hand, link "local, primordial sentiments to a universal category" (p. 9), claiming not a "particularized identity" (like ethnic groups) but connection between Indigenous peoples nursing in common the twin grievances of settler colonialism—namely, resource extraction and economic marginalisation (p. 9). Recognition by the governing state and the world of their *special* status, not *equal* status, is their overarching political goal. While ethnonationalist groups often make their grievances known via protest and violence, Indigenous groups have tended to express their discontent through representation at international fora (p. 16). To belong to an ethnonationalist group, one must subscribe to a common creed (belonging, in other words, is identity-driven), but membership of an Indigenous group is determined at least partially by birth (that is, it has a biological basis) (p. 13).[4]

Given Niezen's exposition of the differences between ethnic/ethnonationalist and Indigenous groups—both seeking self-determination but for different reasons, in divergent ways and with politically variant outcomes in mind—it is clear that, to date, West Papuans had more closely aligned themselves with the ambitions and practices of ethnonationalist groups than with those of Indigenous peoples, despite using Indigenous cultures and the practice of indigènitude to build their sense of group cohesion. Papuans had fervently fought for self-determination and sovereignty in the form of

their own state, wanting equality with Indonesia and other members of the international community of states, rather than recognition of special status within Indonesia. West Papuans identified with other West Papuans through a shared national culture, or creed, symbolised by the Morning Star flag, the mantra "*merdeka*" (meaning freedom/independence in Bahasa Indonesia), Melanesian identity and unified opposition to Indonesian brutality.

It was, however, as a handful of West Papuan elites were beginning to realise, potentially politically expedient for West Papuans to present themselves as Indigenous peoples instead of or as well as an ethnic group. The term "Indigenous" first emerged in legal and political discourse when it was included in the International Labour Organization (ILO) Convention (No. 107) Concerning the Protection and Integration of Indigenous and Other Tribal and Semi-Tribal Populations in Independent Countries (1957). By the 1980s, it had "attained an ever-widening circulation, to the point where it [was] no longer a specialized legal term but [was] recognized by a lay audience" (Niezen 2003: 3) and applied self-referentially by the world's "first peoples" to "promote and protect their rights" (p. 4). No formal UN definition of Indigenous peoples exists, but the definition provided in a 1987 UN report by José Martínez Cobo is commonly invoked:

> Indigenous communities, peoples and nations are those which, having a historical continuity with pre-invasion and pre-colonial societies that developed on their territories, consider themselves distinct from other sectors of the societies now prevailing in those territories, or parts of them. They form at present nondominant sectors of society and are determined to preserve, develop and transmit to future generations their ancestral territories, and their ethnic identity, as the basis of their continued existence as peoples, in accordance with their own cultural patterns, social institutions and legal systems. (Martínez Cobo 1987: 29)

Under this definition, these innovating activists reasoned, West Papuans as a body politic could as aptly fit the criteria of indigeneity as of ethnonationalism. First, historical continuity with pre-Dutch and -Indonesian colonial societies had indeed been maintained. For example, despite Indonesian attempts to ban them, Indigenous languages were still spoken throughout West Papua (although numbers of speakers were on the decline) (Viktor Kaisiepo, pers. comm., 11 Sep. 2008, Amersfoort). Indigenous religions, such as Koreri on Biak Island, were still practised (Sharp 1994: 74), and "the old stories and old songs were still sung" (Oridek Ap, pers. comm., 10 Sep. 2008, The Hague). Second, distinct Papuan tribes to this day maintain their identities through their interactions with and the features of their traditional lands (Barber and Moiwend 2011). This is one of the major ways in which they distinguish themselves from Indonesian migrants who

have made Papuans a minority in many parts of their own territory (Elmslie 2017). And third, attempts to live in accordance with Indigenous "cultural patterns, social institutions and legal systems" are made by West Papuans through local customary councils (*lembaga masyarakat adat*).

Viktor Kaisiepo, a West Papuan who lived in the Netherlands until his death in 2010, was one of the first West Papuan activists to become interested in the potential of Indigenous rights for improving Papuans' life conditions. Viktor's father, Markus, had been a key figure in the early preparations for West Papuan independence, chair of the New Guinea Council, and a prominent organiser of West Papua activist politics while living in exile in the Netherlands (Van der Kroef 1968: 691). I interviewed Viktor in 2008 about his hope for Indigenous rights as a path towards self-determination for West Papuans. He informed me that in 1980 he became aware of the Fourth Russell Tribunal on the Rights of the Indians of the Americas that was being held in Rotterdam. The Tribunal revealed to him the plight and denial, in his words, of "collective rights of Indigenous peoples globally … you name it, all over the world" (pers. comm., 10 Sep. 2008). Since that time, he reflected, he had viewed West Papuans' struggle as part of a larger struggle of Indigenous peoples around the world rather than an ethnonationalist one. "This is where I differ", he reflected, "with most of the West Papuans. Because I am not interested in West Papua as such. … It's not only Indonesia, it's also Australia, it's also [the] US, it's also India, Brazil, you name it." Your "cultural entity is your starting point" for independence, as is acknowledging your interdependence with other people, Viktor theorised. It was his view that if West Papuans continued to fight for an independent state, they would perish doing so, because Indonesia was unswerving in its claim over West Papua, and the international community was not receptive to Papuans' pleas for their own state.

By switching their focus from gaining statehood to preserving their Indigenous cultures, West Papuans might just survive, Viktor believed. It was with this conviction that he became instrumental in developing the Dewan Adat Papua, or Papuan Customary Council, in Papua in 2002. The DAP, as it is known, was established, according to Viktor, to "restore the Indigenous rights in West Papua regarding their natural resources and cultural heritage": that is, "to fight [for] cultural heritage" rather than for "political independence" (pers. comm., 2008; see also Papua Customary Council *et al*. n.d.). Using an international legal framework of Indigenous rights, Viktor hoped, would give West Papuans a benchmark against which they could hold Indonesia accountable at the international level for its treatment of them: "Now intellectually speaking, being part of the UN, Indonesia has to live up to the commitments internationally. Whether they do it or not, that's not the point. For me, I can say listen, this is the format that you have,

you have to stand up for this", he told me. Focusing on Indigenous rights rather than on independence would serve two purposes, Viktor reasoned. First, it would give West Papuans an opportunity to engage in a process of ownership—not of a state, but of their "destiny", to be able to say, "I own my future, I own my past, I own my cultural heritage". And second, by working together on this trajectory, he hoped West Papuans would realise that they would never be meaningfully independent from Indonesia nor from global capitalism—they could, rather, form a powerful interdependence with Indigenous peoples from around the world. To underscore his point about interdependence, he recounted a story of a West Papuan highlands elder who suffered a heart attack upon hearing that the New York stock exchange had collapsed. The value of the elder's people's resources (extracted by American mining giant Freeport-McMoRan) had plummeted on the stock exchange, and suddenly, the elder's bank account was empty. What does independence mean anyway, Viktor asked me rhetorically, in the context of a globalised economy that allows Indigenous groups little to no control over their resources? Would it not be better for West Papuans to abandon the outmoded ideal of a nation-state in a globally corporatised world and join forces with this newly significant and emerging player in international relations—Indigenous peoples?

During the 1990s, Nancy Jouwe, also based in the Netherlands and the daughter of another prominent early architect of the West Papuan independence movement, Nicolaas Jouwe, became involved in the West Papuan Indigenous rights movement. As a feminist and young activist, she told me during an interview (12 Sep. 2008, Utrecht) that she "spoke at a couple of international fora, especially the Indigenous fora. At that time, this is the beginning of the 90s, all these UN conferences sprung up and every year there was somewhere a UN conference on something. They had the women's decade, and then you had the Indigenous decade, and all these preliminary meetings and so during '93 to '97, on a yearly basis, I would go to a couple of those meetings and speak on Papuan issues." Like Viktor, Nancy invested her activist efforts in Papuan cultural survival and resurgence rather than independence. Interestingly, Nancy's father, Nicolaas, and Viktor's father, Markus, were embroiled in a bitter feud over the best way to carry out the West Papuan independence campaign (Farhadian 2005: 73). The dispute among the patriarchs, according to scholar Charles Farhadian, was region-of-origin based (p. 73). Jouwe was from the Sentani region near the West Papua/Papua New Guinea border and Kaisiepo was from Biak Island on the far western side of the territory. Jouwe complained that Kaisiepo always insisted on being in charge—a typical Biaker trait, he claimed (in Farhadian 2005: 73)—and each had their own competing ideas for leading West Papua to independence. It is

perhaps no coincidence that their children, Viktor and Nancy, stepped away from the "do or die" commitment to West Papuan independence that had characterised the ethnonationalist movement for so many years and caused deep rifts among leaders. Instead, they chose to work towards what they saw as the less ideologically charged goal of accommodating and safeguarding the many Indigenous peoples of West Papua *as they were*, avoiding the demands of bringing into existence one national people in the context of the unreceptive international political climate of the day.

INDONESIA ULTIMATELY REFUSES TO RECOGNISE WEST PAPUAN INDIGENOUS RIGHTS OR STATEHOOD

Despite efforts by West Papuan activists including Viktor, Nancy and several of their peers to lobby for West Papuan Indigenous rights at the UN and to mobilise West Papuans in support of their Indigenous rights, Indonesia was unresponsive. On the one hand, this was surprising because in formally granting West Papuans Indigenous status, Indonesia could have mitigated some of the international criticism from other states and NGOs it continues to encounter over its apparent disregard for West Papuans' right to self-determination and other human rights (see Hadiprayitno 2015: 133–35). Instead, the state has displayed contempt toward the pan-Papuan nation *and* towards Papuan Indigenous nations, seeking to eliminate the first and deny the existence of the second. On the other hand, one can perceive the logic in Indonesia's refusal to recognise special rights for West Papuans. To do so would likely result in pressure on the state to extend the same recognition to the myriad other peoples in Indonesia[5] meeting the criteria for indigeneity set out in Martínez Cobo's definition. Instead, to maintain control of a sprawling, multiethnic archipelago, Indonesia works assiduously and at times ruthlessly to unify, through assimilation, the many cultural, ethnic and Indigenous identities of the peoples living within its borders. Presumably for this reason, and although it is a signatory to the UNDRIP, Indonesia has still not formally acknowledged the presence of Indigenous peoples within its borders.[6] Instead, in its constitution and various laws that deal with natural-resource use and cultural expression, Indonesia refers to the custodians of these resources and cultures variously as customary, traditional or remote peoples (People's Consultative Assembly 1945). The state has made "no modifications … to account for the different socio-economic, political, and cultural differences that distinguish[] [West Papua] from the rest of Indonesia" (Bertrand 2011: 856). Indonesia's former president Suharto once argued that either all of Indonesia's people are Indigenous or none of them are, as nearly all its ethnic groups lived within the state's boundaries prior to Dutch colonisation and then Indonesian independence (see Lawson 2014: 2).

This logic is problematic, however, for several reasons. First, it is internationally and legally accepted that "who is Indigenous" can only be determined by Indigenous communities themselves, not states or international organisations[7] (Corntassel 2003: 75). Therefore, when West Papuans identify as Indigenous, Indonesia cannot, under international law, say that they are not. Second, when Indigenous groups from one part of Indonesia, for example, Java, migrate en masse to another part, for example, West Papua, appropriating the latter's resources and cultures, as has happened under Indonesia's massive, sponsored transmigration programme, conflict resolution options outside of those offered through an Indigenous rights framework are limited for the aggrieved party. And third, when domestic and foreign businesses exploit Indigenous resources, as Freeport-McMoRan's gold and copper mine, BP's gas plant, and a multitude of overseas-owned wood-felling operations and oil-palm plantations are doing in West Papua (see Ballard 2002 for examples), Indigenous peoples have no legal recourse *as Indigenous peoples* to advocate for themselves. At a very basic level, Indonesia's claim that all its peoples are Indigenous[8] in the sense that their existence predates current nation-state boundaries might be true, but using this logic to argue that they therefore do not need specially recognised Indigenous rights is highly problematic in the context of intra- and interstate migration and foreign depredatory business practices. It also gives Indonesia scope to continue its exploitation and occupation of West Papuan peoples and resources whilst evading international accountability frameworks.

Indonesian Accommodation

Jacques Bertrand argues that a key reason West Papuans have had such little success in pressuring Indonesia to recognise their status as Indigenous peoples is because they have simultaneously "maintained demands as a nation" (2011: 852). But given the danger West Papuans are faced with in living as West Papuans in West Papua every day, "playing the 'indigenous' card" as well as the "nation card", as Bertrand puts it (p. 852), makes sense in terms of covering all potential bases for securing human rights. Bertrand writes that West Papuans' greatest hope of making gains in terms of achieving Indigenous rights status and treatment in Indonesia was at the time of constitutional change, during the Reformasi period in 1999 when Indonesian dictator Suharto was deposed and the state was at its most vulnerable (p. 866). According to Bertrand, West Papuans did not take sufficient advantage of this opportunity, perhaps disheartened in the face of ongoing Indonesian state dismissal of their Indigenous rights campaign (p. 852; see also Ballard 2002). Around this time, the struggle for Indigenous rights appeared to fall away while West Papuan activists pressed their claim for nation-state sovereignty more persistently than ever.

Encouraged by Indonesia's granting of a referendum on independence to East Timor, a group of 100 West Papuan leaders visited Suharto's successor, B.J. Habibie, in the presidential palace, and petitioned him directly for independence, going "all in" with the "nation card". Habibie was reportedly shocked, and at a loss for a response (MacLeod 2015: 126). In a move both *realpolitik* and seemingly progressive, Indonesia's next president, Abdurrahman Wahid, a "soft-liner" compared with his compatriots, tried to temper West Papuans' independence demands by offering regional autonomy. This offer was consolidated in a law known as Special Autonomy that came into effect in 2002, representing the closest act by Indonesia to recognising West Papuans as Indigenous people with special rights, although the text of the bill never uses the term "Indigenous". An all-Papuan team was established to assist in formulating the arrangement, and the draft developed by this team was "impressive", according to analyst Peter King: "It combined far-reaching measures to achieve genuine autonomy and Papua-friendly democratisation, and it also proposed rigorous measures for the protection of human rights and Papuan traditional (*adat*) rights" (King 2004: 83). The version of the law that was ultimately adopted by Jakarta, though, was far more limited and limiting. While Papuans were permitted the freedoms of flying their flag, renaming their province (from Irian Jaya to Papua), selecting a "native Papuan" governor (Indonesia Law No. 21 2001, Article 12) and establishing an all-Papuan upper house, and although the law allowed for a substantial return of resource revenue to Papua (King 2004: 83–89), it fell short of the original Papuan draft in significant ways. There was no official end to government-sponsored transmigration, no option for a new referendum on Papua's political status and no "Commission for the Rectification of Papuan History" (pp. 88–89). Even so, some prominent West Papuan leaders continued to promote the promise they saw in the law. Viktor Kaisiepo, for example, declared himself "in favour of" Special Autonomy, which, he reasoned, "simply says the neglect of West Papuans as an Indigenous part of Indonesia for the last 38 years requires a different type of approach. … I am a supporter of that law, and I am preaching it all over the world … that [it] is going to look after the Indigenous heritage of the West Papuans irrespective of whether they are under Indonesian control, Australian control, US control or whoever's control" (pers. comm., 2008).

The Failure of Special Autonomy as the Failure of Indigenous Rights

It was clear by 2003, however, that the Special Autonomy law was not being properly implemented and that the state will to do so did not exist. The central government delayed establishing the MRP—the all-Papuan upper house—for four years. Under Special Autonomy, the MRP alone was imbued with the power to create or reject proposals to administratively divide Papua

province. Therefore, when Wahid's successor, Megawati Sukarnoputri, made the executive decision to split the territory in two and create a Papua Barat province in Papua in 2003, before the MRP had come into existence, she was undermining the Special Autonomy law, and her actions were widely seen amongst West Papuans as a divide-and-rule tactic (Mietzner 2007: 4–7). The money flowing back into West Papua ultimately found its way into corrupt pockets of elite administrators, and with no mechanisms for accountability, these funds did nothing to better the lives of ordinary Papuans (King 2004: 90). Under Special Autonomy, militarisation increased in West Papua, Indigenous leaders were murdered with impunity, the number of political prisoners multiplied and the use of terror by security forces against Indigenous people increased (MacLeod 2015: 131–36). In 2005, the DAP led a demonstration of between 10,000 and 15,000 people who marched with a coffin marked "OTSUS" (an abbreviation of the Indonesian term for Special Autonomy: Otonomi Khusus) to the provincial parliament building in Jayapura (p. 147). The message conveyed was that Special Autonomy was considered dead by Papuan Indigenous people and was being handed back to the Indonesian government. When I interviewed the head of the DAP, Forkorus Yaboisembut, in 2008, he no longer held out hope for Indigenous rights being fulfilled under the governance of the Indonesian state. He told me: "Experience [has] demonstrated that even the promotion of Indigenous West Papuan rights, cultures and traditions [was] considered a separatist activity under Indonesian colonialism" and that it was no use campaigning for Indigenous rights when basic human rights were being violated. Therefore, the "pursuit of independence [in Yaboisembut's view] must precede the pursuit of Indigenous rights" (pers. comm., 2008).

