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Observations on Pigafetta filaris

T. A. DAVIS
Haldane Research Centre, Nagercoil-4, Tamilnadu, India

T. KUSWARA
National Biological Institute, Bogor, West Java, Indonesia

Pigafetta filaris, the single-stemmed pinnate palm, native to Sulawesi, Indonesia, is the most elegant among palms, according to David Fairchild (1943). Those who have seen and admired this dioecious species in its wild state, growing at elevations between 300–1,500 m above sea level, on slopes of well-drained volcanic hills studded with lush equatorial vegetation, would only agree with Fairchild's eulogy of *Pigafetta*. M. E. Darian (1973), Dransfield (1973), and Sneed (1981) have paid further tribute in *Principes* to this remarkable, erect, stately palm.*

The authors made several visits to *Pigafetta* forests of north (Fig. 1) and central Sulawesi Provinces and examined the way the delicate-looking tiny seedlings of *Pigafetta* struggle to become established on the hill slopes and grow into massive palms. Germination studies were made at the Coconut Research Institute at Manado, North Sulawesi, Indonesia. Also we recorded the emergence, development and shedding of leaves in adult palms and measured their size at the Botanical Garden at Bogor, where some palms were introduced by J. Dransfield and J. P. Mogea in 1973. In addition, some data are provided on the size of male and female inflorescences as well as the number of fruits per infructescence.

*Dransfield (1976) drew attention to the curious ecology of *Pigafetta*, commenting on the huge number of very small seeds produced, and on the apparent behavior of *Pigafetta* as a light-demanding pioneer.

Size of Fruit, Germination and Seedlings

The tiny, orbicular fruits (Fig. 3) about 6 mm in diameter covered with scales are borne by the thousands on long infructescences that stay almost horizontal in the crown up to fruit maturity (Fig. 2), beyond which they gently bend downwards. Two consecutive mature fruit-bunches each were cut from 5 palms, and 100 fruits from each infructescence were weighed and the values recorded in Table 1.

Fruit samples collected from palms growing near Lake Tondano, North Sulawesi were sown in polybags (that are normally used for raising coconut seedlings) at the residence of the first author close to the Coconut Research Institute, Manado. Shoots started appearing 30 days after sowing. An additional couple of days elapsed before the eophyll could be seen above the surface of dry leaf mulch. According to Dr. M. E. Darian, germination ran from two to three months in California. Observations were recorded on: germination of fruit and nature of seedlings; date when the lamina portion of each leaf fully emerged; length of lamina portion of leaf; number of leaflets per leaf; diameter of collar at soil level; number of epidermal hairs (as far as possible to count); the height of plant from ground to tip of tallest leaf; date of withering of each leaf; and size of infructescences and number of fruits per infructescence. The size of fruits does not vary significantly between inflorescences

1. A grove of wild *Pigafetta filaris* on a hill slope in North Sulawesi, Indonesia.

from either the same palm or between palms from the same locality.

From the above observations, we calculated the duration of full emergence of a leaf from its first appearance outside the leaf preceding it. The data in Table 2 show that the leaves took 10–19 days for full emergence of lamina from its first becoming visible, and that this time could vary considerably. For example, leaves 3–8 took the least time for emergence while leaves 17–20 required the maximum time. The difference in the time of emergence of leaves could be due to the presence or absence of rain. The period for the emergence of successive leaves also shows considerable variation. A new leaf is produced at an interval of 10–19 days. However, such variation decreases in adult palms. The active life of each leaf (as inferred from its green state) was also calculated from the dates of full emergence to complete withering. The first two leaves remained green for a longer period compared with the subsequent six leaves. Thereafter, for subsequent leaves there is clear indication that the leaf remained green for progressively longer periods. Within about one year, the plant had grown to about 140 cm. (Darian reported a much greater growth for his well-cared for young palm.) Also its girth has registered a tenfold increase from 5th month to 12th month. The first leaf had 6 leaflets. The lamina was bilobed, and each lobe had 3 unsplit leaflets. The 20th leaf bore 39 leaflets, all free.

