The Journal of Pacific History, 2026
https://doi.org/10.1080/00223344.2026.2613309

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Taro Swamps on Ontong Java Atoll: Past, Present, and Future

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ABSTRACT

Ontong Java atoll, Solomon Islands, transitioned in 1900 from a colonial copra export economy to one dominated since 1973 by bêche-de-mer sales. Prior to colonial influence, its inhabitants relied on two staple root crops – taro (*Colocasia esculenta*) and giant swamp taro (*Cyrtosperma merkusii*) – alongside coconuts and fish. This article examines taro cultivation on wetland 'taro swamps' across six of the atoll's 120 islands. We assess the decline of taro cultivation triggered by imports of carbohydrate foods, hurricane damage in 1967, introduced pests and diseases, and ongoing salinization from storm surges and climate change. Integrating swamp area and productivity data with approximated dietary carbohydrate needs, we estimate the carrying capacity of the atoll was between 2450 people (taro at 25 per cent dietary energy) and 6195 people (taro at 10 per cent). The higher estimate aligns with H. I. Hogbin's (1930) estimate of 5000–5500 for the pre-contact population. Our findings highlight the cultural and subsistence importance of taro cultivation in atoll communities before colonial contact.

Keywords: Ontong Java atoll, taro swamps, *Colocasia esculenta*, *Cyrtosperma merkusii*, carrying capacity, depopulation

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This article was originally published with errors, which have now been corrected in the online version. Please see Correction (http://dx.doi.org/10.1080/00223344.2026.2652759)

Acknowledgements: Most of the data from Ontong Java presented in this article could not have been collected without the active collaboration of the people of the atoll, and their vital role is fully specified and acknowledged in TBS's previous publications. His fieldwork took place between June 1970–May 1971, June–August 1972, and May–June 1986, and during this time, we acknowledge that the assistance of Timothy Kepangi (President) and David Kaia'enga (Clerk) of the Luangiua

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Taro in the Ontong Java Ecosystem

Ontong Java is a large atoll situated at 5 degrees south and 159 degrees east, and 270 km north of Santa Isabel island in Solomon Islands (Figure 1). By total area, it is the sixth largest atoll in the Pacific Ocean.[1] It is a Polynesian Outlier with some Micronesian influence.[2] Only limited information has been published on its geography and history, and very few aspects of its archaeology and geomorphology have so far been investigated. Even published descriptions of the atoll's vegetation are brief and highly generalized.[3] In contrast, the Ontong Java people have extensive knowledge of their ecosystem, with names for almost all the important plants, birds, and fish found on the atoll.[4] From the 1880s until the 1970s, the economy centred around the export of copra or dried coconut, resulting in 72.5 per cent of the vegetated area of Ontong Java now being covered in coconuts.[5] Since 1973, bêche-de-mer rather than copra has become the people's main source of income.[6]

This article discusses the changing importance of taro on Ontong Java. Our analysis is based on a re-examination of data from the 1970s and recognition of the significance for taro cultivation of some unpublished observations made by the first author (henceforth TBS) in 1986. It also benefits from more recent publications on Ontong Java by climate change consultants, and from the

Area Council and Arthur Kemahaku (Pelau) was particularly important. TBS's fieldwork in 1970–1 was funded by the UK Social Science Research Council, in 1972 by the Harvard Biomedical Expedition, and in 1986 by the South Pacific Smallholder Project, University of New England, Armidale, Australia. The archival work by TBS in 2015–16 was supported by Leverhulme Emeritus Fellowship, Grant Number EM-2015-041; SS is funded by a Feodor Lynen fellowship from the Alexander von Humboldt foundation. The collaboration of TBS and SS in 2025 was made possible by meetings supported by St John's College, Cambridge, UK. We acknowledge and thank these institutions and individuals, and many others, for their assistance.

[1] Walter M. Goldberg, 'Atolls of the World: Revisiting the Original Checklist', *Atoll Research Bulletin* 610 (2016): 1–47.

[2] Lawrence Y.C. Lai and J. Bloom, 'Genetic Variation in Bougainville and Solomon Islands Populations', *American Journal of Physical Anthropology* 58 (1982): 369–82.

[3] J.R.D. Wall and J.R.F. Hansell, *Land Resources of the Solomon Islands*, vol. 8, *Outer Islands* (London: Land Resources Division, Overseas Development Administration, 1976); SPREP, *Vulnerability and Adaptation (V&A) Assessment for Ontong Java Atoll, Solomon Islands*, PACC Technical Report No. 4 (Apia, Samoa: South Pacific Region Environment Programme, 2014).

[4] Sebastian Steibl and T. Bayliss-Smith, 'Flora and Vegetation of Ontong Java Atoll', article in preparation; Andreas E. Christensen, 'Marine Gold and Atoll Livelihoods: The Rise and Fall of the Bêche-de-mer Trade on Ontong Java, Solomon Islands', *Natural Resources Forum* 35 (2011): 9–20; Tim Bayliss-Smith and A.E. Christensen, 'Birds and People on Ontong Java Atoll, Solomon Islands, 1906–2008: Continuity and Change', *Atoll Research Bulletin* 562 (2008): 1–36.

[5] Michael W. Burnett et al., 'Satellite Imagery Reveals Widespread Coconut Plantations on Pacific Atolls', *Environmental Research Letters* 19 (2024): 124095.

[6] Tim Bayliss-Smith and A.E. Christensen, 'From Copra Sequestration to Outboard Engine Trawling: Historical Change in the Carbon Footprint of Ontong Java Atoll, Solomon Islands', *Journal of Pacific History* (henceforth *JPH*) 59, no. 4 (2024): 468–90.

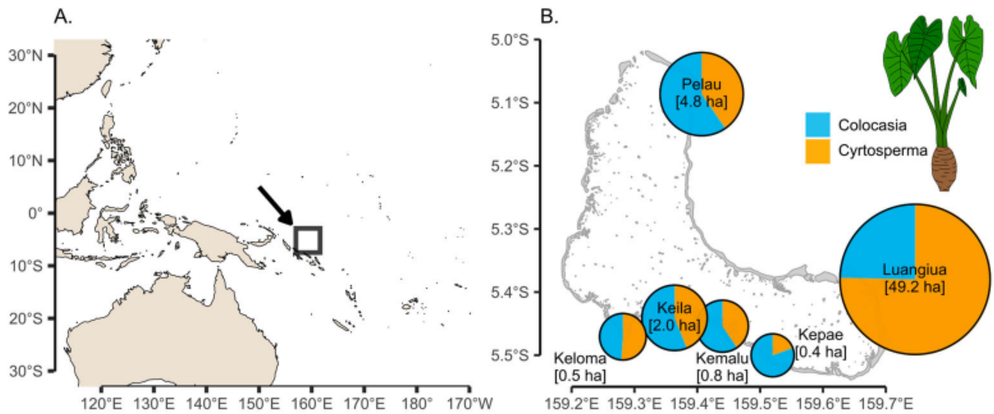

FIGURE 1: Maps showing the location of Ontong Java atoll and the estimated areas of taro swamp on Luangiua, Keila, Kemalu, Keloma, Kepae, and Pelau islands in the pre-contact period. The diagrams also show the estimated proportions of taro (*Colocasia esculenta*) and giant swamp taro (*Cyrtosperma merkusii*).

insights of Andreas Christensen and others following their visits to the atoll in the period 2006–8.[7]

We use the term 'taro swamp' for those freshwater wetlands, partly natural and partly excavated, that are found on six of the atoll's total of 122 islands. In the past, those six islands not only maintained taro swamps but also permanent villages and cemeteries.[8] Where possible, taro (*Colocasia esculenta*) as well as giant swamp taro (*Cyrtosperma merkusii*) were cultivated in the swamps alongside turmeric (*Curcuma domestica*). Turmeric was and is valued for its yellow or red colour and is used especially by women for body staining in a range of ritual contexts.[9] In the late 19th century, new banana varieties were introduced and since then some ornamental plants and weeds species have also arrived, some of the weeds making taro cultivation more onerous.

