APPENDICES

APPENDICES

The present section includes: appendices from Matthews (1984) (Appendices 1–11), appendices from Matthews (1990) (Appendices 12–20), an unpublished protocol for sampling wild taro sites (Appendix 21), a guide to assist the survey, description, and identification of wild-type taro (Appendix 22), and an unpublished flyer describing the introduction of two Japanese cultivars to New Zealand (Appendix 23).

Appendix 1. Early correspondence

In this appendix, correspondents of the period 1981 to 1983 are listed alphabetically, together with a brief description of the subject of correspondence. It is hoped that access to the correspondence made during the present research will help in future studies of taro, botanical or ethnographic. The letters themselves were first filed with the Herbarium, Department of Botany, University of Auckland, and were later transferred to the Herbarium, Auckland War Memorial Museum.

Adams, N. M.	National Museum of New Zealand, Private Bag, Wellington. 3.3.81 List of taro specimens held at the National Museum Herbarium.
Arditti, J.	University of California, Irvine, Department of Developmental and Cell Biology, School of Biological Sciences. 2.4.82 Unable to assist on questions about taro cytology or biochemistry.
Arnott, F. D.	Hauraki Gulf Maritime Park Board, Department of Lands and Survey, P. O. Box 5249, Auckland. 10.12.81 Permit to visit Little Barrier Island. 7.1.82 Permission to remove taro specimens from Little Barrier Island.
Baker, T.	Auckland, July 1983 Enquiry about growing taro in the Far North (phone call).
Barber, I.	c/o Department of Anthropology, University of Auckland, Private Bag, Auckland. Oct. 1983. Reports information from Māori informants.
Barker, M. C.	Herbarium, Department of Botany, University of Canterbury, Christchurch. 3.8.81 No specimens of New Zealand taro in the Herbarium.
Bawden, P.	Royal Oak, Auckland. 25.1.83 Reports taro locations in Whangaroa area. 3.2.83 Further information on a taro site.

Bayliss, G.	University of Otago, Dunedin. 5.4.57 Reports taro at Omaio Bay, East Cape. (Letter to J A Rattenbury, Department of Botany, University of Auckland).
Bellingham, P.	Puketi Forest Headquarters, P. O. Box 249, Kaikohe. 22.2.83 Reports taro sites in Northland. 22.1.84 Reports fruiting of aroid (arum lily) at Ngawha.
Botany Department	University of Auckland. April 1983 Public response to Open Day display: offers of information on taro.
Braggins, J. E.	c/o Department of Botany, University of Peradeniya, Peradeniya, Sri Lanka. 19.10.82 References and some comments on Southeast Asian taro. Contact names for Indonesia.
Brook, P. J.	Plant Diseases Division, Department of Scientific and Industrial Research, Private Bag, Auckland. 8.12.81 Offer of ground space for growing an experimental taro plot.
Burns, B.	Department of Lands and Survey, Auckland, 1.6.83. Reports taro sites on Coromandel Peninsula.
Chamberlain, T.	Manganese Point Road, Tamaterau, R D 4, Whangarei. 2.4.82 Gives history of taro in his garden and reports a nearby site. (Source of AKL 34, diploid taro cultivar).
Clark, F.	Waitara, Taranaki. Reports taro in New Plymouth gardens and at a very old Māori settlement area on the North Taranaki Coast.
Connor, J.	c/o Department of Anthropology, University of Auckland. 10.8.82 Gives names of people met during May 1982, field trip with P Matthews.
Cooper, R. C.	Whangaparaoa, Auckland. 29.9.81 Sends slides from his work on New Zealand taro during the 1950s and early 1960s. Comments on New Zealand taro.
Coster, J.	Archaeologist, Department of Lands and Survey, Auckland. 17.11.83 Reports taro sites in the Far North.
Data, E. S.	Philippine Root Crop Research and Training Center, 8 Lourdes Street, Pasay City 3129, Philippines. 3.6.82 Information on a symposium and contact addresses.
Dawson, J.	Botany Department, Victoria University of Wellington, Private Bag, Wellington. 17.12.82 Offer to assist with taro research while visiting Tahiti and Hawai'i.

Derby, M.	c/o Post Office, Mangamuka Bridge, Hokianga. 12.7.82 Discusses possibility of local assistance with taro research by the Hokianga Experimental Training Nursery. Asks for information on taro for the *Tai Tokerau Co-operatives Information Exchange* magazine.
Diongzon, Jr, O. C. E.	Plant Breeder, Visayas State College of Agriculture, Philippine Root Crop Research and Training Center, 8 Lourdes Street, Pasay City 3129. 8.10.82 Sends abstract and methods of her/ his study "Cytology and Morphology of Edible Aroids". Comments on corm shapes.
Doolin, E. R.	Waikato Regional Committee, New Zealand Historic Places Trust, c/o Hamilton Teacher's College, Private Bag, Hamilton. 13.3.81 Copy of letter to Botany Division, Mount Albert Research Center, D.S.I.R., Auckland. Sends taro sample collected from Aotea Harbour. Comments addended by Alan Esler, Botany Division, Mount Albert.
Esler, A.	Botany Division, D.S.I.R., Mount Albert Research Center, Auckland. February 1982. Provides reference to unpublished D.S.I.R. report giving taro locations in the Bay of Plenty.
Eyles, J. R.	Director, West Coast Historical Museum, P. O. Box 1S5, Hokitika. 3.11.82 Reports no local knowledge of taro on the South Island West Coast. Gives origin of taro grown at Kelson (Te Kaha, East Coast, North Island).
Fuller, G.	Curator, Pukekura Park, Parks and Recreation Department, Private Bag, New Plymouth. 29.11.82 Describes taro growing at Pukekura Park and contact addresses in New Plymouth. 13.4.83 Gives descriptions of taro material sent to Auckland and address of someone who might know of taro on the Whanganui River.
Gaillard, J.	Project Secretary, International Foundation for Science, Sibyllegatan 47, S-11442, Stockholm. 20.4.82 Sends IFS Report No. 11. Gives contact address for Philippines.
Gardiner, J.	Chief Ranger, Bay of Islands Maritime and Historic Park Board, Box 134, Russell. 23.8.82 Offer of assistance with sea transport for fieldwork.
Gardner, R.	Auckland. 16.1.82 Reports taro sites. Asks for planting material for glasshouse. 22.3.82 Comments on taro grown in Auckland city for greens. Gives a reference. October 83 Gives reference on pig consumption of taro.
Godley, E.	Director, Botany Division, D.S.I.R., Private Bag, Christchurch. 5.8.81 Reports absence of taro in the Botany Division Herbarium.

Gollifer, D.	Department of Agricultural Research, Private Bag 0033, Gaborone, Republic of Botswana. 30.9.81 Sends xeroxed parts of his PhD thesis on fungal pathology of taro.
Goodin, V. & M.	Managers, Moturoa Island, Private Bag Paihia. 17.3.83 Reports taro absent from island. Reports other locations with taro.
Gordons	Jane Nelson Place, Whangarei. 23.5.83 Letter to Molly Taylor (Department of Botany, University of Auckland). Reports taro in Whangarei area.
Harlow, R.	Department of Linguistics, University of Otago, Box 56, Dunedin. 21.10.83 Computer research for Māori names for taro in the three volumes of poems/songs of Ngaa Mooteatea.
Hatch, E. D.	Laingholm, Auckland. Reports taro on the Manukau Harbour coast.
Hayward, M. T.	Noxious Plants Officer, Bay of Islands County Council, P. O. Box 11, Kawakawa. 6.5.82 Offers information, invites visit.
Heginbotham, M.	Woodlands Road, Opotiki. 14.9.82 Is unable to give precise locations for taro reported in unpublished manuscript (*Wild Plants of Ohope to East Cape*) private report to Botany Division, D.S.I.R., 1979). Gives other locations and sends live samples. 20.12.82 Invitation to visit, people to contact at Torere, East Cape.
Hensley, V.	R D 4, Kaitaia. 29.1.82 Reports taro sites in the Far North.
Hooper, A.	Department of Anthropology, University of Auckland, Private Bag, Auckland. 17.3.82 offers information on *Cyrtosperma* in the Tokelau Islands.
Hovell, J.	Te Aute College, Pukehou, Hawkes Bay. 6.12.82 Gives contact addresses for Coromandel Peninsula and East Cape, and Easter Island. Comments on history and present cultivation.
Jones, K.	Staff archaeologist, N.Z. Historic Places Trust, Private Bag, Wellington 1. 19.10.82 Sends samples and gives locations. Reports absence of taro at Tolaga Bay. 11.4.83 Reports taro sites on East Coast and remarks on present attitude to taro there.
Knowles, R.	Lower Weld Road, R D 4, New Plymouth. 28.11.83 Offers to send taro from a Whanganui River Māori settlement. 24.1.84 Sends variant RR sample.

Krumins, G.	Canoe Camping Limited, 112 Owhiro Bay Parade, Wellington 2. 8.7.82 Reports taro sites along Whanganui River.
Laundon, G.	Plant Health and Diagnostic Station, Private Bag, Levin. 7.10.81 States that no permit is required to import taro into New Zealand. Would like to be informed should reasons be found for imposing a restriction.
Leach, H.	Department of Anthropology, University of Otago, Private Bag, Dunedin. 26.7.82 Letter to D. Sutton, Department of Anthropology, University of Auckland. Comments on N.Z. taro. 18.4.83 Historical references and draft from her forthcoming book *A Thousand Years of Gardening in New Zealand*. 2.2.84 Comments on interpretation of taro distribution and names.
Leahy, A.	Mount Eden, Auckland. 3.5.82 Reports taro sites in Bay of Islands and Bay of Plenty, and taro flowering.
Lewis, M.	Department of Zoology, University of Auckland, Private Bag, Auckland. 26.5.83 Gives identification of beetle commonly found in taro flowers.
Lord, W. B.	Bay Road, Waiheke Island, Auckland. 11.1.82 Describes his method of growing taro.
Lusk, P.	No. 1 Road, Westport, South Island. 26.3.82 Reports South Island taro sites.
McConnell, R.	Te Araroa, East Coast. 2.6.83 Notes on taro in the East Coast – East Cape areas. Reports flowering.
Matthews, P. J.	Department of Botany, University of Auckland, Private Bag, Auckland. 10.1.83 Advertisement for field assistant.
Mizen, P.	Titikaveka, Rarotonga, Cook Islands. 26.9.83 Reports taro absent from Ahuahu Island, New Zealand.
Navaratnam, S. J.	Department of Health, P. O. Box 100, Woden, A.C.T. 2606, Australia. 26.10.83 Letter to D E Yen: permission for import of New Zealand taro.
Pollack, N. J.	Department of Anthropology , Victoria University of Wellington, P. O. Box 196, Wellington. 6.4.83 Describes her ethnographic research on the use of food plants in the Pacific.
Prickett, N.	Auckland Institute and Museum, Private Bag, Auckland. 21.4.82 Advice for writing NZAA Newsletter article and an address for taro site information.
Rau-Kupa, Mrs.	Raleigh Street, New Plymouth. 25.2.83 Taro and information on history, use and cultivation.

Raupo Trust	R D 3, Kaitaia. 1982 Asks for information on growing taro.
Reid, M.	Taranaki Museum, P. O. Box 315, New Plymouth. 20.12.82 Has no information.
Reynolds, K.	Anzac Road, Whangarei. 9.10.81 Reports taro sites, history and names. 3.5.82 Reports taro sites and flowering in the Far North.
Rickard, J.	Overseas Development Administration, Tropical Products Institute, 56–62 Gray's Inn Road, London WCIX 8LU. 3.12.82 Sends and asks for information on taro.
Robinson, S.	Museum Historian, Gisborne Museum and Arts Centre, P. O. Box 716, Gisborne. 26.11.82 Gives contact addresses for East Coast area.
Rogers, G.	Department of Anthropology, University of Auckland, Private Bag, Auckland. 4.3.82 Notes flowering of Auckland City taro. 3.2.83 Notes on frost damage to cultivated taro in North Auckland.
Ross, M.	Scanlan Street, Grey Lynn, Auckland. 25.1.83 Reports taro site at Hunua Gorge.
Sheward, A.	Rotorua. 18.1.84 Reports distribution and names of taro.
Smith, W. P.	Whangarei. 13.4.83 Reports Whananaki taro sites, Northland-Asks for information.
Spriggs, M.	Department of Anthropology, University of Hawai'i at Manoa, 2424 Maile Way, Honolulu, Hawai'i 96822. 30.11.81 Gives suggestions for the N.Z. taro study, references and contact addresses.
Stevenson, G.	Ploustow Lane, Bromley, Kent BR 1 3JE, England. 16.9.83 Doesn't have her papers or notes with her. (Ref. "Botanical evidence linking the New Zealand Māori's with New Caledonia and the New Hebrides", *Nature* 276, 704–5).
Strauss, M. S.	Department of Botany, College of Arts and Sciences, Northeastern University, 360 Huntington Avenue, Boston, Massachusetts 02115, U.S.A. 20.5,83 Sends reprint. Asks for plants. 5.12.83 Sends pre-publication xerox of a review: Michael S Strauss and Daniel C Sheirer, "Morphology of taro, Colocasia esoulenta (ARACEAE)' submitted to *Economic Botany* 12/83.

Sutherland, J. F. Department of Lands and Survey, Map and Photo Sales, Private Bag, Charles Fergusson Building, Wellington 1. 8.11.83 Cost of an aerial photograph of Torere East Cape. Information about aerial photo sets.

Sutton, D. G. Department of Anthropology, University of Auckland, Private Bag, Auckland. 3.8.82 Ethnographic references.

Tangiwai, P. Te Awamutu. 7.6.83 Information on use, names, history and cultivation of taro. Asks for information.

Taylor, M. Hirini Street, Gisborne. 18,12.82. Remembers taro thirty-two years ago at Te Araroa.

Thain, E. M. Director, Overseas Development Commission, Tropical Development and Research Institute, 127 Clerkenwell Road, London EC1R 5DB. 12–5.83 Can't help re taro. Describes the work of the T.D.R.I.

Thyrme, A. F. Executive Officer, The Royal Society of New Zealand, Science Centre, 11 Turnbull Street, Private Bag, Wellington. 1.11.82 Research Grant from the Mappin Trust. 16.8.83 Acknowledges receipt of application for a second Grant. 12.12.83 Sends cheque for second Grant.

Twohill, N. Thames. 27.6.82 Reports taro along the Thames coast. Comments on effects of winter on plants.

Vincent, D. Editor, *Northland Age*, P. O. Box 45, Kaitaia. 26.4.82 Reports taro sites and history for the Far North. 1.9.82 Reports taro sites and history for the Far North again.

Walls, G. Botany Division, D.S.I.R., Private Bag, Christchurch. 4.5.82 Reports general absence of taro from the Nelson and Marlborough areas. Gives South Island contact address.

Walls, J. Takaka, Golden Bay. 22.9.83 Reports South Island taro, ethnographic references, and South Island contact address.

Walton, A. Archaeology Section, New Zealand Historic Places Trust, Private Bag, Wellington. 10.5.82 Sends computer list of taro sites from NZAA site recording scheme.

Wang, J.-K. Department of Agricultural Engineering, University of Hawai'i at Manoa, 3050 Maile Way, Honolulu, Hawai'i 96822. 28.3.83 Information on projects, Hawai'i taro collection and flowering.

Watson, J.	Manager, Imported Fruit Department, Turners and Growers Limited, P. O. Box 56, Auckland. 2.7.82 Gives history of taro imports to New Zealand. Also see J. Watson (1979) in Plucknett (ed.) *Small-Scale Processing and Storage of Tropical Root Crops* pp. 151–65.
Whitmore, F. W.	Registrar, Plant Varieties Office, P. O. Box 24, Lincoln, New Zealand. 12.9.83 States legal situation under the Plant Varieties Act 1973 regarding taro.
Williams, D. B.	Root Crops Development in the Pacific Project, F.A.O., P. O. Box 890, Apia, West Samoa. Outlines aims of the Project regarding taro.
Wright, A. E.	Botanist, Auckland Institute and Museum, Private Bag, Auckland 1. 15.3,83 Programme for Offshore Islands of K.E. New Zealand symposium. 9.11.83 Reports taro grown at Rotorua under traditional names.
Wright, P.	Secretary, Waikato Regional Committee, New Zealand Historic Places Trust, Hamilton. 2.6.83 History of taro at Raukumara, Aotea Harbour. Reports that taro is common in the Waikato area.
Yen, D. E.	Department of Prehistory, Research School of Pacific Studies, Australian National University, P. O. Box 4, Canberra ACT 2600. 3.5.82 Comments on Oceanic, Australian and New Zealand taro. 4.11.82 Reports chromosome counts of Australian and Papua New Guinean taro. Further information on his work with New Zealand taro including stolon information. 28.3.83 Further comments on work with N.Z. taro; Māori naming, flowering.

Appendix 2. New Zealand taro site records

The site records are held in the Herbarium, Department of Botany, University of Auckland (later transferred to Auckland War Memorial Museum). An example is given below. Explanation of terms:

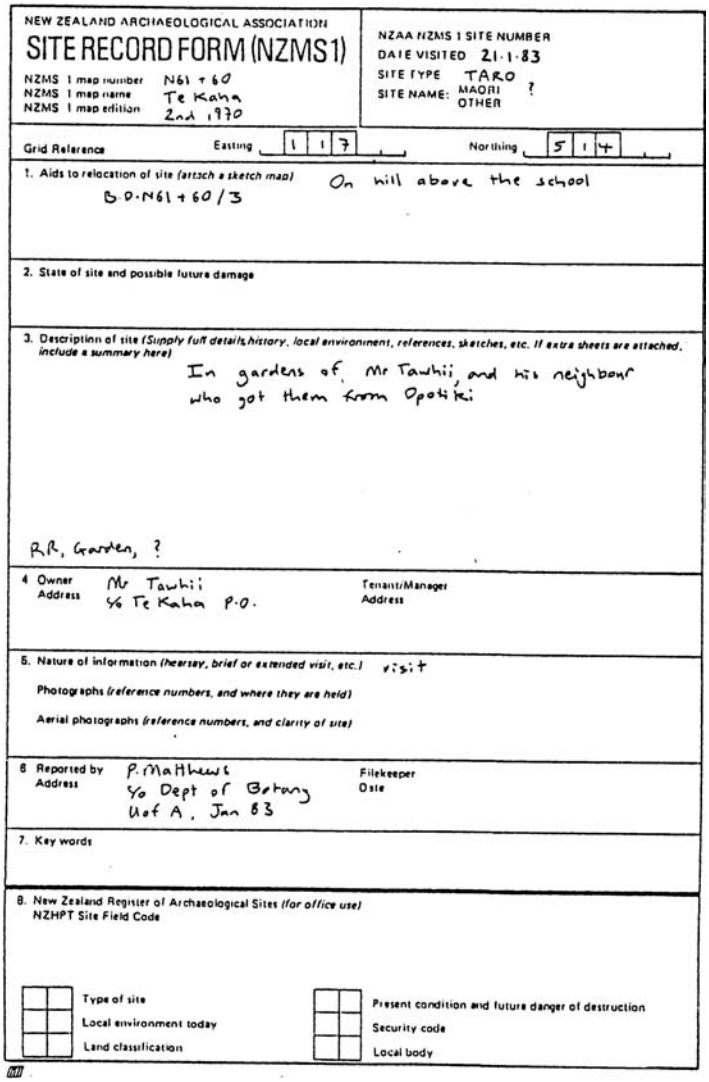
Botany Department Site Number: Map number (NZMS1 Series except for NZMS 259 Great Barrier Island and Little Barrier Island) followed by the individual site number in sequence of recording.

Grid reference: NZMS map grid reference, Easting and Northing, to 100 yards (91 m).

Variant: Informal nomenclature for three variants of New Zealand taro, RR, GR, and GP described in Chapter Ten. Variants other than RR, GR or GP are identified by their live-plant collection number, prefixed by 'AKL', in the Auckland live-plant collection. The collection is described in Appendix 3.

Site Description: Full definitions of site categories are given in Chapter Twelve.

Site Record (*example*):



NEW ZEALAND ARCHAEOLOGICAL ASSOCIATION

SITE RECORD FORM (NZMS1)

NZMS 1 map number N61 + 60
NZMS 1 map name Te Kaha
NZMS 1 map edition 2nd 1970

NZAA NZMS 1 SITE NUMBER
DATE VISITED 21·1·83
SITE TYPE TARO
SITE NAME: MAORI ? OTHER

Grid Reference Easting 117 Northing 514

1. Aids to relocation of site (attach a sketch map) On hill above the school
B·D·N61 + 60 / 3

2. State of site and possible future damage

3. Description of site (Supply full details, history, local environment, references, sketches, etc. If extra sheets are attached, include a summary here)
In gardens of Mr Tawhii and his neighbour who got them from Opotiki

RR, Garden, ?

4 Owner Address Mr Tawhii c/o Te Kaha P.O.
Tenant/Manager Address

5. Nature of information (hearsay, brief or extended visit, etc.) visit
Photographs (reference numbers, and where they are held)
Aerial photographs (reference numbers, and clarity of site)

6 Reported by Address P. Matthews c/o Dept of Botany U of A, Jan 83
Filekeeper Date

7. Key words

8. New Zealand Register of Archaeological Sites (for office use)
NZHPT Site Field Code

Type of site
Local environment today
Land classification
Present condition and future danger of destruction
Security code
Local body

Botany Dept. site number	Grid ref. E.N	Variant	SITE DESCRIPTION			
			Garden			Wild
			Cultiv.	Non-cultivated		
				non-derelict	derelict	
N1&2						
1	374 452	RR	?			
2	352 515	GP				X
3	43? 51?	?	?			
4	314 455	?				X
5	466 452	?	?			
6	352 510	* GP, GR				X
7	344 523	?	?			
8	65 481	?	?			
N3&4						
1	534 118	* GR	?			
2	515 164	GR				X
N7						
1	144 874	GP	?			
2	84? 00?	?	?			
3	047 878	?	?			
4	051 865	?	?			
5	03? 90?	?	?			
6	911 986	?	?			
N8						
1	210 846	?	?			
2	283 881	RR				X
3	443 829	RR				X
4	442 837	RR				X
5	446 843	RR				X
6	352 823	?	?			
7	277 886	?	?			
8	444 832	RR				X
9	444 842	RR				X
10	443 836	RR				X
11	440 839	RR				X
12	444 844	RR				X
13	222 819	RR	?			
14	340 833	GP				X
15	284 877	?	?			
16	282 877	?	?			
N9&13						

1	* 724 503	GP				X
2	723 504	GP				X
3	722 505	RR				X
4	724 533	RR		X		
5	* 684 599	GP				X
6	675 605	* GP, GR				X
7	660 603	GP, GR				X
8	618 616	GP				X
9	605 614	GP				X
10	597 617	GP				X
11	626 609	GR		X		
12	712 514	?	?			
N10						
1	864 639	GR				X
2	822 666	?	?			
3	78? 79?	?	?			
4	045 576	GR		X		
5	035 583	?	?			
6	583 049	RR				X
7	705 622	RR				X
8	777 744	?				X
9	779 742	?				X
10	785 741	?				X
11	784 737	?				X
12	774 738	RR				X
13	776 740	RR				X
14	778 739	RR				X
15	776 734	RR				X
16	776 694	RR				X
17	045 693	RR				X
18	054 586	RR				X
19	14? 71?	?	?			
N11						
1	* 604 658	?	?			
2	548 523	GP				X
3	474 695	?	?			
4	* 428 768	RR				X
5	* 436 775	?				X
6	622 637	RR				X
7	* 430 759	RR				X
8	518 694	?	?			
9	52? 67?	RR	?			
10	318 699	?	?			
11	636 534	RR				X

12	300?	?	?			
13	296 790	GP	?			
14	318 699	?	?			
N12						
1	797 542	RR			X	
2	811 614	?	?			
3	714 602	?			X	
4	718 584	?	?			
5	772 565	RR				X
6	810 609	RR				X
7	69? 57?	?				X
N14						
1	107 401	RR				X
2	872 313	RR	?			
3	812 293	GP			X	
4	895 370	?	X			
5	MISSING					
6	843 300	?	?			
7	970 394	GR	?			
8	003 324	RR	?			
9	108 235	GR		X		
10	100 242	RR	X			
11	048 274	RR	X			
12	979 259	GR, RR		X		
13	975 266	RR	X			
14	929 228	GP		X		
15	977 253	RR	?			
16	043 281	RR	?			
17	094 247	RR	X			
18	118 256	RR		X		
19	114 267	RR				X
20	098 399	GR, RR		X		
21	057 343	RR		X		
22	086 362	RR		X		
23	106 380	RR	?			
24	134 422	RR		X		
25	055 454	RR				X
26	078 479	RR				X
27	014 476	GR		X		
28	050 415	RR		X		
29	797 303	RR		X		
30	838 298	GR, GP				X
31	* 872 314	RR	?			
32	902 369	GR		X		

33	894 372	GR		X		
34	763 403	RR		X		
35	763 398	GR		X		
36	784 410	GR		X		
37	809 405	GR			X	
38	812 430	GR		X		
39	818 435	GR, RR		X		
40	760 348	RR	?			
41	754 362	?	?			
42	837 441	?			X	
43	752 413	?	?			
44	115 404	RR	X			
45	019 341	RR		X		
46	807 307	GP				X
47	100 242	RR		X		
N15						
1	440 406	?	?			
2	388 411	RR				X
3	368 399	RR				X
4	370 383	GP				X
5	371 343	RR	X			
6	317 343	RR		X		
7	382 468	GP.RR				X
8	418 476	RR				X
9	?	RR	X			
10	598 434	GP				X
11	461 404	RR		X		
12	* 595 426	GP				X
13	373 385	?	?			
14	583 385	?	?			
15	383 416	?	?			
16	647 260	?	?			
17	291 317	RR	X			
18	337 426	GP				X
19	336 407	GP		X		
20	345 407	RR				X
N16						
1	847 348	RR				X
2	888 300	RR				X
3	927 305	RR				X
4	855 312	RR				X
5	730 464	?	?			
6	733 448	?	?			
7	730 450	?	?			