In 2004, when presented with the opportunity to respond to a "critical" report on West Papua tabled at the UN Permanent Forum on Indigenous Peoples, instead of commenting on the allegations, Indonesia simply stated that West Papuans were not Indigenous (Hadiprayanto 2017: 21) and that therefore the report had no standing. It is evident that Indonesia signing the 2006 UNDRIP has done little to improve the plight of West Papuans. This is glaringly obvious in several major mining and agrobusiness ventures in West Papua which have wreaked havoc in Indigenous communities. Anthropologist Chris Ballard (2002) describes how the exploitation of West Papuan copper, gold, gas, oil and timber by extraction and plantation industries has placed immense pressure on Indigenous lands: "The way in which these industries acquire land and exploit resources that West Papua's indigenous people consider theirs is one of the most important sources of local conflict and fuels the West Papuan desire for independence from Indonesia", he contends. "In theory", a joint DAP submission to the Universal Periodic Review of the United Nations Human Rights Council (Third Cycle)

13th Session states, "indigenous landowners have the right to legal recourse through the Basic Agrarian Law 1960 but can only attempt to claim land where the court deems such a claim would not impede national interest. As a result, there is no provision of legal protection for indigenous communities by the state" (Papua Customary Council n.d.). Ballard (2002) cites this lack of legal remedy for Indigenous landowners as the reason many Papuan communities concede to deals with government agencies and businesses that are highly exploitative—Papuans do not feel they have any alternative.

The Merauke Integrated Food and Energy Estate (MIFEE), an Indonesian government sponsored mega-agribusiness project in Merauke, West Papua, is a case in point. MIFEE analyst Irene Hadiprayitno describes the project as a 1.2-million-hectare plantation launched in 2010 for "cash crops and biofuels … [that was] designed as an integral part of the Master Plan for Acceleration and Expansion of Indonesian Economic Development … [and] launched by [former] Indonesian President Susilo Bambang Yudhoyono" (2015: 129). In 2017, Hadiprayitno found that MIFEE had "attracted investments from 36 companies" (2017: 16). A detailed investigation undertaken by the Gecko Project and Mongabay, both environmental advocacy journalism organisations, focusing on exploitation of the Marind-Anim people of Merauke by the Korindo Group, a "privately owned conglomerate that had been logging Indonesia's rainforests since the 1970s", found a gross violation of the UNDRIP principle that users of Indigenous peoples' resources obtain "free, prior and informed consent" from those people (Gecko Project and Mongabay 2020; United Nations 2006; Chao 2019). In many instances, permission to use lands has never been sought from appropriate Indigenous leaders. In others, promises of oil-palm smallholdings were made but never kept. Negotiations with Indigenous communities took place with security forces present, and communities were coerced to hand over their lands. In some cases, local people did not understand that their customary land would revert to state ownership after the expiry of leases: "They didn't know that land would never be returned to them" (Gecko Project and Mongabay 2020). The Indonesian state's presence is felt not as a protector of Marind rights but as an enforcer of exploitative business practices. In the meantime, biodiversity is being demolished. The Marind people, according to Marind activist Rosa Moiwend and her fellow researcher Paul Barber, "identify themselves with the natural features of the land and environment" (Barber and Moiwend 2011: 45). They "recognise their ancestors and their ancestral lands through the presence of specific symbols such as trees, bamboo plants and the like" (p. 46). It is probable, they contend, that "the next generation of [Marind] people will no longer sing: 'I grew up together with the wind, together with the leaves, together with the sago, together with the coconut trees.' Instead, they will sing: 'I grew up without the wind, without the leaves,

without my sago village. I know nothing about my *Dema*, the symbol of my tradition, my language, my homeland. I will no longer be able to talk about my origins. All I will be able to say is that Papua is the land of my ancestors, the land where I was born'" (p. 49).

WEST PAPUANS ENACT SELF-DETERMINATION, PURSUING A STATE WITH AN INDIGENOUS WEST PAPUAN IDENTITY

Even if Indonesia did acknowledge the jurisdiction of the UNDRIP over West Papuans, the sovereignty entailed in the Declaration is perceived by West Papuans as insufficiently comprehensive. The UNDRIP merely "limits the unilateral sovereign power of the state over indigenous collectives", legitimising "non-state challenges to the total authority of the state" (Nicol 2017: 796–97). It may not, as the Declaration states, be "construed as authorizing or encouraging any action which would dismember or impair, totally or in part, the territorial integrity or political unity of sovereign and independent States" (UNDRIP 2006, Article 46). While this may be a moot point for many Indigenous peoples operationalising the UNDRIP, Niezen (2003: 203) writes that "Indigenous peoples … do not as a rule aspire toward independent statehood" (see also Graham and Wiessner 2012: 410). This caveat to self-determination poses a serious problem for West Papuans wishing to secure their future existence as a national people and as Indigenous peoples in their own state by invoking international Indigenous rights law. Thus, when appealing to international law, West Papuans tend to hang their hopes on an earlier UN declaration—the 1960 Declaration on the Granting of Independence to Colonial Countries and Peoples—and on two covenants which, having the advantage of being legally binding for those who have ratified them (declarations, by contrast, are not), also "provide for secession as an option in situations in which states are violating a people's basic human rights and fundamental freedoms" (Niezen 2003: 204): the 1966 ICESCR and the 1966 ICCPR (see Ondawame 2010: 29). In addition to these laws, West Papuan politician and academic Otto Ondawame cites Resolution 1541 (XV) of the UN General Assembly, 1960—Right to Self-Determination, which sets out the criteria for non-self-governing territories to become fully independent nation-states (2010: 29). The Resolution states that "the integrating territory should have attained an advanced stage of self-government with free political institutions, so that its peoples would have the capacity to make a responsible choice through informed and democratic processes" (United Nations 1960: Annex, Principle IX).

Following the directive in Resolution 1541, West Papuans have recently begun to establish an advanced form of self-government. David Webster described West Papua as a "notion-state" in 2002 (p. 527), and West Papuans as a people who had avoided colonisation of the mind if not of governance.

But this designation was made before West Papuans had united their various independence-seeking factions under the United Liberation Movement of West Papua (ULMWP) in 2014. Since 2014, Papuans have demonstrated determination to become more than just a "notion-state", actively practising sovereignty under the governance of the ULMWP despite the absence of Indonesian recognition of their nation or of their Indigenous peoplehood. In 2020, the ULMWP announced it was forming a "Provisional Government … to mobilise the people of West Papua to achieve a referendum on independence, after which it will take control of the territory and organise democratic elections" (United Liberation Movement for West Papua 2020). Benny Wenda, a West Papuan activist living in exile in England, was declared interim president of the Provisional Government, and a provisional constitution was drafted. In 2021, 12 departments and cabinet positions were created, although ministers' names were not announced due to "intense political repression [by] the Indonesian regime" (United Liberation Movement for West Papua 2021). For decades, West Papuans had waited for recognition from Indonesia and from the international community of states in order to start acting like a state.[9] In 2020, they took matters into their own hands and began practising statecraft in self-recognition of their sovereignty.

The Provisional Government has incorporated Indigenous priorities in its vision for West Papua, identifying West Papua as the world's first intentionally Green State. Interim president Wenda has stated his vision thus:

> Before Dutch and Indonesians arrived, there was a green state already, before Europeans colonised us. [We were] friends with the mountains, friends with the river ... We didn't have the culture of cutting the trees and mak[ing] palm oil plantations, [of] irrigat[ing] massive areas and plant[ing] the rice, [of] pollut[ing] the river to destroy the huge mountain. River is our pool, we are all connected between mountain ... The greediness of the modern world is destroying our nature, our culture, our identity. Our mission is to liberate ourselves from the Indonesian colonialism. We need a vision for the future of where we are heading. We want to say to the world that we have a provisional government and a vision to match it. We want to restore the balance. If we want to save the planet, West Papua is a solution. West Papua is a lung of the world. Restore the damage by the company working with the Indonesian government. (Benny Wenda, pers. comm., 14 Sep. 2021)

This more-than-notional state has presented a policy combining the rhetoric of indigènitude with a proposal for addressing one of the world's current and foremost concerns—climate change. West Papuan Indigenous ways of life and practices have been desecrated under Indonesian rule, but the Provisional Government is keen to signal that West Papuan sovereignty asserts a very different approach.

Despite the difficulties West Papuans have faced thus far in their attempts to pursue self-determination/state sovereignty using international Indigenous rights infrastructure, primarily because Indonesia refuses to acknowledge that West Papuans are Indigenous, the ULMWP maintains a presence at pertinent fora. Its representatives take advantage of any opportunity they can to be heard, although still with limited success. For example, in 2016 and in 2019, the ULWMP sent West Papuan representative John Anari as its ambassador to the UN Permanent Forum on Indigenous Issues. In 2019, Anari made an intervention in the Forum during a session which had convened to discuss selection criteria for Indigenous representation at the UN. Part way into presenting the history of the UN's betrayal of West Papua in 1969, he was twice interrupted by the Forum's chair for being "off-topic", and his chance to speak was revoked (West Papua Liberation Organization 2021). ULMWP representative Herman Wainggai also attended a UN General Assembly session in 2019. When invited to speak, he identified himself as a West Papuan Indigenous leader concerned that "West Papua, as an Indigenous people, we're still living under the situation that the Indonesian government doesn't recognise our right as Indigenous people" (Wainggai 2019). He continued, "We encourage, in this forum, the United Nations … state members to let Indigenous people exercise their rights in their own country" (Wainggai 2019). When an Indonesian delegate was asked to respond to Wainggai, the delegate replied that his delegation was "compelled just to note again [Indonesia's] disappointment that this forum remains used by certain individuals that raise the agenda of which is not due to be discussed at this meeting. We regret that once again this forum has been used for baseless propaganda against the purposes of and principles of the Charter of the United Nations" (see Wainggai 2019). These sorts of exchanges, in which Papuans are rebuked for raising the injustice of their situation, reinforce West Papuans' belief that Papuan state sovereignty is a precondition for the recognition of Papuan Indigenous sovereignties at the international level and the realisation of the same at the local level.

CONCLUSION

Indonesia refuses to recognise the presence of Indigenous peoples within its state borders, ergo, it does not consider the first peoples of West Papua to be Indigenous. While it is straightforward enough to argue that Indigenous status is something that is self-designated, i.e., only West Papuans—not Indonesians—can decide whether they are Indigenous, this is cold comfort to West Papuans who, living under conditions of genocide (Elmslie and Webb-Gannon 2013), have no recourse under Indonesian law to the rights internationally accorded Indigenous peoples. Rather than relying solely

on Indigenous rights to limit cultural erasure and alleviate the oppression they have experienced during decades of Indonesian occupation, Papuans have followed a two-step strategy that seeks first state sovereignty for the pan–West Papuan nation (not an "Indigenous state" per se, but one with Indigenous leadership and Indigenous-friendly policies) that in turn will facilitate West Papuan Indigenous sovereignties (Webb-Gannon 2021: 66). Indigenous practices such as those Arnold Ap documented and broadcast, and the practice of indigènitude as expressed in the performances of the Black Brothers, exerted considerable influence on the formulation of a West Papuan national identity even prior to the ascent of the global Indigenous rights movement. Several West Papuan activists, however, disenchanted with the lack of response from the international community to West Papua's ethnonationalist pursuit of a state, and with the unremitting violence experienced by West Papuans under Indonesia's iron grip, wondered whether Indigenous rights might offer an alternative route to self-determination for West Papuans. But with Indonesia's ongoing refusal to recognise West Papuans as Indigenous, the extent of what Papuans could achieve via representation at UN fora was limited. The Reformasi period in Indonesia engendered a renewed push for independence by Papuan activists. The resulting desultory effort from Indonesia to assuage Papuan demands in the form of Special Autonomy, a de facto acknowledgement on paper, if not in implementation, of Papuans' Indigenous rights, was ultimately rejected by Papuans as disingenuous and unhelpful. West Papuans, instead, have progressively pursued sovereignty on their own terms, intent on establishing a state for the West Papuan Indigenous nation(s) which can then, they anticipate, honour West Papuans' Indigenous rights. Of course, statehood offers no guarantee that all West Papua's Indigenous peoples' rights will be equally respected, nor that a West Papuan state would be immune from committing human rights violations against Indigenous and non-Indigenous citizens of its state (see Niezen 2003: 98–110). But then, nothing in politics is guaranteed. As long as West Papuans are entitled to self-determination, and as long as self-determination is denied them under Indonesian rule, history has demonstrated that West Papuans will maintain their pursuit of this so-far elusive right via whatever means available.

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NOTES

1. In this article, in solidarity with West Papuans who have never ceded their land, I use the term "West Papua" to refer to West Papuans' territory.
2. West Papuan academic Elvira Rumkabu comments that outsiders frequently erroneously view West Papuans as a single entity, whereas Papua is diverse—"we cannot say that Papua is one single identity" (2022).
3. Mohammad Shahabuddin argues that "international law, as a core element of the ideology of the postcolonial state [read here, Indonesia], contributes to the marginalisation of minorities" (2020: 1).
4. Although it may also be argued that one is born into an "ethnicity" and that indigeneity practises its own sort of creed.
5. The Indonesian Bureau of Statistics identified 1,072 ethnic "codes" in Indonesia in 2020 (Aspinall 2011: 292).
6. It is worth noting that Indonesia is not alone in its reluctance to acknowledge the presence of Indigenous peoples in its state. Benedict Kingsbury describes the questioning of the relevance of such a political category to Asian countries as the "Asian controversy" in which "several governments of Asian states argue that the concept of 'indigenous peoples' is so integrally a product of the common experience of European colonial settlement as to be fundamentally inapplicable to those parts of Asia that did not experience substantial European settlement" (1998: 418). It is not European colonial settlement in relation to which West Papuans are claiming Indigenous status, though, but Asian-Indonesian colonisation, so pleading along the lines of the so-called Asian controversy probably does not exonerate Indonesia from its own annexation of West Papua.
7. "In 1977 … the second general assembly of the World Council of Indigenous Peoples (WCIP) passed a resolution stating that 'only indigenous peoples could define indigenous peoples'" (Corntassel 2003: 75).
8. With the exception of Chinese people and perhaps Arabs (Bertrand 2011: 853).
9. This notwithstanding the various declarations of independence since 1971, all of which failed due to lack of internal support and factionalism.

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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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THE ORIGINS AND DISPERSAL THROUGHOUT THE PACIFIC ISLANDS OF FEHI BANANAS (*MUSA* SERIES *AUSTRALIMUSA*)

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ABSTRACT: Fehi bananas are a Pacific Islands and eastern Indonesian assemblage of parthenocarpic diploid and triploid cultivars in *Musa* series *Australimusa*. Fehi cultivars were derived principally from *M. maclayi*, *M. lolodensis* and *M. bukensis s.l.* and related entities. Eleven Fehi cultivar groups comprising morphologically similar cultivars are described, along with naturalised forms from eastern Polynesia. Fehi cultivars have been referred to particular species such as *M. troglodytarum* and

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M. fehi, but further genetic research is needed to ascertain how human-selected cultivars are interrelated and derived from any particular species.

