

A descriptor list for Giant Swamp Taro (*Cyrtosperma merkusii*) and its cultivars in the Federated States of Micronesia

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Abstract

Atoll islands are the diversity hot spots for *Cyrtosperma merkusii* (giant swamp taro) and its traditional knowledge, especially in the Federated States of Micronesia (FSM). In these atolls and islands the giant aroid is given high importance in the food, cultural and traditional systems. Despite this, a significant lack of knowledge and threat of salt water intrusion in the face of climate change exists for the aroid. To curb this issue a classification descriptor list using the taro descriptors (1999) and traditional knowledge of the FSM farmers was developed. The descriptor list was then employed to classify the many cultivars present in FSM. The list consisted of 37 morphological traits divided into plant habit leaves, petiole, inflorescence, root, corm, taste and special characteristics. Using this descriptor list 40 distinct FSM cultivars was classified, four of which were unknown to the locals namely PF1, Semesrao, Liha mwahu and Nah. The results of the classification provided some knowledge of the various cultivars and also showed that diversity did exist within the gene pool of the aroid. With further research and documentation the diversity that exist within the gene pool of the aroid can be explored and utilized to buffer the impacts of salt water intrusion, while conserving the aroid and building its knowledge base.

Introduction

There are four types of taro which are normally found in the Pacific, these include the common taro *Colocasia esculenta*, *Xanthosoma sagittifolium*, *Alocasia macrorrhizos* and the giant swamp taro *Cyrtosperma merkusii* (frequently incorrectly referred to by its synonym *C. chamissonis*). Of these four types of taro *Cyrtosperma* is the largest reaching up to five metres in height (Dunn 1976; Iese 2005; Webb 2007). It also takes the longest to reach maturity, and is known for its hardy qualities of surviving in atoll environments (Thaman 2002; Manner 2009). Giant swamp taro is one of the root crops that have spread across the Pacific reaching as far as Makatea Island on the northwest of Henderson Island in the Tuamotu Archipelago (Hather 2000).

Hay (1990) and Lebot (1992) state the origin of the giant aroid to be the high lands of Papua New Guinea, while on the other hand some have concluded it to be of Indonesian or Indo-Malayan origin (Bradbury and Holloway 1988). While it has been perceived that giant swamp taro was domesticated in Indonesia,

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the Indo-Malayan region is the region which holds the greatest diversity of the root crop (Bradbury and Holloway 1988; Iese 2005). However, employing techniques of archaeobotanical analysis Hather and Weisler (2000, p. 154) found that "...*Cyrtosperma* was an aboriginal introduction across Polynesia except for New Zealand and Easter Island where climate plus cultural preferences may have discouraged its growth..." he also found that *Cyrtosperma merkusii* was present as far back as 1451 A.D.

The production levels of this giant aroid in the atolls are now under threat from the effects of climate change and related sea level rise. The increased frequency and intensity of king tides and sea swells bring huge waves inundating the low lying atoll islands (Liz 2007; Talia, 2009; White and Falkland 2010). This inundated sea water percolates into the groundwater lens increasing salinity in the fresh groundwater lens (Woodroffe 1989; Mimura 1999; Gerald et al. 2007). Along with this, the disturbance caused by rise in sea level to the sensitive balance of the groundwater lens results in seawater intrusion which adds to the increasing salinity levels (White and Falkland 2010).

In addition, modernization has played a pivotal role in shaping the present trends in lifestyle preferences with nutritional Pacific staple crops being replaced by nutritionally poor imported foods. Giant swamp taro is no exception and has also 'fallen' a victim to modernization. It was once a major food source in the Indo-Pacific region, but it is now being replaced by western food at an accelerating pace. Foods such as instant noodles, rice, flour, biscuits are not only replacing giant swamp taro but also other local food crops such as pandanus, taro, yams, breadfruit and many others. Moreover, not all the cultivars are cultivated as preference varies according to taste, use, ease of cultivation and so on (Iese 2005). So apart from the effects of climate change and modernization, current preferences may also contribute to the extinction of some of these cultivars.

The objective of this paper is to develop a detailed descriptor list for classification, conservation and documentation of giant swamp taro cultivars in the Federated State of Micronesia (FSM).

Methodology

The descriptor list was developed during a two day workshop conducted in Pohnpei, FSM with the help of local people. The workshop consisted of 37 participants, 27 farmers and 10 agriculture field technicians of Pohnpei Agriculture Department. There was an equal distribution of age ranging from young to old farmers, while a 3:1 gender ration for men to women was present in the workshop. Using a giant swamp taro descriptor list composed by Iese (2005) consisting of 27 descriptors, along with IPGRI (1999) full descriptor list for *Colocasia esculenta* (taro) a detailed draft descriptor was prepared. This was then presented and explained to the participants with translations in Pohnpeian from the Pohnpei Chief Agriculture Officer Mr. Adelino Lorens. Through an open discussion, the participants at the workshop selected the most pertinent descriptors for swamp taro. There was common agreement among the participants for all the selected descriptors across both age range and gender. Mr. Adelino Lorens had collected approximately 50 proposed cultivars from his previous trips to the outer islands of FSM and had planted these in the Pilot farm. The Pilot farm presented a fair collection of all FSM cultivars, hence it was used for characterization of the aroid cultivars using the developed descriptor list with the help of four agriculture field technicians. Unfortunately, no qualified taxonomists were available for this workshop from either FSM or Fiji.

Results and discussion

Descriptor

Divided into eight sections namely plant habit, leaves, petiole, flower, root, corm, taste, and special characteristics, 37 key morphological traits were identified. Plant habit had three traits: namely plant span, height at maturity (a plant was considered mature by the presence of inflorescences and/or dying of 50% leaves) and number of suckers (Table 1). Leaves had 10 traits: leaf base shape, spread of leaf lobes, blade colour, main vein colour, presence of appendages (small leaf like structures emerging on the underside of leaves), arrangement, number of leaves, lamina length: width ratio, and petiole junction pattern (Table 2). Petiole had nine traits: colour of top, middle and bottom thirds of petiole, presence of stripes, shape of petiole, presence of spines, number of spines, spine colour and size (Table 3). Inflorescence, flower and fruits had eight traits: formation, stalk colour, spathe colour, spadix colour, colours of berries, seed viability, exposure of flower male portion, degree of fertility (Table 4). Corm had four traits, corm size, cortex colour, central corm colour, and fibre colour (Table 5). General descriptions were given for root, taste and special characteristics as it is difficult to construct closed more structured questions for these traits (Table 6).

