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DISTRIBUTION OF CITRUS SPECIES ON POHNPEI ISLAND OF THE FSM

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Introduction

The geographical position of Pohnpei Island of the FSM can allow the cultivation of Citrus spp, however, the prevalent heavy rainfall may present a problem with economical production of citrus fruits. The exploratory study of MORIMOTO (1981) did some work on description of existing species on the same island. Apart from the changes which may have occurred with the passage of time from the last survey, we carried out studies on the Citrus spp distribution and also the problems associated with economic exploitation of citrus on Pohnpei Island. We found that although the people planted a few trees around their homes there were no large orchards, citrus fruits are consumed as fresh fruit and for sauce or flavoring fresh fish. The common ones being lime (*C. aurantifolia* SWINGLE) and calamondin (*C. madurensis* LOUR). In this study we collected 49 samples including fruits, shoot and leaves. The results of the species description showed that apart from lime and calamondin, pummelo (*C. grandis* OSBECK), ponkan (*C. reticulata* BLANCO), lemon (*C. limon* BURM. f.) and Melanesian papeda (*C. macroptera* MONT.) are grown on Pohnpei Island. The hybrids between these spesies, for example tangelo (*C. reticulata* x *C. grandis*) are also found on Pohnpei Island.

Materials and Methods

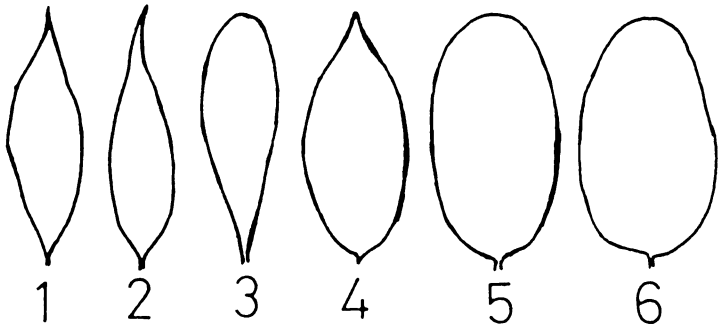
A total of 16 sites were sampled (Fig. 1). Tissue collected were leaves, shoots, flowers and fruits. Leaf morphology was characterized according to the scheme in Fig. 2 (IWAMASA), flowers were classified based on petal colour and fruits on the basis of fruit weight, fruit shape, peel texture, thickness of flavedo and albedo, flesh colour, juiciness, seed and embryo number and their colour, and also juice acidity and total soluble solids content (Brix) (SAUNT, 1990; TANAKA, 1946; TANAKA, 1954). Of the samples collected, some of them were difficult to classify due to absence of reproductive growth but most were successfully classified.

Results and Discussion

The results of leaf, stem and fruit samples collected from the 16 sites are tabulated on Table 1. Of the 49 samples, 14 had winged petioles and 10 samples were collected while still in the flowering stage and 12 samples had no fruit or flowers. Results on reproductive growth analysis are presented on Table 2. Exclusive of 12 samples which had no reproductive structures at sampling time 37 samples based on reproductive growth were classified up to species level. For the non classified materials it is supposed that 9 belong to the *C. reticulata* group and 3 in the *C. aurantifolia* group.

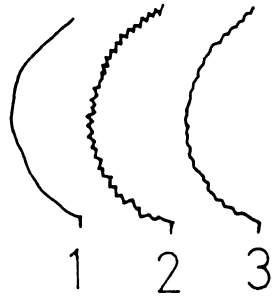
Fig. 1 Sampling locations for citrus in Pohnpei Island of the FSM.

Based on leaf, flower and fruit characteristics the samples were classified into 11 species according to Table 3. The lime group *C.aurantifolia*, accounted for the largest species i.e. 25. According to seediness, embryo number and colour the following group were recognized, Tahiti lime *C. latifolia* (mono embryo), sweet lime *C. limettioides* (light green multi embryonic fruit) and Mexican lime *C. aurantifolia* (green multi embryonic fruit). In total 12 samples were sweet lime, 9 of Tahiti lime and the balance made up to Mexican lime. There were 7 samples which had very small fruits, of these, 6 were classified as calamondin *C. madurensis* and the other as Melanesian papeda *C. macroptera*. Ten samples had leaves and shoots which resembled ponkan *C. reticulata* in morphology but absence of reproductive growth prevented complete description. There other samples were classified as pummelo *C. grandis* (2 samples), tangelo (2 samples) and single samples of lemon *C.limon*, sweet orange *C. sinensis* and sour orange *C. aurantium*.