Speedy germination, fast rates of growth, production of leaves and roots, long internodes and nodal roots characterize the early growth of *Pigafetta filaris* (Fig. 4). The rapid growth-rate of the seedlings is achieved by having very long internodes and developing roots from nodes that help

Table 1. Pigafetta filaris*: Weights of 100 mature fruits from each infructescence.*

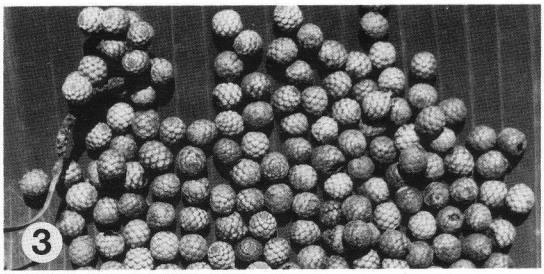
Palms	Wts. of 100 Fruits from Older Infructescence (gm)	Wts. of 100 Fruits from Younger Infructescence (gm)	Mean per Palm (gm)
1	66.59	66.17	66.38
2	65.71	65.64	65.68
3	65.49	66.72	66.11
4	66.25	66.19	66.22
5	66.29	65.65	65.97
Mean	66.07	66.27	66.17

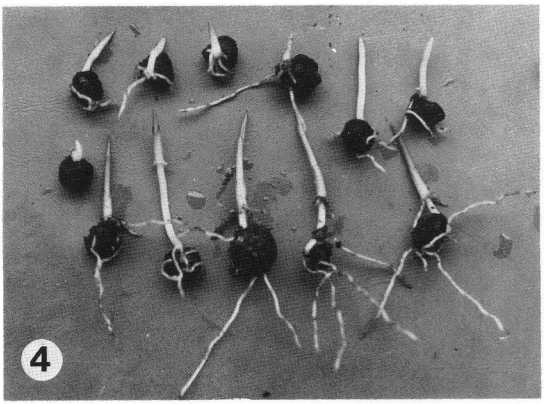
2. Female *Pigafetta* bearing about ten infructescences.

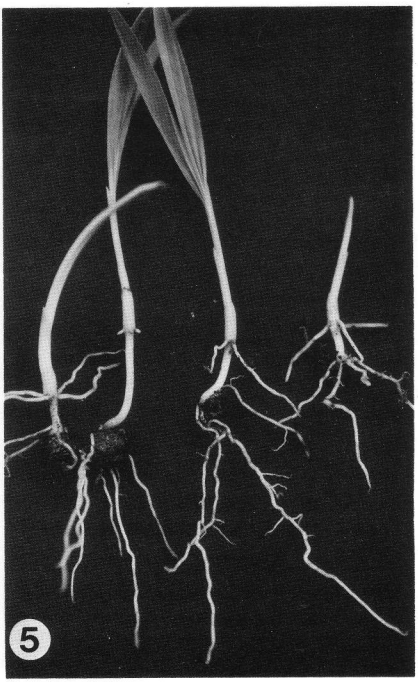
to anchor the young palm by serving as stilt roots. The lowest portion of the stem is the thinnest; with every node where more and stronger roots are produced, the girth of the stem increases steadily (Fig. 5). Such stem growth is similar to that of certain palms which produce stilt roots, like *Vershaffeltia splendida*. Another extreme case is *Eugeissona minor*, in which the whole plant is supported by stilt roots (see Holbrook, Putz, and Chai 1985). Thus, the development of the trunk of *Pigafetta* is different from that of palms which develop a thick bole at the base of stem, a good example being the coconut.

A seedling produces two scale leaves before the appearance of the first laminate leaf. The leaves of *Pigafetta filaris* have a profusion of long, slender epidermal spines of a golden color. Especially on the leaf-base and petiole, they are arranged characteristically in horizontal, long or broken rows (Fig. 6). The stem is smooth where the lighter-colored, grayish annular leaf-scars contrast with the greenish-brown, shiny internodes. The lowermost portion of the trunk above ground level may produce numerous aerial roots that penetrate the soil and serve as extra support for the tall stem, and as additional organs for the absorption of nutrients. Up to some distance above this aerial root zone, many palms show a profusion of short, rootlike structures that dry up and function as hard spiny outgrowths (Fig. 7).