Table 1. Plant habit descriptors

Trait	Variability
1.1 Plant span/ spread	Narrow (<50cm) Medium (50–100cm) Large (>100cm)
1.2 Plant height at maturity	1.Short (3-4m) 2.Medium (5-10m) 3.Long (>10m)
1.3 Number of suckers (direct shoots)	1. Many (< 10) 2. Few (5–10) 3. Less (>5)

Table 2. Leaves descriptor

Trait	Variability
2.1 Leaf base to petiole attachment	1. > 45° 2. < 45°
2.2 Spread of leaf lobes	1. Overlapping 2. Acute angles (<45°) 3. Right angles (90°)
2.3 Leaf blade margin	1. xxx (not wavy) 2. Undulate (wavy) 3. Sinuate (very wavy)

Acute lobes

Overlapping lobes

Entire margin

Wavy margin lobes

2.4 Leaf blade colour upper surface	<ol style="list-style-type: none"> 1. Whitish 2. Yellow/ Yellow green 3. Light green 4. Dark green 5. Pinkish green 6. Reddish green 7. Purplish 8. Blackish 	
2.5 Leaf lamina appendages	<ol style="list-style-type: none"> 1. Absent 2. Present 	 <div data-bbox="1238 633 1359 667" style="border: 1px solid black; padding: 2px; display: inline-block;">Cataphylls</div>
2.6 Leaf main vein colour upper surface	<ol style="list-style-type: none"> 1. Whitish 2. Yellow/ Yellow green 3. Light green 4. Dark green 5. Pinkish green 6. Reddish green 7. Purplish 8. Blackish 	<div data-bbox="1018 779 1150 808" style="text-align: center;">Leaf main vein</div> 
2.7 Leaf arrangement	<ol style="list-style-type: none"> 1. Counter-clockwise 2. Clockwise 	 <div data-bbox="991 1350 1082 1379" style="text-align: center;">Clockwise</div> <div data-bbox="991 1563 1161 1592" style="text-align: center;">Counter-clockwise</div>
2.8 Number of leaves	<ol style="list-style-type: none"> 1. Few (<5) 2. Normal (5-10) 3. Many (>10) 	

2.9 Leaf lamina length : width ratio

Greatest width was measured at right angles to mid vein



2.10 Petiole junction pattern

Describe

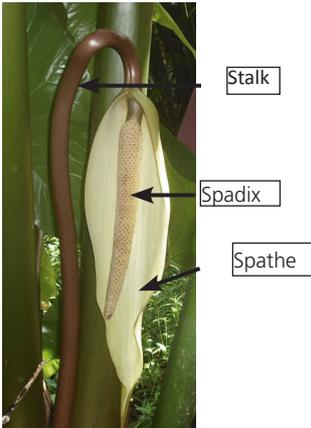
Table 3. Petiole descriptor

Trait	Variability	
3.1 Colour of top third	1. Whitish 2. Yellow/ Yellow green 3. Light green 4. Dark green 5. Pink-Pinkish green 6. Red-Reddish green 7. Purple 8. Black	
3.2 Colour of middle third	Same as above	
3.3 Colour of lower third	Same as above	
3.4 Petiole stripes	1. Absent 2. Present	 <p data-bbox="1278 1308 1393 1361">Petiole with fine stripes</p>
3.5 Petiole shape	1. Striaight 2. curved 3. swan's neck	<div style="display: flex; justify-content: space-around;"> <div data-bbox="199 1603 560 1895">  <p data-bbox="199 1861 284 1895">Striaight</p> </div> <div data-bbox="619 1603 970 1895">  <p data-bbox="619 1861 683 1895">curved</p> </div> <div data-bbox="1031 1603 1358 2049">  <p data-bbox="842 1989 963 2022">Swan's neckt</p> </div> </div>

3.6 Petiole throne/spine	1. Absent 2. Present	
3.7 Number of spines	1. Very little (<20 per/petiole) 2. Few(20-50 per/petiole) 3. Plenty(>50 per/petiole)	
3.8 Petiole spine colour	1.Green 2.Dark green 3.Yellow 4.Red 5.Pink 6.Purple	
3.9 Average spine size	1.Short(<2mm) 2.Medium (2-3mm) 3.Long (3-4mm) 4.Very long (>4mm)	

Thorns/ Spines

Table 4. Inflorescence or flower descriptor

Trait	Variability	
4.1 Flower	1. Absent 2. Present	
4.2 Flower stalk colour	1. Whitish 2. Yellow/ Yellow green 3. Light green 4. Dark green 5. Pink-Pinkish green 6. Red-Reddish green 7. Purple 8. Black	
4.3 Spathe (flower cover) colour top/ bottom and young/old	Describe	
4.4 Spadix colour	Same as 4.2 options	
4.5 Berries colour	Same as 4.2 options	
4.6 Seeds Viability	1. viable (grow) 2.non-viable (don't grow)	
4.7 Bottom portion of spadix	1. Enclosed 2. Exposed	
4.8 Fertility of the inflorescence	1. none 2. Low (<40% fertile flowers) 3. Intermediate (<80%) 4. High (almost 100%)	

Indicator of fertility

Berries/ seeds

Table 5. Corm descriptor

Trait	Variability
5.1 Corm Size	1.Small (<30cm) 2.Medium(30-50cm) 3.Large (>50cm)
5.2 Corm Cortex Colour	1. White 2. Yellow 3. Orange 4. Pink 5. Red 6.Purple 7. Other
5.3 Corm flesh colour central part	Same as above
5.4 Corm flesh Fibre colour	Same as above



Corm



Central part
Roots
Cortex

Table 6. Descriptors of root, taste and special characteristics

Trait	Variability
6. Roots	Describe
7. Taste	1. Very Hard 2. Itchy/ irritating 3. Good 4. Very good
8. Special characteristics eg. drought or salinity tolerance	Describe

While all the 37 descriptor traits were useful in characterizing the cultivars, there were a few outstanding ones that were key to effective characterization. These included number of suckers, presence of appendages, spread of lobes, leaf arrangement, traits related to spines on petiole and colour of spathe.