8	740 453	?	?			
9	735 415	?	?			
10	868 424	RR	?			
11	967 204	?	?			
12	821 367	RR	?			
13	651 489	RR				X
14	653 491	RR		X		
15	792 450	RR	?			
16	783 517	RR	?			
17	955 264	?	?			
N18 & 22						
1	075 044	RR				X
2	943 144	GR, RR		X		
3	052 146	GR, RR		X		
4	024 147	RR	X			
5	006 153	RR		X		
6	907 187	GP		X		
7	024 147	RR		X		
N19						
1	220 902	?	?			
2	219 900	?	?			
N20						
1	035 975	?	X			
2	804 944	?	?			
3	818 923	?	?			
N23						
1	233 847	RR				X
2	274 857	?	?			
3	267 864	?	?			
4	233 847	RR	X			
N24						
1	943 898	RR	?			
2	937 893	RR, AKL34	?			
3	947 883	RR				X
N28						
1	045 581	?	?			
N33						
1	071 119	RR	?			

NZMS259						
1	345 740	RR		X		
2	607 838	?	?			
3	634 856	RR	?			
4	630 854	RR		X		
5	580 831	?	?			
6	669 853	RR				X
7	673 817	?	?			
8	623 843	?	?			
9	622 793	?	?			
10	671 696	?	?			
N34						
1	360 133	RR				X
2	363 116	RR		X		
3	324 177	RR	?			
N35						
I	973 001	RR		X		
2	953 012	RR		X		
N37						
1	875 844	?	?			
2	884 835	?	?			
3	900 813	?	?			
4	974 937	?	?			
5	952 722	RR			X	
N39						
1	929 930	RR	?			
2	862 963	RR			X	
3	966 759	RR		X		
4	974 872	GR		X		
5	908 936	RR				X
6	899 941	GR, RR		X		
7	856 966	RR				X
8	858 964	RR				X
9	957 998	RR	X			
10	643 708	?	?			
11	660 712	?	?			
N40						
1	074 866	RR		X		
2	049 827	RR		X		
3	064 804	?				X
4	032 800	RR		X		

5	036 904	?	?			
6	013 904	?	?			
N41						
1	093 423	?	?			
2	082 403	RR		X		
N42						
1	504 679	?	?			
2	16? 46?	RR	X			
3	109 414	RR	?			
N43						
1	557 681	RR	X			
2	558 678	RR		X		
3	553 677	RR				X
4	977 494	RR		X		
5	978 495	RR		X		
6	980 485	RR				X
7	943 533	RR				X
8	930 557	RR		X		
9	930 551	RR				X
10	956 603	RR		X		
11	970 603	RR	X			
12	972 604	RR			X	
13	989 596	RR			X	
14	987 601	RR			X	
15	947 606	?	?			
16	945 531	RR		X		
17	947 528	RR		X		
18	662 688	?	?			
N44						
1	000 457	?	?			
2	306 615	RR		X		
N46&47						
1	095 372	?	?			
2	103 368	GP				X
N60 & 61						
1	112 511	RR		X		
2	107 509	RR				X
3	117 514	RR	?			
4	131 525	RR			X	
5	142 548	RR				X

N62						
1	318 639	RR		X		
2	442 706	RR	X			
3	554 695	RR	X			
4	?	RR	?			
5	539 723	?	?			
M63						
1	708 664	RR	9			
2	928 529	RR	X			
3	791 616	RR		X		
4	792 615	GR		X		
5	758 606	RR	X			
6	767 611	RR		X		
7	764 610	RR		X		
8	716 647	RR			X	
9	773 613	GR, RR	X			
10	775 614	RR	X			
N65						
1	?	?	?			
N70						
1	102 493	?	?			
2	839 213	RR		X		
3	036 402	RR		X		
4	053 414	GP				X
5	914 253	RR	?			
N72						
1	836 462	RR	X			
2	833 458	RR			X	
3	837 460	RR		X		
4	803 426	RR			X	
5	806 425	RR				X
6	817 393	RR		X		
7	827 384	RR				X
8	784 390	RR			X	
9	724 306	RR	X			
N73						
1	343 186	9	?			
N78						
1	?	RR	?			
2	722 192	RR	?			

3	577 135	RR		X		
N80 & 81						
1	676 032	RR			X	
2	675 003	?	?			
N89 & 90						
1	673 713	?		X		
N109						
1	?	AKL 79	?			
2	?	AKL 80–82	?			
N121						
1	53? 60?	RR	?			
N131						
1	68? 19?	?	?			

Appendix 3. Auckland Taro Collection

Accessions in the collection of *Colocasia* sp. (living plants) made at the Department of Botany, University of Auckland, 1982–83. Unless otherwise stated, all accessions were *C. esculenta* (L.) Schott and were from within New Zealand.

Coll. No.	Variant/ Name/sp.	Accession Date	Discard Date	Collector	Coll. Date	Source - Botany Dept Site No.	Location
AKL							
1	RR	19.3.82	Mar-84	P Matthews	24.8.81	NZMS259/1	Te Waikohere Stream
2	RR	19.3.82	Mar-84	P Matthews	9.ll.81	N41/2	Little Huia
3	RR	19.3.82	Mar-84	R Grace	Nov-81	—	Mimiwhangata
4	RR	19.3.82	Mar-84	P Matthews	7.1.82	N43/3	Wilma Road
5	RR	19.3.82	Mar-84	P Matthews	7.1.82	N43/2	Homai Road
6	RR	19.3.82	Mar-84	M Dye	Mar-82	N44/2	Hahei
7	RR	19.3.82	Mar-84	A Wright	Feb-82	N16/1	Mokau Stream
8	RR	19.3.82	Mar-84	I Lawlor	?	—	Coromandel Peninsula
9	RR	19.3.82	Mar-84	I Lawlor	?	N33/1	Ogles Creek
10	RR	19.3.82	Mar-84	I Lawlor	?	N78/1	Paerata Ridge
11	RR	25.3.82	Mar-84	E Matthews	23.3.82	N12/1	Whangamumu Harbour
12	Tonga Sea	8.4.82	—	R Fullerton	Mar-82	—	Totokoitu Research Station, Rarotonga
13	Mataga	8.4.82	—	R Fullerton	Mar-82	—	Totokoitu Research Station, Rarotonga

14	Sunday Fauli	8.4.82	—	R Fullerton	Mar-82	—	Totokoitu Research Station. Rarotonga
15	Niukini Ava' ava	8.4.82	—	R Fullerton	Mar-82	—	Totokoitu Research Station. Rarotonga
16	RR	14.4.82	Mar-84	K Johns	Apr-82	N24/2	Manganese Point
17	GP	14.4.82	Mar-84	O Sutherland	7.4.82	Nl& 2/2	Kapowairua
18	RR	14.4.82	Mar-84	O Sutherland	Apr-82	N14/1	Horeke
19	RR	14.4.82	Mar-84	O Sutherland	Apr-82	Nl &2/1	Te Ngako
20	RR	4.5.82	Mar-84	E D Hatch	1930-31	N41/1	Kaitarakihi
21	RR	23.5.82	Mar-84	P Matthews	16.5.82	N15/2	Pungatere Stream
22	RR	23.5.82	Mar-84	P Matthews	16.5.82	N15/3	Waikahikatea Stream
23	GP	23.5.82	Mar-84	P Matthews	16.5.82	N15/4	Ngawha Settlement
24	RR	23.5.82	Mar-84	P Matthews	17.5.82	N15/6	Kaikohe Museum
25	RR	23.5.82	Mar-84	P Matthews	17.5.82	N15/7	Whakataha Road
26	GP	23.5.82	Mar-84	P Matthews	17.5.82	N15/7	Whakataha Road
27	RR	23.5.82	Mar-84	P Matthews	17.5.82	N15/8	Okokako Road
28	RR	23.5.82	Mar-84	P Matthews	19.5.82	N15/9	—
29	GP	23.5.82	Mar-84	P Matthews	19.5.82	N15/10	Ridgens Road
30	GP	23.5.82	Mar-84	P Matthews	20.5.82	N11/2	Te Arakanihi
31	RR	23.5.82	Mar-84	P Matthews	20.5-82	N15/11	Pakaraka
32	RR	23.5.82	Mar-84	P Matthews	21.5.82	N23/1	Te Kawa Stream
33	Malahu	31.5.82	—	R Fullerton	Mar-82	—	Totokoitu Research Station, Rarotonga
34	Eddoe	1.6.82	—	P Brook	Jan-82	N24/2	Manganese Point
35	RR	2.6.82	Mar-84	P Matthews	21.5.82	N18 & 22/1	Waipoua Forest Headquarters
36	RR	8.6.82	Mar-84	E Cameron	7.6.82	N14/2	Matamata Stream
37	GR	22.6.82	Mar-84	M Bellingham	Jun-82	N14/7	West Coast Road
38	RR	30.8.82	Mar-84	A Wright	Aug-82	N8/7	Mahinepua
39	RR	8.9.82	Mar-84	W Booth	3.9.82	N11/7	Waiaua Bay
40	?	15.9.82	—	E Cameron	15.8.82	—	Takuvaine Stream, Rarotonga
41	RR	16.9.82	Mar-84	M Heginbotham	Sep-82	N70/2	Opape
42	RR	22.10.82	Mar-84	K Jones	Oct-82	N78/2	Opotiki
43	RR	22.10.82	Mar-84	K Jones	Oct-82	—	Crarer Street, Wairoa
44	RR	10.11.82	Mar-84	P Whitehead	Feb-82	—	Coromandel Peninsula
45	RR	15.11.82	Mar-84	R Booth	Nov-82	N11/9	Te Tii
46	RR	6.12.82	Mar-84	P Matthews	30.ll.82	N8/8	Papatara Bay
47	RR	6.12.82	Mar-84	P Matthews	1.12.82	—	Waiiti Bay
48	RR	6.12.82	Mar-84	P Matthews	1.12.82	N8/10	Waiiti Bay
49	RR	6.12.82	Mar-84	P Matthews	1.12.82	N8/11	Waiiti Bay
50	RR	6.12.82	—	P Matthews	1.12.82	N8/12	Kikipaku Stream

51	RR	6.12.82	Mar-84	P Matthews	3.12.82	N11/6	Howe Point
52	RR	6.12.82	Mar-84	P Matthews	3.12.82	N11/11	Waitata Bay
53	RR	10.1.83	Mar-84	P Matthews	30.12.82	N34/1	Swansea Bay
54	RR	10.1.83	Mar-84	P Matthews	30.12.82	N34/2	Swansea Bay
55	RR	10.1.83	Mar-84	P Matthews	1.1.83	NZMS259/6	Whangapoua Beach
56	RR	14.1.83	Mar-84	C West	Jan-83	N63/1	Onepoto Bay
57	RR	1.2.83	Mar-84	M Bellingham	Jan-83	N14/8	Wharekawa Road
58	RR	1.2.83	Mar-84	P Matthews	21.1.83	N61 & 60/1	Kopuni Point
59	RR	1.2.83	Mar-84	P Matthews	26.1.83	N80 & 81/1	Mangahauni Valley
60	RR	1.2.83	—	P Matthews	24.1.83	N72/5	Putanga Marae
61	GR	1.2.83	Mar-84	P Matthews	23.1.83	N63/4	Te Hekawa
62	RR	1.2.83	Mar-84	P Matthews	23.1.83	N63/3	Te Hekawa
63	GP	1.2.83	Mar-84	P Matthews	20.1.83	N70/4	Rerepa Stream
64	RR	1.2.83	Mar-84	P Matthews	21.1.83	N62/1	Taratuia Point
65	RR	1.2.83	Mar-84	P Matthews	21.1.83	N61 & 60	Hamana Stream
66	RR	1.2.83	Mar-84	P Matthews	20.1.83	N70/3	Otehirinaki
67	GR	14.2.83	—	P Matthews	3.2.83	N14/12	Whirinaki
68	RR	14.2.83	Mar-84	P Matthews	3.2.83	N14/12	Whirinaki
69	GR	14.2.83	Mar-84	P Matthews	4.2.83	N18 & 22/2	Waimamaku Beach Rd.
70	RR	14.2.83	Mar-84	P Matthews	4.2.83	N18 &	Waimamaku Beach Rd.
71	GP	14.2.83	Mar-84	P Matthews	5.2.83	N14/14	Waiotemarama
72	GR	14.2.83	Mar-84	P Matthews	7.2.83	N10/4	Mangamuka
73	GR	14.2.83	—	P Matthews	8.2.83	N14/30	Reena
74	GP	14.2.83	—	P Matthews	8.2.83	N14/30	Reena
75	GP	14.2.83	Mar-84	P Matthews	9.2.83	N9 & 13/5	Ngaire Stream
76	GP	14.2.83	Mar-84	P Matthews	10.2.83	N9 & 13/10	Tauroa Peninsula
77	RR	14.2.83	Mar-84	P Matthews	10.2.83	N10/12	Whangatane
78	GR	14.2.83	Mar-84	P Matthews	11.2.83	N10/1	Te Rore Stream
79	black	28.2.83	—	M Rau-Kupa	25.2.83	N109/1	Raleigh Street
80	?	13.4.83	—	G Fuller	13.4.83	N109/2	Pukekura Park
81	?	13.4.83	—	G Fuller	13.4.83	N109/2	Pukekura Park
82	?	13.4.83	—	G Fuller	13.4.83	N109/2	Pukekura Park
83	GR	27.4.83	Mar-84	J Coster	Apr-83	N3+4/1	Waihopo
84	RR	16.8.83	Mar-84	P Matthews	16.8.83	N35/1	Port Charles
85	GR	16.8.83	Mar-84	P Matthews	15.8.83	N39/4	Colville
86	RR	26.9.83	Mar-84	V Rickard	18.3.83	N37/5	Woodhill
87	sp?	15.1.84	—	P Matthews	11.2.83	Nl0/20	Bell’s Hill

Appendix 4. Specimens of *Colocasia* in New Zealand herbaria

CHR = Botany Division, DSIR, Christchurch.
WELT = The National Museum,
AK = Auckland War Memorial Museum.
AKU = Department of Botany, University of Auckland.
Other herbaria were not checked.

Herbarium	Number	Collector	Coll. date	Location	Description
CHR	None in collection		—	(E Godley, pers. comm. 1981)	
WELT	?	Rev. E Jennings	29.5.1897	?	'*Taro hohia*'
WELT	?	G Abercrombie	pre 1897	Kioreroa, Whangarei	?
WELT	?	N M Adams	23.3.1979	Manganese Point, Whangarei	?
AK	477	T F Cheeseman	Feb 1895	Waimate, Bay of Islands	flower
AK	5476	R H Matthews	Apr-21	Kaitaia	flower
AK	44326	R C Cooper	Jun-56	Met. Station, Raoul Island	flower
AK	70451	A T Pycroft	Apr-62	Auckland	flower
AK	71737	R C Cooper	?	St. Heliers, Auckland	flower
AK	90327	A Leahy	Dec-63	Kerikeri	flower
AK	90328	A Leahy	Dec-63	Kerikeri	flower
AK	90329	A Leahy	Dec-63	Kerikeri	flower
AK	90330	A Leahy	Dec-63	Kerikeri	flower
AK	95475	M Hodgkins	Nov-45	Tauranga	leaf
AK	123004	D Simmons	May-70	Remuera, Auckland	flower
AK	151544	D Simmons	Feb-74	Remuera, Auckland	flower
AK	151597	D Simmons	Apr-80	Remuera, Auckland	flower
AKU	14354	P Matthews	8.2.1983	North Hokianga	flower, variant GP
AKU	14693	P Matthews	18.3.1983	ex Site N109/1 (New Plymouth)	leaf, AKL 79
AKU	14694	P Matthews	18.3.1983	Botany Dept	leaf, variant RR, AKL62
AKU	14695	P Matthews	18.3.1983	Botany Dept	leaf, variant RR. AKL2
AKU	14696	P Matthews	18.3.1983	Botany Dept	leaf, variant GR, AKL37
AKU	14697	P Matthews	18.3.1983	Botany Dept	leaf, variant GP, AKL29
AKU	14699	P Matthews	18.3.1983	Botany Dept	leaf, AKL34
AKU	14832	P Matthews	12.4.1983	Botany Dept	flower, AKL80
AKU	15137	P Matthews	17.1.1984	Botany Dept	leaf, flag leaf, AKL81
AKU	15138	P Matthews	17.1.1984	Botany Dept	leaf, AKL82
AKU	15139	P Matthews	17.1.1984	Botany Dept	leaf, AKL87

Appendix 5. Leaf sample sites and descriptions

Leaf sample descriptions for taro variants RR, GR, and GP, showing site number, location, date, site category (garden/wild), and site description. Descriptive statistics are given for the largest measured blade dimension, A, the front lobe, to indicate variation in size within and between sites. Site categories are defined in Chapter Seven. 'Stream' implies flowing water at time of observation, unless otherwise indicated.

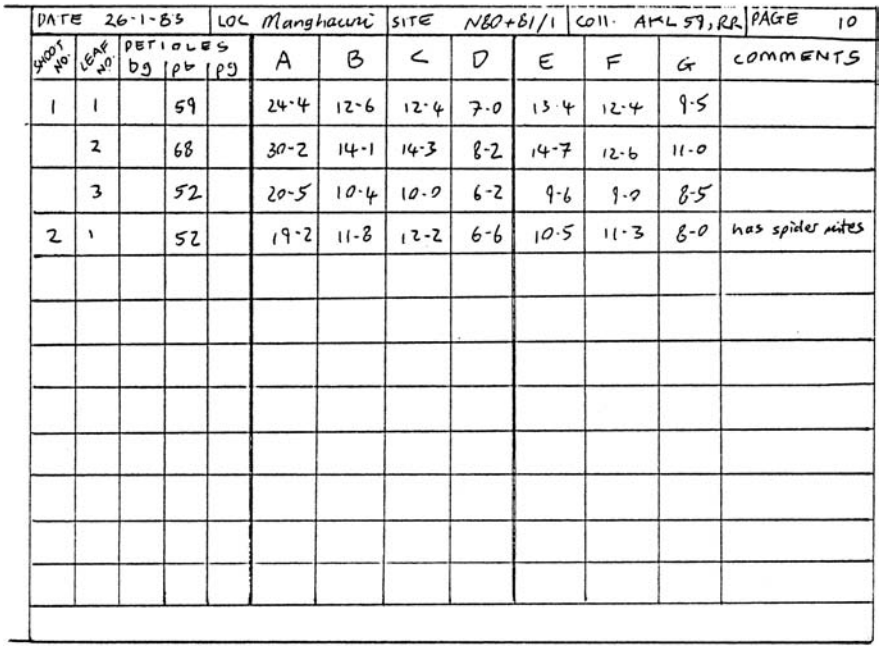
	n	mean cm	s.d. cm	min. cm	max. cm	covariance %
VARIANT RR						
N8/8	Papatara Bay, Cavalli Islands; 30.ll.82; wild; in streams, clumps scattered along streams.					
	12	18.8	6.0	10.3	26.7	32
N8/13	Rere Bay, Whangaroa; 2,12.82;?; plants on flat beside stream.					
	1	17.7	-	-	-	-
NlO/12	Awanui Flat, Kaitaia; 10.2.83; wild; clay topsoil clumps under light scrub near a stream.					
	12	18.2	5.4	10.4	26.2	30
N14/12	Whirinaki, Hokianga; 3.2.83; garden, non-cultivated, non-derelict; clumps growing in boggy ditch above river, mixed with clumps of variant GR.					
	12	20.1	7.9	7.1	30.6	39
N15/3	Waikahikatea Stream, Bay of Islands; 16.5.82; wild; clumps scattered in and beside stream, by pasture.					
	12	23.8	12.6	5.7	45.0	52
N15/8	Okokako Road, Bay of Islands; 17.5.82; wild; taro in stream flowing through pasture and bush and into swampy flats (the fanner reports a big patch of taro was washed out twelve months ago).					
	2	27.8	3.9	25.0	30.5	15
N15/11	Waikopiro Stream, Bay of Islands; 20.5.82; garden, non-cultivated. non-derelict; single clump amongst large patch of Canna in boggy bank beside stream.					
	3	2.1	12.8	24.4	46.8	40
N18/2	Waimamaku Road, Hokianga; 4.2.83; garden, non-cultivated, non-derelict; variants RR and GR in mixed and separate clumps, scattered along dry stream bed through pasture.					
	11	20.1	5.2	13.2	28.5	26
N23/4	Te Kawa Stream, Dargaville; 21.5.82; garden, cultivated; in shade - measured seven shade leaves; also measured twelve leaves from single wild clump upstream, in clay topsoil, in open pasture (recorded as Site N23/1).					
	19	20.2	19.8	4.8	56.0	98
NZMS259/6	Whangapoua Beach, Great Barrier Island; 1.1.83; wild; clumps in patch in flat pasture beside creek.					
	12	24.2	11.7	11.5	49.0	48
N42/4	Mt. Albert, Auckland; 24.4.82; garden, cultivated; fertile volcanic soil, single clump.					
	44	22.2	13.5	3.4	46.0	61
N43/7	Coromandel Peninsula; 14.8.83; wild; clumps along narrow stream at mouth of steep-sided coastal gully, leaves weather-damaged.					
	12	19.1	4.5	12.0	24.5	24

N70/2	Ohope, East Cape; 19.1.83; garden, non-cultivated, non-derelict; clumps in patch at site of former garden, in wet pasture at foot of a slope.					
	12	18.0	6.0	8.2	27.5	33
N80/1	Mangahauni Valley, East Cape; 26.1.83; garden, non-cultivated, derelict; clumps dispersed over open pasture in fan where streamlet emerges from gully, plants originate from clumps in stream beside house, on hill above.					
	12	18.1	5.4	11.3	30.2	30
VARIANT GR						
N10/1	Te Rore Stream, Kaitaia; ll.2.83; wild; clumps scattered along stream and stream banks.					
	12	31.0	11.5	14.8	44.0	37
N14/12	Whirinaki, Hokianga; 3.2.83; garden, non-cultivated, non-derelict; clumps growing in boggy ditch above river, mixed with clumps of variant RR.					
	12	28.5	11.0	15.5	46.2	39
N14/30	Reena, Hokianga; 8.2.83; wild; two clumps in drier upper part of stream at edge of forest and pasture, above a very large patch of variant GP.					
	11	24.1	9.1	13.7	43.0	38
N18/2	Waimamaku Road, Hokianga; 4.2.83; garden, non-cultivated, non-derelict; variants GR and RR in mixed and separate clumps, scattered along dry stream bed through pasture.					
	12	21.0	7.9	11.9	36.0	37
N39/6	Curtis farm, Coromandel Peninsula; 15.8.83; garden, non-cultivated, non-derelict; clumps in boggy soil and humus near streamlet under forest, mixed with variant RR.					
	12	15.4	5.0	7.0	24.5	33
N63/4	Te Hekawa, East Cape; 23,1.83; garden, non-cultivated, non-derelict; in streamlet above coastal road.					
	12	24.3	8.8	12.2	38.5	36
VARIANT GP						
N11/2	Te Arakanihi, Bay of Islands; 20.5.82; wild; clumps scattered over damp ground in weedy area by swamp, amongst light scrub.					
	12	29.2	9.1	18.4	46.5	31
N14/3	Mitimiti Road, Hokianga; 8.2.83; garden, non-cultivated, derelict; plants in clay soil in damp roadside ditch, by pasture, down-slope from stunted clumps in dry ground before derelict house.					
	12	21.3	5.7	9.8	29.0	32
N14/14	Waiotemarama, Hokianga; 5.2.83; garden, non-cultivated, non-derelict; clumps in boggy stream bed, growing with broad shade leaves and bronze colouring on petioles, under trees.					
	12	27.9	8.4	17.0	41.8	30
N14/30	Reena, Hokianga; 8.2.83; wild; dense patch of clumps in large area of boggy ground by pasture.					
	12	24.8	9.8	11.0	43.0	39
N15/4	Ngawha, Bay of Islands; 16.5.82; wild; dense patch of clumps in large area of boggy ground by pasture.					
	24	22.7	10.0	7.4	43.4	44
N15/12	Kawakawa - Paihia Road; 20.5.82; wild; clumps dispersed along stream and stream banks, by pasture.					
	12	27.7	14.1	9.4	51.0	51
N70/4	Rerepa Stream, East Cape; 20.1.83; wild; clumps dispersed over long distance of stream amongst weeds, boggy ground.					
	12	28.0	12.8	10.8	46.5	46

Appendix 6. Leaf morphology

Ap. 6.1 Example data recording sheet

Measurements of the length of corm between the petiole base and the ground (bg) were not made. Petiole lengths were measured from the tip to the base of the petiole (pb) where possible, or from the tip to the ground surface (pg) otherwise.



DATE 26-1-85 | LOC Manghaeui | SITE NEO+81/1 | COLL. AKL 59, RR | PAGE 10

SHOOT NO.	LEAF NO.	PETIOLES bg	pb	pg	A	B	C	D	E	F	G	COMMENTS
1	1		59		24·4	12·6	12·4	7·0	13·4	12·4	9·5	
	2		68		30·2	14·1	14·3	8·2	14·7	12·6	11·0	
	3		52		20·5	10·4	10·0	6·2	9·6	9·0	8·5	
2	1		52		19·2	11·8	12·2	6·6	10·5	11·3	8·0	has spider mites

Ap. 6.2 Univariate descriptive statistics

(a) Observed leaf characters. Units in centimetres except for skewness (unitless).