Damage and saltwater intrusion during the 1967 hurricane meant that *Colocasia* and turmeric were destroyed on all islands except Pelau (undamaged in 1967) and Luangiua (only partial damage). In 1970, *Colocasia* and turmeric were still being cultivated on these two large islands, but elsewhere the swamps were being maintained for occasional harvests of *Cyrtosperma* or were planted with coconuts or abandoned to fallow. In this article, we discuss the taro swamps on Luangiua and Pelau islands using the 1970 maps of TBS that show the boundaries of the taro

[7] Ibid.; Tim Bayliss-Smith et al., 'Managing Ontong Java Atoll: Social Institutions for Production and Governance of Atoll Resources in Solomon Islands', *Singapore Journal of Tropical Geography* 31 (2010): 55–69.

[8] Tim Bayliss-Smith, 'Changing Patterns of Inter-Island Mobility on Ontong Java Atoll', *Archaeology and Physical Anthropology in Oceania* 13 (1978): Table 3, 60.

[9] Tim Bayliss-Smith, 'Taro, Turmeric and Gender', in *Polynesian Outliers: The State of the Art*, ed. Richard Feinberg and Richard Scaglion (Pittsburgh, PA: Dept of Anthropology, University of Pittsburgh, 2012), 109–38.

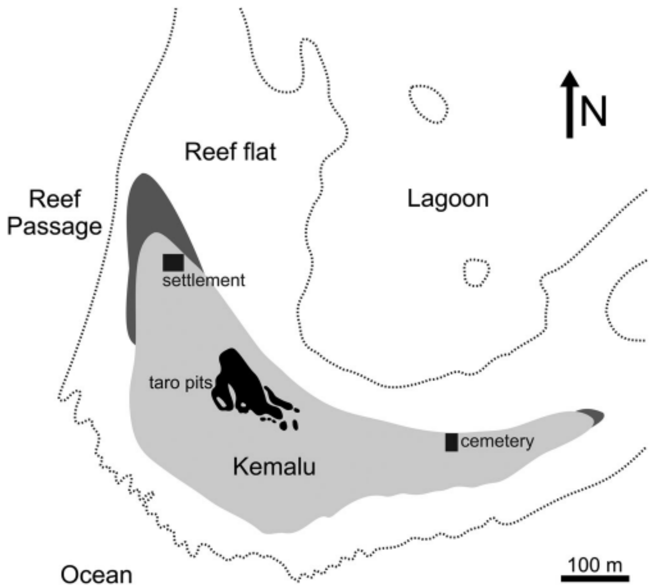

FIGURE 2: The taro swamps of Kemalu island, mapped in 1970 when *Colocasia* taro had been abandoned on this island and all the swamps were planted with giant swamp taro (*Cyrtosperma*).

swamps.[10] He also mapped the Kemalu swamps (Figure 2), measured the boundaries of taro swamps on two other islands (Kepae and Keila), and made estimates for Keloma using air photographs.

From these data, we have quantitative data or reasonable estimates for all six of the islands with taro swamps (Table 1). From fieldwork, it became clear that some areas now being cultivated with *Cyrtosperma* had previously been planted with the higher-yielding but more labour-intensive *Colocasia*, a change in land use linked to the people's focus in the 20th century on making and selling copra and their consumption of imported food. Further land use changes resulted from the damage caused by Cyclone Annie in 1967, which destroyed *Colocasia* in Luangiua, Keila, and Kepae when the taro swamps on these islands were inundated.[11] Despite the atoll's high rainfall, it took at least three years for the salt to be sufficiently leached away from soils for some cultivation to resume. Normally, the climate of Ontong Java is continually wet, with a rainfall of 3357 mm measured in the 11 months June 1970 to May 1971, suggesting an annual total of about 3650 mm.[12]

The recent and ongoing changes in climate and sea level mean that the future existence of islands on atolls is now being questioned, and it seems likely that within a few decades the Ontong Java flora recorded by TBS in 1970–86 will

[10] Ibid., figures 2, 3, and 4, 127–8.

[11] Tim Bayliss-Smith, 'Role of Hurricanes in the Development of Reef Islands, Ontong Java, Solomon Islands', *Geographical Journal* 54 (1988): 377–91.

[12] Tim Bayliss-Smith, 'Ecosystem and Economic System of Ontong Java Atoll, Solomon Islands' (PhD thesis, University of Cambridge, England, 1974), Table 1, 17–19.

TABLE 1: The taro swamps of Ontong Java in 1970–1

Island	Total land area (hectares)	Taro swamps in 1970–1 (hectares)			
		Cyrtosperma	*Colocasia*	Fallow	TOTAL
Luangiua side					
Luangiua	177.84	32.12	2.79	14.26	49.17
Keila	71.53	0.26	0	0.33	0.59
Kemalu	8.68	0.75	0	0	0.75
Keloma	12.74	0.50	0	0	0.50
Kepae	27.00	0.07	0	0.30	0.37
67 others	254.12	0	0	0	0
Total for Luangiua side					
72 islands	551.91	33.70	2.79	14.89	51.38
Pelau side					
Pelau	80.14	3.73	0.52	0.56	4.81
47 others	145.60	0	0	0	0
Total for Pelau side					
48 islands	225.74	3.73	0.52	0.56	4.81
Total for Ontong Java atoll					
120 islands	777.65	37.43	3.31	15.45	56.19

Source of 1970–1 data: Taro swamp areas from Bayliss-Smith (1974), figures 19, 20, 21, 22, pp. 286–91, with island areas from Table 86, pp. 364–7; for areas see also Bayliss-Smith (1978), Table 3, p. 60, except for Keila island where the area of taro swamp stated on p. 60 is incorrect. In Luangiua and Pelau the areas of fallow land also include small areas planted with turmeric, *Curcuma domestica*.

have changed. Some of the introduced plants, agricultural or ornamental, can be expected to disappear, especially in parts of the atoll no longer cultivated, while the native species, being better adapted to storm surges, overwash events, and saltwater intrusion, will increasingly predominate. This ongoing process has already been observed on Manuae atoll in the Cook Islands.[13]

The taro swamps in particular will increasingly be vulnerable to salinization. As with the wells dug on the bigger islands to access drinking water, the freshwater swamps depend on a layer of fresh groundwater (the Ghyben-Herzberg lens) floating above the denser saltwater. This freshwater aquifer is recharged through the infiltration of percolating rainfall, and this process can be affected by drought conditions, storms, and/or sea-level rise.[14]

We can expect that in the future all the wells on Ontong Java will become too salty to drink, and the taro swamps will be substantially altered or even destroyed by

[13] Sebastian Steibl, Samuel D.J. Brown, and James C. Russell, 'Terrestrial Biodiversity of Manuae Atoll, Cook Islands', *Pacific Science* 79, no. 1 (2025): 55–70.