Characterization

Using the developed descriptor list for giant swamp taro 40 distinctive cultivars were characterized of the 50 cultivars present in FSM Pilot farm. The characteristics of all 40 cultivars is summarised in the Appendix (see below), namely Mwangpawiliet, Nah, Lihamwahu, Semesrao, Pahweitata, Mwangwel/nihndanis, nihndihjon/saimon, Mwangseh, PF1 Nihndoahm, Nihneri, Mwangwiklale, Omp 1, Omp 2, Loahr, Smihden 1, Smihden 2, Smihden 3, Smihden 4, Inpahrau, Nein serin, Mwang Palau, Mwang Meir, MwangNukuwer, Mwang so kalewe, Mwangweitahtatakateki, Pahrotorot, Nein Aidai, Anetchimo 1, Anetchimo 2, Smihden en nukuro, Mwangseri, Mohotuwa, Nenisehm 2, Nenisehm 3, Nenisehm 4, Fanal en nukuro, Weito, Pula fabul and Pularis. Of the 50 proposed cultivars present in the pilot farm only 40 were characterized as some cultivars had been severely damaged hence inadequate for characterization, lost or were a duplicate.

During the characterization it was found that four of the 40 cultivars found in FSM were not distinguished by locals hence these were named Nah, Lihamwahu, Semesrao and PF1. The first unknown cultivar was named Nah as the cultivar originated from the island of Nah. Lihamwahu meaning nice lady was the name given to the second unknown cultivars as a form of appreciation for the author's contribution to towards the farmer's crop. Semesrao was the name given to the third unknown cultivar as this cultivar was identified by the field technician Semes and the author Rao. PF1 was the name given to the fourth unknown cultivar to acknowledge the Pilot Farm (PF) the cultivars was identified on. These names were given by the participants of the workshop and were agreed to by everyone.

While generally the flowers of the giant swamp taro are not known to have fragrance it was found that the cultivar Semesrao had a frangipani-like fragrance and therefore similar to the flowers of *Colocasia esculenta*. The flower of Semesrao has a light yellow spathe and a white spadix, but unfortunately specific use of the flower is unknown but they can be used for floral decoration. Another outstanding cultivar which is easily distinguished is the Mwangnukuwer due to the presence of appendages. It is the only cultivar that had these appendages and is similar to the Paipaitalinga found in Tuvalu.

Conclusion

A descriptor list for *Cyrtosperma merkusii* (swamp taro) was prepared during the Workshop in Pohnpei (Federated States of Micronesia). Many of the FSM cultivars in the collection were characterized during this Workshop. While the descriptor list has many of the morphological and some physiological descriptors present, it can be made more effective through further use and/or by the addition of more traits. The use of molecular markers would also add another dimension to the characterization process. For effective conservation, collections have to be described and therefore a list of descriptors is essential. They help to rationalize an existing collection, thereby saving resources and they can assist in identifying unique accessions for safe conservation and duplication. The existing threats of climate change and modernization means that it is vital to conserve the diversity of this important and unique crop. The Secretariat of the Pacific Community, Centre for Pacific Crops and Trees (SPC CePaCT) based in Fiji is working towards conserving and documenting the Pacific aroids which include the giant swamp taro.

It is essential not only to conserve these cultivars but also to document them, so that the valuable information about these cultivars is not lost. Currently a handful of the cultivars are threatened as many of these have evolved in isolation on the islands, including the four cultivars that were unknown to the locals.

Apart from being a food crop giant swamp taro is also woven into the island culture and traditions, which makes this a particular crop of major significance for these island nations. Loss of this species cultivars will not only have implications for food security but also for culture, traditions and to some extent identity.

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Appendix

Characteristics of Giant Swamp Taro (*Cyrtosperma merkusii*) Federated States of Micronesia Cultivars

Anetchimo 1

This cultivar is tall and has a large span with plenty of suckers. Leaves are entire with $\leq 45^\circ$ petiole attachment, arranged in a clockwise direction. It has more than ten leaves with leaf lobes that are at an acute angle. The cultivar has light green petioles with a straight neck and no stripes or spines. The flower has a green stalk with yellow spathe and reddish brown stripes; spadix is yellow and enclosed. Corm is pale yellow.



Fig.1. *Cyrtosperma merkusii* – Anetchimo 1 a, whole plant; b, inflorescence; c, exposed spadix; d, corm (cross-section).

Anetchimo 2

Is similar to **Anetchimo 1**, the only difference is the plant span, leaf attachment, arrangement and petiole. This cultivar has a narrow plant span with a $>45^\circ$ petiole attachment and a counter-clockwise leaf arrangement. The petiole is yellowish green turning pink towards base and has a curved neck. The corm of **Anetchimo 2** is light yellow and has a good taste.

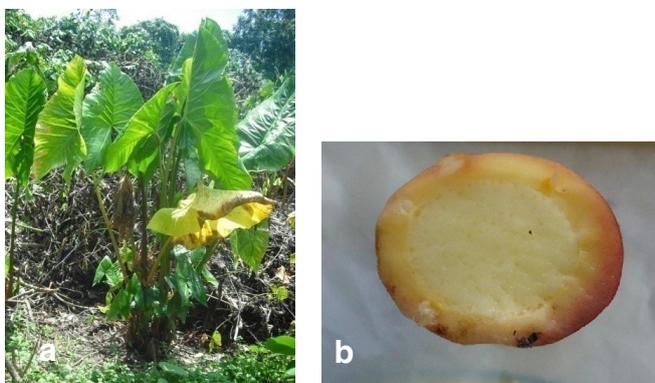


Fig. 2. *Cyrtosperma merkusii* – Anetchimo 2 a, whole plant; b, corm (cross-section).