Keywords: Australimusa biogeography, *Callimusa*, crop wild relatives, Fehi bananas, Micronesia, Polynesia, Makira Island (Solomon Islands), Tahiti, historical linguistics of Fehi, Fehi origins and dispersals

DEDICATION

This paper is dedicated to the Pacific Islanders who selected and maintained Fehi cultivars and the intrepid voyagers who sailed throughout the Pacific carrying and dispersing Fehi and many other crops; to Dr Richard Markham (1956–) for his inspirational leadership of the International Network for the Improvement of Banana and Plantain (INIBAP) (2003–2008) and as Pacific Crops research programme manager at the Australian Centre for International Agricultural Research (ACIAR) (2010–2019); and to the late Dr Lois Englberger (1949–2011) for her passionate human nutritional work in the northern Pacific, promoting the conservation and use of Karat and other Fehi bananas.

The worldwide familiarity with bananas conceals an ancient and complex history in the Asia-Pacific region, home to a rich profusion of types never seen by most consumers. The biogeographical, taxonomic and cultural histories of bananas are the subject of a huge literature that is increasingly specialised, drawing on rapidly advancing biomolecular methods as well as new insights from other fields such as archaeobotany and linguistics. This interdisciplinary research, crucial to the conservation and improvement of the world banana crop, has a long history. Its emerging consensus is rewriting earlier, oversimplified outlines of the botanical and cultural origins of cultivated bananas, revealing ever greater complexity (e.g., Cenci *et al.* 2021; Christelová *et al.* 2017; Fu *et al.* 2022; Perrier, De Langhe, *et al.* 2011; Perrier, Jenny, *et al.* 2019; Sardos, Breton, *et al.* 2021).

This paper focuses on one iconic Pacific type of banana, the Fehi banana. While bananas all belong to the genus *Musa*, Fehi bananas are botanically distinct. They were domesticated from wild ancestors belonging to series *Australimusa* (Cheesman) Simmonds (sect. *Callimusa*), while most cultivated bananas, including the commercial Cavendish, were domesticated from sect. *Musa* species[1] (all notes are provided as on-line supplementary information at https://thepolynesiansociety.org/thomson_etal_SI.pdf). Species and cultivars within series *Australimusa* are genomically different from sect. *Musa* species (Janssens *et al.* 2016; Simmonds and Weatherup 1990) and are represented by *M. textilis* Née (T genome). Both *M. textilis*—the fibre crop *abacá* 'Manila hemp'—and Fehi bananas have received far less attention than the commercially important bananas of sect. *Musa* grown for fruit.

In the literature cited above, Fehi are hardly mentioned, yet their biological and cultural histories, including pathways to domestication and subsequent spread by people in the Pacific, are entangled with the other Pacific bananas. We include new data from recent collections and reassess the origins and spread of Fehi cultivars throughout the region. We hope that our attention to this neglected group will stimulate further research, especially much-needed comprehensive genetic, cytological and morphological assessments.

Bananas, including Fehi types, are believed to have been carried by Lapita colonists from the western Pacific into Remote Oceania, during the initial colonisation of Polynesia around 3000–2800 BP (Barrau 1959: 49; Kirch 1997: 205, 218; Kirch and Green 2001: 122–25). Kennedy (2008) pointed out that the generalised inclusion of bananas as part of the foundation of Polynesian agriculture oversimplifies the botanical complexity of multiple, distinctive lineages of Pacific banana cultivars, including, but not limited to, Fehi bananas, a complexity that is poorly reflected in a literature full of terminological confusions. She reviewed new evidence of the multiple biogeographical origins of Pacific bananas, which strongly suggests similarly complex dispersal pathways. The linguistic evidence summarised by Kirch and Green (2001: 123) distinguishes Oceanic cultivated bananas as Fehi and the rest (i.e., series *Australimusa* and sect. *Musa*, respectively). This distinction has frequently given rise to the mistaken assumptions that only Fehi bananas derive from wild species indigenous to the New Guinea region, that the sect. *Musa* cultivars were introduced from the west and that reconstructed terminologies will reflect this. But, since this simplification of the New Guinea–region bananas is no longer tenable, more detailed evidence is needed to facilitate reconstruction of the terminologies of early Lapita times. Despite much speculation, it is not known precisely which cultivars were locally available, nor which might have been imported by Austronesian-speaking colonists (Kennedy 2009a; Ross 2008).[2] The definition, chronology and distribution of Lapita sites continue to be refined and debated (Bedford *et al.* 2019). Other Pacific staple crops, notably breadfruit (*Artocarpus* spp.), sweet potato (*Ipomoea batatas* (L.) Lam.), taro (Araceae spp.) and yams (*Dioscorea* spp.), have presented similar problems of rationalising terminological and biogeographical data, as documented in a considerable body of literature (Ballard *et al.* 2005; Kennedy and Clarke 2004: 27–29; Langdon 1989; Lebot 1999; Matthews 2014; Ross 2008; Yen 1974b, 1993; Zerega *et al.* 2006).

The Fehi bananas, sometimes referred to as *M. troglodytarum* L. or *M. fehi* Bertero ex Vieill.,[3] represent a distinctive Pacific Islands, New Guinean and eastern Indonesian assemblage of cultivars in *Musa* L. series *Australimusa* (Daniells and Janssens 2021; Kagy *et al.* 2016: 8; Kennedy

2008, 2009a; Sharrock 2001; Simmonds 1959: 65–75). Häkkinen (2013) formalised reduction of genus *Musa* taxa into two sections, viz. sect. *Musa* (including Baker's subgenera *Eumusa* and *Rhodochlamys*) and sect. *Callimusa* Cheesman (including sect. *Australimusa* Cheesman and sect. *Ingentimusa* Argent (Baker 1893; Cheesman 1947, Argent 1976). Recent phylogenetic analyses strongly support two clades (Burgos-Hernández *et al*. 2019; Fu *et al*. 2022; Janssens *et al*. 2016). We have used the term series to distinguish *Australimusa* cultivars and their assumed progenitors, following Simmonds's (1959: 52; 1962: 101) usage. This monophyletic easterly distributed clade is characterised by a unique set of morphological characters (Daniells and Janssens 2021).

Series *Australimusa* bananas are characterised by more or less erect bunches of seedless edible fruits; starchy yellow-orange, sometimes greenish-tinged, pulp rich in carotene precursors; and typically a red-purple sap exudate from the cut pseudostem (MacDaniels 1947; Simmonds 1959: 65). Members of the group have a complex and unsatisfactory taxonomic history including the naming of dubious, incompletely described and/or conspecific "species",[4] and misapplication of their names (Cheesman 1949; Häkkinen *et al*. 2012; MacDaniels 1947: 15–23; Sagot 1893: 222; Simmonds 1959: 66). From the start of European taxonomic work, there has been confusion, because the bananas described by Linnaeus as *M. troglodytarum* included two entities now referred to different sections of the genus. *Musa troglodytarum* has since been lectotypified so as to be based on Rumphius's *M. uranoscopus* of 1747 and also referred to sect. *Callimusa* (Merrill 1917: 150).

Musa troglodytarum is a cultivated banana from Ambon, Buru, Haruku, Kei Besar, Saparua and Seram in Maluku Province, eastern Indonesia (MacDaniels 1947: 16), where it is known locally as *tongkat langit pendek*, *tongkat langit kecil* and *telo mata lala* (Hermanto *et al*. 2014: 5, 12). Rumphius (1747: 137) described it as having flattened, brown seeds in five or six longitudinal rows. These seeds are vestigial and non-viable according to our observations and a report in MacDaniels (1947: 16), both in accord with its triploid status (Hermanto *et al*. 2014: 5; flow cytometry analysis at the International Banana Genotyping Centre in the Czech Republic). *Musa troglodytarum* is morphologically distinct from the New Caledonian *M. fehi* Bertero ex Vieill.,[5] with which it has often been merged (MacDaniels 1947: 16–18). A stark difference is in the male inflorescence: the male peduncle of *M. troglodytarum*—based on Rumphius's *M. uranoscopus*—is pendent (Rumphius 1747: t. 61) and the male bud (or bell) is green, smooth and narrow, and up to 30 cm long (Rumphius 1747: 137), while the male peduncle of *M. fehi* is erect (Vieillard 1862: 45) and short with few (6–12) acuminate, spreading, cream to pale whitish-green bracts (and closely

resembling *M. troglodytarum* var. *acutaebracteata* of MacDaniels 1947: 21). *Musa troglodytarum* has several morphological resemblances to the wild *M. lolodensis* Cheesman, from eastern Indonesia and New Guinea, making the latter a candidate ancestor of the cultigen.

Fehi bananas include both diploid and triploid cultivars[6] (Sardos, Christelová, *et al.* 2018) with 2n = 20 and 3n = 30, but few cultivars have been examined for their ploidy level. Accordingly, there is a need for the ploidy levels of more Fehi cultivars to be assessed, through flow cytometry and direct chromosome counts. By comparison with the more widespread, commercially important cultivars of sect. *Musa*, the Fehi cultivars and their relationships to wild relatives have been given relatively little attention in molecular studies (Christelová *et al.* 2017; Čížková *et al.* 2015; Davey *et al.* 2013; Fu *et al.* 2022; Jarret *et al.* 1992; Kennedy 2008; Sharrock 2001). The nearest relatives of Fehi cultivars appear to be a group of Papuasian and Australasian *Musa* species: *M. bukensis* Argent (Fig. 1)—possibly including undescribed entities such as *awawe* (Makira), *ba'u lalao* and *ba'u kokofio* (Malaita) (Fig. 2), *M. fehi*, *M. jackeyi* W.Hill, *M. johnsii* Argent, *M. lolodensis*, *M. maclayi* F.Muell. ex Mikl.-Maclay[7] (Fig. 3) and *M. peekelii* Lauterb: indeed, several of these species have previously been suggested as likely contributors to Fehi/*M. troglodytarum* (Jarret *et al.* 1992; Ploetz *et al*. 2007: 3; Sharrock 2001; Simmonds 1956: 485). Simmonds (1962) considered some of these species, and their subspecies, as rapidly evolving because of the lack of effective genetic isolating mechanisms, but often manifesting as morphologically distinguishable geographical variants. Argent (1976: 96) reported that variation in *M. maclayi* was much greater in the eastern part of its range and suggested that some populations on Bougainville had introgressed with another unknown species. This "unknown" species may be *M. bukensis*, or other possibly undescribed species in series *Australimusa* recorded from the central and eastern Solomon Islands by Daniells (2007) and Sachter-Smith (2011). Fu *et al.* (2022) suggest that the series *Australimusa* species constitute a very recent radiation associated with New Guinea orogeny. Notably, while their sample of these species is more comprehensive than earlier studies, they nevertheless comment that incomplete taxonomic and gene sampling of genus *Musa* remains a barrier to full understanding.

Fehi bananas were first domesticated in Papuasia (Kagy *et al.* 2016; Kennedy 2008, 2009b; Simmonds 1956; Smith 1979: 186) with secondary centres of domestication and selection in Micronesia and Tahiti. It is here considered that most reports of wild, fertile "*M. troglodytarum*" in the southwestern Pacific (Papua New Guinea and Solomon Islands) refer to *M. maclayi,* which produces irregular compressed seeds 6–9 mm across (De Langhe 2009: 273; Mueller 1885: 355). This includes the wild fertile

forms of Fehi from Boana, near Morobe (Papua New Guinea) reported by MacDaniels (1947: 40 & t. 10B—image provided by Mary Strong Clemens (1873–1968)), which match typical *M. maclayi*. Fertile variants of Fehi from near Farino and Canala in the interior of Grande Terre, New Caledonia, appear to be referable to *M. fehi* Bertero ex Vieill. *sensu stricto*.[8]

Figure 1. *Musa bukensis* (*Australimusa*), Autonomous Region of Bougainville (Photo: Gabriel Sachter-Smith). Inset: Cut pseudostem showing purple sap exudate.

Figure 2. *Musa* aff. *bukensis* (*Australimusa*). 2a: *Awawe*, Makira, Solomon Islands (Photo: Jeff Daniells). 2b: *Ba'u lalao*, East Kwaio, Malaita, Solomon Islands (Photo: Gabriel Sachter-Smith). 2c. *Ba'u kokofio*, East Kwaio, Malaita, Solomon Islands (Photo: Gabriel Sachter-Smith).

Figure 3. *Musa maclayi* subsp. *maclayi* var. *maclayi*, Morobe, Papua New Guinea. 3a: Variation in mature bunch (infructescence). 3b: Close-up of fruits. 3c: Longitudinally cut fruit showing seeds. Photos by Axel Poulsen.

IMPORTANCE OF FEHI IN POLYNESIA AND BEYOND

Fehi are cultivated on volcanic high islands and are poorly adapted to low-lying atolls. However, they are grown on the raised coralline island of Niue, and possibly also occur on the Federated States of Micronesia atolls of Mokil and Nukuoro (Caroline Polynesian Outlier), where the local name has been borrowed from Pohnpei (Ken Regh, pers. comm., 2021). In many Pacific islands, cultivars of Fehi have traditionally been important sources of human food, as well as providing dyes and fibres for weaving; like most bananas, many parts of Fehi plants are useful (Kennedy 2009b; Kepler and Rust 2011: 259–60). In Tahiti, they became an important, if not the principal, staple food, being a major source of carbohydrate (Cuzent 1857; Henry 1928: 33; MacDaniels 1947: 5–6; Simmonds 1959: 70–71). In prehistoric times, Fehi (Tahitian *fe̅ ʻī*) cultivars were mostly planted at > 500–800 m elevation

with many small gulches named *peho fei* and *Vallée à fei* ‘fē‘ī valley’ on the land register [https://www.tefenua.gov.pf/]. Nowadays, most fē‘ī fruits sold in Tahitian markets come from lowland plantations, although long-lived relicts of earlier plantings and naturalised fē‘ī survive in difficult-to-access uplands and provide fē‘ī hunters with fruit. Many fē‘ī bunches are left to go to waste and/or are consumed by feral pigs.

In other parts of Polynesia, Fehi were less important as human food, with a much smaller number of cultivars recorded and traditionally exchanged. Fehi cultivars were grown and variously used for food, fibre, dyes and medicines in the Cook Islands (Sardos, Sachter-Smith, Ghanem, *et al*. 2019; Wilder 1931: 33), Hawai‘i (Kepler and Rust 2011: 252–54; MacDaniels 1947: 44–45), the Marquesas (Jouan 1865: 45), Niue (Yuncker 1943: 37–39), Sāmoa (Whistler 1984: 481; 2000: 198) and Wallis & Futuna (Kirch 1978: 166) and on several Polynesian outliers including Rennell and Bellona (Elbert 1975). Fehi were of considerable cultural significance in Rotuma (McClatchey *et al*. 2000: 354; Harieta Bennett, pers. comm., 17 February 2021).

Fehi cultivars appear to have been rather sparingly used for human food in most parts of Melanesia, including Papua New Guinea (Kennedy and Clarke 2004: 24, tables 9 & 10; Sardos, Paofa, *et al*. 2019), Bougainville (Sardos, Breton, *et al*. 2018), Vanuatu (Walter and Sam 2002: 42), New Caledonia (Kagy 1998; Vieillard 1862: 45) and Fiji (Dodds 1946 as *M. fehi*; Seemann 1865: 29 as *M. uranoscopus*; Smith 1979: 186). An exception is Makira (San Cristobal), Solomon Islands—a notable repository of Fehi diversity—with at least nine cultivars still being grown (Daniells 2007; Daniells, Englberger and Lorens 2011; Daniells, Sachter-Smith and Taylor 2016; Englberger, Lyons, *et al.* 2010; Sachter-Smith 2011). Fehi are relatively common and remain important local food sources in Makira, but, even though they are found throughout the main Solomon Islands, they are less favoured as food than are bananas in sect. *Musa* (Yen 1974a: 257).

Apart from Fehi, another distinctive set of Pacific bananas (sect. *Musa* genome AAB),[9] including Maoli and Pōpō‘ulu sub-groups, likely originated in the New Guinea region (Carreel *et al.* 2002; Daniells 1990, 1995; Lebot *et al.* 1993; Lebot 1999). They were ancient introductions to New Caledonia, where they have great cultural significance in Kanak society (Kagy and Carreel 2004; Kagy *et al.* 2016). Fehi bananas also feature prominently in New Caledonian myths and legends, and have special cultural significance in the northeast and east (around Canala) of Grande Terre, as well as on Maré, Loyalty Islands: it was believed that as Fehi were originally found in the forest they could be the origin of all bananas in New Caledonia (Kagy 1998). Fehi have deep symbolic value as the red/purple sap is believed to be the blood of the ancestors, including in Fiji (see p. 296), and accordingly they are sometimes planted around houses for protection. The symbolism, practices and taboos depend on the clan, and associated Fehi creation myths. Red or black colours are always associated with ancestors, but sometimes with evil

spirits, as in Paimboas/Ouégoa in the northeast of New Caledonia. Fehi are often subject to cultural taboos, including prohibitions on the planting and movement of suckers and on the eating of fruits, with consumption on Maré permitted only during famines (Kagy 1998).