Leaf shape types

Leaf tip types



Leaf margin types

Fig. 2 Leaf characters of citrus.

Table 1. Characteristics of stem, leaves and fruitlets of citrus fruits collected on Pohnpei Island of the FSM

Number	Collected location (Fig.1)	Branching	Leaf characters (Fig. 2)					Leaf brade		Petiole length (mm)	Flower petal colour	Inflorescence
			Shape	Tip	Margin	Size	Wing	Length (mm)	Width (mm)			
1	A	Upright	5	2	3	M	None	84.2	39.0	9.5	None	–
2	A	Upright	5	2	3	M	None	82.4	43.0	10.3	None	–
3	A	Upright	5	2	3	L	None	95.3	54.0	7.0	Purple	Raceme
4	A	Spreading	6	3	1, 3	L	S	101.0	45.0	11.3	None	–
5	A	Spreading	6	4	1, 3	L	S	102.6	61.0	11.7	None	–
6	B	Upright	5	3, 4	3	M	None	89.0	43.3	11.3	None	–
7	A	Spreading	4	2	3	M	None	81.3	42.0	12.3	None	–
8	D	Unknown	5	3	3	M	None	85.7	39.7	6.0	None	–
9	E	Spreading	4	2	3	S	None	75.0	36.3	15.3	None	–

Abbreviations, L=Large, M=Medium, S=Small

Table 1. continued

Number	Collected location (Fig.1)	Branching	Leaf characters (Fig. 2)					Leaf brade		Petiole length (mm)	Flower petal colour	Inflorescence
			Shape	Tip	Margin	Size	Wing	Length (mm)	Width (mm)			
10	G	Upright	5	3	3	M	M	78.7	43.0	21.7	None	−
11	G	Upright	5	2	3	M	None	97.2	43.1	12.1	None	−
12	D	Upright	4	3	3	M	None	84.5	40.7	6.1	None	−
13	F	Upright	4	2	1, 3	S	None	64.4	35.1	11.4	None	−
14	P	Upright	5	3	3	M	S	79.2	41.3	18.3	None	−
15	P	Upright	5	3	1, 3	S	S	66.3	33.5	10.8	None	−
16	P	Upright	1	1	3	S	None	60.7	34.4	11.0	None	−
17	P	Upright	4	2	3	M	None	104.0	46.0	10.3	None	−
18	O	Upright	4	2	3	M	None	92.2	46.3	9.2	White	Raceme
19	P	Upright	1	1	3	S	None	77.6	32.5	9.8	None	−
20	N	Unknown	5	4	3	M	None	81.9	46.7	9.0	White	Raceme
21	M	Upright	5	3	3	M	None	77.7	44.8	7.1	White	Raceme
22	M	Unknown	5	4	3	L	M	91.2	60.8	21.2	None	−
23	L	Upright	5	4	3	S	None	62.3	34.6	7.6	None	−
24	L	Upright	1	1	3	S~M	None	82.2	36.1	6.9	None	−
25	K	Upright	6	4	1, 3	M	None	90.0	55.5	13.1	None	−
26	E	Upright	5	4	3	M	None	101.0	58.3	9.5	None	−
27	H	Upright	1	2	3	M	S	69.6	39.3	16.0	None	−
28	I	Upright	5	4	3	M	M	77.6	43.5	18.8	White	Raceme
29	I	Upright	4	2	3	M	None	92.8	48.7	6.2	White	Raceme
30	C	Upright	4	3	3	S	M	56.4	26.5	13.3	None	−
31	C	Upright	4	2	3	L	None	108.8	53.3	9.1	None	−
32	C	Upright	1	2	3	S	None	76.9	28.7	8.7	None	−
33	C	Upright	5	3	3	M	None	94.0	56.3	7.7	None	−
34	J	Spreading	4, 5	3, 4	3	M	None	93.5	39.5	9.4	White	Single
35	J	Upright	1	1	3	M	None	100.2	45.4	13.6	None	−
36	J	Upright	5	3	3	S	S	69.6	38.0	15.6	None	−
37	J	Unknown	4	3	3	M	L	66.9	38.3	59.2	None	−
38	J	Unknown	4	3	1, 3	M	None	62.3	47.1	9.2	None	−
39	J	Spreading	4	3, 4	3	M	None	104.0	48.3	8.1	None	−
40	J	Unknown	5	4	3	M	None	81.1	41.8	7.5	None	−
41	J	Spreading	5	4	3	M	None	74.3	35.5	7.5	None	−
42	J	Spreading	5	4	3	S	None	53.8	31.8	7.9	White	Single
43	J	Upright	4	3	3	M	M	82.9	57.3	25.6	None	−
44	J	Upright	4	3	3	M	None	90.4	40.7	9.5	Purple	Raceme
45	J	Spreading	1	1	3	L	M	108.7	53.9	14.4	White	Raceme
46	J	Spreading	4	3	3	L	None	78.8	39.9	15.4	None	−
47	J	Spreading	5	3	3	L	S	74.6	56.0	14.7	None	−
48	J	Spreading	4	3	1, 3	S~M	None	74.2	36.3	12.8	None	−
49	E	Spreading	1	1	3	M	None	100.2	48.5	9.5	None	−