Fanal en nukurou

Is a medium height cultivar with a narrow plant span and few suckers (5–10). Entire leaves have a $\leq 45^\circ$ petiole attachment, arranged in a clockwise direction with acute angled leaf lobes. The distinctive characteristic of this cultivar is that the petiole is dark purplish green with many white spines (spines 2–3 mm long). The petiole also has a curved neck and purple stripes at base.

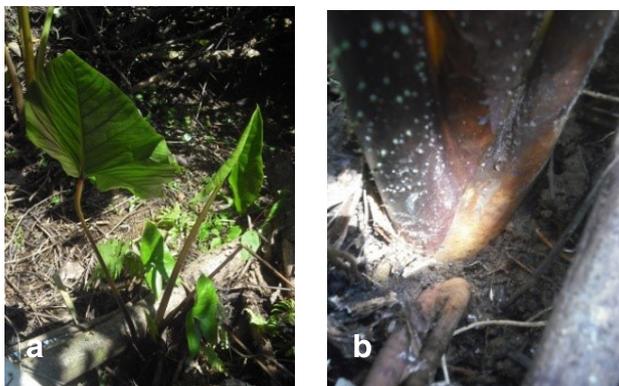


Fig. 3. *Cyrtosperma merkusii* – Fanal en nukurou a, whole plant; b, Petiole with white spines.

Inpahrau

Plants of this cultivar are 5–10m in height with a narrow plant span and has plenty of suckers. The leaves of this cultivar are undulate with a $\geq 45^\circ$ petiole attachment and arranged in a counter-clockwise direction. One of the distinctive features of this particular cultivar is its right angled leaf lobes which is rare amongst the cultivars. It has a smooth dark green petiole with a straight neck and stripes at base. It has flowers with dark green stalk similar to the petiole with a white exposed spadix and a yellowish brown spathe. The corm flesh is yellow with light brown fibres.



Fig. 4. *Cyrtosperma merkusii* – Inpahrau a, whole plant; b, Right angle leaf lobes; c, Inflorescence

Liha mwahu

Liha mwahu meaning ‘nice lady’ is a tall plant with medium span and less the five suckers. Dark green undulate, $>45^\circ$ leaves to petiole attachment with overlapping lobes are arranged in a counter-clockwise direction. It has green petioles, smooth with a curved neck. The flowers of the cultivar have a light green stalk with a white spadix and a yellowish green spathe. The flowers are 80% fertile. Corm has a light yellow flesh with brown fibres and many roots.



Fig. 5. *Cyrtosperma merkusii* – Liha mwahu **a**, whole plant; **b**, young inflorescence; **c**, inflorescence with mature flowers bearing seeds; **d**, corm (cross-section).

Mwahng loahr

Height and span is same as **Liha mwahu** but has fewer suckers, less than five. Leaves are entire with $>45^\circ$ petiole attachment arranged in a clockwise direction. Leaves have overlapping leaf lobes and less than five leaves are present on the plant. The cultivar has dark green petiole with straight neck and few white spines that are less than 2 mm long. Flowers have a dark green stalk with a yellow spathe enclosing a light yellow spadix. Corms have a pinkish yellow flesh that tastes good and has plenty of roots.

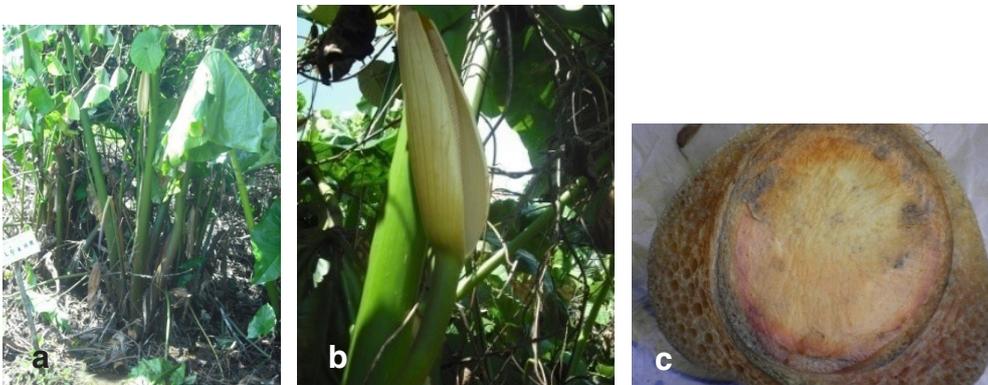


Fig. 6. *Cyrtosperma merkusii* – Mwahng loahr **a**, whole plant; **b**, inflorescence; **c**, corm (cross-section).

Mwahng meir (Mwahng form the mountain)

Cultivar has a medium height and span with fewer than five suckers. Leaves are undulating with $\leq 45^\circ$ petiole attachment, arranged in a clockwise direction. The plants have few leaves and acute angled leaf lobes. Petioles are yellowish green with few white stripes towards base, it is also smooth with a straight neck. The corm flesh is orange yellow with few roots and it tastes good.

Mwahng nukuwer

Medium height cultivar with narrow span and more than ten suckers. The distinctive feature of this particular cultivar is the presences of leaf appendages on the underside of the leaves. Other leaf characteristics include undulate leaf blade and $\leq 45^\circ$ petiole arrangement. Leaves are arranged in a counter-clockwise direction with acute angled leaf lobes. Petioles are light green turning darker towards base with purple stripes, it is also smooth with a curved neck. The cultivar has purplish green flower stalks with a bright orange spathe enclosing a pink spadix with viable seeds, inflorescence fertility with less than 80% fertile seeds. Cultivar has a white corm flesh with yellow fibres, few roots and tastes good.



Fig. 7. *Cyrtosperma merkusii* – Mwahng meir **a**, whole plant.



Fig. 8. *Cyrtosperma merkusii* – Mwahng nukuwer **a**, whole plant; **b**, appendages on under-side of leaf; **c**, inflorescence.