[14] F. Ray Fosberg, 'Atoll Vegetation and Salinity', *Pacific Science* 3 (1949): 89–92; Harley I. Manner, 'Taro (Colocasia esculenta (L.) Schott) in the Atolls and Low Islands of Micronesia', in *Proceedings of the Sustainable Taro Culture for the Pacific, 1992*, ed. Ferentinos (Honolulu: University of Hawai'i, 1993), 91; Kent W. Bridges and W.C. McClatchey, 'Living on the Margin – Ethnoecological Insights from Marshall Islanders at Rongelap Atoll', *Global Environmental Change* 19 (2009): 140–6.

ongoing changes in the atoll ecosystem. Already in 2011, a team of consultants reported that *kakake* (giant swamp taro) was no longer growing as well in Luangiua and Pelau as in former days:

> Initially [after sea flooding in 2008[15]] the issue occurred mostly in gardens that were located in the areas close to the coast on both islands, but later it also slowly affected the patches in the centre and the southern end of the island. Plant growth [in 2011] is decreasing further, with plants now about 30–60 cm [in height] at the most and no big trees are standing in there. However, in the patches [of *Cyrtosperma*] that are positioned in the centre of the islands with big trees standing, *kakake* plants are [still] growing really healthy with heights of 1–5 feet [30–150 cm].[16]

These consultants blame a combination of rising average sea level and extreme sea-level events during the ocean swell of 8–9 December 2008. These processes operating together have contaminated the freshwater lens that feeds the swamps where taro is grown, affecting *Colocasia* especially. The drought resulting from the 2010–11 El Nino Southern Oscillation was particularly severe, with an increased saltiness of the water in the 13 wells of Luangiua and the 17 of Pelau, which led to a much greater dependence on roof catchments to supply drinking water.[17]

It is clear that Ontong Java's ecosystem is now changing, while our information for the taro swamps and their productivity derives from fieldwork by TBS 40–50 years ago. These data represent a historical situation that is already out of date and which in the future may well be transformed. At the same time, these historical data can be an important reference point for future research that aims to establish the resilience capacity of taro swamps and their cultivation within atoll ecosystems of increased dynamism due to global change.

Taro Swamps at European Contact

Despite the historic importance of taro in both economy and culture of Ontong Java, little was written about the atoll's taro swamps until the late 20th century. After 1875, traders, colonial officials, missionaries and, later, anthropologists and natural scientists made an increasing number of visits, but the taro swamps were generally overlooked or ignored. In this article, we reconstruct the history and prehistory of the

[15] Ron K. Hoeke et al., 'Widespread Inundation of Pacific Islands Triggered by Distant-Source Wind-Waves', *Global and Planetary Change* 108 (2013): 128–38.

[16] SPREP, *Vulnerability and Adaptation*, 42; Andrew McGregor and Casper S. Supa, *The Solomon Islands PACC Ontong Java Pilot Food Security Project: A Benefit Cost Analysis* (2012), https://www.adaptation-undp.org/sites/default/files/resources/solomon_islands_pacc_cba_final_report.pdf, 6–7.

[17] SPREP, *Vulnerability and Adaptation*, 50–1.

part of atoll subsistence that is based on taro swamps, and the reasons for their changing importance in recent times. Today it is unclear if Ontong Java's taro swamps will have much future in a warming world where both climate and sea level are changing. The atoll islands themselves and their native local flora have an inherent dynamism, with significant local resilience against climate change.[18] On the other hand the cultural landscapes of taro swamps, dependent as they are on fresh water, are likely to be more vulnerable.

The nature of atoll landforms and soils has always made any form of agriculture difficult or impossible on most islands. On a few of the larger islands of Ontong Java freshwater swamps exist, partly natural in formation, and partly enlarged by digging or newly excavated. These swamps were planted with giant swamp taro (*Cyrtosperma*) and taro (*Colocasia*), and in precolonial times these two crops were vitally important for atoll subsistence. Indigenous myths about origins recount that the first settler was Kasivi, a man who brought with him a woman 'and also the taro plant'.[19]

Visitors did often not see the taro swamps of Ontong Java and their impressions can be misleading. For example, the captain of the ship that raised the German flag at Luangiua in 1889 had little contact with the people, and never walked inland beyond the village, but nevertheless he reported that 'with regard to food the natives are the poorest I have yet contacted in the South Seas; … they live solely on coconuts and never cook'.[20] Fifteen years later a Methodist missionary made a brief visit. He reported that most of the islands were 'thickly inhabited' but wondered 'How the people live is a mystery, for they have no food except cocoanuts and fish. Yet on this fare they not only manage to live but seem to thrive wonderfully'.[21]

Visitors from Solomon Islands were always surprised at the absence of typical Melanesian root crops. An Anglican catechist wrote that 'here you cannot plant kumara [sweet potato] or yams because there is no soil, only white sand and coral … The only root food that will grow here is swamp taro'.[22] Despite having lived in Luangiua for two years in 1936, he seemed never to have visited the extensive *Colocasia* taro gardens in the island's interior, which he avoided perhaps because they were women's property and their exclusive domain.

[18] Sebastian Steibl et al., 'Rethinking Atoll Futures: Local Resilience to Global Challenges', *Trends in Ecology & Evolution* 39, no. 3 (2024): 258–66.

[19] Charles M. Woodford, 'On Some Little-known Polynesian Settlements in the Neighbourhood of the Solomon Islands', *Geographical Journal* 48 (1916): 26–49.

[20] Anon., 'Auszug aus einem Berichte S.M. Kreuzerkorvette "Alexandrine", betreffend drn Besuch der Lord Howe-Gruppe (auch Ontong-Java gennant), westlich der Salomon Inseln', *Mitteilungen aus den Deutschen Schutzgebieten* 3 (1890): 87–8.

[21] J.F. Goldie, 'A visit to Ontong Java (Lua Niua)', *Australian Methodist Missionary Review* 14, no. 7 (1903): 6–7.

[22] Tasiu J. Bosamata, 'The Brothers at Lord Howe', *The Southern Cross Log*, September (1936): 140–1.

However, other visitors recognized that subsistence on Ontong Java was based on more than just coconuts and fish and involved many plant foods that needed quite elaborate processing and cooking. The trader William Wawn, an experienced observer, reported in 1888 that 'The chief articles of food are fish and cocoanuts, with a little breadfruit, and very coarse taro'.[23] The German plantation administrator Richard Parkinson made several visits to Ontong Java and other Northern Outlier atolls in the 1880s and 1890s, and he too recognized the importance of both taro and giant swamp taro. He visited Ontong Java and neighbouring atolls during the two decades prior to 1900, at a time when their populations were less affected by introduced disease and before copra production began to dominate the atoll economy. He described the cultural landscape of taro swamps in some detail:

> In the middle of the islands, protected against onshore winds by a dense stand of trees, the people conduct small-scale agriculture, which is characteristic of these islands. The islanders have dug flat pits out of the upper surface of the coral reef for probably hundreds of years. These are up to 2 metres deep and 100 to 500 square metres in area. In the bottom of the pit over the course of time they have built up a scanty layer of humus by throwing in all kinds of plant material, and here they grow a small species of taro [*Colocasia esculenta*] and a considerably robust species of *Alocasia* [in fact *Cyrtosperma merkusii* or giant swamp taro] … Bananas have been introduced only in recent times, but are still regarded as a luxury item.[24]

From this description it appears that Parkinson is providing an eye-witness account of an ongoing process of taro pit construction. In an earlier account he gives slightly different estimates of the size and depth of taro pits:

> To prepare a site for planting taro, the coral soil in the island's interior is broken down to a depth of 4 metres. A pit about 20 to 30 metres long to 10–15 metres wide is dug. The excavated material is broken further and ringed around the pit. A mulch is made of palm leaves and other vegetable wastes. The mulch is mixed with sand and the taro field is ready for planting. Even with that, however, the taro grows only to the size of a fist.[25]

[23] William T. Wawn, *The South Sea Islanders and the Queensland Labour Trade. A Record of Voyages and Experiences in the Western Pacific, from 1875 to 1891* (London: Swan Sonnenschein, 1893), 411.
[24] Richard Parkinson, *Dreissig Jahre in der Südsee* (Stuttgart: Berlag von Streder & Schroder, 1907). Translated by John Dennison as *Thirty Years in the South Seas* (Bathurst, NSW: Crawford House, 1999), 235.
[25] Richard Parkinson, 'Zur Ethnographie de Ontong Java- und Tasman-Inseln, mit Einigen Bemerkungen die Marqueen- und Abgarris-Inseln', *Internationales Archivs für Ethnographie* 10 (1897): 104–18, 137–51. Translated and edited by Richard Feinberg as 'Ethnography of Ontong Java and Tasman Islands with remarks re the Marqueen and Abgarris Islands', *Pacific Studies* 9 (1986): 1–31.