In the Federated States of Micronesia (Chuuk, Kosrae, Pohnpei and Yap) Fehi bananas were vital traditional sources of nutrition, for example as an important infant food, while in Pohnpei they were used for traditional offerings to high chiefs (Daniells, Englberger and Lorens 2004; Englberger, Daniells, *et al.* 2018; Englberger, Darnton-Hill, *et al.* 2003). Ironically their consumption declined in some places on Pohnpei, where ill health was spuriously linked to Fehi's effect of turning urine orange-red—the latter being an indication that excess provitamin A compounds were being excreted—in communities where there was chronic vitamin A deficiency. This was addressed in the early 2000s by the Pohnpei Island Food Community, Dr Lois Englberger and Federated States of Micronesia governments, culminating in Karat being declared the State Banana of Pohnpei on 19 October 2005.

In eastern Indonesia, at least four Fehi cultivars—known locally as *pisang tongkat langit*—are used for food (Rumphius 1747: 137, 139, t. 61; Rant 1934), and have been moved and cultivated as far west as Mount Galunggung in West Java (Dwivany *et al.* 2020).

CLASSIFICATION OF FEHI BANANAS

Fehi bananas are a diverse assemblage of cultivars, morphologically and biochemically linked by their erect fruit bunches,[10] red-purple sap exudates and fruits with bright yellow-orange pulp, rich in provitamin A. In order to account for these traits we consider that the majority of Fehi cultivars have a member of the *M. maclayi* complex as the source of at least one of the parental species, as was posited by Simmonds (1956: 485) and De Langhe *et al.* (2009: 169). In other words, Fehi cultivars are considered as mainly comprising a set of selected parthenocarpic clones of *M. maclayi s.l.*[11] and their hybrids with other *Musa* species.

Kepler (2011) determined that major morphological variations among Fehi bananas enable provisional division into nine subgroups. Since 2011, additional banana-collecting expeditions in the South Pacific Islands (e.g., Sardos, Breton, *et al*. 2018; Sardos, Sachter-Smith, Ghanem, *et al.* 2019; Sardos, Sachter-Smith, Shandil, *et al.* 2019; Sardos, Paofa, *et al.* 2019), unpublished genetic and cytological studies and our research for this paper have enabled these subgroups to be revised,[12] as elaborated in the following descriptions. Using the International Code of Nomenclature for Cultivated Plants, we employ the term cultivar group, rather than subgroup, to aggregate morphologically similar and putatively related cultivars in 11 cultivar groups, a naturalised or wild, seeded group being the 12th, as described below and illustrated in Figs 4–15.

Diploid Cultivar Groups[13]

1. ‘Aiori[14]

Ploidy: Diploid.

Pseudostem: 4.5–5.5 m tall,[15] slightly swollen near base, slender (25–35 cm ⌀ near base) then slightly tapering, green without with magenta underlayers, weathering grey-tan or light pinkish-brown, peeling near base, glazed black at base (to 0.6–0.1 m).

Figure 4. Fehi cultivar group ‘Aiori. 4a: *Toraka fagufagu*, Makira, Solomon Islands (Photo: Jeff Daniells). 4b: *‘Aiori*, Hawai‘i, USA (Photo: Forest and Kim Starr). 4c: *‘Aiori piripiri*, Tahiti, French Polynesia (Photo: Maurice Wong). 4d: *‘Aiori varavara*, Nuku Hiva, Marquesas, French Polynesia (Photo: Jean-François Butaud). 4e: *Limot*, Buka Island, AR Bougainville (Photo: Gabriel Sachter-Smith). 4f. *Säe*, Rotuma (Photo: John Bennett).

Inflorescence: Male peduncle erect, short approx. 30 cm long; inflorescence bracts lanceolate, deciduous; typically < 10–25 bract scars, ± terminal, bulbous organ (greenish-yellow with greyish cap).

Infructescence: Bunch elongated/rounded trapezoidal, with 6–12 hands. Fruits (20–) 40–60 (–90) per bunch ± compact/tight, but more open in *ʻaiori māʻa āteatea*, *ʻaiori māʻa varavara*, *toraka parao*. Fruits typically ≤ 12–15 cm long × 4–6 cm ⌀ (up to 18 cm long × 7 cm ⌀ in basal fruits), pedicellate (pedicel ± 4–5 cm long), 3- to 5-angled, ± rounded near apex; style persistent (with curly spent matchstick appearance), apical fruits with persistent beak formed from united flower parts, pericarp yellow-green turning yellow to orange-red with linear-tessellated brownish cracks at maturity, then black and coppery red; ± persistent style (deciduous or short to approx. 5 mm long, curly). Infrequently with viable seeds.

Cultivars/distribution: *Lolu*, *wore* (West New Britain Province, Papua New Guinea), *limot*, *poso-olohi* (Buka, Bougainville), *toraka parao*, *toraka fagufagu* (Makira, Solomon Islands), *soaqa* (Fiji), *säe* (Rotuma, Fiji), *ausulasula* (Sāmoa), *hulahula* (Niue), *ʻaiori* (ten cultivars, Tahiti, French Polynesia), *ʻārutu* (Tahiti, French Polynesia).

2. Baubaunio

Ploidy: Diploid.

Pseudostem: 4–5.5 m tall, stout at base (40–45 cm ⌀), tapering to 30 cm ⌀ (*haʻa*, *djan*) to 6–8 m tall (e.g., *ʻāʻata*, *rūreva, toro aʻiaʻi*); purplish-black at base, grey or greyish-brown in middle, and green apically.

Inflorescence: Male peduncle erect, short. Bracts sharply pointed, green without and cream to pale green within, 6–12 evident in unopened bud, not evenly distributed, deciduous; at maturity the male peduncle reduced to very short, scarred stem (10–15 bract scars), ± few floral remains—truncate, greenish-yellow bulbous stub(s) with a grey-black cap.

Infructescence: Roughly triangular, ± open arrangement of fruits in 8–10 hands; 35–40 (–60) fruits per bunch, largest fruits proximal 15–25 cm long × 3.5–4.7 (–5.5 cm) ⌀, ± strongly angular to cylindrical (at full maturity), fruits allantoid, ± narrowing towards apex with apices curving upwards. Fruits ± sessile or very shortly pedicellate (pedicel 2–4 mm). Infrequently with viable seeds.

Cultivars/distribution: *Toraka baubaunio* (Makira, Solomon Islands), *djan* (Grande Terre, New Caledonia), *ʻāʻata*, *toro aʻiaʻi*, *haʻa, mahani*, *rūreva* (Society Islands, French Polynesia).

Figure 5. Fehi cultivar group Baubaunio. 5a: *Toraka baubaunio*, Makira, Solomon Islands (Photo: Lois Englberger). 5b: *'Utū tūroa*, Rarotonga, Cook Islands (Photo: Gabriel Sachter-Smith). 5c: *Mahani*, Tahiti, French Polynesia (Photo: Maurice Wong).

3. Bonubonu

Ploidy: Unknown (presumed diploid).

Pseudostem: 5–6 m tall, slender (15–20 cm ⌀ near base), uniformly tapering; black at base, then mid-dark green, weathering greyish-tan above.

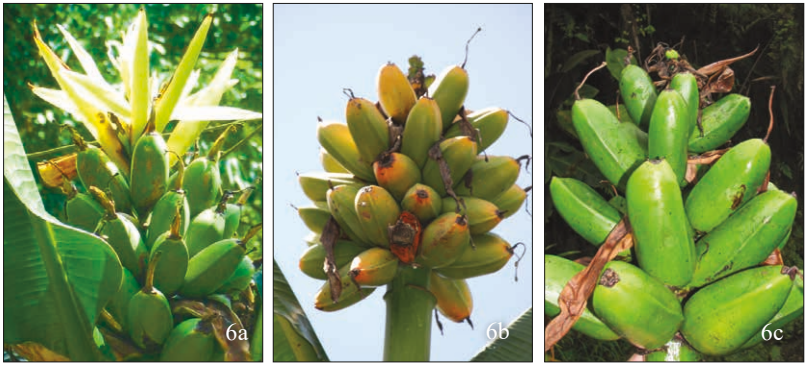

Figure 6. Fehi cultivar group Bonubonu. 6a: *Toraka bonubonu*, Makira, Solomon Islands (Photo: Jeff Daniells). 6b: *'U'ururu*, Tahiti, French Polynesia (Photo: Maurice Wong). 6c: *'U'ururu*, Lavatubes, Tahiti, French Polynesia (Photo: Jean-François Butaud).

Inflorescence: Male peduncle erect, short (< 30 cm). Bracts sharply pointed, cream to pale green, deciduous; at maturity male peduncle reduced to very short, scarred stem (3–9 bract scars) ± few floral remains—truncate bulbous stubs (greenish-yellow with grey-black cap).

Infructescence: Bunch cylindrical to narrowly triangular, small- to medium-sized, open to compact, 25–45 to 100–130 fruits (fewer in *pūputa*); fruits ovoid, ± slightly angled, 7.5–12 cm long × 4–6 cm ⌀ (smaller near apex in *ʻuʻururu*), shortly pedicellate approx. 1 cm long, dark orange pericarp ± brownish markings; deep yellow flesh. Old pistils present on near-mature fruits as tiny protruding nipples or resembling curly spent matchsticks, but absent in mature and over-mature fruits.

Cultivars/distribution: *Toraka bonubonu* (Solomon Islands), VUT151 (Vanuatu), *pūputa* (Niue, Sāmoa), *ʻuʻururu* (Tahiti, French Polynesia).

4. Kourai

Ploidy: Diploid.

Pseudostem: 4–5 m tall, rather slender (approx. 20 cm ⌀ near base) and gently tapering; dark green, weathering pale whitish-brown or yellow-orange brown.

Inflorescence: Male peduncle erect, short (< 30 cm long); bracts lanceolate, cream but ageing brown; 12–15 bract scars.

Infructescence: Bunch broadly top-shaped. Fruits ± open arrangement of 15–25 fruits, with tendency to fall off easily at maturity; hands 3–6; proximal

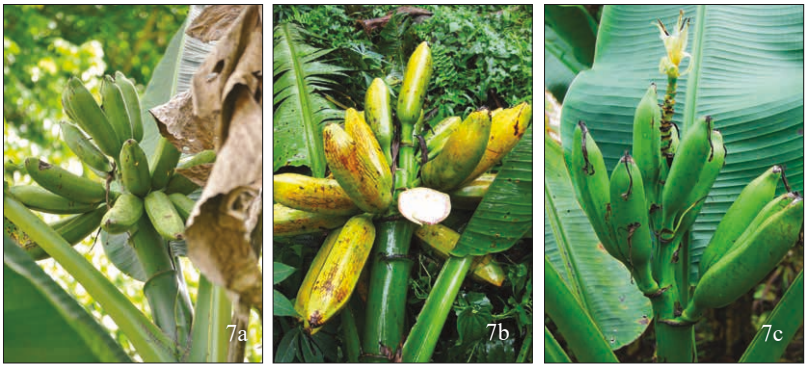

Figure 7. Fehi cultivar group Kourai. 7a: *Kourai*, Solomon Islands (Photo: Gabriel Sachter-Smith). 7b: *Torres*, Vanua Lava, Vanuatu (Photo: Fabien Cormier). 7c: *Toraka gatagata*, Solomon Islands (Photo: Gabriel Sachter-Smith).

fruits largest 15–25 (–30) cm long × 3.5–4.7 cm ⌀, ± strongly angular to cylindrical (at maturity), basal fruits ± apices curving upwards or straight, ± sessile or shortly pedicellate (pedicel 2–4 mm long).

Cultivars/distribution: ?*Kateen* (Manus Island, Papua New Guinea), ?*utafan* (New Ireland, Papua New Guinea), *kourai* (Bougainville), *toraka gatagata* (Makira, Solomon Islands), *hoaka*/*hereibuero*, *ota* and *ota 2*, *sawak*, *sokamé*, *Torres* (Torba Province, Vanuatu), *'oe'oe* (Tahiti, French Polynesia).

5. Menei

Ploidy: Diploid.

Pseudostem: 4.5–5 m, moderately stout, approx. 40 cm ⌀ at base, tapering strongly and uniformly to apex; green, weathering light greyish-brown.

Inflorescence: Male peduncle erect, stout, short ≤ 25 cm long, bracts deciduous, absent at maturity or with 1 or 2 floral remains on < 15–20 cm scarred stem.

Infructescence: Bunch obturbinate of 7–9 hands and 35–45 (–70) fruits, allantoid, angular, in rather open arrangement, 20–25 cm long × 6–7 cm ⌀, subsessile to shortly pedicellate, yellow turning coppery brown at maturity with yellow edges.

Cultivars/distribution: *Menei* (Manus Island, Papua New Guinea), *tongkat langit* (Ambon, Seram and Java, Indonesia).

Figure 8. Fehi cultivar group Menei. 8a: *Menei*, South Johnstone Research Station, north Queensland, Australia (cultivated, ex Manus Island, PNG) (Photo: Jeff Daniells). 8b: *Tongkat langit*, Panjang, Seram, eastern Indonesia (Photo: Adriana Hiariej).

6. Naturalised

Ploidy: Diploid.

Pseudostem: 2–4.5 m tall, ±slender, slightly swollen near base, green without, with magenta underlayers, weathering grey-tan; shiny black at base (for 0.6–0.9 m).

Inflorescence: Male peduncle erect, stout, short. Bracts sharply pointed, deciduous.

Infructescence: Bunch irregularly shaped, generally <20 variable shaped fruits which resemble cultivars in the ‘Aiori group. Variably seeded depending on environmental factors, fruits ±filled with well-developed, viable seeds approx. 3 mm diameter.

Figure 9. Naturalised or wild fē‘ī. 9a: Fē‘ī in Upper Punahitahi Valley, South Tekou, Fatu Hiva, Marquesas, French Polynesia. 9b: Naturalised or wild fē‘ī near Viriviriterai, Tahiti, French Polynesia. Photos: Jean-François Butaud.

Cultivars/distribution: Variants ± seeded found wild or naturalised in high elevation locations in French Polynesia: Marquesas (*huetū kakano* on Nuku Hiva; *huetū popoi*, *fio*, *ʻomaʻo*, *nafa* on Fatu Hiva), Tahiti (*fēʻī ʻiriʻiri*) and Raʻiātea (*fēʻī ʻōfaʻi*). Further field, propagation/seed viability, genetic and cytogenic research may indicate that these wild, seeded populations constitute environmental (high-elevation) variants of the ʻAiori group.

7. Tāti‘a

Ploidy: Diploid.

Pseudostem: 5–7 m, 50–60 cm ⌀ at base, green-black at base weathering to pale grey-brown.

Inflorescence: Male peduncle ± pendulous, 1–2 m long. Bracts blunt or rounded at tip, ≥ 30, evenly imbricate in large, green, broad-lanceolate bud; mature bracts drying light brown, persistent, but may be weathered off near the base of the peduncle.

Infructescence: Bunch cylindrical, with 12–15 hands and comprising 100–150 tightly packed fruits, angular, scarcely tapering, 14–19 cm long × 4–6 cm ⌀, apical ones less angular and not tapered; pericarp bright coppery orange, cracks few or absent.

Cultivars/distribution: Unnamed/“Mt. Popomanaseu” (Solomon Islands), *tāti‘a*, *ʻāfara tārere* (Tahiti, French Polynesia), *vēʻī o ʻoka*, *ʻūatū pīvai* (Cook Islands). (?Parthenocarpic selections of *baʻu lalao* or *baʻu kokofio* from East Kwalo, Makira, Solomon Islands.[16])

Figure 10. Fehi cultivar group Tāti‘a. 10a: *Tāti‘a*, Tahiti, French Polynesia (Photo: Quito Braun-Ortego). 10b: *ʻĀfara tārere*, Tahiti, French Polynesia (Photo: Maurice Wong).

Triploid Cultivar Groups

8. Rimina

Ploidy: Triploid.