Mwahng shem

Cultivar plants are narrow in span, tall with many suckers. They have undulate leaves with $\leq 45^\circ$ petiole attachment and are arranged in a counter-clockwise direction. Leaf lobes are overlapping and a single mature plant has fewer than five leaves. Petioles are smooth, green with red stripes towards base and a straight neck. Flower has dark green stalk with purplish green spathe and an exposed whitish green spadix. Corm flesh is pale with few roots and tastes good.



Fig. 9. *Cyrtosperma merkusii* – Mwahng shem **a**, whole plant; **b**, inflorescence with mature flowers; **c**, corm (cross-section).

Mwahng so kalowe (few roots)

Narrow span cultivar with medium height and 5–10 suckers. It has fewer than five leaves that have an entire leaf blade arranged in a counter-clockwise direction. Petiole attachment to leaf is $\leq 45^\circ$ with overlapping leaf lobes. The cultivar has smooth, light green petiole turning pinkish green towards base with stripes and a curved neck. Flowers have a dark reddish green stalk with yellow spathe and an exposed whitish orange spadix which is generally infertile. Corm flesh is light orange with orange fibres, few roots and tastes good.



Fig. 10. *Cyrtosperma merkusii* – Mwahng so kalowe **a**, whole plant; inflorescence; **c**, corm (cross-section).

Mwahng weitahta takatek

Tall cultivar with medium span and fewer than five suckers. It has undulate leaves with $\leq 45^\circ$ petiole attachment, arranged in a counter-clockwise direction and has overlapping leaf lobes. The distinctive characteristic of this cultivar is its spiny petiole that has many spines (2–3mm long) which are the same colour as the petiole. Other characteristics of the petiole include its light green colour that turns pinkish towards base and a straight neck. Flowers of this cultivar have a reddish green stalk with an exposed pale red spadix and a spathe which is green and turns yellow as it matures. It also has a light yellow corm flesh with plenty of roots and tastes good.



Fig. 11. *Cyrtosperma merkusii* – Mwahng weitahta takatek **a**, whole plant; **b**, inflorescence with mature flowers; **c**, inflorescence with young flowers; **d**, corm (cross-section).

Mwahng wikalale (hybrid)

A single mature plant is tall, has medium span and fewer than five suckers. Has less than five leaves which are undulate, with $\leq 45^\circ$ petiole attachment and overlapping leaf lobes. Curved neck petioles are yellowish with stripes and a few short spines. Flowers have a green stalk with curved yellow exposed spadix and a yellowish pink spathe which is less than 40% fertile with viable seeds. Yellow corm with few roots and tastes good.

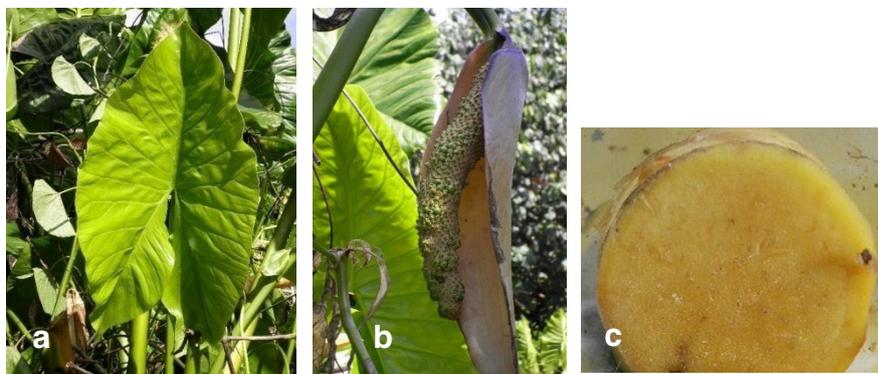


Fig. 12. *Cyrtosperma merkusii* – Mwahng wikalale **a**, whole plant; **b**, inflorescence with mature flowers; **c**, corm (cross-section)

Mwahng palau (Palau Taro)

Medium height and span cultivar with plenty suckers. Entire leaves with $>45^\circ$ petiole attachment arranged in a counter-clockwise direction having acute angled leaf lobes. Its petioles have swan neck shape, whitish green in colour with plenty of light green medium sized spines. Yellowish green flower stalks support a white exposed spadix and purplish green spathe that gradually turns reddish yellow with maturity. Corm flesh is light orange with brown fibres, also has plenty of roots and tastes good.



Fig. 13. *Cyrtosperma merkusii* – Mwahng palau **a**, whole plant; **b**, young inflorescence; **c**, inflorescence with mature flowers; **d**, corm (cross-section).

Mwang seri (Baby)

Plant habitat characteristics same as **Mwahng palau**, leaves are undulate with $\leq 45^\circ$ petiole attachment and acute angled leaf lobes. Leaves are arranged counter-clockwise with smooth, straight necked light green petioles and soft white corm with few roots.

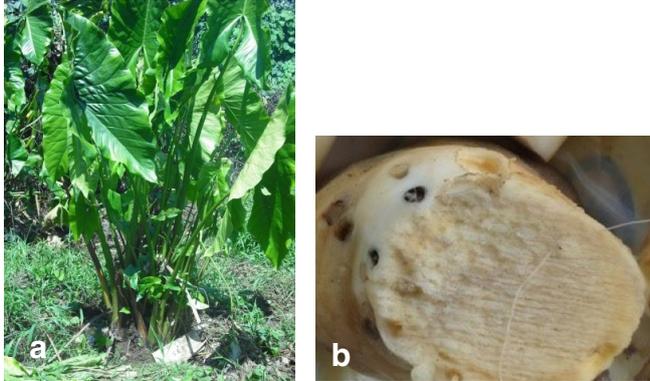


Fig. 14. *Cyrtosperma merkusii* – Mwang seri a, whole plant; b, corm (cross-section)..

Mohotuwa

Medium height cultivar with a narrow span and fewer than five suckers. Leaves are undulating with $\leq 45^\circ$ petiole attachment and overlapping leaf lobes. Leaves are arranged in a clockwise direction with smooth, straight necked petioles that are dark green in colour turning pinkish towards base. The corm flesh of the cultivar is pinkish orange with medium amount of roots.