The hairy outgrowths on the leaves of *Pigafetta* start appearing practically from the eophyll. The periphery of the petiole starts supporting a linear row of soft spines. The two margins of the petiole of subsequent leaves also develop such hairs. As more leaves are produced, the hairy outgrowths also start developing from the leaf rachis, both on the abaxial and adaxial surfaces. The petiole and the leaf-base develop greater numbers of hairs which grow long and eventually get stiffer. The increase of hairs as the seedling grows is shown in Table 2. It was not possible to make accurate counts of the numerous







3. Tiny, spherical, ripe fruits of *Pigafetta* covered by spirally-arranged scales. 4. Seedlings of *Pigafetta*; note the elongated thin internodes and nodal roots. 5. Stages of germination: bifid leaves appear after 2 rudimentary leaves; adventitious roots emanate from nodes.

outgrowths on the leaves beyond the 11th leaf.

Figure 8 shows a *Pigafetta* seedling bearing 7 laminate leaves which is about five months from sprouting of seed. The same seedling is illustrated at 10 months in Figure 9, having produced 15 leaves, many of the older ones having already withered away.

The Stem

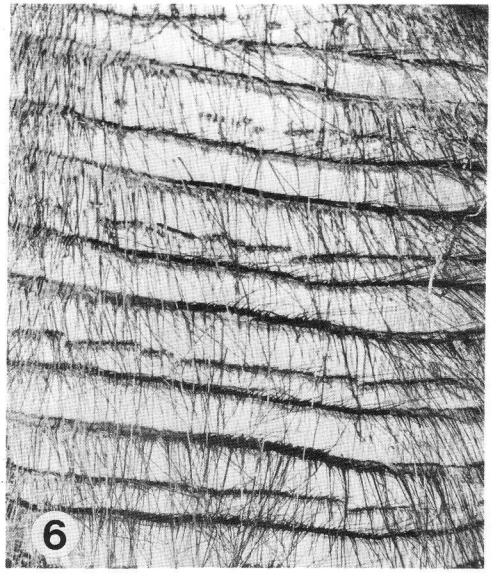
The stem of *Pigafetta filaris* is fast-growing, solitary, stout and "as straight as an arrow." Since many palms stand close to each other in their natural habitat, the shining, dark-green and smooth stem makes a magnificent sight. The periphery of the mature portion of the stem is very strong although the inner core is pithy and soft. Farmers make conduits (Fig. 10) out of the mature stem by removing the soft core. Another good use for the stem of *Pigafetta* is as pillars or legs for granaries and houses of the Toraja People of South Sulawesi, as illustrated by Sneed (1981).

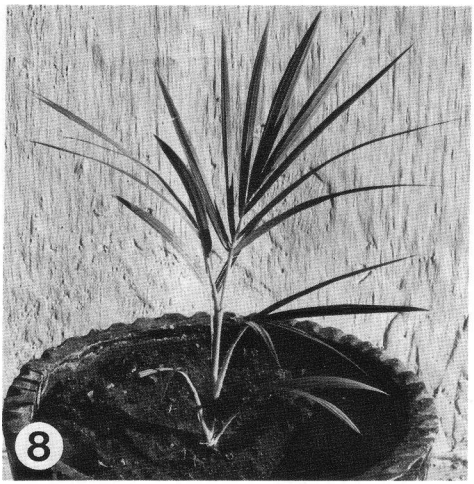
The girth of the stem of 3 female and 3 male palms at the Botanical Garden, Bogor was measured at one-meter intervals to see at what rate the stem decreases in girth. The data are given in Table 3.