	Variant RR					Variant GR					Variant GP				
	n=176					n=71					n=96				
	x̄	s.d.	skew	min.	max.	x̄	s.d.	skew	mm.	max.	x̄	s.d.	skew	mm.	max.
(a) Observed Character															
A	20.9	11.3	0.79	3.4	56.0	24.0	10.2	0.8	7.0	46.2	25.5	10.3	0.39	7.4	51
B	12.1	6.5	0.63	0.5	32.5	12.9	4.9	0.58	3.4	24.5	16.8	6.8	0.32	3.5	32.2
C	12.0	6.6	0.71	0.3	34.5	12.6	4.8	0.53	3.8	23.8	16.6	6.8	0.33	4.1	32.0
D	6.7	3.8	0.79	0.1	19.5	7.3	3.4	1.60	2.0	22.5	6.6	3.1	0.56	1.4	14.1
E	11.1	5.9	0.68	1.4	28.5	12.0	4.7	0.63	3.5	25.0	12.9	5.5	0.45	3.0	25.0
F	11.5	6.2	0.82	1.2	31.5	12.1	4.3	0.49	3.8	22.2	13.2	5.6	0.34	3.4	26.3
G	8.9	4.8	0.75	0.7	25.0	10.5	4.6	0.61	1.8	23.0	16.8	7.6	0.60	4.0	36.0
petiole height	58	25	—	7.5	119	65	25	—	18.5	132	78	34	—	18.0	175

(b) Derived characters. The derived characters are calculated as follows:

sinus angle (degrees) = $2.\sin^{-1}$ (G/B+C)
symmetry = (ExB)/(FxC)
lobedness = (B+C)/2/A
peltateness = D/A
width/length = (E+F) /A
rear/width = G/(E+F)

	Variant RR					Variant GR					Variant GP				
	n=176					n=71					n=96				
	x̄	s.d.	skew	min.	max.	x̄	s.d.	skew	mm.	max.	x̄	s.d.	skew	mm.	max.
(b) Derived character															
sinus angle	46.8	9.4	3.52	27,8	122.1	47.8	8.2	-0.17	26.6	67.7	60.2	10.8	-0.02	28.1	86.7
symmetry	1.00	0.18	0.91	0,35	1.94	1.02	0.14	1.10	0.81	1.47	1.00	0.13	0.18	0.44	1.59
lobedness	0.58	0.11	1.26	0.12	1.37	0.54	0.08	-0.80	0.26	0.70	0.66	0.08	2.26	0.51	1.08
peltateness	0.32	0.07	1.37	0.03	0.72	0.31	0.06	1.00	0.17	0.52	0.25	0.04	0.9	0.16	0.44
width/length	1.10	0.17	3.04	0.68	2.47	1.03	0.15	-0.76	0.5	1.36	1.02	0.11	1.54	0.65	1.64
rear/width	0.40	0.07	0.52	0.20	0.70	0.43	0.07	-0.22	0.25	0.61	0.64	0.11	0.52	0.31	1.10

Appendix 7. *Aweu*, a wild taro in Hawai'i

Description of the Hawai'ian taro variety *Aweu* (Whitney et al. 1939). This variety resembles the New Zealand taro variant GP in morphology (Chapter Five) in its occurrence in the wild, and possibly also in its poor eating quality (Chapter Seven). Whitney et al. (1939) describe two types in the category of rhizome (stolon) producing varieties, but regards these as unrelated. They are noted as commercially the least important of all the taros, since the rhizomes increase the difficulty of cultivation and harvesting. The *piko* is the upper surface of the blade above the point of petiole insertion.

Variety (Number and Name): 6. *Aweu*. Other Names: *Aweo, Aweoweo, Aweuweu, Mamauweo, Maauweo*.
General Characteristics: Medium in height to tall. Moderately spreading, maturing within 9 to 12 months, producing from 10 to 15 long slender rhizomes, distinguished by length of rhizomes. Petiole: 70 to 105 cm long, light green often inconspicuously flecked with dark green near base, white at base, with narrow, light purplish to indistinct edge, curved sharply at apex so that blade hangs vertically. Leaf Blade: 40 to 65 cm long, 25 to 45 cm wide, 35 to 55 cm from tip to base of sinus, narrowly ovate, thin in texture, light green, margins slightly undulate, *piko* greenish to faintly purple, lobes acute with shallow, narrow sinus. Corm: Flesh white with yellowish fibres; skin cream-coloured, usually with pink or purple along leaf-scar rings, the outer skin shaggy and fibrous. Origin and derivation of Name: Native variety; derives its name from shaggy outer skin of corm. Distribution: Formerly widely distributed in wild state, now scattered along streams and

in forests in the mountains. Use: Good as *poi*, but not used at present because the corras are usually small; the leaves are used for *luau*. Remarks: This variety was used by the old Hawai'ians for *poi* only when other food was scarce. The corms are too acrid to be used as table taro unless cooked for a long time. *Aweu* is often called wild taro because of its frequent occurrence in the wild state. The rhizomes, sometimes as long as 70 cm, come so close to the surface that they appear like creeping stolons.

Appendix 8. Flowering in New Zealand and Hawai'i

Ap. 8.1 Observations by P. J. Matthews, 1982–83

Each taro inflorescence is identified by either its number in the sequence recorded, or by its number in the sequence of inflorescences produced by the shoot. The *flower reference number* is given for cross-reference to the records of flowering (Table 5.1).

The developmental stage of each inflorescence is identified by the state of the upper spathe, as follows, (younger to older): G = green. G, Y = green and yellow together. Y = yellow. Y, O = yellow and orange together. O = orange. O, B = orange and brown together. B = brown. Wi = withered. pe = pre-emergent**.** Note: measurements for one flower (first in table) on two dates are given to illustrate shrinkage of the upper spathe during maturation.

						Spathe (cm)				Spadix (cm)					Ratio		
															Spat.	Spadix	
Variant/ALK No.	Flower ref. no.	Shoot number	Infl. number	Infl. position	Date	Stage	Total length	Lower part	Upper part	Total length	Pistillate zone	Sterile mid-zone	Staminate zone	Sterile appendage	Lower/Upper	Sterile Ap./Spadix	Sterile Ap./Stam. Z.
RR	1	1		1	9.3.82	Y	28.2	5.2	23						0.23		
					11.3.82	O,B	25.5	5.5	20			2.0	6.1	4.3	0.28		0.70
				2	10.3.82	Y	26.5	5.5	21						0.26		
				5	17.3.82	pe				10.8	2.0	1.4	4.2	3.2		0.30	0.76
		2		1	19.3.82	Y	23.5	4.5	19						0.24		
RR	2	1		1	25.3.82	G,Y	20	4.2	15.8						0.21		
RR	3			1	15.7.82	G	30	6.0	24.0	18.8	3.6	2.8	7.5	4.9	0.20	0.26	0.65
RR	4	1		2	12.3.83	Wi				10.3	2.2	1.4	4.8	1.9		0.18	0.40
				4	12.3.83	Y				12.0	3.0	1.5	5.5	2.0		0.17	0.36
RR	5		1	?	15.7.83	Y				15.8	4.3	1.8	5.8	3.9		0.25	0.67
GP	6	1		2	8.2.83	Y				8.8	2.3	1.6	2.3	2.6		0.30	1.13
		3		1	8.2.83	W				8.8	4.6	0	2.5	1.7		0.19	0.68
		4		1	8.2.83	W				9.0	4.2	0	3.1	1.7		0.19	0.55
GP	6	4		2	8.2.83	Wi				11.4	3.6	1.3	3.7	2.8		0.25	0.76
GP	7	1	1	?	8.2.83	Y				10.2	3.5	2.3	1.8	2.6		0.25	1.44
		2	1	?	8.2.83	Y				10.0	3.3	1.9	2.0	2.8		0.28	1.40

		3	1	?	8.2.83	Y				12.1	3.7	1.8	3.7	2.9		0.24	0.78
		4	1	?	8.2.83	Y				10.1	3.5	1.7	2.4	2.5		0.25	1.04
		5	1	?	8.2.83	Y				11.1	3.5	2.3	2.5	2.8		0.25	1.12
		6	1	?	8.2.83	Y				8.6	3.0	1.6	2.2	1.8		0.21	0.82
GP		7	1	?	8.2.83	Y				12.2	4.0	1.8	3.2	3.2		0.26	1.00
		8	1	?	8.2.83	Y				10.5	3.6	2.4	2.0	2.5		0.24	1.25
		9	1	?	8.2.83	Y				13.1	4.7	2.4	2.8	3.2		0.24	1.14
GP	8	1	1	?	9.2.83	Y				11.2	4.2	1.7	3.0	2.3		0.21	0.77
		2	1	?	9.2.83	Y				12.8	4.0	2.0	3.5	3.3		0.26	0.94
		3	1	?	9.2.83	Y				11.5	3.5	2.0	3.2	2.8		0.24	0.88
GP	9	1	1	?	9.2.83	Y				12.4	3.5	2.5	3.8	2.6		0.21	0.68
GP	9	2	1	?	9.2.83	Y				13.2	4.4	2.0	3.5	3.3		0.25	0.94
		3	1	?	9.2.83	Y				12.5	3.9	1.6	3.8	3.2		0.26	0.84
		4	1	?	9.2.83	Y				9.1	3.0	2	2.0	2.1		0.23	1.05
		5	1	?	9.2.83	Y				10.9	3.5	1.6	3.0	2.8		0.26	0.93
80	10	1	1		12.4.83	Y				16.0	7.2	2.0	2.3	4.5		0.28	2.00
80	11	1		?	Sep-83	B				13.5	3.5	3.0	3.3	3.7		0.27	1.12
12	12	1	1	?	29.4.83	Y	22.4	3.8	18.6	8.4	2.2	1.6	3.5	1.1	0.20	0.13	0.31
1	13	1	1	?	29.4.83	Y	14.6	3.3	11.3	6.0	1.5	1.6	2.4	0.5	0.29	0.08	0.21
16	14	1	1	?	25.4.83	Y	18.2	3.5	14.7	6.7	1.5	1.5	3.0	0.7	0.24	0.10	0.23

Ap. 8.2 Observations by R C Cooper (1969)

The taro variety identifications are those made by E C Cooper. The ratios are calculated here from the previously published measurements.

Cheeseman Herbarium Specimen Number	Variety	Location	Date	Spathe (cm)	Spadix (cm)					Rations	
				Total Length	Total Length	Pistillate Zone	Sterile Mid-zone	Staminate Zone	Sterile Appendage	Sterile Append. / Spadix	Sterile Append. / Staminate
477	?	Waimate	Feb 1895	15.5							
5476	antiquorum	Kaitaia	Apr 1921	22.5	14.9	3.1	2.3	4.9	4.6	0.31	0.94
44326	esculenta	Lava Pt.	June 1956	16.4	6.0	1.8	1.2	2.5	0.5	0.08	0.20
70451	esculenta	Edmund St.	Apr 1962	26.6	13.8	3.0	2.0	6.5	2.3	0.17	0.35
90327	esculenta	Ngaire Bay	Dec 1963	24.1	9.1	1.9	2.5	2.4	2.3	0.25	0.96
90328	esculenta	Kerikeri bch	Dec 1963	22.8	9.2	5.5		1.7	2.0	0.22	1.18
90329	esculenta	Kerikeri bch	Dec 1963	26.2	8.7	5.6		2.5	0.6	0.07	0.24
90330	esculenta	Kerikeri bch	Dec 1963	25.6	8.7	5.5		2.6	0.6	0.07	0.23
118571	antiquorum	Whareora	Sept 1968	18.1	11.8	3.8	1.1	3.7	3.2	0.27	0.86

Ap. 8.3 Observations by Whitney et al. (1939) on a field-station varietal collection

These authors present only range end-point values. Range mid-point values have been calculated here for the estimation of the ratios. The variety numbers are those given by Whitney et al. (1939). A large majority of the varieties listed here were collected within the Hawai'ian Islands.

GROUP	VARIETY		SPATHE (cm)					SPADIX (cm)				RATIOS	
			Total Length		Lower Part		Upper Part	Total Length		Sterile	Append.	Spathe	Spadix
	No.	Name	Range	Mid-point	Range	Mid-point		Range	Mid-point	Range	Mid-point	Lower / Upper	Sterile Append. / Spadix
Rhizomatous	7	*Kakakura-ula*	24–32	28	4–5	4.5	23.5	9–11	10	0.7–1.3	1	0.19	0.1
Mana	11	*Mana Uliuli*	12–16	14	2–2.5	2.25	11.75	6–9	7.5	0.4–0.8	0.6	0.19	0.08
	12	*Mana Ulaula*	14–17	15.5		3	12.5	4–5	4.5	0.5–0.6	0.55	0.24	0.12
	15	*Mana Kukuluhema*	21–24	22.5	3–4	3.5	19	7–8	7.5	0.4–0.5	0.45	0.18	0.06
Piko	18	*Piko Kea*	15–20	17.5	3–4.5	3.75	13.75	5–6	5.5		0.4	0.27	0.07
	21	*Piko Uliuli*	15–20	17.5	3–4.5	3.75	13.75	5–6	5.5		0.4	0.27	0.07
	22	*Piko Eleele*	15–20	17.5	3–4.5	3.75	13.75	5–6	5.5		0.4	0.27	0.07
	23	*Elepaio*	17.5–18	17.75		2.5	15.25		6	0.7–0.8	0.75	0.16	0.13
	24	*Uahiapele*	18–24	21	3–4	3.5	17.5		6		0.6	0.20	0.10
	26	*Tahitian*		30		5	25					0.20	
Kai	27	*Kai Uliuli*	18–20	19		4	15	7–8	7.5		0.4	0.27	0.05
	28	*Kai Ala*	19–22	20.5	3–4	3.5	17	7–9	8	0.7–1.0	0.85	0.21	0.11
	29	*Kai Kea*	18–23	20.5	3–4	3.5	17	6–9	7.5	0.7–1.1	0.9	0.21	0.12
	30	*Apuwai*					20–25	17–20	18.5		1		0.05
	32	*Piialii*	26–33	29.5	4.5–9	6.75	22.75	9–12	10.5	1.2–2	1.6	0.30	0.15
	33	*Paakai*	21–24	22.5	3–4	3.5	19	7–8	7.5	0.8–0.9	0.85	0.18	0.11
	34	*Moana*	22–25	23.5	4–5	4.5	19					0.24	
	35	*Akuugawai*	26–28	27	1–4.5	4.25	22.75	8.5–9	8.75		1	0.19	0.11
Lauloa	36	*Lauloa Eleele-omao*	30–35	32.5	5.5–6	5.75	26.75					0.21	
	38	*Lauloa PaUakea-eleele*	32–37	34.5	5–6	5.5	29		11		1.3	0.19	0.12
	40	*LauZoa Palakea-papamu*	20–24	22		4	18	8–10	9		1.1	0.22	0.12
	41	*Lauloa Palakea-keokeo*	30–35	32.5	5.5–6	5.75	26.75		12	1.2–1.7	1.45	0.21	0.12
Eleele	43	*Eleele Makoko*	22–25	23.5	3.5–4.5	4	19.5	7–9	8	0.6–0.7	0.65	0.21	0.08
	44	*Eleele Naioea*	24–26	25	3.5–4.5	4	21	8–9	8.5	0.6–0.7	0.65	0.19	0.08
	45	*Marnini- owali*	26–30	28	4.5–5.5	5	23	10–11	10.5	1.1–1.2	1.15	0.22	0.11
	47	*Nawao*	18–23	20.5	3–4	3.5	17					0.21	
Ulaula	48	*Ulaula Kumu*	21–23	22	3–4	3.5	18.5		7	0.4–0.5	0.45	0.19	0.06
	55	*Manini Toretore*		28					9		0.8		0.09
	59	*Manini-opelu*	28–32	30	4–5	4.5	25.5					0.18	
	60	*Hinupuaa*		24	4–5	4.5	19.5		8		0.7	0.23	0.09
Lehua	63	*Lehua Maoli*	14–20	17	2.5–3	2.75	14.25	6–7	6.5	0.6–0.8	0.7	0.19	0.11
	66	*Lehua palaii*	18–23	20.5	3–4	3.5	17	7–8	7.5	0.5–0.8	0.65	0.21	0.09
	68	*Wehiwa*	22–26	24	3–3.5	3.25	20.75		10	0.8–0.9	0.85	0.16	0.09
	71	*Leo*	15–17	16	2.5–3	2.75	13.25	6–7	6.5	0.8–1.1	0.95	0.21	0.15
	73	*Haokea*	26–37	31.5	4–5	4.5	27	8–11	9.5	0.9–1.4	1.15	0.17	0.12
Unclassified	83	*Pikoele*	18–20	19		3	16	6.5–7	6.75		0.9	0.19	0.13

Appendix 9. Māori naming of taro

Introduction

During the present study, a small amount of information was obtained on the Māori naming of taro. The records listed below and the following discussion are intended simply as a starting point for anyone who wishes to take the topic further.

List of names and sources

Many of the names listed here come from the list of 45 names collated by Best (1976) from the nineteenth century records of W. Colenso, J. White, E. Tregear (1891) and the *Williams' Māori Dictionary* (edition not specified). Where authors are referred to without a publication year, the listed name has been only sighted in Best (1976). Names reported by correspondents (see Appendix 1) are indicated as personal communications. Names encountered during fieldwork, 1982–83, are indicated by the author's name (P. J. Matthews) followed by the date of the field notes (also held at the Herbarium).

Except for two names known to be derived from overseas place names, no capitals have been used, though this may not be strictly correct and does not always follow the reports; however, reports also vary. Names applied to or implying introductions after European arrival are listed separately at the end.

NAME	SOURCES
awhanga	V. Gregory, pers. comm. 1983
awanga	Colenso 1880; White
hanina	V. Gregory, pers. comm. 1983
haukopa	Colenso 1880; Biggs 1981
ipurangi	Taylor 1848; Tregear
taro ipurangi	V. Gregory, pers. comm. 1983
kakaratapae	V. Gregory, pers. comm. 1983
kakatarahaere	Williams
kakatarahae	Colenso 1880
kakatupari	Taylor 1848; Tregear
kaokao-paraoa	White
kauere	Biggs 1981
kaunaunga	Taylor 1848; Tregear
keakea	Taylor 1848; Tregear
kiekie	White
kinakina	Colenso 1880; White; Biggs 1981
koareare	Colenso 1880; V. Gregory, pers, comm. 1983
kohuarangi	Colenso; Williams
kohuhurangi	Biggs 1981
kohukohurangi	Biggs 1981

kohuorangi	Colenso 1880; White; Biggs 1981
kohurangi	Williams; V. Gregory, pers. comm, 1983
kokohurangi	Biggs 1981
maehe	Taylor 1848; Tregear
maire	White
makati	V. Gregory, pers. comm. 1983
makatiti	Williams; D. Yen, pers. comm. 1983; A. Sheward, pers.comm. 1984
matatiti	Colenso 1880
mamaku	Colenso 1880; V. Gregory, pers. comm. 1983
manuwenua	Taylor 1848; Tregear
taro maori	Wilson 1894; K. Reynolds, pers. comm. 1982; V. Gregory, pers. comm. 1983; P.J. Matthews 17.5.82, 19.1.83.
real Māori taro	P. J. Matthews 19.5.82, 5.2.83, 8.2.83
old Māori taro	P. J. Matthews 4.2.83
ngaue	Williams
ngaaue	Biggs 1981
ngongoro	Colenso 1880
patai	Colenso 1880
paatai	Biggs 1981
paeangaanga	Colenso 1880; Williams; White; V. Gregory, pers. comm. 1983
pehu	Williams; Biggs 1981
pakaue	Williams; Biggs 1981
pongi	Taylor 1848; Williams; White; V. Gregory, pers. comm. 1983
pongi matapo	Best 1976
pongo	Colenso 1880
pongu	D. E. Yen, pers. comm. 1983
taro punga	A. Sheward, pers. comm. 1984
poporo	Gregory, pers. comm. 1983
potango	Colenso 1880; White; P. J. Matthews 19.5.82
potangotango	V. Gregory, pers. comm. 1983
takatakapo	V. Gregory, pers. comm. 1983
takatakaapo	Colenso 1880
tanae	Williams; Biggs 1981
tangae	Taylor 1848; Tregear
taropo	White
tautaumahi	V. Gregory, pers. comm. 1983
tataumahei	Colenso 1880
tokotokohau	Colenso 1880; Biggs 1981
turitaka	Colenso 1880; White; Biggs 1981
uhikoko	Colenso 1880
uhi (uwhi) koko	Biggs 1981

uhiraurenga	Colenso 1880
uhi (uwhi) raurenga	Biggs 1981
upokotike	V. Gregory, pers. comm. 1981
upokotiketike	Colenso 1880
taro upokotiketike	Sheward, pers. comm. 1984
wairuaarangi	Colenso 1880
wakahekerangi	Taylor 1848; Tregear
wakarewa	Taylor 1848; Tregear
akarewa	Williams; V. Gregory, pers. comm. 1983
taro akarewa	A. Sheward, pers. comm. 1984
whakatauare	Biggs 1981
Names applied to or implying introduction after European arrival:-	
taro hoia	Colenso 1880; Williams; D. Vincent, pers. comm. 1982; V. Gregory, pers. comm. 1983; I. Barber, pers. comm. 1983; B. Biggs, pers. comm. 1983; P. Tangiwai, pers. comm. 1983; A. Sheward, pers. comm. 1984; P. J. Matthews, 19.1.83, 25.1.83, 4.2,83, 5.2.83 (two occurrences), 7.2.83.
taro oia	Polack 1838
taro Merekena	Wilson 1894
taro poaka	P. J. Matthews 18.5.82
taro Tonga	P. Tangiwai, pers. comm. 1983

Discussion

Generally descriptions of the plants to which names apply are lacking. Colenso (1880) provides extremely cursory descriptions of varieties and only general statements regarding their location. The fullest descriptions have been provided by V. Gregory (pers. comm. 1983) but other correspondents give information also. An attempt was made (see correspondence to B. Biggs, pers. comm. 1983) to group Viv Gregory's descriptions according to the variant (RR, GR, or GP) which they most clearly resemble. This attempt has been abandoned because it requires the assumption that past and present Māori naming is based on only the three major variants recognised during the recent fieldwork.

Two other variants, as yet known from only single sources, have been claimed as historically associated with the Māori: AKL 34 was named as 'genuine' *taro maori* when presented at Pakaraka, Central Bay of Islands (K. Reynolds, hearsay only, pers. comm. 1982), and AKL 79, although named as 'black taro', for want of a better name, is regarded as a Māori taro and 'very old', (M. Rau-Kupa, pers. comm. 1983). These claims are indicative, but by no means substantiate, that a wider range of botanically distinct variants are historically important.

Recognition of the three variants, RR, GR, and GP, can be made using just two characters, namely blade shape and petiole colour. These characters appear stable, being more or less distinctive of each variant regardless of habitat. Their use reflects the belief that stable phenotypic characters distinguish the underlying genotype best. Such an understanding may not be explicit in taxonomies not of the European tradition. It is

characteristic of the folk-taxonomies of cultivated plants that varieties are distinguished on a great wealth of plant detail, including size, taste, internal texture and colour, as well as external shape and colour (Whitney et al.1939; Panoff 1972; Bulmer 1974). Variations in such vegetative characters reflect to greater or lesser extents diversity in natural and cultivated habitats rather than genetic diversity. While the descriptions provided by V. Gregory (pers. comm. 1983) include such a wealth of plant detail, it is not known how much they actually reflect the original derivation of the names. A possible original derivation can be seen in the name *kakatarahae*, which means the 'quarrelling or scratching parrots' and may recognise astringency in the taro flesh (B. Biggs, pers. comm. 1983).

External associations, both cultural and physical, which might also be recognised in Māori naming include habitat type, place or area name, and personal or geographic sources. Although the descriptions made by V. Gregory (pers. comm. 1983) include many details of habitat which vary from variety to variety, it is not known how much these external details provide essential definition rather than coming after definition. External associations are clearly recognised, for example, in the names *taro maori, taro poaka* (taro fed to pigs), *taro Tonga*, and *taro Merekena* (American taro).

To what extent external associations are recognised in the other possibly more traditional names listed has not been established. There do appear to be at least two examples:

(1) *ngaue* is noted by R. McConnell (pers. comm.) as a suffix meaning 'wet taro cultivation' in a local East Cape stream name, Waingaue;

(2*) ipurangi* is described by Best (1976) as a shallow type of *parua*, a basin-like hole in which taro is planted.

These examples however must be accepted with caution, since it is quite possible that the words in fact represent part of the vocabulary of cultivation, closely linked to the plants without actually naming them. The general lack of records of use in living context — i.e., ethnographic description — presents another stumbling block to interpretation of the listed names: the taxonomic positions of the names are not known, whether non-terminal (subdividable) or terminal (non-subdividable). For taro at least, the lower order groupings or structure of the Māori classification system has not been recorded. *Taro* clearly holds a non-terminal position in binomials such as *taro ipurangi*, while names such as *kakatarahae* and *kakatupari* could either be terminal uninomials or binomials with *kaka* representing a group of varieties. What proportion of the name list comprises of terminal taxa is unknown.

Bulmer (1970) comments on the question of correspondence between the terminal folk taxa of folk-taxonomies and the biological species recognised by the biologists of Western science. In particular he notes that vegetatively propagated domesticated plant species often include a host of genetically distinct varieties, with reasonably stable morphological characters, which maintain their identity by the fact of their vegetative propagation. It is then argued that the relatively large number of terminal taxa recorded for such cultivated plants reflects not 'high cultural significance' (i.e., external, cultural reasons for differentiating between plants) but objective observation of morphologically

and genetically distinct strains.

To some extent this argument may be correct, but only so far as Western science does in fact recognise genetic differences rather than simply differentiating between phenotypes for external, cultural reasons. This is well illustrated in the botanical classification of Hawai'ian taro cultivars by Whitney et al. (1939), who note that the vegetative characters which they use as criteria often group varieties which have little else in common. The correspondence between their classification and the traditional Hawai'ian naming is so great that many of the Hawai'ian group and variety names are retained, but this does not imply that the Hawai'ian system is based on objective observation of genetically distinct strains.