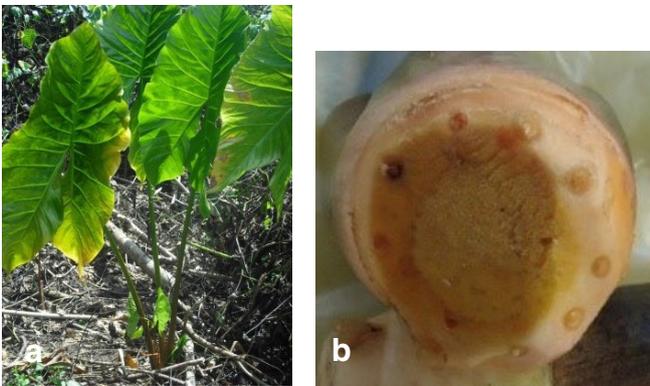


Fig. 15. *Cyrtosperma merkusii* – Mohotuwa a, whole plant; b, corm (cross-section).

Nah

Nah is the name of the particular atoll island where this taro is cultivated. Plants of the cultivar **Nah** are medium height with a narrow span and plenty suckers. Leaves have $>45^\circ$ petiole attachment with overlapping lobes, undulate arranged in a clockwise direction. It also has yellowish green petioles turning red towards base with a curved neck and plenty of medium sized whitish spines. Reddish green flower stalks have brownish red spathe and an exposed spadix with viable seeds and 100% fertility. Corm has yellow flesh with brown fibres and few roots.



Fig.16. *Cyrtosperma merkusii* – Nah **a**, whole plant; **b**, inflorescence; **c**, exposed spadix.

Nein Serin

Medium Height and spread cultivar with plenty suckers and leaves arranged counter-clockwise. Leaves are entire with $\leq 45^\circ$ petiole attachment and acute angled leaf lobes. The petioles are light green with purple stripe towards base, they are also smooth with a straight neck. The inflorescence has a dark green stalk with an exposed spadix and a green spathe with purple tip. Corm flesh is white with yellow flesh fibres and few roots.

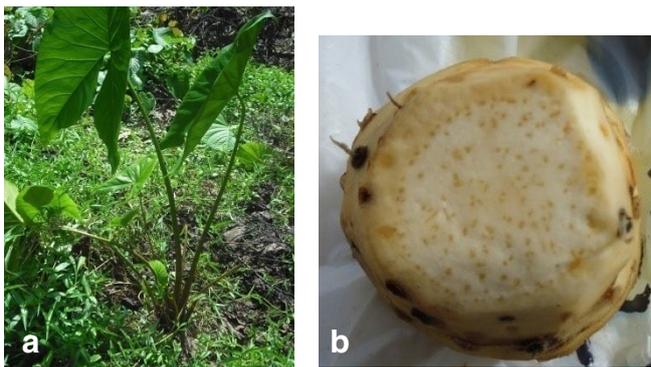


Fig. 17. *Cyrtosperma merkusii* – Nein serin **a**, whole plant; **b**, corm (cross-section).

Nihn dhanis/ M.wel

Is a medium size narrow span cultivar with less than five suckers and counter-clockwise leaf arrangement. Leaves are undulate with $\leq 45^\circ$ petiole attachment and acute angled leaf lobes. The petioles are straight necked, dark green with plenty of whitish spines (3–4mm long). Corm flesh is orange with few roots.



Fig. 18. *Cyrtosperma merkusii* – Nihn dhanis **a**, whole plant; **b**, petiole with large spines; **c**, corm (cross-section).

Nihn dijohn

Medium height cultivar with narrow span and plenty of suckers, leaves arranged in a counter-clockwise direction. Number of leaves per single matured plant is less than five with sinuate leaf blades, $\leq 45^\circ$ petiole attachment and overlapping leaf lobes. It has yellowish green petiole turning red towards base with stripes.



Fig. 19. *Cyrtosperma merkusii* – Nihn dijohn a, leaves; b, spathe; c, inflorescence; d, corm (cross-section).

Petioles also have a straight neck and plenty of medium sized spines same in colour as petiole. Low fertility inflorescences have a reddish green stalk with an exposed light orange spadix and reddish brown spathe. The corm has yellow flesh and few roots.

Nihn doahm

Tall cultivar with narrow span and few suckers, leaves are arranged counter-clockwise, with fewer than five leaves with $\leq 45^\circ$ petiole attachment, entire leaf blades and acute angled lobes. Petioles are smooth, straight necked and light green in colour. The cultivar has a unique flower with a dark green stalk and a uniquely shaped bright orange spathe enclosing a pale spadix. The corm has reddish yellow flesh with yellow fibres and few roots.

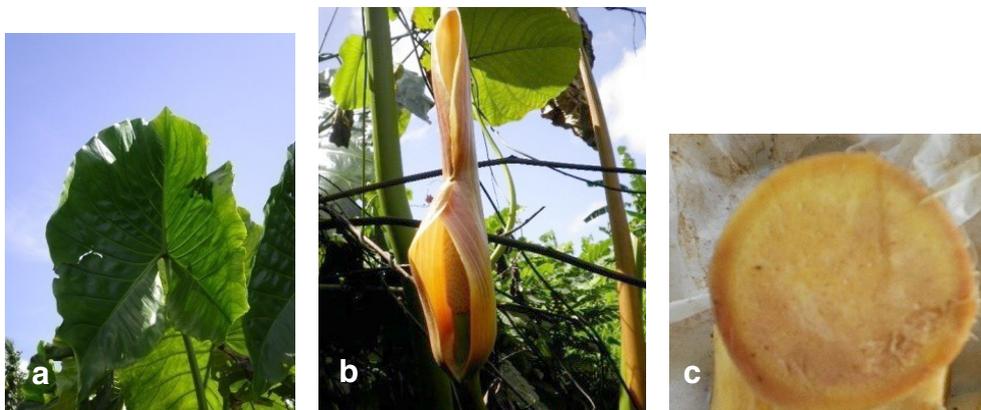


Fig. 20. *Cyrtosperma merkusii* – Nihn doahm a, leaves; b, enclosed inflorescence; c, corm (cross-section).