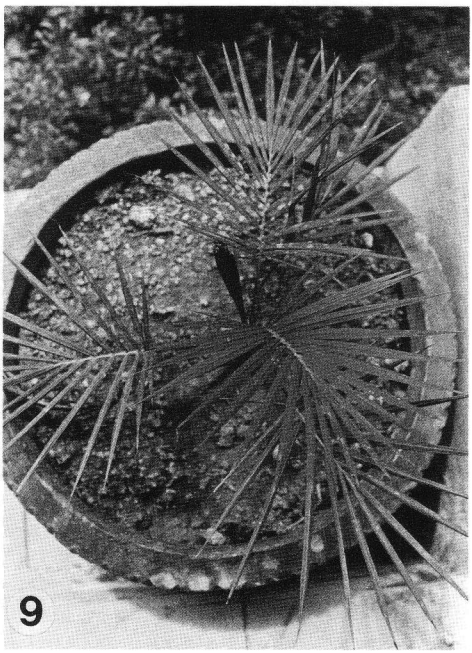
The stems of adult *Pigafetta* show a bolar swelling up to about one-meter in girth from ground level. It may be recalled that all these palms were transplanted in 1973, when the original thin stem-tips were buried in the seedling hole. Further, the palms at Bogor were planted on level ground unlike the hilly terrain of their natural habitat where they have to struggle

Table 2. Pigafetta filaris: *Germination and growth of a typical seedling (sown 5-5-1978).*

Number of Laminate Leaves	Date of Emergence	Interval btn. Leaves (days)	Duration of Emergence (days)	Lamina Length (cm)	No. of Leaflets	Collar Thickness (cm)	No. Epidermal Hairs	Date of Drying 1978–1979	Life of Leaf (days)	Ht. of Plant (cm)
1	22 Jun 78	—	—	6.5	6	—	13	21 Oct	121	—
2	20 Jul 78	28	19	7.2	6	—	22	10 Nov	117	—
3	28 Aug 78	39	12	8.3	7	—	34	2 Dec	96	—
4	12 Sep 78	15	10	9.5	8	—	38	10 Dec	89	—
5	26 Sep 78	14	11	12.3	9	0.4	57	18 Dec	83	17.0
6	10 Oct 78	13	11	14.3	12	0.5	68	5 Jan	87	22.5
7	25 Oct 78	13	11	16.8	14	0.8	102	24 Jan	91	30.0
8	10 Nov 78	16	12	20.8	16	1.1	120	17 Feb	99	33.5
9	27 Nov 78	17	13	18.7	18	1.2	135	19 Mar	112	36.5
10	18 Dec 78	21	14	17.0	22	1.4	145	18 Apr	121	37.5
11	9 Jan 79	22	13	19.2	24	1.5	200	1 May	112	—
12	27 Jan 79	18	13	20.0	24	1.6	numerous	20 May	113	—
13	16 Feb 79	20	12	16.0	25	—	numerous	9 Jun	115	—
14	1 Mar 79	13	10	18.0	27	2.8	numerous	30 Jun	121	45.0
15	15 Mar 79	14	11	25.0	29	—	numerous	20 Jul	127	—
16	29 Mar 79	14	10	27.0	31	—	numerous	—	—	76.5
17	17 Apr 79	19	15	38.0	34	3.5	numerous	—	—	—
18	8 May 79	21	16	43.0	37	3.8	numerous	—	—	—
19	4 Jun 79	26	19	45.0	39	4.0	numerous	—	—	138.0
20	1 Jul 79	27	18	44.0	39	4.1	numerous	—	—	—

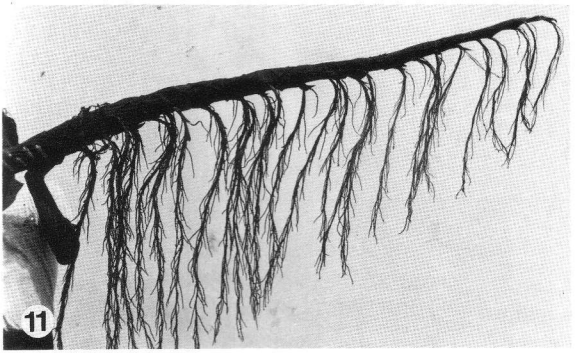






6. Profuse hairy outgrowths (spines) distributed in horizontal rows on the outer side of leaf-base. 7. Many palms develop spiny outgrowths and aerial roots towards the base of the stem. 8. Five-month old seedling raised in a clay pot at Manado. 9. Seedling in Figure 8 at 10 months from sprouting. Pinnate leaves start bending gently even at this stage.