Abbreviations, L=Large, M=Medium, S=Small

Table 2. Characteristics of citrus fruits collected on Phonpei Island of the FSM

Number	Fruit weight (g)	Fruit diameter (mm)	Fruit height (mm)	Shape index	Peel texture	Stem end neck	Stylar[x] end convex	Navel	Peel thickness (mm)	Segment number	Flavedo thickness	Albedo thickness	Flesh[y] colour	Juice	Seed number	Embryo Number	Embryo Colour[y]	Brix	Acidity (%)
1	25.8	36.8	37.0	99.5	Smooth	Low	S	None	2.80	9.7	Medium	Medium	Cream	Much	16.0	3.5	Green	8.0	5.30
2	26.7	36.2	39.9	90.7	Smooth	Low	S	None	2.33	9.3	Medium	Medium	L-yellow	Much	16.0	3.5	L-green	7.8	6.21
3	97.2	53.7	66.7	80.5	Smooth	None	L	None	3.37	10.0	Thin	Thin	White	Less	0	–	–	6.0	4.05
4	78.4	53.6	55.7	96.2	Coarse	None	–	None	8.33	10.7	Medium	Medium	Cream	Less	3.7	2.5	White	8.6	2.77
5	121.8	62.0	63.1	89.3	Smooth	None	–	None	5.50	11.3	Medium	Medium	Cream	Medium	5.7	2.5	L-green	7.6	3.51
6	41.5	43.4	41.9	103.6	Smooth	None	–	None	2.13	9.0	Thin	Thin	L-orange	Medium	7.7	2.5	L-green	7.2	5.35
7	No fruit																		
8	95.4	56.6	61.0	92.8	Coarse	None	M	None	3.33	8.7	Medium	Thin	L-orange	Much	12.7	3.5	White	7.4	6.10
9	3.1	17.0	16.6	102.4	Smooth	None	S	None	1.13	8.0	Thick	Thin	L-yellow	Medium	7.0	4.5	Green	10.4	6.61
10	26.6	35.5	39.3	90.3	Smooth	Low	S	None	2.23	10.3	Thin	Medium	White	Medium	6.7	3.5	L-green	7.0	5.65
11	15.5	30.4	32.5	93.5	Smooth	None	S	None	2.00	11.0	Medium	Thin	L-green	Much	3.0	1	L-green	7.6	6.16
12	No fruit																		
13	6.2	21.5	22.2	96.8	Smooth	None	–	Small	1.10	6.3	Medium	Thin	L-orange	Much	5.0	4.5	Green	8.2	6.43
14	18.2	31.3	35.9	87.2	Smooth	None	M	None	2.07	10.3	Thin	Medium	L-green	Medium	7.0	4.5	L-green	6.8	4.90
15	12.2	29.1	26.3	110.6	Smooth	None	–	None	1.60	8.0	Thin	Thin	L-orange	Much	6.0	3.5	L-green	8.0	6.33
16	No fruit																		
17	No fruit																		
18	21.9	34.2	34.5	99.1	Smooth	None	S	None	2.40	9.7	Medium	Medium	L-green	Medium	9.7	3.5	L-green	7.6	5.56
19	No fruit																		
20	20.7	33.5	34.9	96.0	Smooth	Low	S	None	2.57	9.7	Thin	Medium	L-green	Much	10.3	3.5	L-green	7.2	5.80
21	74.9	51.7	56.6	91.3	Smooth	None	M	None	3.77	11.0	Medium	Medium	Cream	Much	0	–	–	6.6	5.29
22	278.5	92.0	98.1	93.8	Smooth	None	–	None	16.47	11.0	Medium	Thick	L-yellow	Medium	26.7	1	White	8.2	2.05