As it still is today, turmeric (*Curcuma domestica*) was an important crop grown alongside taro, but surprisingly, its cultivation was not mentioned by Parkinson, although he found turmeric powder ('gelbwurzpulver') kept in small wooden containers in people's houses, and he also mentions its use as a dye to colour men's clothing.[26] The anthropologist Ian Hogbin was told at Luangiua in 1928 that turmeric cultivation was once more widespread, the plant being grown in taro swamps on Kepae, Keloma, Kemalu, and Keila.[27] Turmeric was also grown on three smaller islands (Akaha, Makamea, Akoo) where today there is no trace of taro swamps.[28]

Ontong Java was transferred as a colony from Germany to Britain in 1900 when the British Protectorate was declared by Charles Woodford, the resident commissioner. Woodford later made three more official visits to Ontong Java. He may have seen the taro swamps in 1906 while searching for endemic bird species and collecting specimens, but in his various writings Woodford makes no mention of taro, turmeric, or swamp management.[29]

Much more information was provided by Ernst Sarfert of the German Südsee-Expedition, following his four-week visit to Ontong Java in 1910. Most of his time was spent in Luangiua village but he also visited Pelau and published photographs showing the landscapes of taro on both islands. Sarfert's report does not include maps or plans of the taro swamps, but he describes in some detail the techniques for cultivating and harvesting taro and giant swamp taro and also the methods used for processing the corms to make food. From information given by his informants, Sarfert lists the local names of 16 varieties of *Colocasia* taro and ten varieties of *Cyrtosperma*. He mentions some other minor starch crops (breadfruit, yams, Polynesian Arrowroot, and banana) with local names given for each, but it is clear that taro and giant swamp taro were far more important than all other plant foods except coconut, in both subsistence diet and culture of the atoll.[30]

In the 1920s, as people became more integrated into the cash economy, women's taro gardens started to find some new value in local exchange systems. Hogbin was told that 'some people did sell out their crops of taro etc.' and that those having gardens at Keila and Kepae 'sold enough taro to cover 10,000 coconuts, a ton and a half of copra'.[31] It seems that taro (probably *Colocasia*) had become a means for women to participate in the cash economy, an economy that by now had become synonymous with copra production.

[26] Parkinson, 'Zur Ethnographie', 116, 118; 1986 trans., 16–17.

[27] H. Ian Hogbin, 'Series 1, Field Notebooks and Diaries, Luaniua, Lord Howe, 4.1.28', University of Sydney Archives P.01s, Notebook 4, 97.

[28] Hogbin, 'Series 1, Field Notebooks', Notebook 4, 105.

[29] Charles M. Woodford, 'Notes on the Atoll of Ontong Java or Lord Howe's Group, in the Western Pacific', *Geographical Journal* 34 (1909): 544–9; idem, 'On Some Little-known Polynesian Settlements', 26–54; Bayliss-Smith and Christensen, 'Birds and People', 1–36.

[30] Ernst G. Sarfert and H. Damm, *Luangiua und Nukumanu. 1. Allgemeiner Teil und materielle Kultur,* Ergebnisse der Südsee-Expedition 1908–10, series 2, subseries B, vol. 12, no. 1, ed. G. Thilenius (Hamburg: Friedrichsen De Gruyter, 1929), 99–109.

[31] Hogbin, 'Series 1, Field Notebooks', Notebook 4, 105.

Taro's Declining Subsistence Role

In the first decade of the 20th century, there is evidence that introduced diseases, in particular malaria, tuberculosis, and recurrent epidemics of influenza, were causing a rapid decline in the population, a trend that was not reversed until after 1939.[32] In the new economy of copra making and imported food (rice, flour, biscuit) taro had less importance in the diet. The more labour-intensive *Colocasia* taro was being replaced by giant swamp taro (*Cyrtosperma*), which is slower growing, more shade-tolerant, and requires much less labour. As a result, in the 20th century it was no longer obvious that both forms of taro had once played a primary role in the diet.

By the time of Hogbin's fieldwork in 1927–8, the copra-based cash economy had grown considerably, with rice, flour, biscuit, and sugar supplementing taro, coconuts, and fish in the diet. He described each taro garden as being 'usually about 150 square yards [125 sq. m] in area'. Five or six adjoining gardens were often enclosed within a bank, and the edges of individual gardens were marked with coral stones.[33]

A typical taro garden in Luangiua, surveyed by TBS in July 1970, shows the intensity of *Colocasia* cultivation before taro's decline in more recent decades. Two women, Sehuli and her daughter Elsie Kaia'enga, owned the garden. It measured 7 × 14 metres (98 sq. m) and contained 17 beds of *Colocasia*. In this case a row of Cyrtosperma plants rather than a line of stones surrounded the taro garden. Most of the taro was planted in blocks of 30–50 plants, cultivated in a four-month cycle of planting, weeding, and mulching, and then harvested followed by immediate replanting. This garden contained altogether almost 700 taro plants and helped to feed a household of three adults and three small children (Figure 3).[34]

As Sarfert had earlier described, taro cultivation in 1927–8, 1970–2, and 1986 was mainly 'women's business' involving arduous work in an environment infested with mosquitoes. The everyday work consisted of weeding, mulching the plots with cut vegetation, harvesting the taro or giant swamp taro, and replanting the setts. After carrying the baskets of corms back to the village, the women then made the coconut cream needed for cooking taro puddings. Hogbin records how women's work in the swamps took place on certain days of the week and was forbidden at other times.[35] This regulation of access to the taro swamps was to discourage the pilfering of taro or turmeric. It was a pattern of work that still prevailed in 1986.

[32] H. Ian Hogbin, 'The Problem of Depopulation in Melanesia as Applied to Ongtong Java (Solomon Islands)', *Journal of the Polynesian Society* 39 (1930): 43–66; Tim Bayliss-Smith, 'Ontong Java: Depopulation and Repopulation', in *Pacific Atoll Populations*, ed. Vern Carroll (Honolulu: University of Hawai'i Press, 1974), 417–84.

[33] H. Ian Hogbin, *Law and Order in Polynesia: A Study of Primitive Legal Institutions* (London: Christophers, 1934; New York: Cooper Square Publishers, 1972), 97.

[34] Bayliss-Smith, *Polynesian Outliers*, Figure 5, 130.

[35] H. Ian Hogbin, 'Coconuts and Coral Islands', *National Geographic Magazine* 65 (1934): 265–98.