against fallen leaves and undergrowth. These factors may be responsible for the swelling. Apart from this basal swelling, the stems of male palms are thinner than the females. Further, they seem to grow more slowly than the females as the figures in Table 4 reveal. The decrease in the girth of the trunk is gradual. Hence, there is no



10. Pipes turned from mature portion of stem, used as conduits between goldfish culturing ponds in North Sulawesi. 11. Male inflorescence bearing several drooping first-order branches, each giving rise to numerous rachillae. 12. Portion of female inflorescence. The rachillae are laden with numerous small fruits.

swellings seen on the stem of *Pigafetta* as in the belly palm (*Colpothrinax wrightii*) or irregular thickenings as on the coconut or palmyra.

Rate of Growth of Stem

Variation in the length of the internodes within the same species grown under uniform conditions indicates variation in the rate of growth of stem. To find if there is any difference in the rates of growth of males and females, the number of leaf-scars of the six palms mentioned in Table 3 were counted. The stem was marked at one-meter intervals. The number of leaf-scars in each one-meter length of stem was counted and the data presented in Table 4.

The stem of females grows faster than that of the males. To produce one-meter height of stem just above the 6th meter, the males have to produce 30 leaves while the females achieve this height by producing only 19 leaves. It is surprising that the females in spite of having to produce massive inflorescences bearing tens of thousands of fruits, can still maintain a higher rate of stem-growth. They were not shaded by other trees.

Leaf Production

The number of leaves in the crown can give a measure of the fruit-productive capacity of a palm; this is particularly clear in the coconut. It is important to know the green life or functional period of a leaf. It is surprising that in spite of years of work by hundreds of researchers investigating the coconut palm, we do not yet know the exact green life of a coconut leaf. As the rate of production of the leaf varies with varieties and forms, and within a variety/form between localities, it is essential to gain knowledge of this area. Partly to give a lead to the coconut scientists, we started to estimate the green life of leaves of many species of palms growing at the Bogor

Table 3. Pigafetta filaris*: Girth of stem at different heights.*

Ht. from Ground (in meters)	Girth (circumference) of Stem in cm							
	Males				Females			
	1	2	3	Mean	1	2	3	Mean
1.00	145	150	132	142.33	142	142	126	136.67
2.00	121	124	132	125.67	125	136	132	131.00
3.00	104	126	118	116.00	123	122	123	122.67
4.00	105	127	122	118.00	118	118	120	118.67
5.00	101	120	112	111.00	117	112	117	115.33
6.00	102	115	105	107.33	115	108	117	113.33
7.00	100	106	101	102.33	110	106	112	109.33
8.00	—	—	100	100.00	106	89	107	106.67
9.00	—	—	—	—	106	—	100	103.00
10.00	—	—	—	—	100	—	—	100.00

Botanical Garden. The study is not complicated. All emerged leaves of a palm crown are numbered from the oldest green leaf to the youngest fully opened one. The dates of initial visibility of new leaves, and their full emergence, as well as the dates when an old leaf starts drying and when it completely withers, are recorded. The green life period of a leaf is calculated from these dates.

Six individuals of *Pigafetta* (3 males and 3 females) were included in the study. Observations were started in May 1979 and concluded at the end of December 1980. During this period, dates of emergence for about 40 leaves in each palm were recorded. Also about 40 leaves withered or were shed from each palm during the period. Because the palm had already 25–30 green leaves in the crown at the time of starting the observations, complete data from emergence to shedding could be had only in ten to thirteen leaves per crown. Data relating to one male and one female palm are presented in Table 5.