Nihn eneri

Is a tall cultivar with medium span and plenty suckers. Its undulate leaves are arranged in a clockwise direction with $\leq 45^\circ$ petiole attachment and acute angled leaf lobes. The straight necked light green petiole turns red towards base with stripes and does not have any spines. The flower of the cultivar has a dark green stalk with exposed light yellow spadix and an orange spathe with yellow tip. Along with light brown corm flesh, brown fibres and few roots.

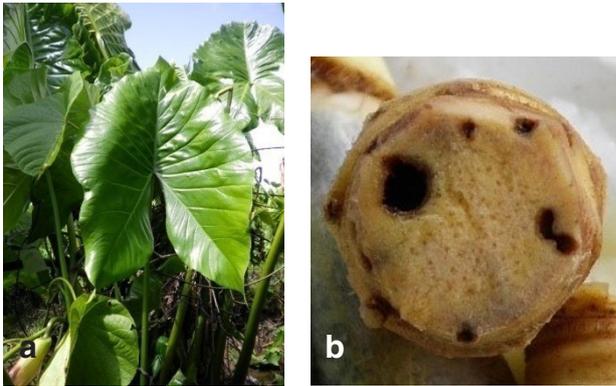


Fig. 21. *Cyrtosperma merkusii* – Nihn eneri **a**, whole plant; **b**, corm (cross-section).

Nihm sehm 2

Medium height and span cultivar with less than five suckers and leaves are arranged in a clockwise direction. Plants have fewer than five leaves, entire leaf blades with overlapping leaf lobes and a $\leq 45^\circ$ petiole attachment. The dark green petioles have straight necks with no stripes or spines.



Fig. 22. *Cyrtosperma merkusii* – Nihm sehm 2, whole plant.

Nihn sehm 3

All characteristic are the same as **Nihn sehm 2** expect its leaf arrangement which is counter-clockwise compared to the clockwise arrangement of **Nihn sehm 2**. It also has $>45^\circ$ leaf petiole attachment compared to **Nihn sehm 2** which has $\leq 45^\circ$.



Fig.23. *Cyrtosperma merkusii* – Nihn sehm 3, whole plant.

Omp 1

Cultivar is more than 10 m high with medium span and has plenty of suckers with leaves arranged clockwise. Leaves are entire, with $>45^\circ$ petiole attachment and acute angled leaf lobes. Its green petiole with red stripes at base has a straight neck with a few spines (< 2 mm long) of the same colour as the petiole. Inflorescence characteristics unknown. Corm has light orange flesh with orange fibres and medium roots.

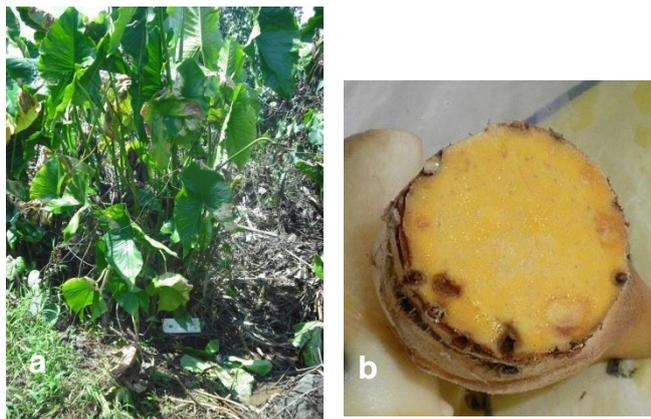


Fig.24. *Cyrtosperma merkusii* – Omp 1 **a**, whole plant; **b**, corm (cross-section).

Omp 2

Cultivar more than 10 m high, a wide span and has 5–10 suckers. Its leaves are entire with $\leq 45^\circ$ petiole attachment and acute angled leaf lobes while being arranged in a counter-clockwise direction. The light green petiole with curved neck turns purplish at base with stripes and has a few short whitish spines. The corm has a light yellow colour with yellow fibres and few roots.



Fig.25. *Cyrtosperma merkusii* – a, whole plant; b, corm (cross-section).

Pah rotorot (Red petiole)

Medium height and span cultivar with 5–10 suckers and leaves arranged in a clockwise direction. Leaves are undulate with $>45^\circ$ petiole attachment and overlapping lobes. Petioles reddish green, turning red towards base with stripes. The straight necked petioles also have a few short spines same in colour as petiole and corm whitish yellow with brown fibres and few roots.

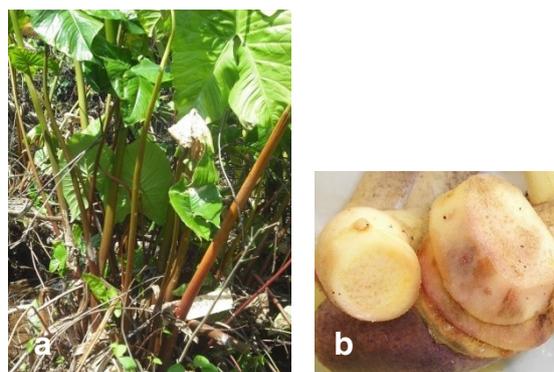


Fig.26. *Cyrtosperma merkusii* – a, whole plant; b, corm (cross-section).

Pwh weitata

The cultivar has tall plants with medium span and 5–10 suckers. Leaves are entire with $\leq 45^\circ$ petiole attachment and arranged in a clockwise direction. The cultivar has fewer than five leaves and leaf blades with overlapping leaf lobes. Its smooth, straight necked yellowish green petiole turns reddish towards base with stripes. Inflorescence has a reddish green stalk with an enclosed light orange spadix and a brownish orange spathe that turns purplish green at maturity. The corm is light orange with brown fibres and plenty of roots.



Fig.27. *Cyrtosperma merkusii* – a, whole plant; b, inflorescence; c, exposed spadix; d, corm (cross-section)..

PF1

Tall cultivar with medium span and 5–10 suckers. Leaves are undulate with $\leq 45^\circ$ petiole attachment and overlapping leaf lobes. Leaves arranged clockwise. Petioles dark green with purple stripes at base and smooth with a straight neck. The inflorescence has a dark green stalk, reddish yellow spathe enclosing a whitish orange spadix. Similar to the spathe colour, the corm has a light orange flesh with reddish brown fibre and has few roots.