Pseudostem: 6–7 m tall, medium-slender; younger stems dark maroon near base and dark green above, older stems green, ageing to greyish-brownish near base.

Inflorescence: Male inflorescence erect, 30–50 cm long. Bud lanceolate with slightly overlapping bracts and approx. 8 acuminate bracts; proximal bracts obtuse, lanceolate, recurving before falling; bract scars, 25–30, not very prominent.

Infructescence: Bunch cylindrical or with slight apical tapering, flattened top, with 10–11 compact hands and 65–100 fruits 14–15 cm long × 4.5–5 cm ⌀, angled; pericarp yellow, turning orange-coppery ± cracks in skin. Flesh yellow orange.

Cultivars/distribution: *Rimina* (Eastern Highlands Province, Papua New Guinea), *ʻāfara potopoto* and *paru* (Tahiti, French Polynesia).

Figure 11. Fehi cultivar group Rimina. 11a: *Rimina*, South Johnstone Research Station, north Queensland, Australia (cultivated, ex Eastern Highlands, PNG) (Photo: Jeff Daniells). 11b: *ʻĀfara potopoto*, Kauaʻi, Hawaiʻi, USA (Photo: Angela Kepler).

9. Asupina

Ploidy: Triploid.

Pseudostem: 3.5–4.5 m tall. Slender (20–25 cm ⌀ near base), very slightly tapering, mainly green with some irregular blackish patches and streaks, ageing light brown.

Inflorescence: Peduncle ≥ 0.30–0.55 m long, pendulous. Bud turbinate, dull. Bracts enclosing broad lanceolate, cream to pale brown, overlapping at apex, revolute before falling; bract deciduous at maturity, scars conspicuous, without floral remains.

Infructescence: Bunch globular-ovoid to irregularly shaped; 5–20 kg with 5–11 open hands and ± 30–45 fruits, 14–20 cm long × 5–6 cm ⌀, pedicellate (pedicel 1.5 cm long), slightly ridged/allantoid, apex rounded or slightly tapered; pericarp yellow-green turning bright orange with coppery cracks when fully mature; flesh dark yellow to orange, with very high levels of carotenoids.

Cultivars/distribution: *Asupina* (West Sepik Province, Papua New Guinea) syn. *skai* (near Kiunga, Western Province, Papua New Guinea), *tongkat langit Papua* (Manokwari, West Papua Province, Indonesia).

Figure 12. Fehi cultivar group Asupina. 12a: *Asupina*, South Johnstone Research Station, north Queensland, Australia (cultivated, ex West Sepik, PNG) (Photo: Jeff Daniells). 12b: *Tongkat langit Papua*, Manokwari, West Papua, eastern Indonesia (Photo: Agus Sutanto).

10. Karat

Ploidy: Triploid.

Pseudostem: (4.5–) 6–7 m tall, approx. 30 cm ⌀ near base, approx. 15 cm ⌀ (at 1.5 m), slender/gently and uniformly tapering; green, weathering grey-tan on lower trunk.

Figure 13. Fehi cultivar group Karat. 13a: *Usr kulasr* (syn. *karat*), Kosrae, Federated States of Micronesia (Photo: Lois Englberger). 13b: *Pouti'a*, Waimea Gardens, Hawai'i, USA (Photo: Angela Kepler). 13c: *Karat*, Pohnpei, Federated States of Micronesia (Photo: Jeff Daniells). 13d. *Pouti'a*, Hawai'i, USA (Photo: Christopher Carter).

Inflorescence: Male peduncle, erect, approx. 0.5 m long; bud large, green-yellow; bracts imbricate, broad-lanceolate/ovate, turning light yellowish-cream and brown before being shed.

Infructescence: Bunch broadly oval to round, rather open, with 3–15 (–30), or rarely even approx. 40 large ± ovoid fruits in few hands, shortly pedicellate (pedicels ≤ 5 mm), rounded at maturity, typically 18–22 cm long × 10–14 cm ⌀; L:W < 2–2.5) or slightly angled.

Cultivars/distribution: Predominantly found in Micronesia; *karat pako*, *karat pwehu*, *karat kole* (Federated States of Micronesia), unnamed/Bauro Central (Makira, Solomon Islands), ?*navis nouel* (Malekula, Vanuatu), *pouti'a* (Tahiti, French Polynesia—where likely extirpated).

11. Sar

Ploidy: Triploid.

Pseudostem: Massive, 6–7.5 m tall, 40–50 cm ⌀ near base, approx. 30 cm ⌀ at 1.5 m, strongly and uniformly tapering to apex; green, weathering brownish near base.

Inflorescence: Female and male flowers subtended by very large, broad-lanceolate (approx. 0.5 m long) green or purplish-green bracts; bracts drying

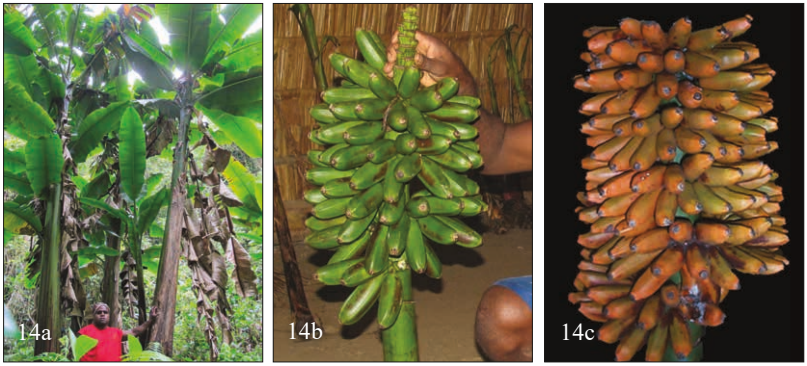

Figure 14. Fehi cultivar group Sar. 14a: *Namaco ni du*, Maré, New Caledonia (Photo: Julien Drouin). 14b: *Toraka warowaro*, Makira, Solomon Islands (Photo: Jeff Daniells). 15c: *Utimwas*, Pohnpei, Federated States of Micronesia (Photo: Lois Englberger).

brownish ± persistent but mostly shed when bunch is mature. Male peduncle erect, stout, usually ≤ 20 cm long and absent at maturity.

Infructescence: Bunch cylindrical or with slight apical tapering, flattened top or with few erect fruits, 15–30 kg, with 18 or 19 compact hands with approx. 130 fruits 10–15 cm long × 4–6 cm ⌀, ovoid, slightly angled (rounded to angular); pericarp yellow, turning orange-coppery, sometimes with maroon tints and cracks at full maturity; flesh yellow orange to deep orange.

Cultivars/distribution: *Sar* (Manus Island, Papua New Guinea), *utin iap* and *utimwas* (Pohnpei, Federated States of Micronesia), *arai ni ngir* (Yap, Federated States of Micronesia), *toraka warowaro* (Makira, Solomon Islands), *namaco ni du* (Maré, New Caledonia). (Note: its morphological appearance suggests it may be a parthenocarpic/autotriploid selection of *M. maclayi* subsp. *ailuluai.*)

12. Tongkat Langit Pendek

Ploidy: Triploid.
Pseudostem: 3–4 m, slender, green weathering brown.

Inflorescence: Erect female section, then semi-pendulous to pendulous, ≥ 1 m long with numerous conspicuous bract scars bud lanceolate to ovoid,

Figure 12. Fehi cultivar group Tongkat Langit Pendek. 15a: *Tongkat langit pendek*, Seram, eastern Indonesia (Photo: Adriana Hiariej).
15b: *Telo mata lala*, Seram, eastern Indonesia (Photo: Jeff Daniells).

≥ 12–15 cm long, shiny, green; bracts ≥ 30 enclosing male inflorescence blunt or apically acuminate, imbricate in bud.

Infructescence: Bunch ± cylindrical or irregular, small to medium, up to approx. 15 kg, with 5–13 loosely to tightly packed hands and 25–120 fruits, 10–12 cm long × 4–6 cm ⌀, slightly angled, blunt to pointed apex; pedicellate (pedicel approx. 1 cm long); pericarp yellow-orange, with brown cracks and marks at full maturity; flesh yellow.

Cultivars/distribution: Comprises two distinct variants (*tongkat langit pendek*, *telo mata lala*) from eastern Indonesia, one of which is referrable to *M. troglodytarum* L. *sensu stricto.* A cultivar similar to *telo mata lala* but with male buds degenerating before maturity has been noted in Manokwari, West Papua Province, Indonesia (Edison *et al.* 2002). (Note: its distribution and appearance suggest this cultivar group may have arisen as a parthenocarpic/autotriploid selection of *M. lolodensis* and/or parthenocarpic selection of *M. maclayi* × *M. lolodensis.*)

Representative fruit bunches and individual hands/fruits of each Fehi group are shown in Figs 4–15, illustrating the morphological variation displayed among Fehi groups, and the different cultivars in each group as indicated by country/island group in Table 1. (provided as on-line supplementary information at https://thepolynesiansociety.org/thomson_etal_SI.pdf)

ORIGINS OF FEHI CULTIVARS AND CLUSTERING OF CULTIVAR DIVERSITY

Domesticated bananas have edible fruits with few or no seeds or with non-viable vestigial seeds. They are parthenocarpic, developing pulp-filled fruits without pollination. Such fruits sometimes have occasional seeds, while the plants bearing them sometimes produce viable pollen. The male and female sterility of many cultivars has been caused by complex mechanisms acting in addition to parthenocarpy; both genetic and environmental factors are likely involved (Kennedy 2008: 77; Simmonds 1962). In sect. *Musa*, parthenocarpy is believed to be driven by a major dominant gene interacting with minor genes (Simmonds 1953). Female sterility is a variable secondary trait closely linked to banana domestication: total seedlessness can be due to the lack of surrounding pollen for effective pollination rather than to the absence of female fertility (Sardos, Rouard, *et al.* 2016). Human selection and vegetative propagation have ensured the survival and spread of domesticated bananas, including Fehi. These human interventions seem to have occurred in parallel but independently in series *Australimusa* and sect. *Musa* (Simmonds 1962: 151). Most Fehi cultivars are parthenocarpic and seedless. However, a few (naturalised forms) do produce viable seeds in New Caledonia (Vieillard 1862: 45)[17] and French Polynesia (Nadeaud 1873: 39).[18]

Due to high levels of sterility, many banana cultivars—Fehi and others—are considered to be selections derived from a single clone (Simmonds 1959). For example, the genetic diversity of 30 mostly West African plantains (*Musa* AAB genome subgroup, sect. *Musa*) constituting a representative sample of the phenotypic diversity appears to have been derived through somatic mutation and clonal diversification of a single seed/original plant (Noyer *et al.* 2005). Similarly, phenotypic diversity is high in the culturally important Maoli-Pōpōʻulu subgroup, but genetic diversity is low (Kagy *et al.* 2016). Concurring with Simmonds (1959: 72), we suspect this also applies to Fehi cultivars, with much of the cultivar variation arising from somatic mutation and/or epigenetic variation, along with hybridisation, polyploidy and parthenocarpic cultivar selection. Where the Fehi cultivars are grown together on a large scale—such as in Tahiti, Federated States of Micronesia and Makira—and especially when some have not entirely lost seed-producing capability, there is potential for hybridisation between cultivars. However, the paucity of bird pollinators in French Polynesian forests—especially the Society Islands and Marquesas, which did not originally[19] have the tiny, efficient pollinator birds (genus *Zosterops* or white-eyes)—could have affected the degree of seediness in Fehi. This, combined with those partially seedless cultivars brought and cultivated by Polynesian settlers, would have encouraged seedlessness and increased palatability.

Our identified clusters of morphologically similar Fehi cultivars (groups) most likely originated through single connected events (hybridisation/autopolyploidy/allopolyploidy) followed by selection, cultivation and subsequent mutation and vegetative propagation of a whole suite of closely related clones. However, some proposed Fehi groups, such as the diverse ʻAiori group, may comprise cultivar selections derived from the same or similar hybrid combinations. Further sample collection and DNA analysis is required to define these Fehi groups better and determine their genetic origins: this will surely lead to further refinement and likely reveal more cultivar groups. These could include additional groups from Makira (Solomon Islands) such as *toraka akeakesusu* or *toraka morikera* as well as from other less well-known Fehi cultivars from Bougainville, Papua New Guinea, Fiji (including Rotuma) and Maluku (Indonesia).

POSTULATED ANCIENT MOVEMENT OF *MUSA* SERIES *AUSTRALIMUSA* AND DOMESTICATION OF FEHI CULTIVARS

Two distinct groups of people are commonly distinguished in Papuasia: the earliest settlers, arriving ≥50,000 years BP from southeast Asia, usually designated Papuans, and then, much later, ≥3500 years BP, Austronesians who came from Taiwan and had moved through the Philippines and along the northern New Guinea coast to the Bismarck Archipelago.[20] Much of the accumulating genetic evidence that describes these people is necessarily

based upon samples drawn from living groups, variously categorised according to geography, language and cultural history. Rare samples of ancient DNA are being added to the increasingly complex picture, notably from Lapita-associated burials in Vanuatu and Tonga, which appear to group with East Asian rather than New Guinea–area modern populations (Skoglund *et al.* 2016). However, later studies with larger samples show that in Vanuatu, the early Lapita population was very soon followed by others related to modern New Guinea/Bismarck groups (Lipson *et al.* 2018; Posth *et al.* 2018). The oversimplified residual category "Papuan" is now being deconstructed, revealing complex interrelations within New Guinea, the Bismarcks and Solomons, and all of these with neighbouring areas including Remote Oceania (Brucato *et al*. 2021; Pedro *et al.* 2020; Sheppard 2019, 2022). Most recently, samples of ancient and modern human DNA from central and western Micronesia have added further complexity, suggesting differentiation among ancient populations in the Bismarcks, with Manus (linked to coastal New Guinea) separated from New Ireland–New Britain, and all of these having multiple links with western and central Micronesia, in the post-Lapita period (Liu *et al.* 2022).

It is probable that many groups contributed to the domestication of Fehi cultivars in Papua New Guinea (PNG), especially around the Bismarck Archipelago. The postulated Fehi ancestor, *M. maclayi*, is a widespread wild species in PNG and the Solomon Islands in seral communities, including old gardens, but is nowhere purposefully cultivated (see, e.g., Argent 1976; Lentfer 2009; Simmonds 1959; Moses Pelomo, pers. comm., 5 July 2021). Through studies using diagnostic seed phytoliths, Lentfer (2009: 248) and Lentfer *et al.* (2010) have confirmed the presence of sect. *Australimusa* bananas at an early Holocene archaeological site (FIF/4, Yombon airstrip) in southwest New Britain, PNG. Lentfer *et al.* (2021: 99–100) also recorded a seeded sect. *Australimusa* banana (volcaniform leaf morphotypes and tabular seed morphotypes) from a Lapita site (dated at 3185–2639 BCE), Nenumbo, Te Motu Taibä/Ngaua, Reef Islands, Temotu Province, Solomon Islands. Lentfer *et al.* (2021: 102) found a relatively high percentage of Musaceae leaf phytoliths in the younger layer but an absence of Musaceae seed types, and suggested wild species of *Musa* were replaced by seedless domesticated bananas, including sect. *Musa* cooking bananas (plantains).

The fruits of the putative wild progenitors of Fehi cultivars are favourite foods of hornbills and are also taken by fruit bats and corvids in Papua New Guinea and the Solomon Islands. In Choiseul, Solomon Islands, *kalo* (*M. maclayi*) has viable seeds, and many germinate at the base of banana mats[21] or in rainforest canopy clearings or close to banyan (*Ficus* spp.) trees, which provide another favoured food of hornbills (Moses Pelomo, pers. comm., 15 February 2021). Solomon Islanders hunt hornbills for food, so hunters often seek out stands of wild bananas: this greatly increases their

opportunity for coming across parthenocarpic forms/hybrids which have potential for human consumption, and then bringing them into cultivation through moving suckers into village gardens. Accordingly, we postulate that parthenocarpic Fehi cultivars may have been first selected from regeneration of members of the *M. maclayi s.l.* complex in rainforest openings in the eastern third of northern New Guinea, Bismarck Archipelago, Bougainville and Solomon Islands. This hypothesis chimes with the ideas of Simmonds (1956: 485), who wrote that "*M. maclayi* … is the probable major (and perhaps even only) source of the *fehi* group of edible bananas".