Objective observations are indeed made in the above examples, but classifications based on phenotypic characters cannot be guaranteed to reflect genetic differences well, regardless of any theoretical knowledge of the genetic basis of life. Direct knowledge of both genetic differentiation and reproductive barriers, (two criteria for identifying phylogenetic relationships or biological species), is extremely limited for taro (see Chapters Two and Three). Identification of formal sub-specific categories among the New Zealand taro has been expressly avoided for this reason, while the use of a species name (as in *C. esculenta*) has been simply for the sake of convention and convenience. The morphological distinctions between variants do suggest genetic differences, but are insufficient as criteria for defining biological species.

To summarise, evaluation of the correspondence of other folk-taxonomies with genetic differences, biological species, or other discontinuities in the biological world is limited by how well the evaluator's own folk-taxonomy does the same job.

Returning to the list of Māori names for taro, further issues regarding interpretation should be noted: transfer of names from one cultivar to another within a genus or between genera may occur (H. Leach, pers. comm. 1984); the list may combine names from different dialects; and the lost cultural and economic importance of taro has probably had important effects on error and consistency in both recorded and continuing usage.

This discussion began with the question of how many botanically distinct variants of taro are represented in the list of Māori names. Because of the problems outlined above it is clear that speculation would be of little value. A second question is now posed: What can be learnt about plant origins from the names?

Only a few names for taro were encountered during fieldwork, and more in correspondence. A general impression, by no means clear, has been obtained of some consistency in the present use of names with the use claimed in earlier records. Taro — which is thought of as belonging to the Māori, as historically important, as cultivated, and as that which is best for eating — may be named as *taro maori* or referred to in phrases such as 'real Māori taro' or 'old Māori taro'. The name and phrases were applied to what has been identified here as variant HR. *Taro potango* a name encountered only once in the field, was used by an elder Māori woman to name corms of variant RR harvested from a garden. These she also called 'real Māori taro'.

Taro hoia was the name most frequently encountered, and was raised in contrast to

taro cultivated in gardens. It is wild taro, or taro not eaten except for the leaves, and is green taro. Direct usage to describe plants in the field was unfortunately not met. Sometimes wild and cultivated taro were contrasted without the use of Māori names. Wild taro of the variant GP was referred to as not good for eating (though eaten by some), and as food for pigs (once also named *taro poaka*, in reference to pork). Variant GP, in addition, has predominantly green petioles so that the impression gained is that variant GP is in fact *taro hoia*.

However there is some confusion since wild taro of variant RR was once contrasted as a different type from cultivated plants of the same variant. It is possible that *taro hoia* could be thought of by some people as any apparently wild taro while others apply the name more closely to wild green taro, that is, variant GP (the variant which is predominantly wild in distribution — see Chapter Seven).

The above illustrates just some of the problems in establishing definitions for names. Other qualities were also used by people to distinguish types, notably colour and texture of the corm either before or after cooking. It was frequently unclear which state of cooking colour described, and sometimes even whether the colour mentioned described the leaf rather than the corm flesh.

The present equation of variant GP with *taro hoia*, though uncertain, corresponds with earlier records: Colenso (1880) writes of taro that 'there are also more than twenty varieties or species, which, like the kumara, differed greatly in size, in quality, and in the colour of its flesh; besides one which is known to have been introduced since the time of Cook's visit. This newer one is called *taro hoia*; it is a much larger root (tuber) and plant, and it is also coarser in its flesh, and is not so generally liked'.

Wilson (1894) states that 'the great labour of growing *taro maori* caused it to be abandoned when the *taro Merekena* was introduced. The latter is hardy, prolific, runs wild in fact, and is easily cultivated, but it is very inferior in flavour and flouriness to *taro maori*'. Wilson's description of *taro Merekena* matches in both growth habit and cultural status to present-day *taro hoia*, identified here as variant GP, and also matches Colenso's (1880) description of *taro hoia* — including the claim for its recent introduction.

Another form of '*Merekena*', namely '*merikana*', is applied to a kumara variety supposed to have been brought on American whaling ships from the Pacific Islands (Best 1976). This raises the possibility that *taro Merekena* was not, in fact, recently introduced but for some reason received its name by transfer from the kumara variety. The reverse could, of course, be true or both taro and kumara varieties may have been introduced by American ships. A recently introduced variety from some other, perhaps unknown, source might also have been dubbed 'American' for want of any other name.

Further confusion is added by the possibility, indicated by J. Diamond (1982; pers. comm. 1984), that early descriptions of *taro Merekena* could refer to the aroid *Alocasia macrorrhizos*, which was apparently introduced last century as an ornamental, and is now commonly found as an ornamental or wild. The rampant growth habit of *Alocasia*, and its poor eating quality (A. Esler, DSIR, pers. comm. 1982), also fit the early descriptions of *taro Merekena*.

Cruise (1824), writing of his travels in 1820, states that 'the taro plant, which has been imported from Otaheite, is cultivated by a few natives with much success'. This statement is ambiguous in that Cruise may be reporting Māori knowledge, or he may, like an earlier writer, be stating his own opinion of the origin (Tahiti). Nicholas (1817) states that 'it does not appear to me that this plant is indigenous to New Zealand, but must, in my opinion, have been brought hither, either by Captain Cook or some other European navigator who has visited the country'. This example is given simply to illustrate an opinion; it is not being suggested that Nicholas influenced the statements of Cruise.

From the above, it is apparent that no definite conclusion can be drawn from written or oral history regarding the possible recent introduction of a named taro variety, early in the period of European occupation. The variety that may have been recently introduced may be variant GP. Of the three major variants, least information was obtained regarding Māori recognition of variant GR. When asked about a mixed patch of variant GR and RR one group seemed to not recognise the co-existence of two types (field notes, 3.2.83). Another informant knew that the non-cultivated clumps of variant GR in her garden were not 'real Māori taro', but could only speculate on its more distant origin (field notes, 8.2.83). A third informant whose plants came from a Māori cultivator some twenty years ago recollected that the 'small green' had been regarded then as sweeter and better than the red (variant RR), although not as big (field notes, 15.8.83). The scantiness of this information may simply reflect the rarity with which both variant GR and people were encountered at the same time during the field surveys. D. Yen (pers. comm. 1983) indicates that *makatiti* may be variant GR.

Conclusions

Written records of the Māori classification of taro are too incomplete to provide any clear suggestions regarding the number, and history, of botanically distinct variants existing in the recent or distant past. However, two easily debated suggestions can be made; firstly that the naming of variant RR as *taro maori* reflects a pre-European origin, and secondly that the naming of variant GP as *taro hoia* indicates that it was introduced by an American whaling ship early last century, from Tahiti.

A wide ranging and thorough etymological study of Māori plant classification would clarify the history of taro, but such an ideal cannot be reached. While ethnographic records are obviously inadequate, encounters during the recent fieldwork did give the impression that valuable knowledge does exist of old traditions associated with taro, mainly amongst the older Māori.

Appendix 10. Cytology

Ap. 10.1 Cytological methods

Preparation

(1) Use recently potted plants with actively growing roots. If plants are stripped of leaves and roots prior to potting, they will be found with suitable roots when the first new leaf is seen emerging. Root tips (l–2 cm) may be harvested at any time of day.

(2) Place tips in 0.2% colchicine (0.03 g per 15 ml distilled water) using sufficient volume to fully immerse the root tips. Leave at room temperature 2.5 to 4 h, aeration is not necessary. This is a very high concentration of colchicine and could perhaps be reduced to 0.02% without loss of effect. Generally, freshly made colchicine is used as it degrades with storage, allowing visible algal growth. The solution may be stored for short periods of some days at least, in a refrigerator, and may be re-used.

(3) Fix tips in 3:1 absolute ethanol/glacial acetic acid, at room temperature, for approximately 24 h. Theoretically, material can be left for longer (e.g., over a weekend) if put in a freezer, but in fact consistently good results were only obtained using freshly fixed tips.

(4) Soften the tips in 1M HCl at 60°C (waterbath) for 4 to 4.5 minutes. Thicker tips tend to need a little more time than thinner tips.

(5) Remove from acid and quickly place directly in small tube containing approximately 2ml (enough to fully immerse the tips) of Feulgen stain. Replace in dark for at least 10 mins or until the tip is stained bright purple.

(6) Remove the tip, cut off the end 1mm with root cap and meristem, and place it on a very clean slide.

(7) Place a very small drop of 45% acetic acid on the tip and with pointed needle begin maceration. Remove the tip epidermis. Place a drop of lacto-propionic orcein on the slide and continue maceration briefly. If the tip is too finely macerated, the time later required to search the slide fully under the microscope will be increased. If not macerated enough clumps of cells will prevent a good spread of chromosomes. The material should have approximately 0.5 mins in the stain before the next step, including the time for maceration.

(8) Put on coverslip and tap with a blunt needle to disperse clumps of cells and remove air bubbles. This is best done holding the cover slip down gently with fingers, with tissue paper between fingers and slide to mop up excess stain as it is squeezed out.

(9) Place slide between layers of blotting paper and squash coverslip onto the slide with very firm thumb pressure, shifting one thumb only while the other maintains the pressure. Any lateral movement of the coverslip will shear the cells into useless fragments.

(10) Label the slide, then inspect under the microscope. For counting, polarised light provides good contrast, but for photographs this contrast may result in difficulty in making prints in which the cell background isn't prominent. Also, better depth of field may be needed for a photograph if the spread isn't very flat — another reason to use bright field optics. The slide may be squashed again to improve the spread of

chromosomes.

(11) If the slide is well made, with no air gaps under the coverslip caused by dust, it may be left for a day or so without drying out. For permanent slides, the following procedure was used:

Hold the slide with tweezers and immerse it fully in liquid nitrogen, until the liquid nitrogen stops bubbling around the slide. Hold the slide in the air and breathe on the coverslip to warm it slightly, without fully melting the chromosome preparation. Place the slide firmly on bench and use a scapel blade to prise the coverslip off. Ideally it should snap off intact, so that time isn't spent removing fragments while the preparation melts. Place a drop of Euparal on the slide and put on a fresh coverslip. Place slide on a low-heat bar or leave at room temperature to dry.

Stain Recipes

Feulgen Stain:

- Leuco — basic fuchsin (modified formula after Darlington and La Cour, 1969).
- Dissolve 1g basic fuchsin by pouring it over 200ml of boiling distilled water.
- Shake well and cool to 50°C.
- Filter (Whatmans No. 1 paper) and add 30ml of HCl to the filtrate.
- Add 3g $K_2S_2O_5$ (or $Na_2S_2O_5$).
- Allow solution to bleach for 24h in a tight stoppered bottle, in the dark; add approximately 4g activated charcoal (for decolourising the solution) and filter (Whatmans No. 1 paper) the solution as fast as possible after addition of the carbon.
- Store in dark at ±5°C. Ideally store in aliquots to reduce exposure to air, or in a concertined plastic bottle.

Lacto-Propionic Orcein:

- Mix: 5g synthetic orcein
  50ml 45% propionic acid
  50ml 45% lactic acid
- Boil in reflux condenser for 3 days, filter while warm and store in fridge (where precipitation will occur).
- Filter into small bottles after precipitation. Can be diluted with the 45% lactic and propionic mixture (see previous page).

Chemicals

acetic acid, analytical Reagent, BDH.
activated charcoal powder, Technical Grade, AJAX Chemicals, Sydney.
basic fuchsin, standard stain, product number 34032, BDH.
colchicine, product number 27805, BDH.
dichloroflaoromethane, 'arctic Air' Refrigerant 12, Hapi International Export, New Orleans, LA 70119.
ethanol, Analytical Reagent, BDH.

lactic acid (source not known).
synthetic orcein (source not known).
propionic acid (source not known).
sodium metabisulphite, UNILAB laboratory reagent, AJAX Chemicals, Sydney.

Ap. 10.2 Cytological observations of New Zealand taro (five variants from 17 localities)
Dyer (1979) states that surveys of root tip cells indicate that mutant karyotypes produced by mitotic errors rarely occur with a frequency greater than 0.05%. It appears generally accepted (D. Goates, Research School of Biological Sciences, A.N.U., pers. comm. 1983) that very few observations of root tip cells are required for accurate counts. The counts presented below are for cells observed with the maximum number of chromosomes for each plant accession. Many ruptured cells were observed with less than the maximum number of chromosomes, due to excessive spreading, and are not recorded here (although some were photographed).

Variant	Plant accession number	Botany department site number	Site type	Locality	Region	Root tip	Cell number	2n chromosome number
RR	AKL 27	N15/8	Wild	Okokako Road	Central Bay of Islands	1	1	42
						2	1	42
							2	42
	AKL 48	N8/10	Wild	Waiti Bay	Cavalli Islands	1	1	42
							2	42
							3	42
							4	42
	AKL 55	N259/6	Wild	Whangapoua Beach	Great Barrier Island	1	1	42
							2	42
							3	42
	AKL 62	N63/3	Garden, non-cultivated, non-derelict	Te Hekawa	East Cape	1	1	42
							2	42
						2	1	42
	AKL 65	N61&60/2	Wild	Hamana Stream	East Cape	1	1	42
						2	1	42
						3	1	42
	AKL 70	N18&22/2	Garden, non-cultivated, non-derelict	Waimamaku	South Hokianga	1	1	42
							2	42
						2	1	42
RR	AKL 84	N35/1	Garden, non-cultivated, non-derelict	Port Charles	Coromandel	1	1	42
							2	42
							3	42
						2	1	42
							2	42
GR	AKL 61	N63/4	Garden, non-cultivated, non-derelict	Te Hekawa	East Cape	1	1	42
							2	42
						2	1	42
							2	42

	AKL 69	N18&22/2	Garden, non-cultivated, non-derelict	Waimamaku	South Hokianga	1	1	42
						2	1	42
							2	42
							3	42
						3	1	42
						4	1	42
	AKL 83	N3&4/1	Garden	Waihope Lake	Aupouri Peninsula	1	1	42
							2	42
							3	42
GR	AKL 85	N39/4	Garden, non-cultivated, non-derelict	Colville	Coromandel	1	1	42
							2	42
GP	AKL 17	N1&2/2	Wild	Kapowairua (Spirits Bay)	North Cape	1	1	42
						2	1	42
							2	42
						3	1	42
							2	42
	AKL 23	N15/4	Wild	Ngawha	Central Bay of Islands	1	1	42
							2	42
							3	42
							4	42
	AKL 63	N70/4	Wild	Rerepa Stream	East Cape	1	1	42
							2	42
	AKL 30	N11/2	Wild	Te Arakanihi	Coastal Bay of Islands	1	1	42
							2	42
							3	42
						2	1	42
AKL 34	AKL 34	N24/2	Garden	Manganese Point		1	1	28
							2	28
AKL 79	AKL 79	NlO9/1	Garden	New Plymouth	Taranaki	1	1	28
							2	28
							3	28
							4	28
						2	1	28
						3	1	28

Appendix 11. Ribulose-1,5-bisphosphate carboxylase

Ribulose-1,5-bisphosphate carboxylase-oxygenase (E.C.4.1.1.39) is the major soluble leaf protein in plants, and catalyses the initial step in Calvin's reductive pentose phosphate cycle. The genetics and physiology of the enzyme have been reviewed by Miziorko and Lorimer (1983).

RuBP carboxylase has been purified to homogeneity from a variety of plant, algal, and bacterial sources. All of the plant and algal enzymes studied to date are of similar molecular weight (560 x 10^3 daltons) and contain eight large (56 x 10^3 daltons) and eight small (14 x 10^3 daltons) subunits (Miziorko and Lorimer 1983). The large subunit is encoded by chloroplast genomes and the small subunit by the nuclear genome (Kung 1976). The reported heterogeneity (multiple bands of dissociated subunits on isoelectric focusing gels) in both large and small subunits has been the basis for use of the enzymes in numerous studies of phylogeny (for example, Kung 1976; Uchimiya et al. 1977; Gatenby and Cocking 1978) and of cytoplasmic inheritance after *in vitro* protoplast fusion (for example, Melchers et al. 1978; Shepard et al. 1983).

The published methods for the extraction, purification and characterisation of RuBP carboxylase vary widely and no one method appears applicable to all species. Chen at al. (1976), for example, obtain and purify the protein by 1) crystallisation in clarified leaf sap (*Nicotiana, Solanum, and Petunia*); 2) salt fractionisation and column chromotography (a wide range of genera including *Chlamydomonas*, *Selaginella,* and *Spinacia*) and 3) by specific absorption to a column of immobilised antibodies that had been raised against RuBP carboxylase from *N. tabacum* (*Ginkgo, Beta,* and *Triticum*).

Oxidation and reactions of proteins with polyphenols are problematic during extraction and the following procedures. The combinations and amounts of protective reagents (sodium metabisulphite, mercaptoethanol, polyvinylpyrrolidone-40, and NaCl to name a few) used during extraction, purification and characterisation vary widely and generally without explanation. O'Connel and Brady (1981) have demonstrated that the widely reported heterogeneity (charge diversity) of three large subunit polypeptides is an artefact of carbamidomethylation of the enzyme before isoelectric focusing, a reaction routinely performed in previous studies of RuBP carboxylase. They report that the simplest isoelectric focusing patterns were observed when the enzyme was isolated rapidly and gently by immunoprecipitation or preparative PAGE.

No published method for the extraction and purification of RuBP carboxylase from *Colocasia* exists. During the present study of *Colocasia esculenta* in New Zealand an unsuccessful effort was made to develop a rationalised procedure for extraction, purification and characterisation of the leaf protein. Extraction and purification procedures tried included:

(1) crystallisation in clarified leaf sap;

(2) extraction with a range of NaCl concentrations in the extraction buffers;

(3) differential precipitation by heat treatment;

(4) immunoprecipitation with antibodies raised against commercially purified RuBP carboxylase from *Spinacia* (spinach);

(5) purification on a G-200 Sephadex column;
(6) preparative PAGE.

The outcome of these trials were:
(1) No crystallisation was observed;
(2) Low concentrations of NaCl (0.1 to 0.4M) had no noticeable effect on yield as determined by SDS-PAGE of SDS-dissociated extracts. With 4M NaCl, yield was no better or less than with extraction in 0M NaCl, although other effects of unknown basis were observed in the comparisons with SDS-PAGE.
(3) Heat treatments of clarified sap extracts precipitated RuBP carboxylase along with other proteins, as shown by SDS-PAGE of treated and untreated extracts.
(4) The antibodies raised precipitated saline (0.14 M NaCl) solutions of the original antigen, and showed high titre, but did not precipitate protein from *Colocasia* leaf sap diluted with saline solution.
(5) Only poor separation of RuBP carboxylase was achieved, indicated by a skewed $^{A}280$ Peak (for eluate passed through a continuous-flow spectrophotometer), and shown by SDS-PAGE of the contents of eluate fractions.
(6) Good purification was achieved with non-dissociating PAGE in gels of large pore size, but a satisfactory procedure for excising or eluting the purified protein from the gels and transferring it to an isoelectric focusing gel was not established. Purity was shown by direct staining of non-dissociating gels or by applying these as samples for SDS-PAGE with slab gels and then staining.

Isoelectric focusing was achieved with RuBP oarboxylase purified from *C. esculenta* using preparative gel electrophoresis. However, the procedure was poor and likely to have caused artefacts, and was not repeated.

Comparative SDS-PAGE of clarified and sap extracts of *C. esculenta* variants RR, GR, and GP, and *Brassica oleraceae* var. *capitata*, alongside molecular weight standards, showed the RuBP carboxylase subunits to have uniform molecular weights, i.e., large subunits: approximately 50 x 10^3 daltons; small subunits: approximately 12.4 x 10^3 daltons.

Appendix 12. Earliest European description of taro in Queensland, Australia

The following description was transcribed by the present author from a 1980 fascimile of the daily journal of Joseph Banks (Banks 1770, *The Journal of Joseph Banks in the Endeavour, Volume Two*, with a commentary by A.M. Lysaght; Surrey, England, Genesis Publications and Rigby Ltd; pp. 203–4).

> *Endeavour River, 27th June, 1770. Some of the gentlemen who had been out in the woods yesterday brought home the leaves of a plant which I took to be Arum esculentum the same I believe as is called Coccos in the West Indies in consequence of this I went to the place & found plenty on tryal however the roots were found to be too acrid to be eat the*

leaves however when boiled were little inferior to spinage in the same place grew plenty of Cabbage trees & a kind of Wild Plantain whose fruit was so full of stones that it was scarce eatable another fruit about as large as a small golden pippin but flattened of a deep purple colour there when gathered off from the tree were very hard & disagreable but after being left a few days became soft & tasted much like indifferent damsons.

28th June. Tupia by roasting this Coccos very much in his oven made them lose intirely their acridity the Roots were so small that we did not think them at all an object for the ship So resolvd to content ourselves with the greens which are called in the West Indies Indian kale. I went with the seamen to show them the Place & Gathered a large quantity. saw one tree and only one notched in the same manner as those at Botany bay….

Note: Banks makes no reference on the 26th of June to the excursion mentioned at the start of his entry for the 27th of June. The purple fruit mentioned here is later identified in his general account of New Holland (Australia) as *Ficus caudiciflora*. Also in this general account he describes Indian kale (*Arum esculentum*) [syn. *C. esculenta*] as occurring in 'tolerable plenty', without reference to specific location. This suggests that he saw it at more than one site. Taro was recorded again in the Endeavour River area during the nineteenth century, the early twentieth century, and in 1987 (Appendix 16).

Appendix 13. Specimens of *Colocasia* spp. seen in European Herbaria

Collection records for three species of *Colocasia*, found at European herbaria in 1984/85: location, date in brackets, collector's name in italics, field number (or herbarium number), and herbarium locations in brackets. Abreviations for herbaria: B = Berlin (Dahlem), BM = British Museum, E = Edinburgh, K = Kew, L = Leiden, LG = Leningrad, P = Paris. Authorities for determinations are given where possible. All specimens were seen by P. Matthews. Additional records, not from herbaria, are noted for *C. gigantea*. See Appendix 16 for full list of herbaria searched.

C. fallax Schott (Engler and Krause 1920)

Pir Pauce, Khasia Hills, India (1850), *Hooker and Thompson* (K, type), det. Schott; Darjeeling, India (1875), Clarke 29237 (K), det. annon; Himalayas, India (pre-1893), ex hortus Herrenhausen, *Engler* 240 (K, B, LG), det. Engler; Dehra Dun, N.W.P., India (1898), *Gamble* 26994 (K), det. anon; Dehra Dun (1898), *Gamble* 27041 (K), det. anon; Singbhum, India (1900), *Haines* 318 (K), det. Haines; Garhwal Dun, W. Himalaya, India (1902), *Jacquel* 27017 (K), det. anon; Ranchi/Palaman, India (1918), *Haines* 4440 (K), det. Haines; Lidi Khola, Nepal (1954) *Stainton, Sykes & Williams* 6801 (BM), det. Nicolson; Shidam Khola, Walna, Nepal (1954), *Stainton, Sykes & Williams* 5165 (BM), det. Nicolson.

C. affinis Schott (Engler and Krause 1920)

Khasia Hills, India (1850), *Hooker* 470 (K, type), det. Schott; Sikkim, India (1850?),

Hooker (K), det. anon; Sikkim, India (1857), *Hanson* 755 (LG), det. anon; Kenseng (?), India (1876), *Gamble* 854A (K), det. anon; Pankabari, Sikkim, India (1879), *Gamble* 7018 (K), det. anon; Sikkim, India (1881), King (K), det. *King*; Manila, Philippines, recorded as exotic (1892), Loher 2435 (K), var. *jenningsii* Veitch, det. Brown; Prome Road, Rangoon (1932), *Parkinson* 1478 (K), det. Parkinson; Doi Chiengdao, SW of Ban Tam, Thailand (1935), *Garrett* 977 (K), det. Garrett;?Prome Hills on the Irrawaddy, Burma (1936), label B attached to *Wallich* 8952A (LG), Silhet, India, *Wallich* 8952A (LG), det. Engler and Krause (1920); Manipur, India (1945/46), *Bullock* (K), c.f. *affinis* det. Sivadasan (P. Matthews: this is almost certainly *C. affinis* var. *jenningsii*); Pasay City, Philippines, recorded as an ornamental (1955), *Steiner* 683A (L), *C. esculentum* det. anon (P. Matthews: the leaf colour pattern indicates *C. affinis* var. *Jenningsii*); Doi Suthep, Chiengmai, Thailand (1968), *Larsen, Santisuk & Warncke* 2588 (L), det. Sivadasan; Dharan, Nepal (1972), *Dobremez* 1435 (BM), var. *jenningsii*, det. Nicolson.