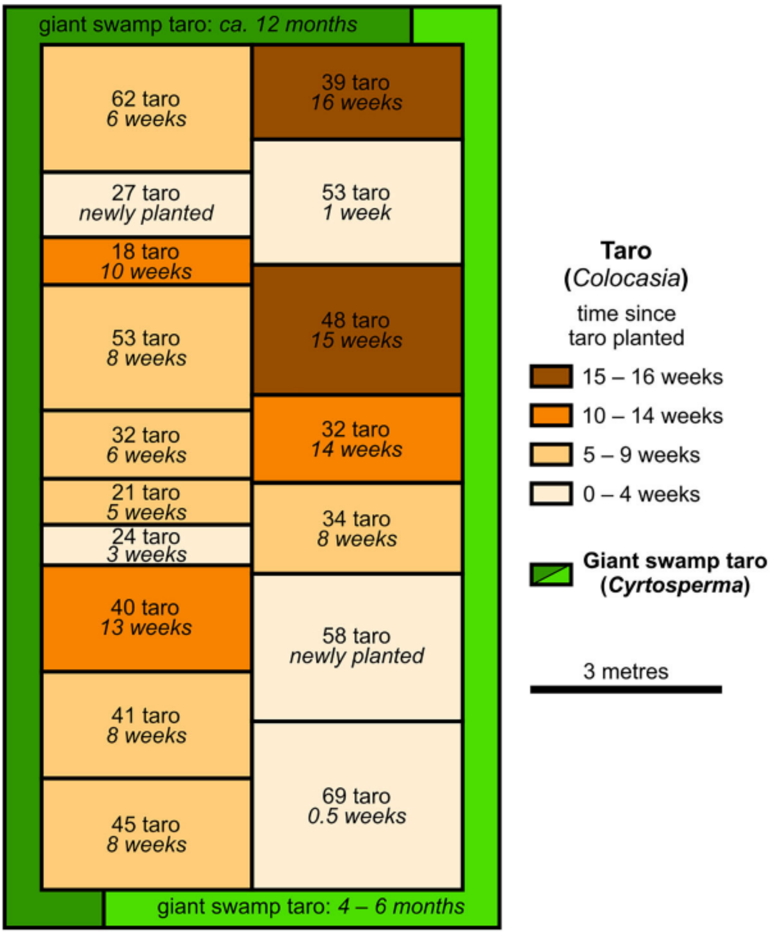

FIGURE 3: The taro garden of Sehuli and Elsie Kaia'enga at Luangiua in July 1970, mapped by TBS at a time when the cultivation of those taro swamps on Luangiua, undamaged by the 1967 cyclone, was continuing probably at its pre-contact level of intensity.

Despite their partial replacement in the 20th century by imported food, taro (*Colocasia*), giant swamp taro (*Cyrtosperma*), and turmeric have all remained important in the culture, but for men in particular the priorities were changing. The growing cash economy was mainly based on making and selling copra and, after 1973, the export of bêche-de-mer. These commodities put money into men's pockets, whereas work in the taro swamps and the resulting food production was not monetized and remained the domain of women.[36]

In this respect, Ontong Java was similar to societies like Ulithi atoll in the Caroline Islands of Micronesia, where men were forbidden to visit the *Colocasia* gardens and women controlled the production of taro, which was the prestige

[36] Bayliss-Smith and Christensen, 'From Copra Sequestration', 473–4.

plant needed for prestation and ritual as well as for subsistence.[37] On Ontong Java, the ritual exchange of taro puddings and the cosmetic use of turmeric in the rites of passage for birth, betrothal, marriage, and funerals were all practices controlled by women, whereas men's lives were increasingly dominated by earning money, buying fibreglass canoes, and running outboard engines. Even in the 1980s, taro and turmeric both remained symbolically important, taro being essential for gift exchange and turmeric being a vital signifier of young people's sexuality and fertility.[38]

Despite population changes and the growing importance of the market economy, there has been a high degree of continuity in the social groups on Ontong Java that own land in the taro swamps, organize the work, and redistribute what they produce. Hogbin analysed the various land-owning groups, which include what he called the garden-owning group, a group containing the women who own and cultivate the land on which taro grows. It generally consists of sisters or the daughters of sisters, these women often being members of the same household. Inheritance of these taro swamps is matrilineal, and the sisters who inherit the land may decide to divide it between them, especially after marriage if they live in different households.[39] The same rules and practices existed in the early 1970s, and despite increasing land disputes they also prevailed in 2007.[40]

Substantial gifts of taro and an exchange of taro puddings were important to mark the betrothal of a couple whose marriage had been agreed.[41] Such ritual exchanges were also taking place in 1986, and in 2006–8, although by that time the importance of taro for subsistence had diminished.[42] Detailed surveys by TBS showed that in 1970–1 the taro swamps provided an estimated 29 per cent of the energy in the average Ontong Java diet (18 per cent from *Cyrtosperma*, 11 per cent from *Colocasia*).[43] By 1986, the contribution of taro had fallen to an estimated 18 per cent in total (12 per cent from *Cyrtosperma*, 6 per cent from *Colocasia*), while imported foods (rice, flour, biscuit, sugar, and so forth) contributed 51 per cent.[44] The bêche-de-mer economy of the late 21st century has further increased the atoll's dependence on imported foods, many of which serve in energy terms as direct substitutes for the taro and giant swamp taro that had once been so important. In terms of vitamins, however, these substitutes are unlikely to provide as healthy a diet as eating the corms and leaves of taro.

[37] Manner, 'Taro (Colocasia esculenta (L.) Schott) in the Atolls', 94, 96.

[38] Bayliss-Smith, 'Taro, Turmeric and Gender', 130–5.

[39] H. Ian Hogbin, 'The Social Organisation of Ontong Java', *Oceania* 1 (1931): 399–425; idem, *Law and Order*, 97–8.

[40] Bayliss-Smith et al., 'Managing Ontong Java', 57–8, 63–4.

[41] H. Ian Hogbin, 'Polynesian Ceremonial Gift Exchanges', *Oceania* 3 (1933): 13–39.

[42] Bayliss-Smith, 'Taro, Turmeric and Gender', 130–5.

[43] Bayliss-Smith, 'Ecosystem and Economic System', Table 72, 320–1.

[44] Tim Bayliss-Smith, *Ontong Java Population, Economy and Society, 1970–1986* (Armidale, NSW: University of New England, 1986), Table 5, 21–5; Bayliss-Smith et al., 'Managing Ontong Java', 63–4.

The declining importance of taro has been an accelerating trend over the last forty years. The arrival of new plant diseases and pests has been one reason for decline; for example, taro leaf blight (*Phytophthora colocasiae*), which was already present in 1970. In 1983, the Ministry of Agriculture introduced blight-resistant taro varieties, but they proved susceptible to a new disease, dry corm rot, that had first been noticed about 1980.[45] The disease is spread by a soil nematode, *Hirchmanniella miticausa*, that was first noticed on Ontong Java in 1982 and had possibly been introduced to the atoll in a bag of soil or on taro corms brought to the atoll by returning migrants.[46]

The taro harvest was devastated by dry corm rot and was only partially rescued by a wholesale conversion from traditional varieties to a semi-resistant cultivar called locally *makakolo*, a variety which spreads through runners not cormels and seems to avoid nematode damage. People regarded *makakolo* as worth cultivating, although not as tasty as the old cultivars. In Luangiua, TBS found 91 per cent of taro plots he examined were *makakolo*. At Pelau, adoption of *makakolo* was slower and there was abandonment of taro plots, so that in 1986, about 35 per cent of the area that had been cultivated in 1970 was now fallow.[47] After their visit in 2011, SPREP consultants blamed the introduction of new fungal diseases for the growing problems of taro cultivation, but local discourse tended to emphasize the negative effects of saltwater intrusion.[48] It is clear that both the effects of storm surges and the establishment of new plant pests make the future of taro cultivation on the atoll uncertain.

Precolonial Ecology of the Taro Swamps

Can the historical ecology of the Ontong Java taro swamps be reconstructed to provide an estimate for their subsistence role before European contact? It is hard to imagine the diet of the atoll at the time of initial settlement, especially if coconuts were not yet the atoll's dominant vegetation. How did people eat before the construction of taro swamps allowed the starchy carbohydrates to become a staple food? In early times, the abundance of fish, shellfish, turtles, and seabirds would have been some compensation, especially the seabirds which undoubtedly had once formed huge nesting colonies in the *Pisonia*-dominated forests of most atolls.[49]

An earlier assessment by TBS was based on the contribution of taro to subsistence, which led him to calculate the 'carrying capacity' of the pre-colonial

[45] Bayliss-Smith, 'Ontong Java Population, Economy and Society', 21.

[46] John Bridge, J.J. Mortimer, and G.V.H. Jackson, 'Hirchmanniella miticausa n. sp. (Nematoda: Pratylenchidae) and its Pathogenicity on Taro (Colocasia esculenta)', *Revue Nematologie* 6, no. 2 (1983): 285–90.

[47] Bayliss-Smith, 'Ontong Java Population, Economy and Society', 22.