Species related to Fehi cultivars, such as *M. maclayi* and *M. peekelii*, have intermediate seed storage characteristics and lose viability within weeks or months of storage and drying (Kallow *et al*. 2020). Nevertheless, some *Musa* seeds (sect. *Musa*) appear able to survive for many years in the ± moist and uniform moderate (20°–25°C) temperature of a shaded rainforest soil seed bank, and this likely applies to seeds of series *Australimusa*. Where present, the seeds in most Fehi cultivars are small, irregular, shrivelled and lacking an embryo (e.g., MacDaniels 1947: 13). While seed is the most convenient form of germplasm for long-distance transport of plants on voyaging Polynesian canoes, we argue that the movement of the Fehi cultivars/clones and indeed other "canoe plants" was principally, if not exclusively, in the form of vegetative propagules. This assertion is made on the basis that:

- Fehi cultivars seldom produce viable seeds (usually only at high elevations);
- Based on storage behaviour of *M. maclayi* seeds, any seeds are likely to have a short storage life and be sensitive to desiccation (Kallow *et al.* 2020);
- Seedlings are difficult to propagate and grow slowly;
- Seedling bananas may not come true to type; and
- There is a considerable interval, at least two years, from seed/seedling to producing fruits and providing a source of human food, whereas a transplanted sucker will usually fruit within one year.

We postulate that at least two Fehi clones (from northern New Guinea/Bismarcks/Bougainville/Solomon Islands) were widely dispersed in the Pacific Islands, both north to Micronesia (Chuuk, Kosrae, Pohnpei and Yap) and south/east to Vanuatu, New Caledonia, Fiji and Sāmoa during the Lapita era beginning ca. 3500 BP (Fig. 16). These clones would have been from the two distinctive cultivar groups Karat and Sar. Both of the original cultivars appear to have been more widely cultivated and used in Micronesia than in Fiji and central-western Polynesia, with each generating three modern cultivars/clones in Micronesia, viz. *karat pako*, *karat pwehu* and *karat kole* in the Karat group and *utin iap*, *utimwas* and *arai ni ngir* in the Sar group.

A cultivar in the Menei group appears to have been moved westwards, possibly in similarly ancient times, from the Bismarcks to eastern Indonesia, where a related cultivar, *tongkat langit*, was selected and grown in Ambon and Seram, and subsequently moved even further west as far as Mount Galunggung in West Java (Dwivany *et al*. 2020).

Outside Micronesia, representatives of the Karat group appear to be rare and only survive with certainty as a few cultivated mats of the Fehi cultivar *pouti'a* in Hawai'i (recently introduced there from Tahiti). One of the Fehi cultivars (*navis nouel*) observed by Cormier (2010) in Malekula (Vanuatu) appears to be a member of the Karat group, as does a cultivar that grows at Bauro Central in the highlands of Makira, Solomon Islands (Michael Pennay; https://www.inaturalist.org/observations/4152943).

ORIGIN OF FEHI CULTIVARS IN EASTERN POLYNESIA

Tahiti was an eastern Pacific hotspot for Fehi diversity, with at least 20 named cultivars of fē'ī including at least nine of 'Aiori. This diversity is quite remarkable given the vast distance, around 5,000–7,000 km, from the posited origins of the Fehi bananas in Papua New Guinea/Solomon Islands, and especially given the apparent lack of Fehi diversity on island archipelagos, such as Fiji and Sāmoa, between them.

In reviewing the origin of the founder clones of fē'ī in Tahiti, we identified Makira (San Cristobal) and Malaita, Solomon Islands, as likely sources, given that both islands have extant cultivars in the Fehi cultivar groups that have proliferated and/or are present in Tahiti (viz. 'Aiori, Baubaunio, Bonubonu and Kourai). Furthermore, undescribed Solomon Islands species related to *M. bukensis*, viz. *awawe* (Makira), *ba'u lalao* and *ba'u kokofio* (Malaita), are morphologically similar to cultivars in the Tāti'a group and could be their direct ancestors.

Accordingly, we argue that Tahiti's founding fē'ī cultivars originated from the Solomon Islands, rather than the closer Sāmoa or Fiji. These Fehi clones (or progenitor wild species) would likely have been moved as carefully packaged sucker material,[22] directly or nearly so, via the traditional pathway from the southeast Solomon Islands Polynesian Outliers through the northern Polynesian Outliers. From the central northern Polynesian Outliers the clones could have been carried on to the Marquesas and/or Society Islands (over ca. 7–8 weeks), ca. 900–1000 years BP in accordance with the East Polynesian settlement hypothesis of Wilson (1985, 2012, 2018, 2021).

The extraordinary Tahitian fē'ī cultivar diversity originally derives from at least four or five ancestral sources: members of the morphologically similar, likely related 'Aiori, Baubaunio, Bonubonu and Kourai groups (at least 18 cultivars) and the Tāti'a (*tāti'a* and *'āfara tārere* cultivars) and Rimina (*'āfara potopoto* and *paru* cultivars) groups. It is interesting to reflect on

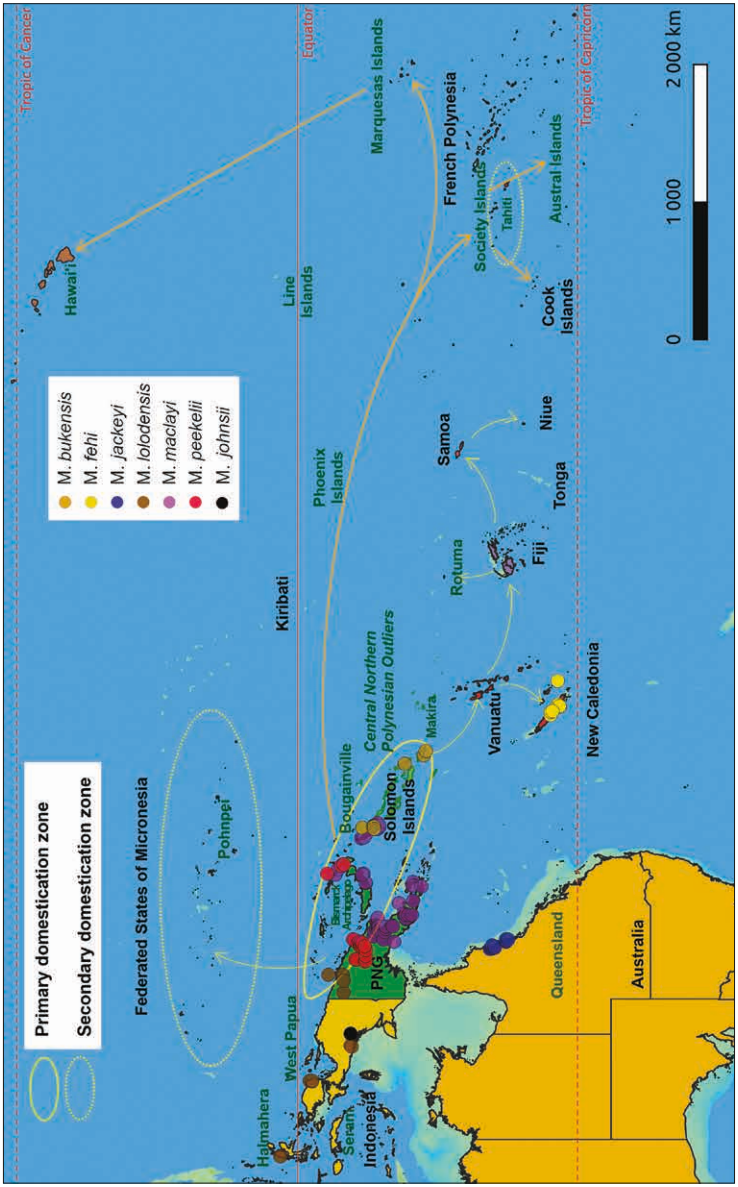

Figure 16. Map of the Pacific Islands from eastern Indonesia to Tahiti showing natural distributions of wild (*M. bukensis*, *M. jackeyi*, *M. lolodensis*, *M. maclayi*, *M. peekelii*) and naturalised species (*M. fehi*), early dispersal of Fehi from Papuasia to Micronesia and to the southeast and later dispersal from Outliers/Solomon Islands to East Polynesia, and primary (Papuasia) and secondary (Micronesia and Tahiti) centres of Fehi domestication.

why there is such fē‘ī cultivar diversity in Tahiti. It is considered that the extensive fē‘ī plantation area, from sea level to more than 1,000 m, of the original and subsequent clones provided a large base in which mutations could arise, and then be selected and propagated by observant Tahitian fē‘ī growers. The native forests in Tahiti are rather low and open, with few highly competitive tree species, and are well suited to recruitment and spread of fē‘ī. Fē‘ī hunters collecting fruit bunches from naturalised populations for food would have been well placed to identify any promising new bananas and bring them into cultivation.

There is one representative of the Karat group known from Tahiti, viz. *pouti‘a*, but this cultivar has always been rare, presumably little cultivated as it was not considered good eating (MacDaniels 1947: 32–33) or productive and is now likely extinct (Kepler and Rust 2011: 264). It is possible that *pouti‘a* is a relatively recent (e.g., past 200–300 years) Polynesian and/or post-European introduction from Sāmoa. However, the possibility of a Karat group cultivar being introduced from Makira via the pathway from the southeast Solomon Islands Outliers into the northern Outliers and on to East Polynesia cannot be ruled out.

In Tahiti, additional desirable and/or morphologically distinct mutations and hybrids of the original introduced Fehi clones were likely selected, propagated and spread further, including to Hawai‘i (Kepler and Rust 2011: 252–54) and the Cook Islands.

ORIGINS AND DERIVATIONS OF NAMES FOR FEHI BANANAS

The name for banana (sect. *Musa* cultivars) in Proto-Polynesian (PPn), the language spoken by the first inhabitants of Polynesia some 3,000 years ago, was **futi*,[23] which goes back to Proto-Malayo-Polynesian **punti* (Blust 1984–85: 49–50; Donohue and Denham 2009: 299–300; Perrier, De Langhe, *et al*. 2011: 11313–14). Reflexes of **futi* continue into the southeast Solomons Polynesian Outliers and all the northern Polynesian Outliers, e.g., Tikopian, Takū *futi*; and Rennellese, Sikaiana, Nukumanu, Kapingamarangi, Nukuoro *huti*. However, Proto-East Polynesian replaced **futi* with **maika*, a term of unknown origin, referring to cooking bananas (AAB genome, including Maoli, Pōpō‘ulu and Iholena subgroups), from which are derived Marquesan *meika* and *mei‘a*; Rapa Nui, Penrhyn *maika*; Hawaiian *mai‘a*; Tuamotuan, Rarotongan *meika* and Tahitian *mei‘a* and *mai‘a*.

Another banana term, **joRaga*, has a robust Proto-Oceanic (POc) reconstruction (Ross 2008: 278), meaning it was probably familiar to the Austronesian-speaking Lapita peoples.[24] **joRaga* has regular reflexes in Papua New Guinea (e.g., Middle Watut *cok*, Mumeng *jon*), the Solomon Islands (e.g., Arosi *toraga*, Sa‘a *hudi tolaka*, Vaghua *soga*), Polynesian

Outliers (Vaeakau-Taumako *hoaka*, Tikopia *soaka*), Vanuatu (e.g., Ngen *sokamé*, Nguna *soaga,* Northeast Ambae *hoaka*, Paamese *sōko*, Raga *hoaga*, Tamambo *soka*, Uripiv *jok*), New Caledonia (Nyelâyu, Kumak, Nemi *dāŋ*), Fiji (Bauan *soaqa*) and parts of central-western Polynesia (e.g., Sāmoa *soa'a*). However, glosses that specify Fehi are not recorded further west of the eastern Solomons. Ross, thus, cautions that "POc **joRaga* is glossed accordingly [as Fehi], but with a question mark, because this was the meaning of the PROc [Proto-Remote Oceanic, approximately the same as Proto-Eastern Oceanic (PEOc)] reflex but not necessarily of the POc term."

Another Polynesian Outlier Fehi term, Rennellese *togaka*, is phonologically marked as a borrowing of a term for Fehi from a Solomon Islands language, such as Arosi spoken on Makira, for which the term for Fehi is *toraka*, itself derived from PEOc **joRaga* by the distinctive retention of **R* as a liquid, whereas Fijian and Proto-Polynesian have lost this consonant. Arosi *toraka* is also marked by the distinctive reflex Arosi *t* for PEOc **j*, while Proto-Central Pacific (PCP) ancestral to Fijian and PPn reflects **j* in this word as **s* > Fijian *soaqa*, Samoan *soa'a.*[25]

While the reconstruction **joRaga* is solidly represented throughout the area as far east as Sāmoa, there is another form which is found in at least two languages. Rotuma, one of the few places where Fehi remain culturally important, has *säe*, which could be derived from PCP **saya* (or **caya/zaya*), and this has been borrowed into Futunan as *sae*, which means the plant and also *mets à base d'amidon et de bananes* 'food based on Polynesian arrowroot (*Tacca leontopetaloides* (L.) Kuntze) and bananas', probably the same as a kind of Rotuman *herhere* which contains *säe*,[26] and also *po'e* (Tahiti) and *poke* (Marquesas). Futuna's neighbour East 'Uvea (Wallis) has two terms for Fehi, which indicate different origins: *lotuma*, pointing to origin from Rotuma (Bataillon 1932) with its derivative *hu'a lotuma* 'purple' (lit. sap or juice of *lotuma*) (Rensch 1984), and *fehi* (Rensch 1984). Note that Bataillon's dictionary was based on research in the mid-nineteenth century, so much the earlier of the two. While *fehi* may look like a cognate of Tahitian *fē'ī*, it is most likely a relatively recent borrowing from Tongan, where *fehi* is 'a kind of plantain' (Churchward 1959), possibly itself a nineteenth-century borrowing from an eastern Polynesian source.

Within Fiji, a number of new names have developed for Fehi, which may be instructive. In parts of northeast Vitilevu, the name is *drāiturukawa* or *drākeiturukawa*, both meaning 'blood of Turukawa', this being a mythical bird that, every morning, woke up Degei, the chief deity of most of eastern Fiji, and was shot dead by a pair of mischievous twins. The name may refer to the sap or the colour of the water when the fruit is boiled. Another innovative name, found in Vanuabalavu, northern Lau, is *duduilagi* 'protruding to the sky'.

A distinct term for Fehi can be reconstructed for Proto-East Polynesian (PEPn), **fua-tu'u*, with a clear derivation from **fua* 'fruit' and **tu'u* 'standing, erect', the main characteristic that distinguishes the plant from **maika*. Proto-East Polynesian **fua-tu'u* is reflected in Marquesan *huetū*, Mangarevan *'uatu*, Rarotongan and Mangaian *'ūtū* and Rarotongan *'uatū*, which covers the two main divisions of the Central East Polynesian language subgrouping (Wilson 2021: 40, 43) followed here and shows expected vocalic reflexes for an old term that spread at an early period before European contact.[27]

Given that names derived from **joRaga* > PPn **soaka* are found as far east as Sāmoa but no further, the question arises as to whether there is any significance in the name changing to **fua-tu'u*, literally 'standing or erect fruit' in eastern Polynesia. The answer is perhaps, but not necessarily so. In a study of PEPn plant names (Geraghty 2009), it was demonstrated that most plants have retained their PPn names. Examples from food plants include PEPn **ifi* [*Inocarpus fagifer* (Parkinson) Fosberg, Tahitian chestnut], **kape* [*Cyrtosperma merkusii* (Hassk.) Schott or '*Alocasia*', 'swamp taro'], **kuru* [*Artocarpus altilis* (Parkinson) Fosberg, 'breadfruit'], **niu* [*Cocos nucifera* L., 'coconut'], **parai* [*Dioscorea nummularia* L., 'Pacific yam'], **pia* [*Tacca leontopetaloides*, 'arrowroot'], **pirita* [*Dioscorea pentaphylla* Lam., 'five-leaf yam'], **talo* [*Colocasia esculenta* (L.) Schott, 'taro'], **tī* [*Cordyline fruticosa* (L.) A.Chev., 'ti'], **'ufi* [*Dioscorea esculenta* (Lour.) Burkill or *D. alata* L., 'yam']. Indeed, the name of only one major food plant was changed, from PPn **futi* [*Musa*, 'banana, plantain'] to PEPn **maika*. The change of PPn **soaka* to PEPn **fua-tu'u* and then **fekī*[28] may well indicate some kind of discontinuity, and fits with our hypothesis that Fehi in East Polynesia did not arrive via Sāmoa or central-western Polynesia.