23	20.8	33.4	35.3	94.6	Smooth	Low	–	None	2.43	8.7	Thin	Thin	L-yellow	Much	9.0	1	L-green	7.8	6.39
24	No fruit																		
25	No fruit																		
26	41.1	42.7	42.7	100.0	Smooth	Low	S	None	2.77	9.3	Thin	Thin	L-yellow	Much	12.3	3.5	L-green	8.0	6.47
27	22.1	32.9	38.9	84.6	Smooth	Low	M	None	2.23	10.3	Thin	Medium	Cream	Much	4.7	1	L-green	7.0	5.07
28	21.4	32.9	38.0	86.6	Smooth	Low	M	None	2.00	10.3	Thin	Thin	L-yellow	Much	4.3	1	L-green	8.2	6.37
29	22.1	33.8	40.5	83.5	Smooth	None	M	None	4.16	11.0	Thin	Medium	White	Less	0	–	–	7.2	2.40
30	No fruit																		
31	80.2	50.8	52.9	96.0	Smooth	None	S	None	5.27	11.0	Thin	Medium	Cream	Medium	0	–	–	5.6	5.20
32	37.5	42.0	42.6	98.7	Coarse	High	–	Small	3.37	10.3	Medium	Thin	Cream	Less	0	–	–	8.8	3.59
33	131.6	65.0	68.0	95.5	Smooth	None	M	None	3.33	11.3	Thin	Medium	Cream	Medium	0	–	–	5.4	4.10
34	104.2	58.7	62.0	94.6	Smooth	Low	–	None	3.60	9.0	Medium	Thin	L-orange	Much	12.0	4.5	L-green	6.2	4.60
35	No fruit																		
36	30.7	37.6	40.9	91.9	Smooth	None	S	None	1.70	10.0	Thin	Thin	L-yellow	Much	7.0	2.0	L-green	7.0	5.87
37	6.1	19.7	33.5	58.7	Smooth	High	M	None	6.10	7.0	Thin	Thick	Green	Immature	2.0	–	–	–	–
38	No fruit																		
39	19.5	34.7	32.9	105.5	Smooth	None	–	None	1.40	10.0	Medium	Thin	L-yellow	Much	2.0	1	L-green	7.4	5.50
40	20.0	33.1	37.4	88.4	Coarse	Low	–	None	2.93	8.3	Thin	Medium	L-green	Medium	7.0	1	L-green	7.4	5.56
41	20.5	33.9	36.9	91.7	Smooth	Low	S	None	2.76	9.3	Thin	Medium	L-yellow	Much	10.7	2.5	L-green	7.8	5.97
42	8.9	25.5	24.2	105.2	Smooth	None	–	None	1.37	7.7	Medium	Thin	L-orange	Much	4.0	Many	L-green	8.0	6.37
43	96.5	58.9	57.6	102.3	Coarse	None	–	None	9.77	10.7	Thin	Thick	Cream	Less	22.7	4.5	L-green	9.0	3.60
44	19.7	29.7	35.3	84.1	Coarse	High	S	None	3.43	9.0	Medium	Thin	L-yellow	Much	0.7	Many	L-green	7.6	5.71
45	93.3	61.8	58.4	105.8	Coarse	None	–	Small	11.30	13.0	Thin	Thick	Cream	Less	9.0	1	White	7.2	1.91
46	1.4	12.4	13.5	91.8	Smooth	None	–	None	1.13	7.7	Thick	Thin	L-yellow	Immature	0.3	–	–	–	–
47	No fruit																		
48	4.5	15.5	17.4	89.1	Smooth	None	–	None	1.67	7.3	Medium	Thin	L-green	Immature	7.0	–	–	–	–
49	No fruit																		