[48] SPREP, *Vulnerability and Adaptation*, 16–17.

[49] Sebastian Steibl et al., 'Atolls are Globally Important Sites for Seabirds', *Nature Ecology and Evolution* 8 (2024): 1907–15.

economy.[50] He argued that in all cases the Northern Outlier Atolls provided three major staple foods: taro (both *Colocasia* and *Cyrtosperma*), coconuts, and fish. These three staple foods provided almost all the energy in the diet, and he identified taro as the one most likely to have been the factor limiting population growth.

Coconut was certainly an important food and daily staple, but the historical evidence from these atolls suggests that populations cannot have grown to the limits of coconut production. Early accounts show that coconut palms were always present, but they were much less abundant than in the 20th century when coconuts were planted everywhere to maximize copra production. For example, the Ontong Java islands were described in 1791 as 'all generally thickly covered in fine trees', and 'very thickly covered with wood, among which the cocoanut was very distinguishable'.[51] As late as 1888, a visiting trader described the atoll as having 'a great number of low, wooded islets … Three or four of the largest of these are permanently inhabited'. [52] As elsewhere in the world, it was only after the onset of the copra trade in the 1880s that people had the incentive to increase coconut production by replacing the forests dominated by *Pisonia grandis* with coconut plantations.[53]

As with coconuts, the marine foods are also not likely to have been the main factor limiting Ontong Java's population. The productivity of some marine activities was low (for example, shellfish collecting) and fishing was difficult unless made possible through labour-intensive technologies for the manufacture of canoes, ropes, nets, lines, and hooks. Even with modern equipment the productivity of the fishing itself is sometimes marginal.[54] Despite their seasonal appearance and occasional abundance, many marine foods (for example, tuna, turtles) were unusual and often unavailable. Although vitally important for nutrition, this marine component of the diet seldom exceeds 30 per cent of dietary energy even with modern technology.[55]

It therefore seems probable that on Ontong Java and neighbouring atolls the limits to taro production were what ultimately limited the growth of population. Most islands were much too small to support a groundwater lens stable enough to allow the construction of taro swamps, and the ultimate limit to taro production was therefore imposed by island geomorphology. Digging or enlarging taro swamps was only feasible on six of the largest islands (see Figure 1 and Table 1).

[50] Tim Bayliss-Smith, 'Constraints on Population Growth: The Case of the Polynesian Atolls in the Pre-contact Period', *Human Ecology* 2 (1974): 259–95.

[51] Daniel Southwell, 'Remark on a voyage from Port Jackson New So. Wales', 1791, in Southwell, Journal and Logbooks 1787–91, vol. 2, British Library, London, Add. Mss. 16382 b; John Hunter, *Historical Account of the Transactions at Port Jackson and Norfolk Island* (London: J. Stockdale, 1793), 222.

[52] Wawn, *The South Sea Islanders*, 408.

[53] Steibl et al., 'Atolls are Globally Important Sites for Seabirds', 1907–15; Sebastian Steibl et al., 'A Renaissance of Atoll Ecology', *Annual Review of Ecology, Evolution and Systematics* 55 (2024): 301–22.

[54] Tim Bayliss-Smith, 'Atoll Production Systems: Fish and Fishing on Ontong Java Atoll', in *Atoll Production Systems: Approaches to Economic Prehistory*, ed. Douglas E. Yen and J.M.J. Mummery (Canberra: Department of Prehistory, Research School of Pacific Studies, Australian National University, 1990), 37–69.

[55] Bayliss-Smith, 'Atoll Production Systems', tables 1 and 2, 61; idem, 'Constraints', 259–96.

The restricted area for the intensification of taro production thus acted as the ultimate constraint limiting the carrying capacity of these atolls. An extreme limit was imposed where taro production was affected by natural disasters (drought, hurricane) or where population growth itself reduced the per capita intake of taro. Dietary surveys on Ontong Java by TBS in 1970–1 showed that, at that time and in most circumstances, between 30 and 68 per cent of the total calories came from *Colocasia* and *Cyrtosperma* taro and 10–30 per cent from fish, whereas coconut contributed a more stable 15–20 per cent.[56]

In difficult times, for example after the damage to taro swamps inflicted by the 1967 hurricane, the amount of starchy carbohydrate in the diet was restricted in those households with less taro, and especially at times when imported rice, flour, and biscuits were in short supply. If the contribution of taro, rice, and so forth fell to 25 per cent of total dietary energy, then, judging from people's comments, we can indeed suggest that a form of 'population pressure' was being experienced. As a result of food scarcity, many families emigrated in the years 1968–73, mostly to Honiara, the Solomon Islands capital, to await better times.

We believe that deficiencies in the diet started to be felt when the supply of taro (or substitutes) fell to around 50 per cent of the diet. This situation of 'pressure' arose in 1970 when the copra price fell, reducing opportunities for food imports. As a result 'taro substitutes' in the diet (rice, flour, biscuit) were no longer available for most people, and the starchy carbohydrates could no longer be eaten in the amounts that people expected.[57]

The Ontong Java Population

For his previous calculations, TBS assumed that a normal perceived limit for an atoll like Ontong Java would be reached when population growth or the destruction of taro by natural disaster caused a decline in the quality of the diet. It was assumed that decline would start to be experienced when the starchy carbohydrates (that is, both *Colocasia* and *Cyrtosperma* taro) could only supply 50 per cent of total food energy, with coconuts and marine foods providing almost all the rest. If the dietary situation continued to deteriorate, with taro swamps in full cultivation but now able to provide only 25 per cent of food energy needs, then a situation of 'population pressure' would have arrived. Using this approach, TBS calculated that in precontact times the atoll could have supported 1020 people at the 50 per cent level, but double that number if starchy carbohydrate consumption had declined to the 25 per cent level.[58]

These calculations were made in 1974, and we now believe they underestimate the flexibility of the prehistoric diet as well as the former extent of *Colocasia* taro if its cultivation were fully intensified. Our new estimates for the areas of taro swamps

[56] Bayliss-Smith, 'Constraints', Table 1, 278.

[57] Ibid., tables 1–4, 278, 280, 286, 287.

[58] Ibid., Table 3, 286.

TABLE 2: The prehistoric extent of taro swamps on Ontong Java atoll, showing estimates for the amount of *Cyrtosperma* and *Colocasia* cultivation circa 1870 before the onset of the colonial economy in the 1880s and the severe depopulation that followed

	Taro swamps before significant colonial contact (hectares)			
Island	*Cyrtosperma*	*Colocasia*	fallow	TOTAL
Luangiua	36.97	12.10	0.10	49.17
Keila	0.87	1.11	0.01	1.99
Kemalu	0.30	0.44	0.01	0.75
Keloma	0.25	0.24	0.01	0.50
Kepae	0.07	0.29	0.01	0.37
Total for Luangiua side				
	38.46	14.18	0.14	52.78
Pelau	1.90	2.80	0.11	4.81
Total for Ontong Java atoll				
120 islands	40.36	16.98	0.25	57.59

Source: The areas shown derive from the same sources as Table 1, modified for all taro swamps on the Luangiua side of the atoll by new information from 1986 concerning the likely former extent of *Colocasia* and turmeric cultivation.

on the six islands are shown in Table 2 with new assumptions about the relative proportions of *Colocasia* taro and giant swamp taro (*Cyrtosperma*). These are based on new information from 1986 fieldwork, which showed that the former extent of *Colocasia* cultivation was greater than TBS had previously assumed.

On the large island of Luangiua, the new surveys showed that quite large areas of land previously suitable for *Colocasia* were abandoned in the 1970s because of saltwater flooding by the 1967 hurricane. In places, the former land use pattern was still visible in lines of coral flagstones marking the boundaries of former *Colocasia* plots. Similarly, on Kepae, people reported that a large open area formerly very productive for taro and turmeric had been flooded by the 1967 hurricane. Even in 1986, these areas were still not replanted, apart from scattered plants of *Cyrtosperma* in taro swamps where sufficient salt had leached away.