Part of the history of *fē'ī* in East Polynesia is the development of this distinct and now universally applied term for it in Tahiti, a locus of major cultivar diversity. The early Tahitian term *fekī* may have derived by vowel lengthening from PEPn **fekī* 'type of tree fern', reflected in Māori as *whekī* 'tree fern species'.[29] The Tahitian term *fē'ī* apparently spread in post-European times, or shortly before that, to the southern Cook Islands resulting in Rarotongan, Aitutakian, Ma'uke *vē'ī* and Mitiaro *ve'i*. Southern Cook Islands *vē'ī*, *ve'i* are clearly borrowings because southern Cook Island languages borrow /*f*/ as /*v*/, but in directly inherited terms their glottal stop and their /*k*/ correspond to Tahitian /*f*/ and glottal stop, respectively. Note that in the Cook Islands, Rarotongan and Mangaian also reflect the older PEPn term **fua-tu'u*, and with the expected direct inheritance phonology as *'uatū* (the most common general term for Fehi cultivars). Terms in the Austral Islands, i.e., Rurutu *ve'i*, Ra'ivavae *he'i* and Tupua'i *fe'i*, as well as Rapan *fe'i*, are also likely very recent, if not post-European, borrowings from Tahitian. These areas have both a post-European and pre-European history

of extensive Tahitian influence. The phonological form of the Ra‘ivavae term could possibly represent an older spread from Tahitian, but the glottal stop in *he‘i* rather than a /k/ suggests a recent borrowing.

Possibly related to the retention of direct reflexes of PEPn **fua-tu‘u* on Rarotonga and Mangaia within the southern Cook Islands is the fact that they are the larger southern Cook Islands, with Rarotonga having the highest elevations, and providing environments where Fehi could flourish best. As larger islands with larger populations, they were also less likely to be as quickly influenced in replacing earlier terms with borrowings from Tahitian.

A Hawaiian cognate of Tahitian *fē‘ī* is *hē‘ī* ‘papaya’ (*Carica papaya* L.). The neotropical papaya was introduced into Hawai‘i between 1800 and 1820 (Yee *et al*. 1970: 3), and the fruit shape of some papayas resembles that of certain Fehi cultivars (e.g., *karat* or *pouti‘a*). Hawaiian *hē‘ī* is a term for *fē‘ī* along with *mai‘a akua* ‘ghost/spirit/god banana’, *mai‘a kāne* ‘male banana, or banana of the god Kāne’, *mai‘a liko* ‘central leaf bud banana’ and *mai‘a polapola* ‘Tahitian banana’, where *polapola* is a post-European name for Borabora. The fact that Hawaiian *hē‘ī* corresponds to Tahitian *fē‘ī* supports the contention of Kepler and Rust (2011: 258) that *hē‘ī* arrived several times before James Cook’s visits to Hawai‘i. If the Tahitian term *fē‘ī* were a post-European borrowing, we would expect it to be pronounced in Hawaiian as *pē‘ī*, parallel to *peawini* ‘fairwind’, *palaoa* ‘flour’ and *Pakuhiwa*, the post-European contact Hawaiian name for Fatu Hiva, one of the Marquesas Islands. Hawaiian *hē‘ī* is the only East Polynesian term suggesting any antiquity for the Tahitian term *fē‘ī*. Even with evidence from Hawaiian, the term **fua-tu‘u* is better supported as the oldest East Polynesian term for Fehi.

Whilst the origin of the name *karat* for certain Fehi cultivars in Pohnpeian is uncertain, it is likely to be ancient. Frederick Christian, who visited Micronesia in 1896 during the Spanish period, recorded the name *karati* ‘the plantain’ in the Polynesian Outlier language Nukuoroan (Christian 1898), and this likely indicates that *karat* was borrowed from Pohnpeian sometime before Christian’s visit, as supported by linguistic evidence (Ken Regh, pers. comm., 2021).

NATURALISED SPECIES OF *MUSA* SERIES *AUSTRALIMUSA* IN FRENCH POLYNESIA?

The presence of ±seeded, likely naturalised Fehi in upland environments in the Marquesas and Society Islands (Fig. 10a, 10b), including *huetū kakano*, *popoi*, *fio*, *‘oma‘o*, *nafa* in the Marquesas (Nuku Hiva, ‘Ua Huka and Fatu Hiva), *fē‘ī ‘ōfa‘i* on Ra‘iātea (Leeward Islands) and variants of *‘aiori* in Tahiti, has long been noted (Jouan 1865: 45; Kepler and Rust 2011: 249; MacDaniels 1947: 13). The Fehi that grow in the remote interior of New Caledonia—presumably conspecific with *M. fehi* Bertero

ex Vieill.— morphologically resemble seeded ‘Aiori cultivars with their black pseudostems and small bunches of short dark-brown fruits and greenish pulp ± viable seed.

Kepler and Rust (2011) hypothesised that seeded Fehi may have been bird-dispersed—especially by *Ducula* pigeons and the now-extinct large *Cyanoramphus* parrots—in a stepped dispersal process from southwest Melanesia to eastern Polynesia. However, there are no records of seeded Fehi bananas growing in uncultivated settings in central Polynesia. The disjunct presence of wild, seeded New Guinean (and Queensland) *M. acuminata* subsp. *banksii* (F. Muell.) N.W.Simmonds (sect. *Musa*) in Sāmoa (Sardos, Sachter-Smith, Shandil, *et al.* 2019), a distance of approx. 5,000 km, provides some support for long-distance dispersal of seeded bananas in the South Pacific: the local name for *M. acuminata* subsp. *banksii* in Sāmoa is *lautaemanu*, which indicates spread via bird defaecation. The distance from the most easterly populations of *M. acuminata* subsp. *banksii* in New Guinea to Sāmoa is of a similar order to that required for long-distance dispersal from the most easterly occurring Fehi species/cultivars (in Makira and Choiseul, Solomon Islands) to Ra‘iātea, Tahiti and the Marquesas (French Polynesia), viz. 5,000–7,000 km. Long-distance bird dispersal of seeds of many plant genera is also indicated between Pacific islands, and between Pacific islands and Indian Ocean islands, e.g., Carlquist (1967) and Harbaugh and Baldwin (2007).

Nadeaud (1873: 39) recorded that Fehi (as *M. fei*) was native in Tahiti, and that in December its fruits were full of well-developed and viable seeds (*‘iri‘iri*). Naturalisation of Fehi in Tahiti is associated with:

1. Widespread cultivation of partly fertile Fehi cultivars, including the normally seedless *‘aiori*, *‘ā‘ata*, *tāti‘a* and possibly also *rūreva*, which bears seeded fruits under certain conditions, notably at higher elevations and during hot, dry periods (MacDaniels 1947: 14);
2. Presence of talus slopes—piles of loose, unstable rock formations that accumulate at the base of a cliff—which are well suited to colonisation and persistence by bananas, rather than by larger woody perennials (Simmonds 1959: 70);
3. Presence of Fehi fruit-consuming and seed-dispersing birds, including pigeons, large parrots and smaller parakeets, some of which survive but are highly endangered (Holyoak and Thibault 1984: 121–22; Kepler and Rust 2011: 256–57); and
4. Absence of competing plants which occupy similar niches elsewhere in the Pacific Islands, such as the wild *Musa*—and postulated parental species—in New Guinea and Solomon Islands, and a giant ginger (*Alpinia boia* Seem.) in Fiji.

The wild forms of Fehi in Tahiti and the Marquesas (Fig. 6) appear morphologically similar to cultivars in the ʻAiori group. There are at least 11 informally named ʻAiori cultivars in Tahiti (Kepler 2011; MacDaniels 1947: 23), briefly characterised as follows:

ʻaiori māʻa ʻanaʻana	shining
ʻaiori māʻa piripiri	tight bunch, a bit sticky, tall
ʻaiori māʻa rahi	large fruit
ʻaiori māʻa āteatea	not tightly clustered
ʻaiori māʻa huʻa	small fruit
ʻaiori māʻa menemene	fruit round/spherical
ʻaiori māʻa tātiʻa	tightly packed cluster
ʻaiori māʻa tanotano	fruit not widely spaced/not too tight, very smooth skin
ʻaiori māʻa varavara	hands wide apart
ʻaʻaiʻa/*ʻārutu* (*teravero*)	1 (or 2) small leaves close to the bunch, attached approx. 2.5 cm below the basal bract inflorescence; larger fruits than *ʻaiori*, basal fruits 18 × 15.5 cm; upper fruits more rounded with blunter apex

Polynesian native parakeets (*Vini* spp.) are nectivorous and are well known to feed on banana flowers, e.g., the critically endangered ultramarine lorikeet (*Vini ultramarina* Kuhl) feeds on Fehi flowers in the Marquesas (Thibault and Cibois 2017). Accordingly, the variation in ʻAiori cultivars in Tahiti and the Marquesas could have arisen from genetic recombination associated with sexual reproduction as well as somatic variation, followed by their selection and maintenance by Fehi growers.

There is a sense of urgency in finding viable seeds and in assessing the taxonomic and conservation status of wild Fehi in Tahiti and the Marquesas, given threats from cattle and feral pig populations, environmentally invasive and ecosystem-transformative plant species such as *Miconia calvescens* DC. (Whittaker and Fernández-Palacios 2006: 318) and the banana corm weevil[30] (Kepler and Rust 2011: 444–50; Simmonds 1959: 68–70), historical unsustainable harvesting and management of wild stands (MacDaniels 1947: 10–11), bunchy top virus and climate change.

CONSERVATION, MANAGEMENT, USE AND IMPROVEMENT OF FEHI CULTIVARS

Throughout their cultivated ranges in the Pacific Islands, Fehi cultivars are disappearing and/or have been displaced by bananas of sect. *Musa*. This is due to a combination of factors:

1. They have lower palatability and sweetness, and an unpleasant acridity—unless fully ripe/overripe, with black skin and soft flesh, and/or cooked—by comparison with other banana cultivars (Kepler and Rust 2011: 259), as well as Islander diets switching to consumption of imported processed foods (Englberger, Daniells, *et al.* 2018: 170).
2. They are difficult to establish from suckers by comparison with most sect. *Musa* cultivars, the latter being generally less demanding, quicker-growing, higher-yielding, more versatile and more reliable. In order to flourish, Fehi require deep planting, partial shade, wind protection, regular fertilisation (high potassium) and watering, and removal of competitive grasses.
3. They prefer very high rainfall environments, such as the mountainous interiors of Tahiti (3,500 mm per annum); Kaua‘i, Hawai‘i (>4,000 mm per annum); Pohnpei, Federated States of Micronesia (4,800 mm per annum); and Makira, Solomon Islands (4,750 mm per annum), coupled with excellent drainage.
4. Fehi are not as vigorous as many other edible bananas and are relatively slow in their development, taking at least two years to reach harvest from a planted sucker compared with one year to harvest for other bananas, which leads to low productivity over time.
5. Their characteristic of turning urine bright yellow or orange-red has been misinterpreted as being unhealthy (Englberger, Daniells, *et al*. 2018: 170, 173).
6. They are susceptible to certain banana pests and diseases, most notably banana corm weevils and banana bunchy top virus (https://www.promusa.org/Fei+bananas) and need fertile, well-watered and well-drained soils (MacDaniels 1947: 10–11).
7. They suffer from grazing animals (feral pigs) and invasive plant species (e.g., *Miconia calvescens*), especially in Tahiti (Englberger, Daniells, *et al.* 2018: 173; Kepler and Rust 2011: 257; MacDaniels 1947: 9).
8. Several cultivars can be cultivated or become naturalised only at high elevations (too dry and possibly also too hot at sea level, including on the west coast of Tahiti or in the Marquesas).

Our thesis, that the Fehi bananas are an assemblage of cultivars and hybrids of *M. maclayi s.l.*, has important ramifications for their conservation and management. Firstly, it is vital that—notwithstanding biosecurity regulation challenges—the apparently great diversity in *M. maclayi* and related wild taxa be conserved *ex situ*, both in field gene banks and in tissue culture (at the International Musa Germplasm Collection, Leuven, Belgium, and the Pacific Community's Centre for Pacific Crops and Trees/ SPC-CePACT, Suva, Fiji). There is an associated pressing need for better characterisation of the diversity in Fehi wild relatives, especially in Papua New Guinea, Bougainville and the Solomon Islands. In these areas, there is also a great need for ethnobiological studies of how local farmers manage the extraordinary biodiversity of wild and cultivated Musaceae and their interrelationships.

It is equally vital that selected cultivars/clones of Fehi be conserved *ex situ* in tissue culture and in field gene banks, notably in the field banana collection in Tahiti, French Polynesia. In addition to diverse Pacific plantains (Kagy *et al.* 2016), the Tahitian collection also conserves the diversity of Fehi cultivars from six different islands in French Polynesia and several Fehi cultivars from Papua New Guinea. It is strongly recommended that the Tahitian field banana collection be broadened to include Fehi cultivars from other Pacific nations using virus-indexed materials, most notably cultivars that have been developed in the Federated States of Micronesia, Bougainville and Solomon Islands (especially Makira), but also Vanuatu, Fiji, Sāmoa and eastern Indonesia, several of which are now at risk of extinction. It is also recommended that the Tahitian and other field collections be backed up in the International Musa Germplasm Transit Centre (ITC; Leuven, Belgium) and SPC Centre for Pacific Crops and Trees (CePACT; Suva, Fiji), and Fehi cultivars in *in vitro* collections be duplicated in field plantings (as much as resources will allow). All *Musa* materials entering ITC are tested against pests and diseases, including viruses, and cleaned from them when necessary, making it the ideal place to first send material, before re-sending it to other collections and/or repatriating to the supplier country.

It is also essential that selected cultivars/clones of Fehi be conserved *circa situ* by Pacific Islands communities and families and they be assisted to conserve their traditional Fehi cultivars in well-managed and effectively monitored traditional agroforestry systems. This will need to be coupled with the promotion of Fehi products in local and export markets, including value-added products such as provitamin A–rich, gluten-free flour and crisps. Lastly, the urgent need for further fieldwork on all aspects of these bananas underlines the importance of such work continuing to be interdisciplinary, with a strong local base.

CONCLUDING REMARKS

The diverse Fehi banana cultivars represent an underused, naturally highly nutritious food source for Pacific Islanders and others in the humid tropics. Along with other traditional Pacific crops, including sect. *Musa* cultivars, breadfruit and *Canarium* nut, Fehi bananas provide an agriculturally low-input, carbon-friendly source of carbohydrates and micronutrients. The early East Polynesian settlers were evidently observant and adept horticulturists who were able to select and vegetatively propagate new and useful cultivars of priority food and cultural plants from a limited number of original introductions, e.g., more than 20 named Fehi cultivars in Tahiti from four or five ancestral sources.

The patterns of Fehi cultivar diversity in the Pacific Islands bear similarities to those of two other important Polynesian canoe plants: breadfruit (*Artocarpus altilis* and relatives) and paper mulberry (*Broussonetia papyrifera*). Our findings have important implications for the history of human–plant interactions and movement in the Pacific Islands.

It is concluded that:

1. Fehi cultivars were likely first domesticated more than 3500 BP in Papuasia—especially northern New Guinea and Bismarck Archipelago—and in Lapita-associated movements, several early Fehi founder clones were dispersed southeast to Vanuatu, New Caledonia, Fiji and Sāmoa and north to Micronesia.[31]
2. On the basis of morphological and genetic data, the progenitor sources of eastern Polynesian cultivars of Fehi banana (and those of breadfruit and paper mulberry[32]) originated from Papuasia, with some passing through Micronesia rather than from central-western Polynesia (including Sāmoa), which has until recently been considered the likely source of East Polynesian canoe plants (e.g., Kirch and Green 2001). This more recent—ca. 900–1000 BP— eastward spread of Fehi founder clones is postulated to have begun from around the Solomon Islands (possibly Makira), reaching eastern Polynesia (the Marquesas and Tahiti) and, later, the Cook Islands and Hawai‘i, in accordance with the East Polynesian settlement hypothesis of Wilson (1985, 2012, 2018, 2021).
3. Linguistic studies also provide support that the source from which these plants reached East Polynesia was not Sāmoa but was instead centred in Polynesian Outliers in the southeast Solomons, with the closest major Solomon Island being San Cristobal/Makira.