***C. gigantea* Hook f. (Hotta 1970)** — including specimens identified as *C. indica* (Lour.) Hassk., a synonym used by Engler and Krause (1920)

Java (pre 1844), *collector illegible* L 898.88 381 (L), det. Bakhuizen v.d. Brink; Java (1857), *Zollinger* (B, K, BM), det. Engler & Krause (1920); Java (19th century), *Zollinger* 472 (LG, P), *C. indica* Kunth det. anon (P. Matthews: fruiting heads and blade look like *C. gigantea*); Dong-Tom, ?Vietnam (1889), *collector?* 2035 (P), det. anon; Hanoi, Vietnam (1890), *collector?* 4525 (P), det. Engler; Balu Caves, Selangor, Malay Peninsula (1896), *Ridley* 8156 (K), det. Ridley?; Rambang, Java (1896); Hong Kong (1905), *Cavalerie* 2506 (E), det. Nicolson; Biutenzorg, Java (1912), *Koorders* 40420B (L), det. Backer; Bienhoa, Chua Chong, Cochinchina (Vietnam) (1914), *Chevalier* 29866 (P), det. Chevalier; Besoeki vic. Kalibendo, Java (1916), *Koorders* 43956B (L), det. Koorders; Qua Nenck, Kelantan, Malay Peninsula (1924), *Nur & Foxworthy* 11910 (K), det. Henderson; Sisawat, Kanburi, Thailand (1926), *Kerr* 10165 (E, K, P), det. Nicolson; vie. Chumphon/Chumpawn, Thailand (1927), *Kerr* 11576 (K, P), det. Nicolson; Thailand (1929), *collector?* 202 (P), det. anon; Hainan, China (1932), *Lau* 490 (K), det. Nicolson; Annam-Cua-Tung, Indochina (1935), *Cadiere* (P), det. anon; Ch'uan District, Northern Kwangsi, very rare (1937), *McClure* 20567 (K), det. Nicolson;?Annam or Dong Tam,?Indochina (1939), *Poilane* 30165 (P), det. Nicolson; Bank Khen, central Thailand (1960s?), *Buneiuai & Nimanong* 38126 (L), det. illegible; Khao Chong Forestry Station, Trang Prov., S.W. Thailand (1962), *Nicolson* 1721 (B, E, K, P), det. Nicolson; Ma On Shan, Hong Kong (1969), *Shiu Ying Hu* 6490 (K), det. Shiu Ying Hu; 40 km south of Chumphon, Thailand (1971), Bogner 427 (K), det. *Bogner*; Szemao, China (date?), *Henry* 12379 (K), det. anon (P. Matthews: inflorescence immature, blade typical for the species); Sumatra (date?), *Jacquinot* 472 (P), det. Nicolson.

Note: Hotta (1970, 1983) reports that *C. indica* (syn. *C. gigantea*) is widely distributed from Malaysia to Borneo and Java, and that it is cultivated in Japan. During the present study, live collections of *C. gigantea* were obtained from Colombo in Sri Lanka (1986) *Amarasinghe*, ANU T321; Rayong, Chantaburi, Chonburi, Thailand (1986), *Yen* 6, ANU T357; and Hoshidate, Iriomote Is., Okinawa Islands, Japan (1982),

Kobayashi & Sakamoto 82.1.18.1.1, ANU T311.

Appendix 14. Poorly defined and poorly known species of *Colocasia*

Records from a survey of European herbaria, 1984/85. The collector surname is in italics, and is followed the collector's field number if available. Abbreviations for herbaria, given in brackets, are: BM = British Museum, B = Berlin (Dahlem), E = Edinburgh, G = Geneva, K = Kew, L = Leiden, LG = Leningrad, P = Paris. Authorities for determinations (det.) are given where possible.

Species and or genus not determined with certainty by original collector, later taxonomists, or by P. Matthews

Taiwan, vie. Taihoku, *Tanaka* 5336 (L), *Colocasia gigantea*? (Bl.) Hk.f., det. Nicolson; Himalaya, Sikkim, Treutler (LG), *Colocasia* sp, det. *Treutler* (blade with shallow sinus and front lobe v. long); Thailand, Chiang Mai Province, *Nicolson* 1650 (P, B), *Colocasia* sp, det. Nicolson; Burma, Upper Chindwin, *Lace* 4197 (E), *Colocasia* sp, det. Nicolson; India, Bengal, *Sinclair* 4274 (E), *Colocasia* sp, det. Nicolson; India, East Bengal, *Griffith* (East India Company) 6007 (K), *Arum nymphaeifolium*? (syn. *C. esculenta* var *nymphaeifolia*? (Vent.) Engl. in Engler & Krause 1920), det. Griffith?; Nepal, Churia Hills, *Williams & Stainton* 8231 (BM), *Colocasia*? new species?, det. Nicolson; China, Yunnan *Houa-Kiang* 7505 (E), *Colocasia*?, det. Nicolson; Thailand, Knwae Noi River Basin, *Kostermans* 1394 (L), *Colocasia esculenta*? (L.) Schott, det. Nicolson; Thailand, Mae Rim, *Larsen, Santisuk & Warncke* 2475 (E), *Colocasia* sp, det. Bogner; Thailand, Dai Chiengdao, *Garrett* 1229 (K), *Colocasia* sp, det. Garrett; Thailand, Doi Soo-tep, *Nicolson* 1650 (K, P), *Colocasia* sp, det. Nicolson; Thailand, Chiengmai, *Larsen, Santisuk, Waracke* 2588 (E), *Colocasia* sp, det. Bogner. India, Darjeeling, *Clarke* 26956 (K), c.f. *C. fallax*, det. Clarke; India M (meridional = southern), *Wallich* 8948B (LG), *C. indica*, det. anon (P. Matthews: could be *C. gigantea*, specimen an inflorescence only); Southern Burma, Tavoy District, vie. Paungdau, *Keenan, Tun Aung, & Rule* 1664 (E), *Colocasia* c.f. *affinis*, det. Bogner; Hong Kong, *Cavalerie* 2136 (E), *C. gigantea*? (Bl.) Hk. f., det. Nicolson; Nepal, vie, Muna, *Stainton, Sykes, & Williams* 4067 (BM), *C. affinis* Schott?, det. Nicolson; Vietnam, Hanoi Botanical Gardens, *Zonkin* (L), ?*Colocasia gigantea*, det. Nicolson.

Previous identification questioned by P. Matthews, with possible alternative identifications suggested in brackets

Java, *Lauterbach* 6060 (G), *Alocasia indica* Schott?, det. Lauterbach (*Colocasia* sp, peltate blade); Himalaya, Silhet, *Wallich* 8944 (LG), *Colocasia fallax* Schott, det. Engler & Krause (1920), (*Colocasia*? blade with v. shallow sinus and front lobe v. long); Bangladesh, Kushtia district, *Khan & Hug* 3935 (E), *Colocasia esculenta* (L.) Schott, det. anon (*C. gigantea*?, spathes white); India, Middle Andamans, *Bhargava* 2822 (L), *Colocasia esculenta* (L.) Schott, det. Sivadasan (*Alocasia*?, blade narrow with deep sinus); India, *Buchanan-Hamilton* 63 (BM), *Arum rupestre*, det. Buchanan-Hamilton

(*Colocasia*?, not *C. esculenta*, peltate blade with v. shallow sinus); India, Calcutta, *Clarke* 33593 (G), *Colocasia antiquorum* Schott, det. Clarke (*Colocasia*?, blade narrow elongate with deep sinus); Thailand, Phu Luang, *Phusomsaeng & Bunchuai* 27 (L), *Alocasia* sp, det. anon (*Colocasia* sp, small peltate leaf with shallow sinus).

Poorly known species

Sumatra, Padang Province, *Becarri* (B), *Colocasia gracilis* Engl., det. Krause (type for Engler & Krause 1920); India, upper Assam at Makum, *Mann* (K), *Colocasia Mannii* Hook. f. (type for Engler & Krause 1920); India, Bengal, *Roxburgh*, illustration for Roxburghiana, Aroideae (K), *Colocasia virosa* Kunth, det. Engler & Krause (1920).

Appendix 15. Canberra Taro Collection

Source collections and collectors for the Canberra Taro Collection, 1981–88 (also known as the ANU Taro Collection).

Institutional sources

(1) Department of Prehistory, Research School of Pacific Studies, Australian National University, Canberra: D. E. Yen, P. J. Matthews.

(2) Australian National Botanic Gardens, Canberra: I. Telford.

(3) Melbourne Botanic Gardens, Melbourne: S. Forbes.

(4) La Trobe University, Melbourne: Y. Fripp.

(5) Royal Botanic Gardens, Sydney: J. Forlonge.

(6) Western Australian Herbarium, Perth: K. Kineally.

(7) Arid Zone Research Institute, Northern Territory Conservation Commission, Alice Springs: P. Latz.

(8) Brisbane Botanic Gardens, Brisbane: D. Shaw.

(9) Department of Agriculture, Lae Technical University, Papua New Guinea: A. Gurnah.

(10) Dodo Creek Research Station, Honiara, Solomon Islands: R. Liloqula.

(11) Kyoto Plant Germplasm Institute, Faculty of Agriculture, Kyoto University: T. Kawahara.

Collectors, by country or area

(1) Australia: D. Yen, R. Jones, P. Latz, D. Rentz, R. Hinxman, R. Collins, P. Randal, N. White, N. Scarlett, S. Forbes, K. Kineally, A. Marchant, D. Rowell, K. Thiele, P. Matthews.

(2) Papua New Guinea: A. Gurnah, P. Lea, M. Quinn, D. Yen, J. Golson, P. Matthews.

(3) Solomon Islands: D. Yen, M. Patel.

(4) Vanuatu: P. Ottino.

(5) Polynesia, including New Zealand: D. Yen, P. Matthews, D. Spennemann.

(6) Timor: D. Yen.

(7) Sri Lanka: V. Amarasinghe.
(8) Nepal: H. Yoshino, S. Sakamoto.
(9) Madagascar: H. Wright.
(10) Thailand: D. Yen.
(11) Philippines: D. Yen, H. Conklin.
(12) Japan: K. Fukui, H. Kobayashi, T. Kawahara, R. Terauchi, P. Matthews.

Appendix 16. Records of wild taro in Papua New Guinea, 1936 to 1985

Herbarium records of wild taro in New Guinea, and 1985 field survey records from Morobe Province, Papua New Guinea. Inspection dates and abbreviations for herbarium names are given in Appendix 17.

1936, June Fly River Expedition of the American Museum of Natural History; Palmer River, an upper tributary of the Fly River, Papua New Guinea; BRI 380777, with inflorescences; gregarious in patches on muddy riverbanks.

1961, 14 October D. Nicolson; Sogeri Rubber Estates, approximately 30 miles east of Port Moresby, Papua New Guinea; B, D.N. field number 1439, with fruit and seed; locally abundant in wet areas, stolons over 1 m long.

1961, 18 November D. Nicolson; Nanokwari, road to Tafelberge, west New Guinea (Irian Jaya), at 30 m altitude; P 23366, with fruit, B field number 1569 with inflorescence; occasional stoloniferous herb in secondary regrowth on limestone.

1964/5 A. Jermy; Buimo Creek northeast of Lae, Morobe Province, Papua New Guinea; BM, A.J. field collection number 4460, with infloresences; along riverbank in marshy situations, in fairly well worked alluvial soil with much humus. Root-stock short, thick, with stolons.

1971, 24 July H. Dosedla; Mount Hagen, also Mount Kuta to 2100 and 2300 m, Western Highlands, Papua New Guinea; P 16679, inflorescence; in rain forest understory, preferring light places; vernacular names '*kumgmb*' (Hagen language) and '*talagh*' (Enga language); plants not used by people.

1985, 29 June P. Matthews; Wau road between Lae and Wampit, foot track to Geb stream; field site 29/6/1; stoloniferous, scattered alongside track to gardens and cocoa plantation belonging to Gabensis Village, in forest with trees to 10 m, but cleared along track.

1985, 29 June P. Matthews; Wau road between Lae and Wampit, above the southeastern extension of swamp at the head of Garagos River; scattered plants interconnected by stolons to greater than one metre length, in shallow flowing creek in

gully with remnant forest, on south side of the road, below steep kunai grassland; Canberra live collection T227.

1985, 29 June P. Matthews; Wau road between Lae and Wampit, at edge of alluvial flats of the Markham River; field site 29/6/4; stoloniferous, in slashed clearing alongside road, at edge of forest, absent from the immediately adjacent forest. *Alocasia macrorrhizos* (*? flabellifera* A. Hay) was scattered alongside the road and within the forest, and *Xanthosoma sagittifolium* (definitely feral, exotic introduction) was also scattered alongside the road.

1985, 29 June P. Matthews; Rumu River, approximately 2 km north of Markham Highway; field site 29/6/5 (see Figure 10.10); stoloniferous, flowering plants in muddy bank of stream at edge of the main river, and at fringe of remnant forest with swidden gardens, with no gardens immediately adjacent to the wild taro; leaves edible, corm not ('i nogut kaikai', middle-aged male informant); Canberra live collection T229.

1985, 4 July P. Matthews; Markham Highway junction with road to Ngasawampum Village; field site 4/7/1; stoloniferous, some with fruit and seed, in forest garden regrowth immediately adjacent to highway, the same variety also in ditches alongside the Markham Highway east of the junction, and in forest on east side of road to the village; according to local informant, an elderly man, the leaves are edible (cook, discard water, cook again), and the plants spontaneous ('wail taro, i kamap nating'). Canberra live collection T226.

1985, 5 July P. Matthews; Leron River valley, road to Sirasira, foot track from Nariyawan village to gardens; field site number 5/7/1 (see Figure 10.9); stoloniferous, in wet forested gully below swidden gardens on steep hill slope, between crossing of stream by the foot track and a bamboo water fountain at the head of the gully. Stoloniferous cultivars were noted in the gardens nearby; vernacular name for wild taro 'umanmumin'; Canberra live collection T225.

1985, 5 July P. Matthews; Leron River valley, road to Sirasira village; field site 5/7/4; stoloniferous, some with fruit and seed, at intersection of stream and road, below a permanent spring in forest remnant, in area of grassland. Taro with pink basal ring, and associated with feral *Xanthosoma sagittifolium*. The taro was spontaneous and inedible, according to local male informants. The spring is used by villagers as domestic water source, and cultivated taro could have been peeled at this site for cooking, giving rise to a feral colony.

1985, 16 July P. Matthews; Labutali, c. 14 km southwest of Lae, Pipi stream below Disina mountain; field site 16/7/1 (see Figure 10.9); stoloniferous, flowering plants along both sides of stream in forest, stolons to more than one metre length, this wild variety known locally as 'kiniku', and is phenotypically distinct from the differently named

varieties inspected at gardens upstream, at Puwamu. *Kiniku* was said to catch on trees and grow on banks in streams further inland, Naligi and Powatu, upstream from Puwamu, as well as being washed down to the beach (elderly male informants). The leaves and corms of *kiniku* are not eaten.

1985, 18 July P. Matthews; tributary on north side of Bwusi River, c. 25 km south of Lae and c. 2 to 3 km inland from beach, a short distance upstream from Bwusi village; field site 18/7/1; occasional clumps of stoloniferous taro on banks, some flowering, stream narrow and subject to flooding, with frequent log jams. '*Ngasange*' was a name given for wild taro, in reference to plants collected by informants from an unseen site near Bwusi village.

1985, 20 July P. Matthews; base of Salamaua Peninsula, on south side between sago swamp and track to Salamaua village; field site 20/7/1; two varieties at edge of swamp, both stoloniferous and flowering, both unvariegated, one with white basal ring and green petiole (similar to the common wild phenotype elsewhere in the vicinity of Lae), the other with pink basal ring and green to purple petiole.

1985, 20 July P. Matthews; Francisco River, south of Salamaua, c. 1 km from river mouth; field site 20/7/3; stoloniferous, some with fruit and seed, scattered in kunai grass at boggy edge of river, below path to gardens along south side of the river from Logui village. Two old men from this village described the wild taro location on the Francisco River ('bikpela wara') and reported further sites on tributaries ('liklik wara').

1985, 22 July D. Yen; Wau road, c. 40 km from Lae, near Mumeng; stoloniferous, flowering plants on stream bank in forest clearing.

Appendix 17. Records of wild taro in Australia, 1770 to 1989

The following records come from herbarium collections, published and unpublished reports, and the present author's fieldwork and correspondence. Searches were made for specimens in the following European herbaria, in 1984 and 1985: Berlin, Dahlem (B), British Museum (BM), Edinburgh, Geneva, Kew (KEW), Leiden (L), Leningrad, Paris (P), Vienna, Warsaw. Searches for herbarium specimens in Australia and Papua New Guinea were made in the years 1985 to 1988: Atherton, Queensland (QRS); Brisbane (BRI); Australian National Gardens, Canberra (CBG); CSIRO, Canberra (CANB); Darwin (DNA); Lae, Papua New Guinea; Melbourne (MEL); Perth (WA); Sydney (NSW). Collection details are noted in the following order: date, collectors, location, herbarium or field number and a descriptive note (if stolons or inflorescences are present); and collectors' field notes.

Synonyms for *Colocasia esculenta* (L.) Schott are noted if not associated with a herbarium specimen sighted by the present author. All the identifications of the species are by either P. Matthews, after direct sighting of living or herbarium specimens, or by

reliable authors and correspondents. Identifications of the Jiyer phenotype (Figure 10.1) were all based on living plants seen by P. Matthews. The listing excludes a small number of records of plants that were definitely not wild, and/or were definitely not of the Jiyer phenotype. Most of these records were for urban or house-garden situations, or for unprovenanced plants located in botanical gardens.

Two letters received in 1987 from Robert Tucker (first with the Department of Parks and Recreation, Council of the City of Townsville, Queensland, and then Project Co-ordinator for the Townsville Palmetum) are presented in their entirety after the list of site records. These letters contain ethnographic information which should only be cited after consultation with R. Tucker. The first letter (1st June) convinced the present author of the necessity to survey wild taro in Queensland. The second letter was received in response to a report to R. Tucker on that fieldwork.

1770 Banks and Solander; New Holland: P 33, with inflorescence, MEL 1560158, with inflorescences. Banks (1770:203–04) describes the discovery and trial as a food of *Arum esculentum* (= *C. esculenta*) near the Endeavour River (Queensland), 27–28 June 1770.

1800–10 G. Caley sn; location not given; BM 191/?

1802 Brown (1830; 1960 fascimile) records Calladium acre (= *C. esculenta*) from tropical Australia (coast of Queensland and the Northern Territory, westward to Arnhem Land). Brown describes floral characters in some detail. Brown's east coast collection sites (W. Stearn, introduction to the 1960 fascimile), seem unlikely locations for taro, and the observation was probably made at the northern end of Cape York, or in the Gulf of Carpentaria.

1844–45 Leichardt (1847) records *Caladium* (= *C. esculenta*, or *Alocasia*) in his diary for May 11th (dry season), in creeks full of water and associated with rich grass, *Pittosporum* scrub, native mulberry, fig tree, several vines, *Polypodium*, and *Osmunda*. The area of this observation was many kilometres inland, west of Rockingham Bay, Queensland.

1858–66 A. Thozet; Cooktown or vicinity, Queensland; MEL 1560160 with inflorescence (material grown by Thozet after being received from another person).

1860–71 Dallachy; Rockingham Bay, Queensland; MEL 1560162, MEL 1560163 with inflorescence, KEW no number (date 1871?).

1863 or soon after. A. Dietrich; Port Denison (Bowen), Queensland; MEL 1560164.

Pre-1866 Fitzalan; Mount Elliot (probably near Townsville) Queensland; collection cited as *C. antiquorum* (taro) by Mueller (1865–66).

1877 Fitzalan; Port Denison (Bowen), Queensland; MEL 1560161.

1882 Persietz; Endeavour River, Queensland; MEL 1560159 with inflorescence.

1873 G.E. Darymple, reports large areas of 'Tara grubbed up by blacks' on the Johnstone River, northeast Queensland (Darymple 1874:615; not seen, citation pers. com. N. Horsfall). 'Tara' is a synonym for *C. esculenta*, and was often used by Europeans in the nineteenth century.

1883 Holtze; Port Darwin, Northern Territory; two sheets, MEL 1560165 with

inflorescence and MEL 1560166 with inflorescence (field number 188).

1891–93 G. Podenzana; Queensland; BM 191/70.

1889 F.M. Bailey (1889) reports in an unpublished manuscript that *C. antiquorum* (*C. esculenta*) grows wild by Harvey's Creek and by the Mulgrave River, Bellenden-Ker, Queensland.

1901 Roth (1901) reports that the corm of *C. antiquorum* (*C. esculenta*) is eaten by Aborigines at Cooktown, Cape Bedford, and in the hinterland and coast of Princess Charlotte Bay (all Cape York, Queensland). Bailey (1902) cites Roth for a record of taro from the Middle Morehead River (hinterland of Princess Charlotte Bay).

1907 N. Holtze; photograph of wild taro on stream bank, vicinity of Port Darwin. See plate titled 'Duck pool in the jungle' (Searcy 1907:98). Behind a large patch of taro, a tall stand of *Pandanus* is visible.

1918 G.J. White; Malanda, Cook District, Atherton Tableland, Queensland; BRI 011517.

1921, 31 August C.A. Gardner; near Mount Learning, King Edward River, Kimberley, Western Australia; WA, field number 1552; Gardney (1923) records that *C. antiquorum* (*C. esculenta*) forms dense colonies in humid valleys, in swampy black soil near Mount Learning, by the lower part of King Edward River. Gardner (ibid) notes that flowers were not seen, and that this was the first record of taro for Western Australia.

1936, 25 October H. Flecker; Freshwater River (near Cairns, Queensland); QR 042744 with inflorescence.

1966, 27 March B. Hyland; Cannabullen Falls, North Kennedy, Queensland; BRI 141536; KEW, two sheets, field number 03793. Upper tributary of Tully River, 17°41′S 145°32′E

1968, 11 April R.W.; Holme's Jungle, Darwin, Northern Territory; DNA 16611 with stolon; growing in water or mud, silty substrate, creek bank, and swamp.

1969 February D. Wheelwright; 12°25′S 130°50′E, Holme's Jungle, Darwin, Northern Territory; DNA, field number D2880, with inflorescence; in rainforest.

1972 I. Crawford; Mitchell Plateau, west of Kalumburu, Kimberley, Western Australia; WA, field number 41/72.

1972, 3 June J. Wrigley and I. Telford; 16°58′S 145°32′E, 13 km from Mareeba towards Kuranda, Cook District (Atherton Tablelands), Queensland; CBG 047693; on creek bank in open forest. Canberra live collection T32.

1972, 11 June J. Wrigley and I. Telford; 16°15′S 145°18′E, Stewart Creek (tributary of the Daintree River), near Mossman, Cook District, Queensland; CBG 043048; in mud beside creek, fringe of rainforest. Canberra live collection T33.

1973, June I. Crawford; Kalumburu (vicinity of a mission station), Western Australia; two sheets, WA field number 108.

1974, October D.R. Harris (1975, 1977:433); Lockhart, Cape York, Queensland; wild, regarded locally as native to the area, corm eaten.

1975, 12 April C. Dunlop; 12°24′S 130°59′E, Holme's Jungle, Darwin, Northern Territory, DNA 10728 with inflorescence; L 467759 with inflorescence; in black clay with fresh running water, margin of jungle and coastal plains, rhizomatous, the stems

above and below ground.

1975, 20 August A.S. George; approximately 15°02′S 126°40′E, Colocasia Creek, Worriga Gorge, Drysdale River National Park, Kimberley, Western Australia; WA field number 14083; rhizomatous herb, in black loam in and beside creek, in low woodland; photographs show cycads adjacent; patch relatively small, consisting of several dozen plants, well established in permanent seepage in a shady area below a cliff, at the upper end of the gorge (pers. coma. 1987).

1980 R. Jones; Mitchell Range, Northern Territory, CBG 8104695; Canberra live collection T30, external characters fit Jiyer phenotype.

1980 R. Jones; 80 km east of Maningrida, Arnhem Land, Northern Territory; CBG 8100854 with inflorescence, ex cultivation in Canberra; wild in running stream; Canberra live collection T31; Jiyer phenotype.

1980, June L. Craven; 13°04′S 132°24′E, near Barramundie Creek, 23 km southwest of Cooinda, Kakadu National Park, Northern Territory; NSW 116; in black organic soil with shallow surface water, in swamp forest; the well-preserved herbarium specimen appears to be of the Jiyer phenotype.

1981 D. Levitt (1981) records taro for Groote Eylandt, Northern Territory, at Emerald River, and also occasionally in sandy areas behind beaches and in rocky areas. Aboriginal names for taro are also recorded.

1981 I. Crawford s.n.; 14°48′S 126°38′E, Ngerwaludalu, approximately 30 km from Kalumburu Mission, North Kimberley, Western Australia; WA, flowering specimen ex cultivation at Floreat Park; Aboriginal name, Ngerwal.

1981, September D. Harris and D. Yen; approximately 10 10′S 142°20′E, Moa Island, north of Saint Pauls, Moa Island, Cook District; CBG 8200958 with stolons; feral taro, used by islanders.

1981, 9 July N. White; map sheet Blue Mud Bay 1:100,000 AMG reference 570 020, Ngilipitji, Walker River, Parson's Range, northeast Arnhem Land, Northern Territory; La Trobe Botany Department voucher specimen NGW81–6; Canberra live collection number T338.

1981, December J. Purdie; Katherine Gorge National Park, Northern Territory; DNA 18972 with inflorescence.

1982, 11 November C. Dunlop and G. Wightman; 13°33′S 131°14′E, Black Jungle, Northern Territory; DNA 21004; aquatic in clayey loam creek line, in open area in rainforest.

1983, 18 August N. White; may sheet Blue Mud Bay 1:100,000 AMG reference 570020, Ngilipitji, Walker River, Parson's Range, northeast Arnhem Land, Northern Territory (same site as visited by White, 9 July 1981, above); Canberra live collection T331.

1983, 22 August N. White; collected by Ritharrngu person in Bawurrpanda (Annie Creek) area, map sheet Annie Creek 1:100,000 AMG reference c.880 500, northeast Arnhem land, Northern Territory; Canberra live collection T332.

1983, 27 August N. White; map sheet Annie Creek 1:100,000 AMG reference 840 455; Bawurrpanda (Annie Creek), northeast Arnhem Land, Northern Territory; Canberra

live collection T333.

1983, 27 September S. Brockwell (pers. comm. 1989); approximately 12°52′S 132°33′E, Kunkolomirrid Spring, upper South Alligator River, Northern Territory; photographic record; wild in permanent creek from spring, slightly above the adjacent floodplain, known to the local people but not eaten.