The 1974 carrying calculations also underestimated a flexibility of diet that could have allowed people to survive beyond the '25 per cent taro' level. Not only would the circumstances of population pressure have stimulated a further intensification of fishing effort, but they also would have necessitated an emergency diet containing less starch and far more coconut than people had previously regarded as tolerable.

There is now evidence from elsewhere that atoll diets can contain remarkably high proportions of coconut. Detailed dietary surveys on Fakaofo atoll in the Tokelau group showed that their diets contained 18–23 per cent of energy derived from starchy carbohydrates and 10–12 per cent from fish. These diets also contained a high proportion of food energy from coconut, where coconuts were always abundantly available in various forms (green, ripe, sprouting). In three large-scale surveys of the food consumption of people on Fakaofo atoll over a three-month period, the data showed that coconut provided on average 54–69 per cent of the energy in the diet.[59]

What prehistoric population levels can we calculate for Ontong Java if both land use intensity (more *Colocasia*, less *Cyrtosperma*) and amounts of coconut in the diet are adjusted to allow us to model a more extreme scenario? In Table 3 are shown the newly calculated figures for both the 25 per cent taro scenario ('population pressure') and the 10 per cent taro scenario ('extreme crisis'). The calculations show that the food energy generated from the Luangiua side of the atoll, from taro grown on the islands of Luangiua, Keila, Kemalu, Keloma, and Kepae, could have amounted to 352 million kcal per year (72 per cent from *Colocasia*, 28 per cent from *Cyrtosperma*). On the Pelau side, with swamps only on Pelau island itself, the equivalent amount is 55 million kcal (91 per cent *Colocasia*, 9 per cent from *Cyrtosperma*). The atoll's annual total is therefore 407 million kcal (74 per cent *Colocasia* and 26 per cent *Cyrtosperma*).

In this model, and under the two projected dietary scenarios, the 25 per cent 'population pressure' scenario suggests a total atoll population of 2480 (2146 in Luangiua, 334 in Pelau). The extreme crisis scenario, with starch consumption falling to 10 per cent of the diet, suggests a maximum atoll population of 6195 (5360 in Luangiua, 835 in Pelau). These calculations assume an annual requirement for food energy of 657,000 kcal per capita (see Table 3). This average energy requirement, like other assumptions, could be raised or lowered if new data suggest it is unrealistic.

A total atoll population of around 2500, as projected in the 25 per cent scenario, is not as large a population as was estimated by some of the early visitors to Ontong Java. In 1900, when *HMS Torch* briefly toured the atoll to declare the British Protectorate, an estimate of 2–3000 for the total population was reported, although the evidence for this claim is uncertain. *Torch* saw only the islands situated on the atoll's southern rim between Luangiua and Keila, and did not visit Pelau at all.[60]

The following year, Bennigsen estimated an atoll total of more than 3000 people, who were then producing annually about 300 tons of copra.[61] All observers at this time report that the population was in rapid decline. Ten years later in 1910, Sarfert reported that only Luangiua and Pelau still had permanent villages, with populations of 1000 and 3–400, respectively. Keila no longer had permanent residents, and all the smaller islands were visited only to collect coconuts or for fishing. Sarfert estimated that the pre-contact population of the atoll had

[59] Ian A. Prior et al., 'Cholesterol, Coconuts and Diet on Polynesian Atolls: A Natural Experiment: The Pukapuka and Tokelau Island Studies', *American Journal of Clinical Nutrition* 34 (1981): 1552–61; Winsome R. Harding et al., 'Dietary Surveys from the Tokelau Islands Migrant Study', *Ecology of Food and Nutrition* 19, no. 2 (1986): 83–97.

[60] Anon., *Pacific Islands, Vol. 1 Western Groups*, 4th ed. (London: British Admiralty, 1908), 345.

[61] V. Bennigsen, 'Über eine Reise nach den deutschen und englischen Salomons-Inseln', *Deutsches Kolonialblatt* 12 (1901): 14.

TABLE 3: Data for the estimated productivity of Ontong Java's *Cyrtosperma* and *Colocasia* gardens showing the population numbers that could be sustained under two scenarios: (1) moderate perceived population pressure, with only 25 per cent of dietary energy derived from the two starchy carbohydrate crops; (2) extreme pressure, with only 10 per cent of dietary energy derived from the two crops

	FOOD ENERGY DERIVED from taro swamps in full production before *circa* 1875			POPULATION potentially supported (a)	
	(millions kcal per hectare per year)				
Islands	*Cyrtosperma* (b)	*Colocasia* (c)	Taro total	Scenario 1: Taro 25% of dietary energy (d)	Scenario 2: Taro 10% of dietary energy (e)
Total for Luangiua	100	252	352	2,146	5,360
Total for Pelau	5	50	55	334	835
Total for Ontong Java atoll	105	302	407	2,480	6,195

Notes: (a) These two scenarios are population estimates for *circa* 1875, before the onset of the market economy and the depopulation that followed. For multipliers for the mean productivity of *Cyrtosperma* and *Colocasia*, see Bayliss-Smith, 'Constraints', 282. Data for Luangiua include the islands of Luangiua, Keila, Kemalu, Keloma, and Kepae; data for Pelau are for that island only (see Table 2). (b) To calculate food energy production the projected *Cyrtosperma* area (see Table 2) is multiplied by 2.6 million kcal per hectare per year; (c) To calculate food energy production the projected *Colocasia* area (see Table 2) is multiplied by 17.8 million kcal per hectare per year. (d) Calculated assuming an annual dietary requirement of 657,000 kcal per capita, in a scenario of perceived population pressure (i.e. 25 per cent energy from taro). (e) Calculated assuming an annual dietary requirement of 657,000 kcal per capita, in a scenario of perceived population pressure (i.e. 10 per cent energy from taro).

been about 4000 people, living in settlements on Luangiua, Pelau, and four other islands.[62]

Some of the decline was the result of new epidemics. Given its frequent German and Australian connections through the copra trade, it seems unlikely that Ontong Java escaped from the global pandemic of so-called Russian Influenza (1889–1904), a highly contagious virus that reached Sydney in 1890.[63] It was reported on Ontong Java in 1906 that an influenza epidemic had caused 30–40 deaths each day.[64] In addition there was mortality from new infections that became endemic, notably malaria, dysentery, and tuberculosis, all of which were introduced after the onset of the copra trade in the 1880s. It was these diseases that Hogbin identified as the main cause of population decline, a process that

[62] Sarfert and Damm, *Luangiua und Nukumanu*, 33–5.

[63] F. B. Smith, 'The Russian Influenza in the United Kingdom 1889–1894', *Social History of Medicine* 8, no. 1 (1995): 55–77.