Fehi have hitherto been comparatively neglected by *Musa* researchers, in part due to their challenging genomic makeup, different to commercial bananas. This review of Fehi cultivar variation provides a foundation for their further improvement and use, and for much-needed further interdisciplinary research.

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PUBLICATIONS RECEIVED*

July to November 2022

MARANDA, Pierre, James Tuita Dede and Ben Burt: *The Last White Canoe of the Lau of Malaita, Solomon Islands*. Canon Pyon, UK: Sean Kingston, 2022. 112 pp., app., index. US$135.00 (hardcover).

SAURA, Bruno: *A Fish Named Tahiti: Myths and Power in Ancient Polynesia (Tahiti, Ra'iātea, Hawai'i, Aotearoa New Zealand)*. Translated by Lorenz Gonschor. Tahiti: Maison des Sciences de l'Homme du Pacifique, 2022. 310 pp., biblio. NZ$34.72 (softcover).

* The inclusion of a publication in this list neither assumes nor precludes its subsequent review.

NOTES

1. The major ancestor of edible bananas is *M. acuminata* (A genome) in sect. *Musa*. *Musa balbisiana* (B genome) and, to a minor extent, other sect. *Musa* wild species such as *M. schizocarpa* (S genome) and series *Australimusa* (T genome), also contributed to the genetic makeup of current-day edible bananas (Heslop-Harrison and Schwarzacher 2007). The botanical/biogeographical status of *M. textilis*, whether genuine species or complex cultivar, and its relationship to Fehi cultivars is uncertain (Christenhusz 2009; Kennedy 2009b; Lasalita-Zapico *et al.* 2010).
2. Fehi, Maoli/Pōpōʻulu and Iholena all appear to have connections to New Guinea and attain their greatest diversity and prominence in the Pacific region and were largely unknown outside of the Pacific. This is not the case for other cultivated bananas (Daniells 1990, 1995).
3. Stover and Simmonds (1987) cautioned that Fehi bananas were so poorly understood that at that time the use of Latin binomials was unwise, and this statement still applies. Simmonds (1959: 66) added to this caution the comment that insistence on Latin binomials for sect. *Musa* cultivars "has been the biggest single barrier to taxonomic understanding of the cultigens and wild plants alike". We concur.
4. These include *M. aiori* Sagot, *M. amboinensis* Miq., *M. fehi*, *M. seemannii* F.Muell., *M. troglodytarum*, *M. uranoscopus* Colla and *M. uranoscopus* Seem.
5. It is unclear from Sagot (1886) whether *M. fehi* produced viable seeds, but there are reports of Fehi from Canala and Farino doing so. Further research may show that the name *M. fehi* is applicable to some Fehi cultivar groups/cultivars.
6. Triploid bananas are known to result from the fertilisation between a non-reduced (diploid) gamete and regular haploid gamete. The diploid gametes result from irregularities in meiosis when the two parent genomes are too different; such can be either interspecific or intersubspecific (Perrier, Bakry, *et al.* 2009).
7. *Musa jackeyi* W.Hill was described from north Queensland (Hill 1874), and, if future research shows it to be conspecific with the morphologically near-identical *M. maclayi*, described later (Mueller 1875), then the name *M. jackeyi* would have priority, unless formally rejected. *M. fehi* Bertero ex Vieill. may also be conspecific with these two species, in which case its name would have priority, having being described earlier in 1862.
8. As discussed by Cheesman (1949), the literature on "*M. fehi*" includes at least three different entities, and interpretation of true *M. fehi* awaits clarification (Häkkinen and Väre 2008).
9. Pacific plantains (genome AAB, Maia Maoli/Pōpōʻulu) are distinctive, starch-rich cultivars which are almost invariably eaten cooked. Note that not all bananas eaten cooked are plantains. The group's origin and distribution are discussed by Kennedy (2008) and by De Langhe *et al.* (2015). The latter make no reference to Fehi despite the apparent chronological and regional overlap of the two groups in the area they discuss.
10. In some cultivars the peduncle may reflex either before the fruits begin to fill or once the fruits mature and weigh down the bunch.

11. *Musa maclayi s.l.* here includes var. *maclayi* (Morobe and Oro Provinces, Papua New Guinea), var. *erecta* (Simmonds) Argent (Bougainville and Solomon Islands), var. *namatani* Argent (New Ireland, Papua New Guinea) and subsp. *ailuluai* Argent (Fergusson Is., Milne Bay Province, Papua New Guinea), along with the closely related species *M. bukensis* (Bougainville), *awawe* (Makira, Solomon Islands), *ba'u lalao* and *ba'u kokofio* (Malaita, Solomon Islands) and *M. jackeyi* (north Queensland, Australia).
12. These cultivar groups are based on morphological data and need to be tested with DNA and cytological analyses. Assignment of cultivar groups to different ploidy levels is provisional and mainly based on unpublished flow cytometry data (generated by the *Musa* Genotyping Centre https://musanet.org/resources/musa-genotyping-centre).
13. These indigenous names for groups have been used in the literature, but only three—*'aiori* and *tāti'a* from Tahitian, and *karat* from Pohnpeian—have been linguistically verified.
14. *'Aiori* has often been misspelt as *'aiuri,* even in recent literature.
15. The height of the pseudostem (from base of pseudostem to emerging point of the peduncle) varies depending on age of mat and environment, especially light levels, soil fertility and elevation. *Ha'a* is a noted dwarf form, maximally to 4 m tall, whereas cultivars in the Sar cultivar group have massive pseudostems to 7.5 m tall.
16. These are the wild bananas reported by Sachter-Smith (2011: 9–10).
17. Vieillard (1862) reported that in New Caledonia some seeds of "*M. fehi*" develop fully and are viable, so that "*M. fehi*" can be propagated from both seeds and suckers.
18. Nadeaud also recorded that "his grandfather germinated seeds of the 'variety' *aiuri* and obtained living plants" (MacDaniels 1947: 14).
19. *Zosterops lateralis* Latham was introduced to the Society Islands in 1937 (Guild 1938).
20. The Bismarck Archipelago is a group of islands off the northeastern coast of New Guinea and includes New Ireland, New Britain, Manus and many smaller islands.
21. Mat is a horticultural term for an interconnected clump of banana shoots and the rhizome from which they arise.
22. Most likely either maiden or bullhead suckers or as seed (see Kepler and Rust 2011: 12–13).
23. An asterisk is used to indicate a reconstructed word in proto-languages.
24. Proto-Oceanic is the reconstructed language spoken by Lapita peoples, who ca. 3000 BP became the first inhabitants of Remote Oceania, i.e., Oceania beyond the main Solomon Islands.
25. Furthermore, the Rennellese *g* (pronounced ngg) of Rennellese *togaka* derives from an earlier PPn **l* and **r*, indicating that *togaka* is an early borrowing into Rennellese before the change of Proto-Nuclear Polynesian **l* > Rennellese *g,* parallel to the Rennellese mythical place name Paugo. Paugo is the name of an external land recounted in traditions of Rennell and Bellona and cognate with Bauro on Makira Island. If Rennellese *togaka* were a recent borrowing, then

we would expect unattested Rennellese **tolaka*. In more recent borrowings Rennellese uses *l* to borrow *l* or *r*, e.g., Rennellese *leta* (borrowing of English "letter") and Rennellese *likoti* (borrowing of English "recording"). Indeed Rennellese Makila (for Makira Island in the Solomons) is likely another late borrowing dating from a post-contact period when the large island formerly termed San Cristobal came to be generally called Makira (Elbert 1988: 278, 283–86). Traditions on Rennell and Bellona indicate that the Indigenous people, Rennellese Hiti < PPn **fiti* 'Fiji, Fijian', who lived on their islands when the Polynesians first colonised them, grew the togaka banana and that the Rennellese obtained it from them (see Elbert 1975 *hiti* (p. 93), *huti o te hiti* (under *huti* p. 103), *togaka* (p. 309), also *huti hahine* and *huti ta'ane* (p. 103)).

26. Another useful plant with origins in Rotuma is sago*, Metroxylon warburgii* (Heimerl) Becc., for which the Rotuman name *ota* has been borrowed in Futunan, while an alternative name in Futuna, *niulotuma* (lit. 'Rotuma coconut'), is also used in Sāmoa.
27. A semantically identical innovative term for Fehi is found in Roviana, West Solomons: *vuaturu*, literally 'fruit + stand' (Waterhouse 1928).
28. *Fekī* was likely the earlier form of *fē'ī*, before PEPn **k* became a glottal stop in Tahitian.
29. Other cognates include Rapan *akī* 'tree fern', *Cyathea societarum* Baker (now *Alsophila societarum* (Baker) Christenh.); Rarotongan *'eki* (vowel length uncertain) 'a fern tree, a *Cyathea* species'; Marquesan *feki*, *heki* 'name of a tree fern with bulbs or shoots at the top eaten during food shortages' (Dordillon 1999 for heki; Crook 2007 for feki). If this term for a tree fern is the source of Tahitian *fē'ī*, there was an irregular lengthening of the initial vowel accompanying the change in meaning. Another possible source, as first suggested by Langdon (1989: 323), is Sāmoan *fa'i* 'banana' through a change of vowel quality as well as length. Ultimately the term *fē'ī* may have replaced an earlier cognate of PEPn **fua-tu'u* (expected Tahitian reflex being *huatū*) through word taboo, the source of many other distinctive Tahitian words.
30. In the unpublished journal of Martin Grant on his 1930–1931 voyage to the Society Islands, it was recorded on 4 December 1930: "The chief [of Paea on Tahiti] lamented the disappearance of the fei due to the boring of insects in the trunk" (Grant 1930–1931: 97).
31. Blust (2010) provides evidence that the Micronesian subgroup of languages is most closely related to the Longgu–Malaita–Makira languages of the southeast Solomons. An ancestral source for Micronesian languages in the southeast Solomons would as a corollary include cultural knowledge of the food crops grown in the southeast Solomons and the likelihood that such crops as the Fehi cultivars developed in the Makira area would be introduced into the high islands of eastern Micronesia. Perhaps relevant is that in Kiribati (Sabatier 1971) Bouru is "a land of ancestors where souls of the dead return", and possibly a reference to Bauro, the central third of the island of Makira.
32. We will add further evidence for paper mulberry as well as for breadfruit in two upcoming publications in this series.

Supplementary Information: Table 1. Listing of named cultivars in each Fehi group by country/island(s)

Country/Island(s)	‘Aiori	Baubaunio	Bonubonu	Kourai	Menei	Wild-seeded	Tāti’a	Rimina	Asupina	Karat	Sar	Tongkat Langit Pendek	Uncertain	References
Putative ploidy	diploid	diploid	diploid	diploid	diploid	diploid	diploid	triploid	triploid	triploid	triploid	triploid		Sardos, Breton, *et al.* 2018; Sardos, Sachter-Smith, Ghanem, *et al.* 2019; see also immediately below this table
Indonesia					*tongkat langit* (Ambon, Seram and Java)				*tongkat langit* Papua (West Papua)			*tongkat langit pendek*/*tongkat langit kecil*, *telo mata lala*		Dwivany *et al.* 2020; Hermanto *et al.* 2014; Hiariej *et al.* 2015; Edison *et al.* 2002; Sutanto *et al.* 2016
Papua New Guinea (Province)	*lolu*, *wore* (West New Britain)			*?utafan* (New Ireland), *?kateen* (Manus)	*menei* (Manus)			*rimina* (Eastern Highlands)	*asupina* (West Sepik), *skai* (Western)		*sar* (Manus)		*apap*, *kapiak* (West New Britain), *wain* (Madang), *sus* (Manus)	Arnaud and Horry 1997; Daniells, Sharrock and Kambuou 1988; Daniells and Paofa 2007; Sardos, Paofa, *et al.* 2019
Autonomous Region of Bougainville	*limot*, *poso-olohi*			*kourai*										Sachter-Smith *et al.* 2016; Sardos, Breton, *et al.* 2018
Solomon Islands	*toraka fagufagu*, *toraka suria* (syn. *aibw*, *aebo*), *toraka parao*	*toraka baubaunio*	*toraka bonubonu*	*toraka gatagata*			Mt. Popomanaseu			Bauro Central	*toraka warowaro*		*toraka akeakesusu*, *toraka morikera*	Daniells 2007; Sachter-Smith 2011; Sardos, Breton, *et al.* 2018
Rennell & Bellona, Polynesian Outliers, Solomon Islands													*ghabaghaghi*, *kangisi‘ibai* (Bellona); *huti ta‘ane* (Rennell)	Elbert 1975
Vanuatu			VUT151	*hoaka*/*hereibuero*, *ota*, *ota* 2, *sawak*, *sokamé*, Torres						*?navis nouel*			*avotchimeto*, *soka turu*	Cormier 2010
New Caledonia	*daak*, *daang*, *dāŋ*	*djan*				*daak*, *daang*, *dāŋ*, *djan*					*namaco ni du* (Maré)			Barrau 1958; Julien Drouin pers. comm.
Fiji	*soaqa* (Fiji), *säe* (Rotuma)		*säe liu* (Rotuma)											McClatchey *et al.* 2000; Dodds 1946; Seemann 1865; Smith 1979
Sāmoa	*ausulasula*		*pūputa*										*fa‘i soa‘a*	Sardos, Sachter-Smith, Ghanem, *et al.* 2019
Niue	*hulahula*		*pūputa*											Yuncker 1943; Poi Okesene pers. comm.
Marquesas, French Polynesia	*huetū* (syn. *‘aiori*); *huetū kāhui fa‘a* (“pandanus bunch”)					*huetū kakano* (Nuku Hiva); *huetū popoi/fio*/*‘oma‘o*/*nafa* (Fatu Hiva)							*pōpō* (large round red fruit); *aitu* (medium red fruit)	J.-F. Butaud (pers. comm.); Brown (1931)
Ra‘iātea, Leeward Islands (Society Is.), French Polynesia	*‘aiori*	*ha‘a*				*fē‘ī ‘ōfa‘i* (meaning stone/seed)	*‘āfara tārere*						*‘ati‘ati* (<10 fruits per bunch); *‘ū‘ū* (red skin like the *‘ū‘ū* or shy soldier fish *Plectrypops lima*); *rauoro* (skin thick with cracks, black ridges on the large fruits)	
Tahiti, Society Is., French Polynesia	*‘aiori* (10 varieties), *‘ārutu*	*‘ā‘ata*, *toro a‘ia‘i*, *ha‘a*, *mahani*, *rūreva*	*‘u‘ururu*	*‘oe‘oe*		*fē‘ī ‘iri‘iri*	*tāti‘a*, *‘āfara tārere*	*‘āfara potopoto*, *paru*		*pouti‘a*				MacDaniels 1947; Académie Tahitienne | Fare Vāna‘a 2017
Cook Islands	*‘ūtū*/*‘uatū* (1–2 varieties)	*‘ūtū*/*‘uatū* (several varieties)					*ve‘i ooka*/*‘uatū pi vai*							Sardos, Sachter-Smith, Ghanem, *et al.* 2019; Wilder 1931
Yap, Federated States of Micronesia										*arai* (syn. *karat*)	*arai ni ngir*			
Chuuk, Federated States of Micronesia										*danon* (syn. *karat*)				
Pohnpei, Federated States of Micronesia										*karat pako*, *karat pwehu*, *karat kole*	*utin Iap* (syn. *usr kolontol*), *usr utimwas*			Daniells, Englberger and Lorens 2004
Kosrae, Federated States of Micronesia										*usr kulasr* (syn. *karat*)	*usr kolontol*		*Kusaie* (introduction from Kosrae to Hawai‘i)	Daniells, Englberger and Lorens 2004

Additional ploidy references (derived from flow cytometry):

asupina: https://www.crop-diversity.org/mgis/accession/01BEL0841027 (3×)

'aiori: https://www.crop-diversity.org/mgis/accession/01GLP005386 (2×)

menei: https://www.crop-diversity.org/mgis/accession/01BEL0841021(2×)

rimina: https://www.crop-diversity.org/mgis/accession/01BEL0841010 (3×)

tongkat langit Papua: https://www.crop-diversity.org/mgis/accession/01BEL0841721 (3×)

wari: https://www.crop-diversity.org/mgis/accession/01BEL084813 (2×)