1984, 16 May S. Forbes; 17°11′20″S 128°15′E, altitude 360 m, Winnama Spring, 17.5 km south of Turkey Creek, Mabel Downs, southeast Kimberley, Western Australia; MEL 672191; abundant in organic humus, in permanent creek under shade of *Melaleuca leucadendra* and *Timonius timon*; Canberra live collection T337, Jiyer phenotype.

1984, 4 July K. Kineally; 17°15′S 128°26′E, 51.2 km southeast from Turkey Creek on track to Bungle Bungle outcamp, Kimberley, Western Australia; WA, field number 9188, with stolons; bulbous semiaquatic, stems rooting at nodes, extremely common in creek beds.

1984, 4 July S. Forbes; 17°13′S 128°24′30″E, altitude 350 m, tributary of Osmund Creek, 4.3 km northwest of Samim Mining Camp (at crossing of Swamp Creek) on Winnama Gorge-Bungle outcamp track, base of Osmund Range, southeast Kimberley, Western Australia; MEL 1534562; abundant in riparian forest with *Sesbania formosa*, *Pandanus ?spiralis*, *Cyclosorus interruptus*, on grey-black humus, rhizomatous, sterile population; Canberra live collection T334, ex. N. Scarlett collection NSA-1, Jiyer phenotype.

1984, 4 July N. Scarlett; 17°24′S 128°26′E, Wurlwurlji near Samim Mining Camp (at Swamp Creek crossing), 19 km due east of Osmund Valley Palms Yard, c. 26 km by mining track, on upper tributary of Osmund Creek, Osmund Range, southeast Kimberley, Western Australia; MEL 1533059; in dense patches in riparian forest dominated by *Syzygium angophoroides*, *Ficus coronulata*, *Nauclea orientalis*, and *Carallia brachiata*, associated with *Cyclosorus interruptus* (a second label also noted *Melaleuca leucadendra*, *Eucalyptus ptychocarpa*, *Heteropogon contortus*, *Ficus racemosa*, and *Eulalia fulva*); Canberra live collection T335, ex N. Scarlett collection NSB-2.

1984, 24 July S. Forbes; 15°37′S 126°23′E, 2.3 km east along nameless track off Kalumburu Road, 10 km north of Drysdale River Homestead, Western Australia, MEL, field number SJF 2715, see also Scarlett (1985); strongly rhizomatous, in mound spring with organic humus and free surface water, and with *Pandanus spiralis*, *Melaleuca viridis*, *Phragmites karka*, and *Cyclosorus interruptus*, surrounded by *Eucalyptus tedifica* dominated woodland; Canberra live collection T336, ex Melbourne Royal Botanic Gardens live collection 84–1455, Jiyer phenotype.

1985 R. Collins (pers. comm. 1985, describing undated collection pre-1985); Frenchman Creek near Babinda, northeast Queensland; Canberra live collection T263.

1985 R. Collins (pers. comm. 1985, field observation pre-1985); western side of Windsor Tableland, northeast Queensland; plants growing in a swampy gully.

1985, 11 September collector?; 13°10′S 134°52′E, Emu Springs, Arnhem Land, Northern Territory; DNA 0026510 (not sighted).

1985 H. Esler (pers. comm. 1986); c. 17°45′S 137°30′E, Malcolm Spring, upper Nicolson River, c. 100 km south of the Gulf of Carpentaria, Northern Territory; plants in

profusion in swamp created by small, artificial earth dam below the permanent spring, near foot of the China Wall; site possibly once a miners' camp.

1986 P. Latz; Blackfella Spring, upper Calvert River c. 100 km from the Gulf of Carpentaria, Northern Territory; plants scattered over several km downstream from permanent spring; Canberra live collection T376, Jiyer phenotype.

1986, 20 June G. Wightman (pers. comm. 1986); 1 km north of Cahill's Crossing, East Alligator River, Northern Territory; plants in moist loam, under monsoon vine forest.

1987 R. Tucker (pers. comm. 1987) reports pre-1987 observation of wild taro in upper Quintel Creek, 2 km upstream from the present Lockhart settlement, Cape York Peninsula, Queensland (the only site known to him in the vicinity of Lockhart), phenotype similar to wild taro common between Cooktown and Townsville (probably the Jiyer phenotype).

1987 G. Wightman (pers. comm. 1987) reports taro as rare on mainland, Northern Territory, but common on some offshore islands, Melville Island for example.

1987, 16 September P. Matthews; 18°53′S 146°13′E, Gap Creek intersection with Bruce Highway, Halifax Bay, northeast Queensland; abundant under remnant *Melaleuca leucadendra* scrub, below *Typha* swamp; field site 16/9/1, Jiyer phenotype.

1987 16 September P. Matthews; 18°52′S 146°10′E, Little Gin Creek intersection with Bruce Highway, Halifax Bay, northeast Queensland; field site 16/9/2, highly modified farm habitat, Jiyer phenotype.

1987, 20 September P. Matthews' 17°26′S 145°47′E, Jiyer Cave, Russell River, northeast Queensland; field site 20/9/1, plants abundant in permanent stream, firmly established by roots and stolons among rocks below waterfall off basalt cliff, alongside the Russell River, in rainforest, inflorescences emergent on some plants; type location for Jiyer phenotype; and for first Australian collection of *Tarophagus colocasiae*; *Alocasia* also present in drier situations than taro; Canberra live collection T395. Isolated clumps of taro with the Jiyer phenotype were also recorded on bends of the river within a few km below Jiyer Cave.

1987, 20 September T. Urvine; 17°26′S 145°47′E, approximately 1 km upstream from Jiyer Cave, upper Russell River, northeast Queensland; PJM field site 20/9/2, Jiyer phenotype; plants among rocks, in rainforest.

1987, 21 September P. Matthews; 17°27′S 145°50′E, Combo's Crossing, c. 5.7 km due east of Jiyer Cave, Russell River, northeast Queensland; plants abundant on open, muddy riverbank with grass, in rainforest; field site number 21/9/2, Jiyer phenotype.

1987, 25 September P. Matthews; 15°19′S 145°03′E, tributary of the Endeavour River, Hope Vale Mission road, first bridge after turnoff for Cape Flattery, Cape York Peninsula, Queensland; field site 25/9/2, Jiyer phenotype; plants in stream.

1987, 26 September P. Matthews; 15°17′S 145°06′E, upper tributary of Endeavour River, adjacent to the new Hope Vale Mission settlement, Cape York Peninsula, Queensland; field site 26/9/1, Jiyer phenotype; fruit green with seed (photo), plants abundant over 500 m in permanent stream above river, in riparian rainforest with *Alocasia*, *Pandanus*, *Dillenia*, *Ficus*, *Livistona* and *Entada*; the taro is regarded by local residents as inedible and is known to have been present since at least the 1930s, before

the mission settlement was built; Canberra live collection T394.

1987, 29 September P. Matthews; 16°22′S 145°20′E, upper tributary of Whyanbeel Creek, northeast Queensland (access courtesy Alan Carle); CBG 88071984; field site 29/9/1, Jiyer phenotype; plants in steep, rocky stream in rainforest.

1987, 29 September P. Matthews; 16°19′S 145°19′E, Stewart Creek, tributary of Daintree River, northeast Queensland; field site 29/9/87, Jiyer phenotype; isolated clumps on both sides of creek, just above ford, with remnant rainforest.

1987, 30 September P. Matthews; 16°18′S 145°19′E, Cassowary Creek, c. 200 m upstream from Stewart Creek road, on creek banks in deforested farmland; site 30/9/1, Jiyer phenotype.

1987, 30 September P. Matthews; 16°29′S 145°24′E, South Mossman River at intersection with Cook Highway, abundant in dense patch of soft bank of accumulated detritus, under remnant of riparian broadleaf rainforest, surrounded by sugarcane fields; field site 30/9/2, Jiyer phenotype, flowering.

1987, 1 October P. Matthews; 17°15′10″S 145°55′51″E, Harvey Creek, 1 km east of the new Bruce Highway, permanent tributary of Mulgrave River, northeast Queensland; field site 1/10/1, Jiyer phenotype; in creek bank at downstream end of a long island, at edge of rainforest remnant.

1987, 1 October P. Matthews; 17°10′0″S 145°49′42″E, western flank of Behana Gorge, in first stream after the Cairns-Mulgrave water pumping station, above road, tributary of Behana Creek and Mulgrave River, northeast Queensland; field site 1/10/2, Jiyer phenotype; in thin rainforest with *Pandanus*, distributed upstream to at least 20 m distance, out of view of the road.

1987, 2 October P. Matthews; 17°20′S 145°52′E, Boulder Falls, North Babinda Creek, tributary of Russell River, northeast Queensland; field site 2/10/1, Jiyer phenotype clump at base of major waterfall and also in isolated small clumps along both sides of creek above the waterfall, in rainforest.

1987, 2 October P. Matthews; 17°32′S 145°50′E, upper tributary of Badgery Creek, both sides of forestry road bridge, Borong State Forest, above north Johnstone River, northeast Queensland; CBG 8807195; field site 2/10/2, Jiyer phenotype, though with unusual tendency to form asymmetric leaf blades; abundant over 200 m of open, rocky stream bed in rainforest, flowering.

1987, 3 October P. Matthews; 18°34′S 146°14′E, Blue's Patch, lower Seymour River, above Neam Inlet (property of B. Costa), Ingham district, lower Herbert River, northeast Queensland; field site 3/10/1, Jiyer phenotype; a few large plants overcrowded by *Panicum grass* invasion, in remnant stand of *Melaleuca*, on sugarcane farm. This patch was known locally to have been present for at least 55 years, and other taro patches were known in this area before the almost complete clearance and drainage of the *Melaleuca* swamp forest.

1988 D. Rentz; 17°15′S 145°38′E, Lake Barrine, Atherton Tableland, northeast Queensland; by edge of lake, in rainforest at least 15 m from walking track, c. 250 m from tourist centre; Canberra live collection T398, Jiyer phenotype.

1988, June N. Williams; 17°13′S 128°14′E, a few km south of Winnama Spring,

upper Turkey Creek, southeast Kimberley, Western Australia; below a permanent spring, *Pandanus* and *Livistona* present, site located by Aboriginal informants; Canberra live collection T386, Jiyer phenotype.

1989 Alan Burwood Calendars (1989), 1989 calendar with clearly distinguishable taro visible at base of Milaa Milaa Falls, upper tributary of north Johnstone River, northeast Queensland; photo by F. Prenzel (pers. comm. 1989).

1989, 6 March R. Hinxman (pers. comm. 1989); 17°10′56″S 145 50′01″E, eastern flank of Behana Gorge, base of Barnard's Spur, tributary of Behana Creek; Jiyer phenotype, plants abundant at each end of a 400 m long anabranch in creek, among granite boulders, in rainforest; at least one hundred inflorescences visible in a single view of the taro patch, fruit green with nearly mature seed (photo), and colonised by larvae of an unidentified species of Syrphidae (hover fly).

1989, 7 October R. Hinxman (pers. comm. 1989); 17°26′30"S 145 46′30"E, Tewon Creek, tributary of Russell River, northeast Queensland; Jiyer phenotype, in rainforest: no fruits or flowers; Canberra live collection T397.

1989, 8 October R. Hinxman (pers. comm. 1989); Moochoopa Falls, on nameless tributary (not on Moochoopa Creek, mislabelled on Bartle Frere Sheet 8063), 2 km due north of Jiyer Cave, above the Russell River, northeast Queensland; Jiyer phenotype, at base of waterfall in rainforest; no fruits or flowers; Canberra live collection T396.

Appendix 18. R. Tucker correspondence

Mr Robert Tucker, a gardener/curator at Rockhampton Botanical Gardens, kindly sent me the following letters based on his experiences in northern Queensland.

1st June, 1987.

Dear Peter,

Thank you for your interesting letter and research proposal involving Taro. Both wild and cultivated Taros have interested me for many years and I have made numerous live collections and maintain these plants in several localities.

Wild Taro occurs very infrequently on the northern Cape York Peninsula, although the Aboriginals at Lockhart River have memories of its uses as food. The wild plants are now quite uncommon due to predation by feral pigs, but those that I saw in the Lockhart area were vegetatively identical to the plants common in the Cooktown to Townsville region. They are green, stoloniferous plants which produce viable seeds and in cultivation are interfertile with diploid cultivars, as my own pollination studies have shown.

In my opinion, it would be very difficult to collect wild plants in the Lockhart area. The only site I know which had these plants was along upper Quintel Creek about 2 kms. upstream from the village. However wild taro in creek habitats are rather temporary. The old people in the village say there used to be a large swamp near the "Old Site" eg. the previous Lockhart River village, where presumably wild taro grew. The Lockhart people do not cultivate garden taro, even though it has been introduced to the area by various people, including myself.

I lived at Lockhart on three field trips, the last stay was for twelve months and I have an extensive knowledge of the region and its vegetation.

I assisted Sonya Plompen in her collection of wild taro in the Cairns area and have observed these plants in great numbers between Cooktown and Townsville. They are all identical. The Lockhart plants are similar (we have some growing here!) but are probably next to impossible to relocate. The most interesting feature of the wild taros is their lack of pigmentation, so when I occasionally find an identical plant with pigmented petioles etc. I take notice. In the Bamaga area, Atherton Tablelands and Tweed Heads areas are plants which are essentially similar to the usual wild taro, but have blackish petioles. I have plants here of a New Guinean cultivar which is very similar and which flower regularly. They seem to be very widespread.

There are currently about thirty (30) taro cultivars in north Queensland, none of which persist in the wild in my experience, except possibly some of the stoloniferous fertile forms.

I believe that the wild taros are truly native and are not introduced. In most areas the Aboriginals did not use them, and in those few places where they were used, the parts used and methods for preparation were purely Aboriginal and did not reflect any technologies used in taro cultivation areas like New Guinea. For example, the Aboriginals in Queensland did not eat taro leaves, which is a common practice in places where taro cultivation is established. One would assume that some information on the food value of the leaves would have been passed on to the Aboriginals if the plant had been introduced to them from elsewhere. Instead they treat the corms in the same way as toxic yams and *Amorphophallus* corms, cooking, grinding, soaking and cooking them again to remove the calcium oxalate. I also find it hard to understand why any taro cultivating people would distribute the scarcely edible stoloniferous forms when superior cultivars were available.

Wild taro also belongs to a floristic community that is widespread in South-East Asia, Melanesia and Australia and could have arrived here by natural means during any period prior to humans. Its habitat associates occur over a wide area and some of them, particularly the fern *Stenochlaena palustris* (which occurs up to Malaysia at least) are less mobile, not being moved by birds as taros are. So I really see no reason to consider wild taros as not native.

I think taro researchers have overlooked New Guinea as the source of cultivated forms. It now seems obvious that taro cultivation, probably involving selected tetraploids as well as selected diploids has been established in New Guinea for perhaps as long as 10,000 years. New Guinea has by far the greatest array of cultivars. The number of cultivars in any region diminishes to the west and to the east, whilst this reduction in variety is quite evident, it is also obvious that the cultivars become more removed from the wild form the further one goes from New Guinea. If New Guinea is the origin of cultivated taros, and remember Australia has been connected to New Guinea several times, it seems perfectly logical to assume that parental forms occurred here naturally as well.

In Queensland there is further evidence of the indigenous nature of wild taro in the

array of insects and birds that are adapted to it as a food resource. Taro cultivation is made difficult in high rainfall areas because of some of these.

I hope all this is some help in your studies.

30th October, 1987.

Dear Peter,

I am sorry to have missed you when you came up this way. As it turns out you appear to have had a worthwhile trip.

Regarding an Aboriginal name for any taro clone, I feel it is perhaps useless to select a name from one language and apply that to the broader range of related plants. There were probably over 20 languages, that included in their vocabulary, terms for Taro plants, the cooked product or parts thereof. Also you really have no way of knowing if a particular name belongs with the Taros in that area today, despite my assertion that all the wild Taros in north Queensland are essentially the same.

Wild Taros are opportunistic plants and normally are colonisers of (favourably) altered sites, usually washouts, flood debris banks, deposition sites inside meanders and the like. Such habitats are usually temporary and it is my experience that large colonies (of many hundreds of plants) can form in less than 12 months on favourable sites, give a deceptive appearance of age. Now we have cleared farmlands etc. which allow longterm colonisation, due to greater stability of the environment. Other long-term habitats include swamp forest and (volcanic) lake margins, where, presumably they are spread by migrating waterfowl or some other movement. The crater lakes of Eacham and Barrine have wild Taros at an elevation of near 1,000 m. Elsewhere they are rare at high elevations, but due more to a lack of habitat than to temperature.

I still have some plants of the Lockhart Taro, in fact we have just planted a collection of wild and cultivated Taros here in which the Lockhart clone was included. We can send you some when we have propagated it. The Lockhart plants are essentially like those from the Cooktown to Townsville area.

That Queensland Aborigines did not eat Taro leaves, is my own experience from both observation and questioning. Nor have I ever heard or read of their using the leaves as food from any other source.

In preparation, the Cape York Peninsula Aborigines that I know, used a technique that is also used on toxic *Dioscorea* and *Amorphophallus* corms:

1. Bake corms (whole) in amai (earth and stone oven) wrapped or unwrapped.
2. Peel cooked corms.
3. Pound cooled corms into paste, something like Polynesian “Poi”.
4. Place paste in very fine “punya” - (a bag made of *Lomandra* leaf fibres) and soak in *running* water for at least one day. Up to 20 “punyas” may be tied in a bunch and soaked in this fashion.
5. Soaked paste (“mai-i”) is drained of excess water, usually by hanging in a tree.
6. Drained paste is fashioned into (1) cakes or balls and “dryfried” on a hot rock in the centre of the fire; (2) cylinders rolled in leaves or bark and baked in hot sand, ashes

or in an amai; (3) rolled into balls and boiled in a pot (traditionally an “alup” - bailer shell) in coconut milk or turtle stew to make a rich sauce-like soup. The term “mai-i” refers to any edible vegetable matter and is used over most of northern Cape York Peninsula. The coconut milk and baiter-shell technology comes from Torres Strait and therefore probably from New Guinea.

This information was obtained from Aborigines that I lived with for over a year, but who no longer practised wild Taro harvesting. I did observe other corms (*Amorphophallus*, *Dioscorea* etc.) being treated in this way. Also “wunki” (*Rhaphidophora pinnata*) stems are cooked in this way.

All the Aborigines and Islanders I know have no traditional use of Taro leaves or cultivated *any* forms at all, with the exception of the extreme eastern and northern Islands (Saibai, Boigu, Erub, Mer etc.) who were more Papuan.

Whilst in Hawai’i, I visited several Arboreta and collections that housed collections of Hawai’ian taro cultivators. Most of them are smallish plants, grown in running water and bear strong similarities to old New Guinean clones. Many are fertile and most are somewhat stoloniferous. Honolulu Botanic Gardens is going to send us a collection of them.

Appendix 19. Frequently used stock solutions

Frequently used stock solutions, in order of first appearance in Chapter Ten (Materials and Methods). Many of these stocks are described by Maniatus et al. (1982), or other standard laboratory manuals. The solutions can be stored for indefinitely long periods unless otherwise stated.

(1) **Leaf DNA extraction buffer**: 50 mM Tris.HCl pH 7.5, 200 mM Na_2EDTA, 100 mM NaCl. Autoclave and store at room temperature (RT).

(2) **Ethanol perchlorate solution (EPR)**: Sodium perchlorate ($NaClO_4$. H_20) in 80% ethanol, prepared as follows. Dissolve 40 g $NaClO_4$. H_20 in ethanol, to a volume of 320 ml; dissolve 120 g $NaClO_4$. H_20in H_2O to a volume of 80 ml; combine the solutions and store the mixture in a brown glass bottle at RT.

(3) **50 TE 20(8)**: 50 mM Tris and 20 mM Na_2EDTA, pH 8.0, prepared from a 50x stock for which the final pH was adjusted to 8.0 with HCl or NaOH. Store 1x stock at RT, 50x stock at 4°C.

(4) **Phenol**: To prepare phenol saturated with aqueous buffer, dissolve high quality crystalline phenol in a glass container, placed in hot tap water. Extract the melted phenol repeatedly by shaking it with 1 M Tris.HCl pH 8.0, until the pH of the discarded aqueous phase is more than 7.6 according to a litmus paper test. Finally, extract once with 0.1 M Tris.HCl pH 8.0, or with distilled H_2O. Store in brown glass bottle at 4°C or -20°C for up to several months. Aliquot small amounts for storage and use at RT. After long

storage, phenol turns pink because of oxidation, and the solution should be discarded before oxidation turns the solution red.

(5) **Chloroform**: Mix chloroform with isoamyl alcohol in the ratio 24:1. Store in brown glass bottle at RT.

(6) **Ethanol and sodium acetate**: Prepare 2 M sodium acetate, pH 5.5, by dissolving 27.2 g sodium acetate with $3H_20$ in 80 ml H_20, adjust pH to 5.5 with glacial acetic acid, then take volume to 100 ml with H_20. Mix 5 ml of this solution with 95 ml of 100% ethanol. Store at RT. To precipitate DNA from aqueous solutions with very little or no salt, add two volumes of the ethanol and sodium acetate mixture. This gives a final concentration of 67 mM sodium acetate and 63% ethanol.

(7) **10 TE 1(8)**: 10 mM Tris and 1 mM Na.EDTA, pH 8.0, prepared from a 100x stock for which the final pH was adjusted to 8.0 with HCl or NaOH. Store 1x stock at RT, 100x stock at 4°C.

(8) **Boiled RNA′se A (pancreatic RNA′se)**: Dissolve 10 mg per ml in a solution of 10 mM Tris.HCl pH 7.5, and 15 mM NaCl. Boil at 100°C for 15 minutes, let cool slowly to RT, then dispense into aliquots. The stock is good for at least several months if stored at -20°C.

(9) **GET buffer**: 50 mM glucose, 10 mM Na_2EDTA, 25 mM Tris base, final pH 8.0. Dissolve 0.9 g glucose, 0.3 g Tris, and 0.37 g Na_2EDTA in H_20, adjust pH to 8.0, and add H_20 to a final volume of 100ml. Store at 4°C.

(10) **3 M potassium, 5 M acetate**: To 60 ml of 5 M potassium acetate, add 11.5 ml of glacial acetic acid and 28.5 ml of H_20. The pH is approximately 4.8. Store at RT.

(11) **Luria-Bertani (LB) medium**: From Maniatus et al. (1982), with modification. Glucose and magnesium chloride are optional. Add 10 g Bacto-tryptone, 5 g Bacto-yeast extract, 5 g NaCL, 2 g glucose, and 0.2 g $MgCl_2$ to one litre of H_20. Mix well and autoclave. Store at RT. Omit $MgCl_2$ when using the medium with tetracycline.

(12) **5 M NaOH**: Store at RT.

(13) **10% sodium dodecyl/ sulphate (SDS)**: Store at RT.

(14) **Ethidium bromide**: Prepare 10 mg/ml stock by dissolving 0.2 g ethidium bromide powder in 20 ml H_20. Stir with magnetic stirrer for several hours, then wrap container in aluminium foil, or transfer to dark bottle. Store at 4°C. The pH can be adjusted to make the powder more soluble. Carcinogen.

(15) **Restriction enzyme buffers**: Initially, the low, medium, and high salt buffers recommended by Maniatus et al. (1982) were used. For much of the later work, the all-purpose TA buffer (O'Farrell et al. 1980) was found equally reliable and more convenient. All the buffers were stored at -20°C. 15.1 **10x low-salt buffer**: 100 mM Tris. HCl pH 7.5, 100 mM $MgCl_2$, 10 mM dithiothreitol (DTT). 15.2 **10x medium-salt buffer**: 0.5 M NaCl, 100 mM Tris.HCl pH 7.5, 100 mM $MgCl_2$, 10 mM DTT. 15.3 **10x high-salt buffer**: 1 M NaCl, 0.5 M Tris.HCl pH 7.5, 100 mM$MgCl_2$, 10 mM DTT. 15.4 **Tris.acetate (TA) buffer**: The final 1x reaction concentrations are 33 mM Tris.acetate, 66 mM potassium acetate, 10 mM magnesium acetate, 0.5 mM dithiothreitol, 100 ug/ml bovine serum albumin (BSA), and pH 7.9. To make 10x stock, prepare three solutions: (A) 0.41 M Tris.acetate, 0.83 M potassium acetate, 0.12 M magnesium acetate, adjusted to pH 7.9 with glacial acetic acid; (B) 50 mM DTT; (C) 10 mg BSA/ml H_2O. Mix A:B:C: in ratios 8:1:1.

(16) **Bromophenol blue (BPB) running dye**: For 2 ml of stock, mix 0.4 ml of 0.5M Na_2EDTA pH 8.0, 1.5 ml glycerol, 0.1ml of 1 M Tris.HCl pH 7.8, and 1 mg of BPB powder. Store aliquots at 20°C for long periods, and at RT for current use. Add 3–6 ul per 50 ul reaction mixture.

(17) **Tris.acetate electrophoresis (TAE) buffer**: The 1x solution contains 40 mM Tris.acetate, 1 mM Na_2EDTA. To prepare 50x stock, dissolve 242 g Tris base in H_20, add 57.1 ml glacial acetic acid, 100 ml 0.5 M Na_2EDTApH 8.0, and H_20 to a volume of 1 litre. Do not autoclave, store at 4°C. The 1x solution may be reused for electrophoresis at least four times, with remixing, but excessive reuse may contaminate gels and filters with DNA.

(18) **Denaturing solution**: 0.5 M NaCl, 0.5 M NaOH. Store at RT.

(19) **20x Standard saline citrate (SSC)**: Dissolve 175.3 g NaCl and 88.2 g sodium citrate ($Na_2H_2H_20$) in 800 ml H_20. Adjust pH to 7.0, and make up to 1 litre. Autoclaving optional, store at RT.