Fig. 28. *Cyrtosperma merkusii* – PF1 **a**, whole plant; **b**, inflorescence with exposed spadix; **c**, corm (cross-section).

Pwiliet

Pwiliet is a common cultivar and is known and grown by many farmers, it is a medium height cultivar with a large span and few suckers. Leaves are undulate with a $>45^\circ$ petiole attachment and overlapping leaf lobes. Clockwise arranged leaves that are yellowish green with red stripes towards base, it also smooth with a curved neck. The inflorescence has a reddish green stalk, an exposed reddish orange spadix and a yellow spathe that gradually turns reddish yellow with maturity. Corm has orange flesh with orange fibres, plenty of roots and tastes good.



Fig. 29. *Cyrtosperma merkusii* – Pwiliet **a**, whole plant; **b**, inflorescence enclosed in spathe; **c**, corm (cross-section).

Pularis

Medium height cultivar with narrow span and less than five suckers. Leaves are undulate with $>45^\circ$ petiole attachment and overlapping leaf lobes. Cultivar has less than five leaves that are arranged in a counter-clockwise direction with smooth, straight necked reddish green petiole.



Fig. 30. *Cyrtosperma merkusii* – Pularis whole plant.

Semes rao

Narrow span, tall cultivar with few suckers and leaves arranged in a clockwise direction. Its entire leaves have overlapping leaf lobes with a $>45^\circ$ petiole arrangement. The dark green petioles have no stripes or spines but have a straight neck. The inflorescence has dark green stalk with an enclosed light yellow spadix and a yellow spathe with green veins. This is the only cultivar that was found to have a frangipani-like fragrance. Its corm has white flesh with brown fibres and few roots.

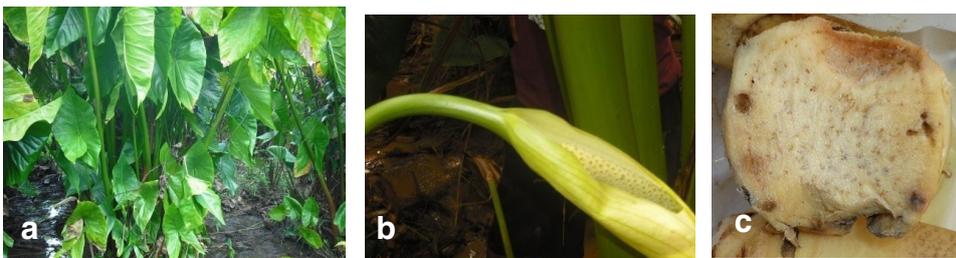


Fig. 31. *Cyrtosperma merkusii* – Semes rao **a**, whole plant; **b**, inflorescence enclosed in spathe; **c**, corm (cross-section).

Smihden 1

This is a tall, large cultivar with few suckers and leaves that are arranged in a counter-clockwise direction. Its undulate leaves have a $>45^\circ$ petiole attachment with acute angled leaf lobes. The petioles are straight necked, dark green with stripes at base and very few short green spines. Inflorescences have a dark green stalk with an exposed yellow spadix and a dark yellow spathe. Fertility of the inflorescence is less than 40%. The corm flesh is white with medium amount of roots and tastes good.



Fig. 31. *Cyrtosperma merkusii* – Smihden 1 **a**, whole plant; **b**, inflorescence enclosed in spathe; **c**, corm (cross-section).

Pula fabul

Medium height and span plant with fewer than five suckers and leaves arranged in a clockwise direction. The leaves are entire with $\leq 45^\circ$ petiole attachment and overlapping leaf lobes. Its yellowish green petiole with red stripes at base has a straight neck and plenty of medium sized spines same in colour as petiole.

Smihden 4

This cultivar is tall, has medium plant span and plenty suckers. It has undulate leaves with $\leq 45^\circ$ petiole attachment is arranged clockwise and has overlapping leaf lobes. The petioles are straight necked, green and have no stripes or spines. The inflorescence have dark green stalks, whitish orange exposed spadix and a reddish orange spathe that turns dark green at maturity. Flowers of this cultivar are not fertile, have brownish orange corms with few roots and tastes good.



Fig. 33. *Cyrtosperma merkusii* – Smihden 4 **a**, whole plant; **b**, young inflorescence enclosed in spathe; **c**, mature inflorescence; **d**, corm (cross-section).

Smihden en nukuro

Plants of this cultivar are of medium height, narrow span and have fewer than five suckers. Clockwise arranged leaves have entire leaf bases with overlapping lobes and $\leq 45^\circ$ petiole attachment. Its green petiole turns pink towards base and has a curved neck with few dark green short spines. The corm flesh is bright yellow with yellow fibres and few roots.

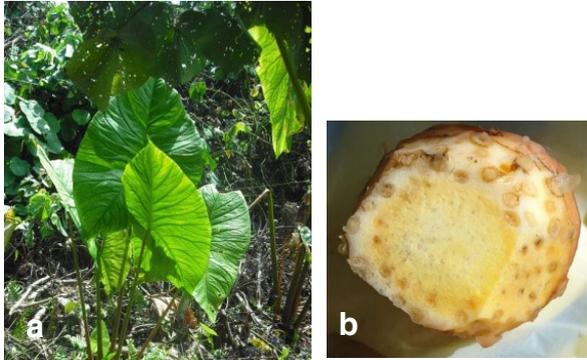


Fig.34. *Cyrtosperma merkusii* – Smihden en nukuro **a**, whole plant, **b**, corm (cross-section).

Weito

Medium height narrow span cultivar with fewer than five suckers and leaves are arranged in a counter-clockwise direction. Its leaf blade is entire with acute angled leaf lobes and $\leq 45^\circ$ petiole attachment. The petioles are generally dark green turning purple towards base with stripes, it also has a straight neck and plenty medium sized dark green spines.



Fig.34. *Cyrtosperma merkusii* – Weito whole plant.