[64] A. Kramer, 'Unveröffentlichte Aufzeichnungen von Luangiua, Nukumanu und Takuu, 1906', cited by Sarfert and Damm, *Luangiua und Nukumanu*, 37.

began 'at least 15 years after the traders', that is, after c. 1880. It was disease that resulted in an Ontong Java population in 1900 that numbered, in his view, 'at least 5000 people', and was reduced to fewer than 1500 within a decade.[65] An original atoll population of 5000 or 5500 was the number quoted by the English copra trader Harold Markham, who lived in Luangiua village from 1907 until 1923, and his estimate was repeated by others.[66]

Our approach to calculating the size of the Ontong Java population, if that population were using the atoll's resources to the maximum, is based on our well-researched data for taro swamp area, *Colocasia* and *Cyrtosperma* productivity, and surveys and extrapolations for the quality of atoll diet. Our calculated maximum 'carrying capacity' shows a population of 6195 people (Table 3). This estimate supports Hogbin's conclusion that 'we can safely say that at the opening of the [20th] century there were at least 5000 people' and that, according to informants, the decline had already begun with a severe epidemic before 1900. Hogbin doubted, however, if the population 'ever went much beyond 6,000'.[67]

Hogbin's claims match our own maximum carrying capacity calculation, but none of these estimates can be tested without archaeological surveys or new historical data. We can note, however, that the scale of population decline that the figures suggest, a collapse from over 5–6000 before 1870 to the 588 people recorded in the 1939 census, is not significantly different from the most severe cases of depopulation documented elsewhere in the Pacific.[68] For example, the population of Takuu, an atoll 220 km west of Ontong Java, collapsed from about 650 before 1850, to 64 in 1884 and 17 in 1896.[69] Similarly, the high island of Aneityum in Vanuatu had a population that fell from about 3500 in 1830 to below 200 in 1930, following epidemics of influenza, measles, diphtheria, and dysentery.[70]

Our figures suggest that Ontong Java's population suffered a decline of 90 per cent over a period of 70 years, and the wider comparisons suggest that unfortunately the scale of its collapse was not unique. Many Pacific island populations suffered a sudden crash from an epidemic of dysentery, measles, influenza, or smallpox, causing an initial loss of 20–70 per cent of their pre-contact population,

[65] Hogbin, 'Problem of Depopulation', 53.

[66] Bayliss-Smith, 'Ontong Java Depopulation, 427.

[67] Hogbin, 'Problem of Depopulation', 45.

[68] Jean-Louis Rallu, 'Pre- and Post-Contact Population in Island Polynesia', in *The Growth and Collapse of Pacific Island Societies: Archaeological and Demographic Perspectives*, ed. Patrick V. Kirch and J.-L. Rallu (Honolulu: University of Hawai'i Press, 2007), 15–34.

[69] Tim Bayliss-Smith, 'The Central Polynesian Outlier Populations since European Contact', in *Pacific Atoll Populations,* ed. Vern Carroll (Honolulu: University of Hawai'i Press, 1974): 286–343.

[70] Matthew J.T. Spriggs, 'Population in a Vegetable Kingdom: Aneityum Island (Vanuatu) at European contact in 1830', in *The Growth and Collapse of Pacific Island Societies*, ed. Kirch and Rallu, 278–306.

but in most cases this crash was followed by a period of slow recovery.[71] In the Ontong Java case, however, there was no slow recovery until after 1940 because of the negative effects of malaria, reducing women's fertility and causing high levels of infant mortality.[72]

An Overpopulated Atoll?

The eagerness of the people of Ontong Java for trade with visiting ships, their attacks on whaling ships from the 1830s onwards, and the *James Birnie* massacre of 1874 are all events that can be interpreted as consistent with symptoms of overpopulation.[73] Further evidence comes from comments about food made by William Wawn in 1888, which suggest a population living on the verge of scarcity, especially in Pelau. Wawn was recruiting labour for the Queensland plantations and had some success at both Luangiua (four recruits) and Pelau (seven recruits). At Pelau, the chief came on board in the evening 'and made an awful feed of fowl and yams' returning next morning 'for another feed'.

Wawn's overall impression was that 'now and then Palau [Pelau] suffers from short commons', and he found the same situation on the neighbouring atoll of Nukumanu, where 'it seemed as though this people, also, were afflicted with short commons'. On both atolls his main tactic for obtaining labour recruits was to offer the chiefs and their entourage plenty of food including 'curried fowl, boiled yam, soft bread, and well-sweetened tea'. In all his dealings on the atoll his rule was 'No boys: no grub', in other words, 'if I get no labour recruits, you get no gifts of food'.[74] Wawn's emphasis on using food as an incentive for trade contrasts with his normal practices in the Solomons and Vanuatu during more than twenty trading voyages that he made before this 1888 voyage to the atolls. In the southwest Pacific his usual tactic was to obtain food for his passengers and crew by trading tobacco, but on Ontong Java there was no surplus food available to him.

There were plenty of men who showed a willingness to leave Ontong Java at this time. After trading contact began in 1875, at least 112 men were recruited for plantation work in Queensland, and at least 32 men went to Fiji, while others worked on inter-island ships.[75] Those who remained on the atoll moved rapidly towards making copra and selling this commodity to resident traders, the first of

[71] B.S. Penman, S. Gupta, and G.D. Shanks, 'Rapid Mortality Transition of Pacific Islands in the 19th century', *Epidemiology and Infection* 145, no. 1 (2017): 1–17.

[72] Bayliss-Smith, 'Ontong Java: Depopulation and Repopulation', 431–59.

[73] Tim Bayliss-Smith, 'The Origins of Co-ordinated Violence on Ontong Java Atoll, Solomon Islands', article in preparation (2025).

[74] Wawn, *The South Sea Islanders*, 411–13.

[75] Charles A. Price and E. Baker, 'Origins of Pacific Islands Labourers in Queensland, 1863–1904: A Research Note', *JPH* 11, no. 2 (1976): 106–21; Jeff Siegel, 'Origins of Pacific Islands Labourers in Fiji', *JPH* 20, no. 1 (1985): 42–54; Charles M. Woodford, *Colonial Papers, Annual No. 347, British Solomon Islands* (London: His Majesty's Stationery Office,1901), 9, section on 'Labour trade'.

whom was present temporarily in the late 1880s. By 1895 a permanent trading station had been set up, and from that date until 1940, German, Swedish, British, or Australian traders were in continuous residence and much copra was exported.[76] As a result, the atoll diet moved towards an increasing dependence on imported food, especially taro substitutes in the form of rice, flour, biscuit, and sugar.[77]

Copra was seen on Ontong Java as a way of satisfying the people's new needs (steel tools, calico, tobacco) through trade but also as a way for people to solve the old problem of finding taro substitutes (rice, flour, biscuit) and so escape from the impossibility of either extending or intensifying taro production. The new colonial economy introduced new problems and infections, but also reduced the former threat of overpopulation, within an atoll environment where it had been impossible to enlarge significantly or to diversify the atoll's food resources beyond taro, coconut, and fish.

Conclusion

For a few years, colonial trade enhanced the food security of the atoll, but these benefits were short-lived. It was probably in the 1880s that the population first experienced the tragic effects of introduced disease and the onset of population collapse. Our data on the taro swamps and their productivity, and our assumptions about the role of taro in the diet, have allowed us to calculate a total pre-contact population of about 6200, but only if circumstances allowed an intensive use of the taro swamps and if people could tolerate an atoll diet in which only 10 per cent of dietary energy derived from *Colocasia* and *Cyrtosperma* taro. We suggest that a figure of about 6000 people represents the atoll's absolute carrying capacity. This conclusion provides some support for historical estimates that suggested the total population had probably stabilized in the range 5000–5500 people.

As a result of the effects of colonialism, the importance of taro was greatly diminished, and to recognize the former role of taro swamps in the atoll's cultural landscape requires the kind of historical reconstruction that this article has attempted. In our warming world, with climate, sea level, and sea temperature all changing, both *Colocasia* and *Cyrtosperma* look vulnerable and the taro swamps of Ontong Java are increasingly subject to saltwater intrusion. As a result, we can expect that by the mid-21st century this component of the atoll's cultural landscape will be largely replaced by tidal mangrove swamps that will produce almost no food. Ontong Java's connections to the market economy have expanded since the 1880s and this growing dependence is now taking place in the context of a warming world leading to a great reduction in the atoll's subsistence capacity. The reduced area of useable taro swamps and their threatened destruction by rising sea levels are the most drastic symptoms of this loss of autonomy and self-sufficiency.

[76] Anon., 'Auszug', 87–8; Anon., 'Statistik', *Nachrichten über Kaiser-Wilhelms-Land und den Bismarck-Archipel* [Reports on Kaiser Wilhelms Land and the Bismarck Archipelago] 11 (1895): 41.
[77] Bayliss-Smith et al., 'Managing Ontong Java', 57.