(20) **100x Denhardt's**: Dissolve 2 g Ficoll 400, 2 g polyvinyl-pyrrolidone (PVP, MW 360,000), and 2 g bovine serum albumin in H_20 to a volume of 100 ml. Store 10 ml alquots at 20°C.

(21) **Pre-hybridisation solution**: Mix 4 ml of 10% SDS, 60 ml of 20x SSC, 20 ml of 100x Denhardt's, and 200 ml formamide (Fluka-purum) with 10 TE 1(8) to a volume of 400 ml. Final concentrations: 0.1% SDS, 3x SSC, 5x Denhardt's, 50% formamide, 3 mM Tris. HCl, and 0.3 mM Na_2EDTA. Store at -20°C.

(22) **5x ligase buffer**: 0.25 MTris.HCl pH 7.8, 50 mM $MgCl_2$ 250 ug/ml bovine serum albumin. Store at -20°C.

(23) **Neutralising solution**: 3 M NaCl, 0.5 M Tris base, (2 M NaCl 0.5 M Tris, may also be used). Store at RT.

(24) **10x Calf intestine phosphatase (CIP) buffer**: 0.5 M Tris.HCl pH 9.0, 10 mM $MgCl_2$, 1 mM $ZnCl_2$. Store at -20°C.

(25) **0.2% w/v colchicine**: Dissolve 20 mg colchicine in 10 ml H_20. Aliquots can be stored at -20°C for at least several months.

(26) **5x RNA polymerase buffer**: 40 mM Tris.HCl pH 7.9, 10 mM $MgCl_2$, 0.1 mM Na_2EDTA, 150 mM KCl, 50% w/v bovine serum albumin. Store at -20°C.

Appendix 20. General survey of rDNA variation in taro

Summary of tests for the general survey of rDNA variation in *C. esculenta* (L.) Schott, not including var. *fontanesii*. Restriction enzyme digestion by *Taq* I and *Hinf* I was followed by analysis with probes made from either the cloned rDNA fragment in pCe34.1 (the 5.5 kb *Eco* RI fragment), or the 2.8 kbp *Taq* I large-intergenic-spacer fragment, from subclone pCe34.11 or excised directly from pCe34.1.

Ribosomal DNA classes, defined on the basis of *Taq* I and *Hinf* I spacer fragments, are recorded. Tests with *Taq* I and *Hinf* I did not always allow a determination of rDNA class, when tests were run on separate gels for example, or when autoradiographs were faint and not all fragments could be detected. In the circumstances just outlined, independent estimates of fragments could nevertheless be made, and these contributed positively to the summary statistics presented in Chapter Fourteen.

Chromosome counts (2n), for one plant per site, were made by P. J. Matthews (no asterisk), P. Gaffey (one asterisk), and T. Kawahara (two asterisks). The habitat, cultivated or wild, is indicated for each sample.

Australia

		Eco 5.5kb		Taq 2.8kb				
ANU T#	Location	Taq	Hinf	Taq	Hinf	rDNA class	2n=	Hab.
31	Arnhem Land	X	X	X	X	Arn 2:2		WILD
33	Queensland						28*	WILD
331	Arnhem Land	X		X	X	Arn 2:2		WILD
332	Arnhem Land	X						WILD
333	Arnhem Land			X	X	Arn 2:2		WILD
334	Kimberley						28	WILD
335	Kimberley			X	X	Kim 2:2	28	WILD
336	Kimberley	X	X	X	X	Kim 2:2		WILD
337	Kimberley	X						WILD
338	Arnhem Land	X						WILD
376	Carpentaria	X	X	X	X	Arn 2:2	28	WILD
386	Kimberley			X	X	Kim 2:2		WILD
Queensland Sites (1987 field trip)								
1	Whyanbeel Ck	X	X			Qld 1:1		WILD
2	Harvey's Ck	X	X			Qld 1:1		WILD
3	Combo's X'ng	X	X			Qld 1:1		WILD
4	Badgery Ck	X	X			Qld 1:1		WILD
5	Hope Vale	X					28	WILD
6	Cassowary Ck	X						WILD
7	Sth Mossman R.	X						WILD
8	Blue's Patch	X					28	WILD
9	Boulder Falls	X						WILD
10	Jiyer Cave	X	X	X	X	Qld 1:1	28	WILD
11	Gap Ck	X						WILD
12	Gin Ck	X						WILD
13	L. Barrine			X	X	Qld 1:1		WILD

Note: In the Queensland survey, 35 plants were tested with Taq I and 14 with Hinf l.

Papua New Guinea

1	WH	X	X			Puk 2:3	28*	CULT
11	EH	X					28*	CULT
19	ENB			X	X		28*	CULT
21	Moresby	X	X					WILD
23	Moresby	X					28*	CULT
46	WH	X	X					CULT
49	WH	X	X				28*	CULT
50	WH	X						CULT
112	Solomon Is.	X	X					CULT
160	WH	X	X			Ruti 3:2B		CULT
163	WH	X	X			Puk 1:2		CULT
164	WH	X	X			Ruti 3:2A		CULT
166	WH	X	X			Qld 1:1		CULT
167	WH	X	X			Puk 2:3		WILD
171	WH	X						CULT
172	WH	X	X			Qld 1:1		CULT

178	WH	X	X			Puk 2:3		CULT
179	WH			X	X			CULT
182	WH	X	X			Puk 1:2		CULT
183	WH	X	X			Puk 1:2		CULT
184	WH				X			CULT
186	WH	X	X			Puk 1:2		CULT
187	WH	X	X			Puk 2:3		CULT
188	WH	X	X			Puk 2:3		CULT
190	WH	X	X			Puk 2:3		CULT
193	WH	X	X			Puk 2:3		CULT
197	WH	X	X			Puk 1:2		CULT
198	WH	X	X			Puk 1:2		CULT
200	WH				X			CULT
202	WH	X	X	X	X	Puk 1:2		CULT
203	WH	X	X	X	X	Buk 2:1		CULT
205	WH	X	X			Puk 1:2		CULT
206	WH	X	X					CULT
207	WH	X						CULT
208	WH	X	X			Puk 1:2		CULT
209	WH	X	X			Puk 1:2		CULT
211	WH	X	X			Puk 1:2		CULT
212	WH	X						CULT
213	WH	X						CULT
225	Morobe	X	X	X	X	Moro 2:2		WILD
226	Morobe	X	X	X	X	Moro 2:3A		WILD
227	Morobe	X	X	X	X	Moro 2:3B		WILD
228	Morobe	X	X	X	X	Puk 1:2		CULT
229	Morobe	X	X	X	X	Moro 3:3	28	CULT
231	Morobe	X						CULT
234	Morobe	X	X	X	X	Puk 1:2		CULT
235	E. Sepik	X	X			Puk 1:2		CULT
236	E. Sepik	X	X			Puk 1:2		CULT
237	E. Sepik	X	X			Puk l:2		CULT
238	E. Sepik	X	X					CULT
239	E. Sepik	X	X			Ruti 3:2B		CULT
240	E. Sepik	X	X			Puk 1:2		CULT
242	E. Sepik	X	X			Puk 1:2		CULT
243	?	X	X					CULT
247	ENB	X	X			Qld 1:1		CULT
249	WNB			X	X			CULT
251	?	X						CULT
256	Morobe		X					CULT
258	E. Sepik	X	X			Qld 1:1		CULT
259	WH	X	X					CULT
348	Solomon Is.	X	X					CULT

WH = Western Highlands Province; EH = Eastern Highland Province; ENB = East New Britain Province; E. Sepik = East Sepik Province; Morobe = Morobe Province; ? = unprovenanced within PNG

Asia and Madagascar								
107	Philippines			X	X		28*	CULT
109	Timor	X	X				28*	CULT
110	Timor	X	X				42*	CULT
131	Philippines	X	X	X	X	Puk 2:3		CULT
134	Philippines	X	X			Bay 2:2		CULT
137	Philippines	X	X					CULT
139	Philippines	X	X					CULT
140	Philippines	X	X					CULT
141	Philippines		X					CULT
142	Philippines	X	X					CULT
143	Philippines			X	X			CULT
152	Philippines	X						CULT
155	Philippines	X	X					CULT
156	Philippines			X	X	Bay 2:2		CULT
293		X	X				42*	CULT
294		X	X				42*	CULT
295	Japan	X	X			Min 3:2		CULT
296		X	X					CULT
297	Japan	X	X					CULT
298	Japan	X	X					CULT
299		X	X				42*	CULT
302		X	X				42*	WILD
303	Japan	X	X					CULT
304		X	X					CULT
305	Japan	X	X					CU LT
306	Japan	X	X					CULT
309	Nepal			X	X	Kat 2:3	42*	CULT
310	Nepal			X	X	Kat 4:4	42*	CULT
319	Sri Lanka			X	X			WILD
320	Sri Lanka			X	X	Col 2:2		WILD
323	Sri Lanka			X	X	Col 3:4		WILD
326	Japan	X	X					CULT
327	Japan	X	X			Col 3:4		CULT
340		X	X			Min 3:2		CULT
355	Thailand		X				28*	CULT
359	Thailand		X					CULT
363	Madagascar	X	X			Puk 2:3		CULT
364	Madagascar	X	X			Col 3:4		CULT
365	Madagascar	X	X			Col 3:4		CULT
366	Madagascar	X	X			Puk 2:3		CULT
Pacific Island								
104	Hawai'i	X	X	X	X	Old 1:1	28*	CULT
106	Hawai'i	X	X	X	X	Puk 1:2		CULT
114	Easter Is.		X	X	X			CULT
117	Easter Is.			X	X	East 1:3	28*	CULT

119	Easter Is.			X	X	East 1:3		CULT
124	Huahine Is.	X	X	X	X	Puk 2:3	28*	CULT
126	Huahine Is.	X	X			Qld 1:1		CULT
127	Huahine Is.	X	X			Qld 1:1	28*	CULT
272	Aotearoa	X					42	WILD
274	Aotearoa	X					42	WILD
275	Aotearoa	X						WILD
276	Aotearoa	X					42	CULT
277	Aotearoa	X					42	WILD
278	Aotearoa	X					42	CULT
279	Aotearoa	X					42	CULT
282	Aotearoa	X					42	CULT
283	Aotearoa	X					42	CULT
284	Aotearoa	X					42	WILD
286	Aotearoa	X					42	WILD
287	Aotearoa	X					42	WILD

Appendix 21. Sampling protocol for wild taro survey

The following protocol was prepared before the first survey of wild taro in Queensland, Australia, in 1987. At that time, leaf samples for DNA analysis had be preserved in liquid nitrogen in order to obtain sufficient quantities of high quality DNA for restriction enzyme analysis. Today, when collecting leaf samples for studies that make use of the Polymerase Chain Reaction (PCR), the quantity and quality of DNA needed is much less. In the field, all that is needed are about 8 g of young leaf tissue, stripped out from between the major veins of the blade and placed in a sealed plastic zip bag with a few grammes of dry silica gel. It is important not to add too much leaf, relative to the amount of silica, because the aim is to dry the leaf tissue as quickly and thoroughly as possible. After quick drying, the tissue will keep its green colour, and provide a good yield of DNA using any standard extraction method. To prevent the tissue from breaking into fragments after dessication, it should be spread out between two pieces of filter paper (or inside a coffee filter envelope) when first put in the bag with silica. With this method of tissue collection, it is easy to quickly sample many plants from within one site, or from many sites in one day. If three bags are prepared from one morphotype or taro variety at one site, I label the bags as 1/3, 2/3, 3/3 if each bag represents a separate leaf from a separate plant. If the samples are strict replicates from a single plant, then the bags are labelled 1a/3,1b/3, 1c/3 etc. In both cases, the first number indicates what kind of sample was made (a strict replicate, or from separate plants), while the second number indicates how many samples were collected. In 1987, the following protocol for collecting samples was used with minor modifications in the field, but was not included in the 1990 thesis. A field guide for describing and recording wild taro and wild taro sites was published later (Matthews 1997; see Appendix 22 this volume), and can be read as a

complementary text.

General aim and method

Looking for evidence of a homogeneous and generally dispersed taro population, distinct from recently introduced cultivars. First priority will be given to isolated, wild patches, large or small. The second aim is to look for evidence of sexual reproduction in the area and to sample in such a way that it can be demonstrated. In large and isolated wild sites, representative sampling will be attempted on an approximate grid system (approximation dependent on terrain) and using relatively large samples. Such samples will be of use in both measuring the effects of sexual reproduction in a local population and in measuring the homogeneity in what may be part of the historically important, regional population. For contrast to these samples, spot samples will be taken of locally grown cultivars and roadside-wild patches to see what types are present and whether they have any relationship with the putative isolated-wild populations. If large, isolated populations are lacking, then not-isolated large, wild populations (e.g., roadside) will be sampled in a representative fashion in order to provide at least the sought-for measure of local, sexual reproduction. In all situations, whatever the desired sample size, the sample number will be achieved by first sampling between clumps, and if this is not possible, then between shoots within a clump.

Cultivated varieties/locally grown market specimens

These may include varieties which are also found in roadside-wild sites. Since they are being moved around the local area, both the cult and feral plants may have interbred with whatever remains (if anything) of pre-European populations. A double frozen-leaf sample or a single live-sample of these will be collected, preferably the former to reduce later maintenance effort. If possible, leaf measurements, flower measurements, and general-phenotype records will be made. Such observations will be made on no more than three each of leaves, flowers, and shoots; a number of one is enough if time is limited.

Roadside — wild

Large patches (clumps dispersed over several metres, for example) may represent a small, sexually reproducing population of ramets. Some priority will be given to those with evidence of flowering, over those without. From such large patches, three samples of live shoots will be taken from those positions which seem least likely to represent branches of a single ramet. If possible, a further six frozen leaf samples will be taken, but only from separate clumps from which live shoots haven't been taken. Phenotypic observations will be made of the shoots from which each "N" and "L" sample, and further phenotypic observations will be made for up to twelve leaves or shoots. With larger roadside populations, for instance where clumps are dispersed over hundreds of metres along a valley, more sampling may be considered. This will depend on time limitations and the extent to which sampling aims for isolated-wild sites have been satisfied. For very small roadside sites, one live sample and/or three frozen samples is sufficient, along with phenotypic observations of up to three leaves/flowers, and general-phenotypic of one

shoot if the patch or clump is of apparently uniform phenotype.

Isolated — wild

Ideally, large samples of 40–60 could be obtained from large patches where sexual reproduction occurs, in three separate populations in the survey area. This sample size would be achieved with N and L collections in the ratio of 2:1 and represents the largest manageable number of samples. If suitable leaves for freezing are unavailable, more live samples will be taken (relative to frozen) to make up the desired number. If the population is smaller than 60 clumps, it will be sampled completely with an N:L sample ratio of 2:1. Where the population is widely and loosely scattered, and numbers (in terms of clumps) much more than 60, no more than 40 shoots representing clumps will be collected, and up to 40 frozen samples will be made, if possible.

Appendix 22. Field guide for wild-type taro, *C. esculenta* (L.) Schott

Original publication: Matthews, P. J. (1997) Field guide for wild-type taro, *Colocasia esculenta* (L.) Schott. *Plant Genetic Resources Newsletter* 110: 41–8.

Summary

This guide is designed to encourage research on wild and possibly natural varieties of taro (wild-types). A short form is provided for recording one plant in one site. With practice, this form can be completed in 10 minutes. The form can also be used to record cultivated varieties of taro, but is not intended as a substitute for the longer FAO descriptor list.

Resume

Guide de terrain pour les types sauvages de taro, *Colocasia esculenta* (L.) Schott

Ce guide a pour but d'encourager la recherche sur les varietes sauvages et eventuellement naturelles de taro (types sauvages). Un formulaire abrege est fourni pour renregistrement d'une plante dans un site donne. Avec un peu de pratique, ce formulaire peut etre rempli en 10 minutes. II peut aussi etre utilise pour enregistrer les varietes cultivees de taro, mais il n'est pas destine a remplacer la liste plus complete de descripteurs de la FAO.

Resumen

Guia de campo para la malanga o taro silvestre, *Colocasia esculenta* (L.) Schott

Esta guia tiene como objetivo estimular la investigacion de variedades silvestres y posiblemente naturales de la malanga o taro (tipos silvestres). Se facilita un breve formulario para registrar una planta en un dado sitio. Con la practica, dicho formulario podra rellenarse en 10 minutos. Tambien podra servir para registrar variedades cultivadas de malanga o taro, aunque no se pretende que substituya a la lista de descriptores de la FAO, que es mas larga.

Introduction

Before the last two centuries of rapid and international plant dispersal, taro was possibly the world's most widely distributed staple crop, ranging from India and Southeast Asia to Northeast Asia, the Pacific Islands, Madagascar, Africa and the Mediterranean (Matthews 1995). Taro can be regarded as a major crop that is minor in many places. Production from 1962 to 1975 apparently rose from 3.3 to 4.5 million metric tonnes, but the estimates were not considered reliable (Wang 1983). A figure of some 400 million users of taro (Bown 1988) or root crops (Wang 1983) is commonly cited, but this figure clearly does not include the huge number of people who use taro in subtropical and fully temperate regions of East Asia. As with many minor crops, or apparently minor crops, research on taro has been very limited (Matthews and Terauchi 1994).

To help investigators recognize and record different taro varieties, the form presented in this guide has two main sections, one for vegetative traits, and the other for floral traits and development. For scientific and/ or practical purposes, we need to learn much more about reproduction by wild and cultivated taros. In most situations, cultivated taros are propagated vegetatively, and sexual reproduction is prevented by a loss of flowering ability (Duncan et al.1985), or because harvesting takes place before flowers or seed develop, or because cultivation takes place in an area with unsuitable climate or no pollinators. For cultivated taros, the most likely opportunities for breeding are when plants escape from cultivation, or are left unharvested in neglected or fallow fields, or when some cultivated plants do reach maturity and release pollen that is then carried by insects to nearby wild taros. For wild taros in tropical Papua New Guinea, there is ample evidence that breeding takes place (Barrau 1959; Carson and Okada 1980; Ivancic et al. 1995).

In theory, wild-type taros may exist in (i) wild, natural habitats, (ii) as weeds in ruderal and cultivated habitats, derived from nearby natural populations, (iii) as wild types that have been brought into cultivation, without effective selection or domestication, and (iv) as weeds in ruderal and cultivated habitats, after dispersal from within cultivation.

In addition, domesticated forms of taro may become ruderal or wild after uncontrolled dispersal of seeds and vegetative parts, or after deliberate discard, or after being planted in the wild without cultivation. Many hard-to recognize categories of taro may also arise through uncontrolled breeding between wild and cultivated taros. To recognise wild-type taros, and to understand the history and ecology of wild taro populations, we must at least try to distinguish different categories, even if this is very difficult (cf. Table 1 in Matthews 1996). The essential starting point is simple observation and recording of taro in all its habitats.

Taxonomy

In this guide, I describe an apparently natural form or variety of taro (i.e., wild-type) and the wild habitats in which it has been found. This information is based on personal experience in Australia, New Guinea, Indonesia and the Ryukyu Islands of Japan (Matthews 1987, 1991, 1995; Matthews et al. 1992). The term 'variety' is used here in a

general and informal sense, to indicate phenotypic differentiation. Hay (1996; pers. comm.) urges that no formal infra-specific taxa be recognised presently in *Colocasia esculenta*, since reticulate relationships are likely to exist between wild-type(s) and cultivated forms of *C.esculenta* .

Previously (Matthews 1991, 1995), I identified *C.esculenta* var. *aquatilis* Hassk. (Hotta 1970) as a possible or likely wild-type. Henceforth, I will refer to the wild *aquatilis* as 'wild-type taro'. This identification is informal and has yet to gain wide recognition.

The practical problem of how to distinguish a wild-type from other categories of taro has been addressed in detail elsewhere (Matthews 1995). If other wild-types are found, then various options are possible for any formal revision of infraspecific taxonomy. Hay states that "we need to do the taxonomy of the wild taros from scratch throughout the entire natural range of the genus, and then see how cultivated forms are related to the wild entities that are recognised" (A. Hay, pers. comm.; paraphrase). This statement is consistent with the recommendations of Burtt (1970).

Scope of the guide

From my own experience (mainly in low-altitude, tropical rainforest), the discovery of wild-type taro is greatly enhanced by focusing on habitats like those described below. Similar habitats exist in many areas that I have not explored. Other wild-types, and other species of *Colocasia*, may occupy different habitats in other vegetation zones (in tropical mountains or subtropical lowlands, for example).

The form presented here is designed for recording taro when time is limited during field exploration. With practice, the form can be completed in about 10 minutes. This form complements more elaborate protocols developed for taro in agricultural research collections (e.g., Whitney et al. 1939; Ghani 1984; Guarino and Jackson 1986; Hirai et al. 1989).

For botanical and ethnobotanical studies of taro, it is not always possible, practical, or necessary to collect whole plants for living collections or herbaria. When whole plants are not collected, it is especially important to record at least some phenotypic traits in the field. The form is based on experience gained during a survey in which leaf samples were collected from many sites, for DNA analysis. The form can be shortened, extended, or otherwise modified according to the particular purpose of the work. It can be used to record cultivated taro varieties, but is not intended as a substitute for the 1985 or later descriptor lists (Guarino and Jackson 1986).

Exploration for wild-type taro

In this section, I introduce the appearance, reproduction and habitats of wild-type taro (see comments on taxonomy, above). A general comparison with cultivated taros is presented in Table 1. The terms in bold face are illustrated in Figures 1 and 4.

Appearance

Wild-type taro is typically almost entirely an even, light green colour; the leaf blade has green veins and lamina; the petiole (leaf stem) is white at the base and green above,

Figure 1

without variegation. The junction of the petiole and the blade is red or purple in some leaves, in some populations. The side-shoots are long green stolons, with many nodes and often more than 1 m in length. The corm is generally small relative to the overall size of the plant, and has a white skin (outer epidermis). The corm core is composed of white storage parenchyma with pale yellow fibres. Loose and fibrous petiole remnants give the corm exterior a brown appearance; this fibrous tissue is easily scraped away to reveal the true skin colour. The true roots are white and coarse (often ea. 2 mm thick).

In wild locations, wild-type corms are usually watery and deficient in starch. Obviously escaped or transplanted cultivars are usually much more starchy. The amount of starch and degree of acridity may vary according to local conditions (water and nutrient supply) and according to season. Starch is often more abundant near the apex of the corm, just below the main shoot. Starch density can be assessed roughly by pressing the blade of a knife against the cross-section of a cut corm. A dense and opaque white liquid will appear if starch is plentiful.

The leaves and corms are very acrid, and the acridity persists after prolonged boiling or frying. Use extreme caution if acridity is to be tested by tasting: do not taste any raw tissue, and do not swallow the tissue or liquid, even after cooking. Acrid taro can irritate the mouth and throat severely and restrict breathing. A safe test can be carried out by rubbing freshly cut tissue against soft skin under the wrist. This produces an itchy effect that soon disappears.

Reproduction

Vegetative reproduction by stolons is obvious in all wild populations, and seed production is common, but almost no information is available regarding seed dispersal and germination. Male and female flowers occupy upper and lower portions of the same spadix. The spadix is covered by a spathe which is entirely green when young. The lower spathe remains green while the upper spathe becomes yellow or orange-yellow at

Table 1 Phenotypic variation in taro: summary for different plant parts in wild-type taro and cultivated varieties (from Matthews 1995)

Plant part	Components	Wild var. *aquatilis*	Variation among cultivated vars.	Comments
Leaf	blade and petiole	An even light green colour; red at junction of blade and petiole of some leaves in some populations; acridity strong	All parts of leaf: green or yellow-green and various red colours, in various graded and variegated patterns; acridity weak to strong	Variegations involve red and/or green pigments; complex colour combinations are common in cultivars
Inflorescence	spathe, spadix and flower parts	Components vary in size; the lower spathe and female flower parts lack red pigments	Components vary in size; the lower spathe and female flower parts may display red pigments	Complex colour combinations are common in cultivars
Corm	size and shape	Cylindrical, diameter usually = diameter of leaf base, size highly variable	Cylindrical to spherical, diameter usually > diameter of leaf base, size highly variable	Corm shape easily modified by environment, in variety-specific ways
	skin	White	White and various red colours; variegated or not	
	cortex	White	White and various red colours	
	core storage parenchyma	White; starch density low	White, various red, orange and mustard-yellow colours; variegated or not; starch density various, often very dense	Texture and flavour after cooking, and time to maturity highly variable among cultivars, rarely tested for wild var. *aquatilis*
	core fibres	White or pale yellow; coarse (thick) and high density	White, yellow and various red colours; various thickness and density	
	acridity (entire corm)	Strong	Weak to strong	
Roots	–	White	White and various red colours	
Side shoots	–	Long stolons, often >1 m in length (surface runners with shoots and roots at nodes)	In different cultivars: long to short stolons, direct shoots, elongate or round side-corms with starch	

maturity. The edges of the mature upper spathe separate to form a small aperture, and a sweet scent is released to attract pollinators. The stigma is sticky at this stage, before the anthers release pollen. The stigma and staminode are whitish or pale yellow. Pollen is released and adheres to the spadix as the spathe opens more fully. Eventually, the upper spathe and upper spadix wither and fall. If fertilization is complete, then the lower spadix develops into a swollen fruiting head with many fruit and several hundred seeds. The mature fruit are soft and green (or yellow-orange, according to Barrau 1959). Immature fruit are hard, shiny, and green. Mature taro seeds are hard, pale brown, and about 1.5 mm long with longitudinal corrugations that are visible to the naked eye. Immature seed are smaller, soft and have a smooth, pearly-white appearance.