Abbreviations, [x]L=Large, M=Medium, S=Small, [y]L-=Light

Table 3. Classification of citrus collected on Pohnpei Island of the FSM

Number	Classification		Number	Classification	
	Common name	Scientific name		Common name	Scientific name
1	Sweet lime	*C. limettioides* TANAKA	26	Sweet lime	*C. limettioides* TANAKA
2	Sweet lime	*C. limettioides* TANAKA	27	Tahiti lime	*C. latifolia* TANAKA
3	Lemon	*C. limon* BURM. f.	28	Tahiti lime	*C. latifolia* TANAKA
4	Tangelo	*C. reticulata* x *C.grandis*	29	Tahiti lime	*C. latifolia* TANAKA
5	Sweet orange	*C. sinensis* OSBECK	30	Unkown (Limes)	*C. aurantifolia* SWINGLE
6	Sweet lime	*C. limettioides* TANAKA	31	Tahiti lime	*C. latifolia* TANAKA
7	Ponkan	*C. reticulata* BLANCO	32	Ponkan	*C. reticulata* BLANCO
8	Mexican lime	*C. aurantifolia* SWINGLE	33	Tahiti lime	*C. latifolia* TANAKA
9	Calamondin	*C. madurensis* LOUR.	34	Sweet lime	*C. limettioides* TANAKA
10	Sweet lime	*C. limettioides* TANAKA	35	Ponkan	*C. reticulata* BLANCO
11	Tahiti lime	*C. latifolia* TANAKA	36	Sweet lime	*C. limettioides* TANAKA
12	Unknown (Limes)	*C. aurantifolia* SWINGLE	37	Melanesian papeda	*C. macroptera* MONT.
13	Calamondin	*C. madurensis* LOUR.	38	Ponkan	*C. reticulata* BLANCO
14	Sweet lime	*C. limettioides* TANAKA	39	Tangelo	*C.reticulata* x *C. grandis*
15	Calamondin	*C. madurensis* LOUR.	40	Tahiti lime	*C. latifolia* TANAKA
16	Ponkan	*C. reticulata* BLANCO	41	Sweet lime	*C. limettioides* TANAKA
17	Unkown (Limes)	*C. aurantifolia* SWINGLE	42	Calamondin	*C. madurensis* LOUR.
18	Sweet lime	*C. limettioides* TANAKA	43	Sour orange	*C. aurantium* LINN.
19	Ponkan	*C. reticulata* BLANCO	44	Sweet lime	*C. limettioides* TANAKA
20	Sweet lime	*C. limettioides* TANAKA	45	Pummelo	*C. grandis* OSBECK
21	Tahiti lime	*C .latifolia* TANAKA	46	Calamondin	*C. madurensis* LOUR.
22	Pummelo	*C. grandis* OSBECK	47	Ponkan	*C .reticulata* BLANCO
23	Tahiti lime	*C .latifolia* TANAKA	48	Calamondin	*C. madurensis* LOUR.
24	Ponkan	*C. reticulata* BLANCO	49	Ponkan	*C. reticulata* BLANCO
25	Ponkan	*C. reticulata* BLANCO			

In summary, of the 49 samples collected 46 were classified into 11 species. As for utilization, sweet lime, Tahiti lime, Mexican lime, lemon, calamondin and sour orange are used as sauce for fresh fish. Ponkan, tangelo and sweet orange are eaten as fresh fruit. Most of the trees on Pohnpei Island are seed raised. At Pohnpei Agricultural Research Station, the former Imperial Japanese Army planted sweet orange, pummelo and tangelo trees most of which died due to disease.

The high temps and rainfall on Pohnpei Island favor disease development and thus severely hinder successful production of citrus. The authors recommend the use of rootstocks and cultivars which are compatible with the geographical location of the island, and prevalent diseases.

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