Habitats

Wild-type taros grow next to permanent streams and waterfalls in wet tropical rainforest (Fig. 2) and next to permanent springs or seepages in monsoonal savannah. They do not grow in deep shade. Permanent populations of wild taro require stable substrates (rock or rarely eroded earth banks) and a permanent water supply. The long stolons follow wet crevices in rock, and the true roots enter these to form strong attachments. Corms and stolons are often washed downstream by floods. The presence of permanent or stable populations at higher locations (upstream) is often signaled by the presence of taro in lower, seasonally flooded positions, within the same stream or watershed. Vegetative growth is most vigorous in wet alluvial mud or silt with abundant sunshine. In such locations, stolons radiate out over wet surfaces, or though the substrates close to the surface.

In Australia, wild-type taro ranges from near sea level to almost 1000m asl, in the northern zones of tropical rainforest and tropical savannah. Stable and unstable habitats in Australia are illustrated in Figure 3. Ruderal habitats with apparently wild-type taro are usually wet ditches or banks, in open locations (with much sunlight) next to fields or roads (Australia, Indonesia, southern Japan).

Plant and site record form

The form has space for one plant, details about the site, and related data. The plant described should be typical for the variety and site. To record more examples of the same variety, or other varieties in the same site, use further pages (without repeating every detail in the form) or develop a new form with a more suitable layout.

Explanation of terms

Here I explain the underlined terms in the same sequence as they appear in the form. Self-explanatory or well-known terms are not covered. Many of the terms are illustrated in Fig. 4.

The record of date, site and variety (informal identification) can be incorporated into one alphanumerical sequence, the dsv number, e.g., 3.iv.96-la indicates ‘variety a’ at the first site visited on 3 April 1996. If whole plants are collected for a living collection or herbarium, a more standard numbering system can be used.

Figure 2 Waterfall habitat of wild-type taro in Queensland rainforest. The heart-shaped leaves are visible at left in the splash zone near the bottom of the waterfall, and in a vertical crevice at the far right of the rock face.

The description of habitat should include indications of proximity to human settlement and activity (e.g., village, foot trail, gardening), local vegetation, geomorphological context (e.g. stream bank, waterfall), water supply (e.g., permanent, seasonal), aspect and exposure to light (e.g., open site on north side of stream, partial shade) and the kind of substrate (e.g., rock, alluvial mud, organic detritus, etc.).

The clump/shoot/leaf (csl) number identifies the first leaf to be measured on one shoot, within one clump. The first leaf measured is not necessarily the oldest or youngest emergent leaf. Within one site, there may be many taro clumps scattered over several or hundreds of metres. The spatial delimitation of sites should be discussed in later reports. For taro in wild locations, an arbitrary separation of 100+m or 400+m along the same stream or river can be used to assign clumps to different sites. For cultivated taros, the site can be defined as an individual field, garden, market or village. A clump is defined here as many plants side by side, with or without obvious vegetative connections. The term clump is convenient because there is often no secure basis for assigning separate shoots to a single clone (initial connections may rot).

A taro leaf consists of a petiole (leaf stalk) and blade. The distance pb, from the petiole base to the junction of petiole and blade, is easily measured by holding the end of a flexible metal tape measure against the base, and then pulling the tape case upwards - with both hands hooked around tape and petiole, to hold the tape and straighten the petiole.

To record the blade dimensions A-G in a consistent manner, use one hand to anchor

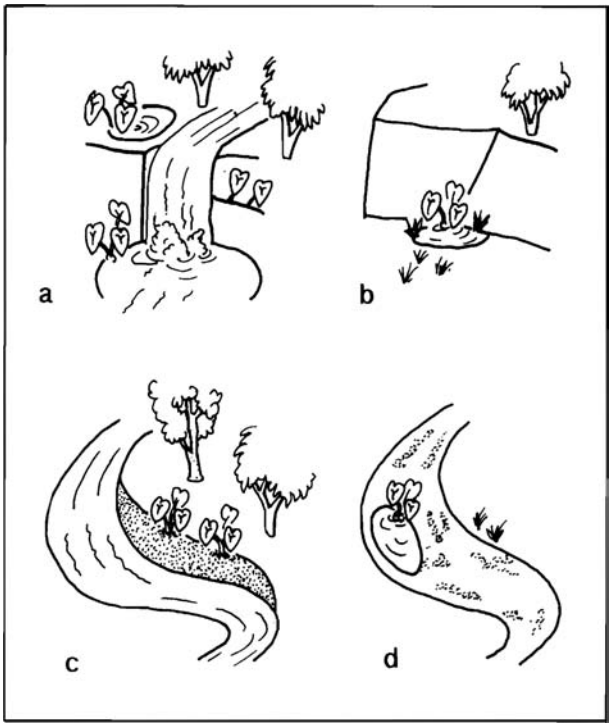


Figure 3 The habitats of wild-type taro: (a) stable habitats in tropical rainforest- waterfalls with permanently wet rock surfaces, in foothills and low tablelands; (b) stable habitats in tropical savannah permanent springs or seepages, at the foot of rocky escarpments; (c) unstable habitats in tropical rainforest- stream or riverbanks with soft substrate (plant detritus, gravel, mud, sand, silt); (d) unstable habitats in tropical savannah - lowland stream or riverbanks, on seasonal floodplains.

the tape measure on the upper blade surface. With large leaves, push one thumb through the blade from below, to anchor the tape above the point of petiole insertion. The anchoring hand can simultaneously rotate the leaf blade to assist measurement. It helps to have a second person, for writing as measurements are called out. The dimensions B and C are maximum distances to the margin or tip of each lobe, and do not always follow the main vein of each lobe.

The veins often curve or divide, so it is not easy to measure in a consistent manner. To measure G consistently, hold the rear of the leaf so that it is fully open without being artificially flattened.

In a previous study in New Zealand (Matthews 1984), the dimensions B, D, E and G were used in a canonical discriminant analysis of leaf shape. In a comparison of three different cultivars (distinguished before analysis), maximum discrimination was obtained by the contrast of large B and small D values with small B and large D values. The dimensions B, C and G were used to calculate the approximate angle between the rear

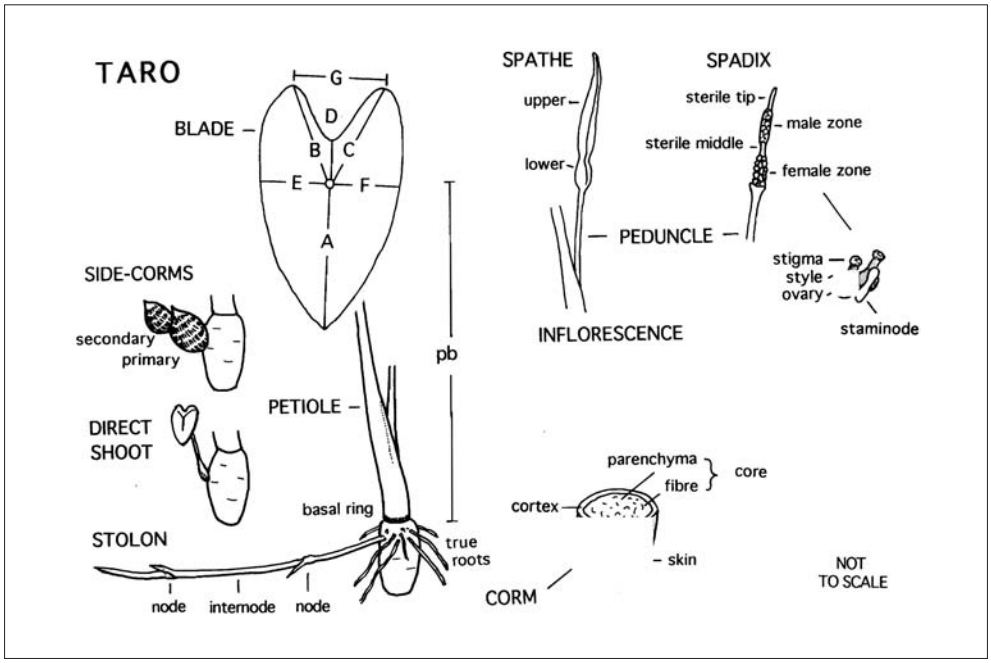
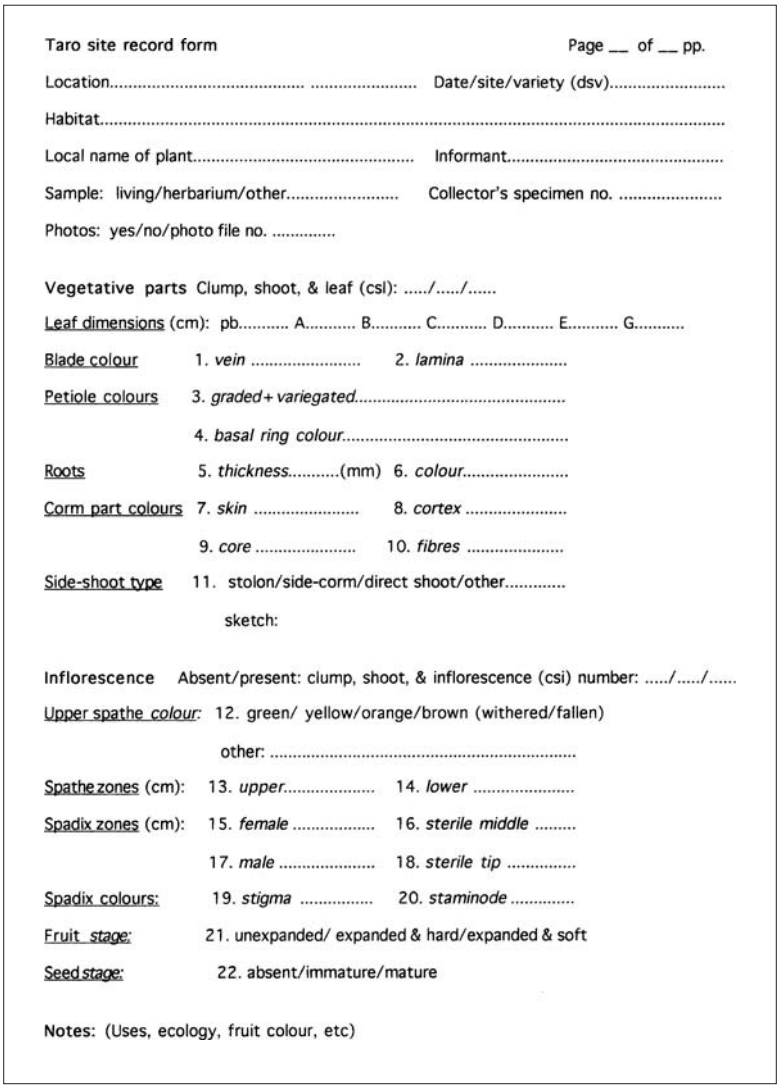


Figure 4 Schematic illustration of terms used to describe taro.

lobes in different cultivars: rear-lobe angle (degrees) = $2\sin^{-1}$(G / B+C). This angle was also useful for distinguishing cultivars, despite difficulty in accurate measurement of G. Other derived characters were calculated as follows: symmetry = (E×B)/(F×C), lobedness = ([B+C] / 2)1A and peltateness D/A.

It is difficult to make accurate or reliable verbal descriptions of colour. We can only expect to make approximate records. These are usually adequate for distinguishing a limited number of varieties in a limited geographical area. Common blade colours, in the main veins and lamina, are: red (R), pink (Pi), purple (Pu), dark purple or 'black' (Bl), green (G), and yellow (Y) or yellow green (Y-G). Similar colours can seen in the petiole. The colour terms can be modified with adjectives such as dark, pale, light, dense. The main veins (central and lateral) are best viewed on the underside of the blade. Fine, tertiary veins contribute to the colour of the lamina (the flat tissue between the main veins).

Petiole colours often grade from one into another vertically, and the graded colours often form a background for attractive variegated colours. Again, the description can only be approximate. The vertical sequence of graded colours, from upper petiole to petiole base, can be indicated by placing a slash between each colour, e.g., G / Pu / W = green above grading into purple and white near the base. Variegated colours may be flecked, striped, or mottled, and the colours can be used as adjectives for each type of variegation, e.g., R fleck, Pu mottle, or W stripe.



Taro site record form Page __ of __ pp.

Location..... ..... Date/site/variety (dsv).....

Habitat.....

Local name of plant..... Informant.....

Sample: living/herbarium/other..... Collector's specimen no. .....

Photos: yes/no/photo file no. .....

Vegetative parts Clump, shoot, & leaf (csl): ...../...../.....

Leaf dimensions (cm): pb..... A..... B..... C..... D..... E..... G.....

Blade colour 1. *vein* ..... 2. *lamina* .....

Petiole colours 3. *graded+variegated*.....

4. *basal ring colour*.....

Roots 5. *thickness*.....(mm) 6. *colour*.....

Corm part colours 7. *skin* ..... 8. *cortex* .....

9. *core* ..... 10. *fibres* .....

Side-shoot type 11. stolon/side-corm/direct shoot/other.....

sketch:

Inflorescence Absent/present: clump, shoot, & inflorescence (csi) number: ...../...../.....

Upper spathe *colour*: 12. green/ yellow/orange/brown (withered/fallen)

other: .....

Spathe zones (cm): 13. *upper*..... 14. *lower* .....

Spadix zones (cm): 15. *female* ..... 16. *sterile middle* .....

17. *male* ..... 18. *sterile tip* .....

Spadix colours: 19. *stigma* ..... 20. *staminode* .....

Fruit *stage*: 21. unexpanded/ expanded & hard/expanded & soft

Seed *stage*: 22. absent/immature/mature

Notes: (Uses, ecology, fruit colour, etc)

Figure 5

Petioles often display a complex combination of graded and variegated patterns involving green and purple colours (chlorophyll and anthocyanin pigments). A bronze appearance (Br) can be produced by the combination of graded green and purple colours. lt is often a matter of subjective judgement whether or not to record two colours as one very fine variegation on a graded colour background, or as two graded colours, or as a single colour. The code G / Br can be used to indicate a predominantly green upper colour grading into bronze. If the purple pigments dominate in the lower part, then the description becomes G / Pu. If the purple pigments form a distinct variegation, then the

description becomes G / G+Pu fleck. If the upper petiole also has some purple, then the description can be Pu / G I/ G+Pu fleck.

The basal ring colour appears as a distinct ring at the very base of the petiole when an obvious anthocyanin pignent (Pu or R or Pi) lies next to a pale graded colour (e.g., W or G). If the main colour of the lower petiole is very dark, then the pale basal ring colour might not be visible, and a question mark should be noted.

Corm colours are often very simple (white in all parts), but anthocyanin pigments do appear in the skin, cortex and core. These pigments are usually similar to the those seen in the leaf, and can appear in variegated patterns. Mustard yellow (Mu) and orange (O) are colours that I have only seen in the core parenchyma; these are presumably carotenoid pigments (these have great potential as targets for breeding attractive cultivars; similar pigments have been important in other root crops). Fibre colours include white, pale yellow, and purple.

Side-shoots are highly variable in colour and morphology. Individual plants may display both direct shoots and stolons. Stolons are defined here as side-shoots in which at least the first internode has a narrow and constant diameter (the first internode lies between the parent corm and the first node). Without this it can be difficult to distinguish an elongate side-corm from a child corm mounted on a short stolon. An sidecorm can display a distinct (protruding) node on a swollen first internode.

The inflorescence also varies greatly in colour and morphology. The colours of peduncle and lower spathe are often similar to petiole colours on the same plant, so no space is given for recording these colours (the apparent correlation between petiole and inflorescence colour is intriguing; the latter is unlikely to have been the object of direct human selection).

The upper spathe colour varies according to developmental stage. It is yellow or orange-yellow when the female flowers are mature, which is when a sweet scent is emitted. The colour from green (G) at emergence from the petiole sheath, to yellow (Y), orange (O) and brown (B) at the onset of withering. Intermediate colours are also seen (Y-G, 0-Y and B-0). Eventually, the upper spathe falls to the ground and a swollen fruiting head develops on the peduncle. Spathe and spadix zones vary in length according to variety and developmental stage. If the upper spathe colour is recorded, then the comparability of measurements from different plants and sites can be confirmed later. I usually measure the spathe and spadix when the upper spathe is yellow or orange-yellow.

Further notes can be added to record details of use, ecology, fruit and seed development, habitat, access, location, starch content, acridity, nearby human activity, insect associates and pollination, seed dispersal and germination, disease and other matters.

Acknowledgements

The author thanks Dr Alistair Hay (Royal Botanic Gardens, Sydney) for advice on the taxonomy of taro, and one anonymous reviewer for helpful comments.

Appendix 23. Two taros from Japan: *Ishikawa-wase* and *Tonoimo*

The following text is from an unpublished article, written in Kyoto, November 1993, and distributed as a flyer together with planting materials.

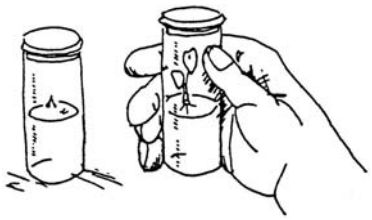
Two Japanese taro varieties were introduced to New Zealand for the first time in 1992. In this article I describe how the plants were introduced and their history in Japan. I also describe the new varieties so that they can be identified, and outline methods for cooking and cultivation. Words marked with an asterisk (*) are explained in a glossary at the end.

It will take time for us to learn how to grow the new varieties in New Zealand. Please try them — and good luck. Write to me if you have questions. I will answer if I can. After you have tried the new varieties, please tell me if they grew well or not. How did you grow them? Was the crop good? How did you cook them? Did you like the taste and texture of the corms? Please copy this article and pass it on.

The journey to New Zealand

On the 14th of April, 1992, 1 left Osaka with several tiny taro shoots inside small glass bottles. The shoots were a present from Masahiro Morishita at the Osaka Agriculture and Forestry Research Centre. Dr Morishita prepared the shoots and put them in bottles so that they could grow without any disease (see methods, Morishita 1988).

On the way back to Auckland, I stopped in Sydney. The quarantine office there looked after the shoots for three weeks, then brought them to the airport when I left. The shoots were allowed in at Auckland Airport because they were clean. I also had import papers that were sent to me before I left Japan. Many people already grow taro in New



Zealand, so I had to be careful not to bring sick plants into the country.

At the University of Auckland, Dr Lena Fraser looked after the shoots until they developed leaves and were strong enough to go into covered trays. The plants were ready to go outside just in time for the summer of 1992/93.

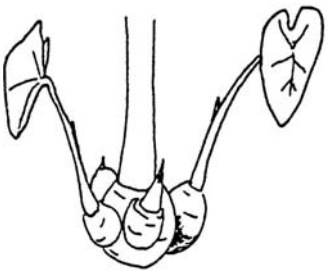
History and identification

Ishikawa-wase and *Tonoimo* are both very popular in Japan. They are widely grown in home gardens and commercially (see Hirai et al. 1989).

Ishikawa-wase is a modern variety less than 200 years old. It probably originated as a spontaneous* new form in a farmer's field at Ishikawa, in Osaka. The likely parent is an old variety that is still grown. The change to a new variety may have involved a loss of purple colour in the leaf, a reduction in plant size, and an increase in the number of side-corms* produced.

Ishikawa-wase is usually less than one metre high at maturity, and produces many small round secondary and tertiary corms* in a cluster. The sheath has a distinctive brown-black margin.

Tonoimo is a very ancient variety. The name was recorded in 560 AD and means something like 'potato from China'. The plant has light-purple to green petioles*, and is 1–1.5m high at maturity (in good conditions). The primary and secondary corms are soft and tasty when cooked.



Cooking

In Japan, corms* are often boiled in water and flavoured afterwards with salt or sauce. They are also gently cooked in watery sauce until the sauce is absorbed. They are often added to soups. Never eat raw taro — it has poisons that protect the plant against animals.

Here is a simple method for cooking small corms, or pieces of larger corms:

(1) boil in water for 5–10 minutes, then discard the water,
(2) boil again for 5–10 minutes, in water or soup stock.

After cooking, the corms should be soft all the way through, without falling apart. Continue cooking if there is an itchy effect in the mouth or throat (there is no danger if you taste carefully, the effect goes away soon, drink milk as an antidote). Peel and cut large corms before cooking. Corms that are too small for peeling can be steamed in their skins (about 20 minutes). To peel a small corm after cooking, squeeze it gently with your fingers. The skin will crack, letting the inside part slip out in one piece.

The petioles of *Tonoimo* are also good for eating. The young petioles are best. Cut them into pieces and boil in water for 5 minutes, then use as a salad vegetable with dressing. Alternatively, cook them as part of a soup.

For Hawai'ian cooking methods, see Kokua (1982).

Distribution and cultivation

Wild and possibly natural taros are distributed all the way from northeastern India and southern China to northern Australia and Papua New Guinea. The first cultivation of taro was somewhere in this tropical region (Matthews 1991). For temperate countries with cold winters and short summers, selection by farmers was needed to develop varieties that could be grown easily. Taros in Japan, Korea, and central China have many starchy side-corms. The corms can be stored over winter, for eating or planting, and the starch helps the new leaf growth in spring.

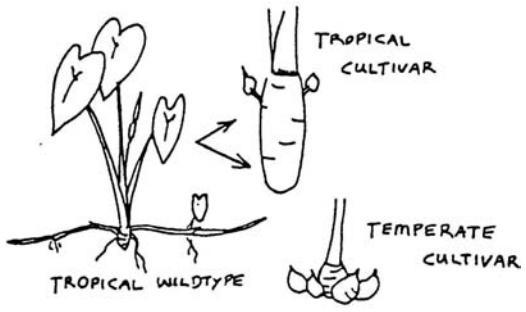
In tropical countries near the equator, the growth of taro is continuous because the climate is continuously warm and wet (Massal and Barrau 1956; Wang 1983). The corms can become very long and cylinder-shaped because of the continuous growth. Tropical taros often have one big central corm. The top can be harvested and then planted without any storage period. Big corms from Fiji, Tonga, and Samoa are sold in New Zealand.

Countries that are slightly north or south of the equator have wet and dry seasons instead of summer and winter. Taro can grow during the dry season if there is irrigation. Planting stocks can be kept growing in permanent streams or ponds, ready for the start of the wet season.

Taro also grows in warm-temperate countries around the Mediterranean Sea. It was a major vegetable in Cyprus up until the 1950s (Cristodoulou 1959), and was recorded as wild in streams in southern Spain in the 1920s. It is still grown in Egypt and Lebanon.

In cool-temperate parts of Japan, taro corms are stored during winter in a covered pit in the field, packed with straw, or in a cellar with good aeration. Primary and

secondary corms are eaten or planted according to the variety. Petioles are harvested during summer and can be dried for storage. Summer is usually quite hot in Japan, so taro patches are often planted in irrigated fields next to rice.



Cultivation in New Zealand

Taro is an ancient crop in New Zealand. It is most common in the northern half of the North Island (Matthews 1985; Part 2, this volume), but also grows in the Nelson district. Taro can survive outside during winter, but stops growing because of the cold temperatures and short days. Exposed shoots are damaged by frost. Shoots that were protected under old leaves or in the ground recover best, when summer comes .

Many trials will be needed to discover the best locations and methods for the Japanese varieties. Here are some suggestions to start with:

(1) For planting material, keep the sort of corms that you like best. Make them all one size if you want an even crop later. Don't take corms from plants that grew weakly or had strange colour patterns on the leaves — the plants may have some kind of disease. Virus and fungus diseases can spread with the corms.

(2) For an early start, plant corms before summer, after the days start becoming longer. In Auckland and further north, October may be a good month to begin planting. Put corms in a warm, sunny corner of the garden, or in a hothouse, until new shoots appear. When the there is no danger of frost (if you have frost) the shoots can be moved to less sheltered positions.

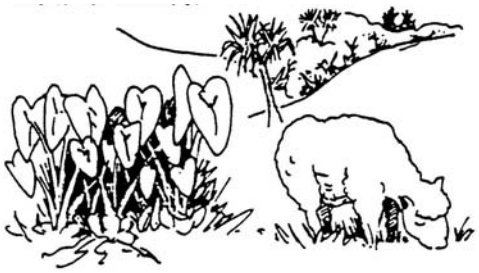
(3) Taros are very sensitive to soil structure, fertility, and water supply. They do well in loose, dark soil near streams and rivers. They often survive drought, but the outer leaves wilt and die quickly. A temporary drought will set plants back all summer. Less water is needed near the end of summer. Too much water encourages leaf growth, and reduces the amount of starch in the corms.

(4) Taros can also be grown without special effort. Plant shoots in a warm, sheltered place with soft soil, next to a ditch or stream that has water in the summer. A patch should develop without much further attention. Break up old clumps of corms, dig in the young side-corms, and pull down the old leaves that stick to the shoots. The old leaves can make it difficult for new leaves to come out. Use the old leaves as a mulch.

(5) Corms are best for eating at the end of summer or soon after (March to May),

depending on the location and variety (*Ishikawa-wase* is an early maturing variety, in Japan). Avoid old corms that are fibrous and watery. They take longer to cook and don't have much starch. A good corm is starchy all the way across, and from the base to the tip. The starch can be seen by pressing the surface in a cross-section. A white liquid should appear. Corm quality can also be judged by size and weight.

(6) There are many different ways to grow taro. The best way will depend on the location, variety, and the type of corm or leaf that you prefer. Try different varieties and cultivation methods, and make notes. If other people already grow taro in your area, ask them for advice!



Glossary

Corm: a storage organ that contains water and starch. Corms are swollen stems and are usually underground.

Petiole: the upright part of the taro leaf, connecting the corm with the leaf blade.

Primary, secondary and tertiary corms: primary - the central or mother corms; secondary - corms next to the mother corm; tertiary - corms growing from secondary or later corm.

Side-corms (cormels): secondary and tertiary corms.

Spontaneous new form: plant with a new shape or colour resulting from a change inside the plant, and not controlled by the farmer. No variety is completely stable. When taro is grown from shoots, the new plants are usually like the parent, but sometimes there are obvious differences. When new forms are noticed, and kept, they are often given a new name.