In the case of the female palm, the mean

Table 4. Pigafetta filaris*: Number of leaf-scars at 1-meter intervals.*

Portion of Stem (in meters)	Numbers of Leafscars per Meter Interval							
	Males				Females			
	1	2	3	Mean	1	2	3	Mean
Ground to 1 m	15	20	14	16.33	10	14	15	13.00
1–2 m	16	20	15	17.00	11	13	15	13.00
2–3 m	18	19	16	17.67	10	14	17	13.67
3–4 m	19	22	16	19.00	10	15	14	13.00
4–5 m	22	20	17	19.67	13	16	16	15.00
5–6 m	24	24	20	22.67	14	20	16	16.67
6–7 m	30	33	27	30.00	14	22	21	19.00
(7.5 m)	(21)	—	—	—				
7–8 m	—	—	29	29.00	18	25	24	22.33
8–9 m	—	—	15	15.00	25	(11)	24	24.50
9–10 m	—	—	—	—	18	—	—	18.00
Total	165	158	169	—	143	150	172	—

Table 5. Pigafetta filaris*: Data on production of leaves.*

Leaf Number	Date of Emergence (1979)	Interval between Leaves	Date of Withering (1980)	Interval between Leaves	Life-span of Leaf (days)
Male palm					
30	5 Jun	—	18 Aug	—	440
31	18 Jun	13 days	6 Sep	19 days	446
32	3 Jul	15 days	20 Sep	14 days	445
33	18 Jul	15 days	10 Oct	20 days	450
34	5 Aug	18 days	25 Oct	15 days	447
35	20 Aug	15 days	15 Nov	21 days	453
36	5 Sep	16 days	8 Dec	23 days	460
37	20 Sep	15 days	29 Dec	21 days	466
Mean		15.29 days		19.00 days	450.88
Female palm					
22	12 Jun	—	1 Jun	—	355
23	29 Jun	17 days	18 Jun	17 days	355
24	17 Jul	18 days	3 Jul	15 days	352
25	2 Aug	16 days	17 Jul	14 days	350
26	18 Aug	16 days	30 Jul	13 days	347
27	4 Sep	17 days	12 Aug	13 days	343
28	20 Sep	16 days	26 Aug	14 days	341
29	8 Oct	18 days	17 Sep	22 days	345
30	22 Oct	14 days	29 Sep	12 days	343
31	4 Nov	13 days	17 Oct	18 days	348
32	18 Nov	14 days	5 Nov	19 days	323
33	9 Dec	21 days	23 Nov	18 days	350
34	30 Dec	20 days	11 Dec	18 days	337
Mean		16.67 days		16.08 days	345.31

green life duration for a leaf is 345.31 days while that of a male palm is 450.88 days. Similar values for another female palm are 325.54 days. Two more male palms show clearly that their leaves remain green for longer periods when compared with those of female trees. This situation suggests that data should be collected on a larger number of palms to see whether the difference in the green life of leaves between sexes are insignificant.

Size of Leaves

The gently curved leaves with numerous gracefully arching leaflets are responsible for the beauty of the crown of *Pigafetta*. The number of green leaves in a crown at any time may vary from 20 to 30 in Bogor. However, during the dry season, shedding of leaves exceeds production, and so, the number of leaves in the crown is reduced. Palms growing under more ideal conditions may bear as many as 35 fully emerged

Table 6. Pigafetta filaris*: Data on size of leaf.*

Sex	Length of Lamina (cm)	Length of Petiole (cm)	Length of Leaf (cm)	No. Leaflets
Male	338.84	299.10	637.94	123.15
Male	347.09	284.10	631.19	123.14
Male	314.99	217.85	532.84	115.73
Female	348.21	257.67	605.88	118.00
Female	323.63	210.85	534.48	118.90
Female	316.66	220.45	537.11	112.81
Mean	331.57	248.34	579.91	118.62

Table 7. Pigafetta filaris*: Size of male and female inflorescences.*

Sex		Length of Inflorescence (cm) of Palms				Max. Girth of Peduncle of Palms (cm)			
		1	2	3	Mean	1	2	3	Mean
Male:	older	145	170	160	158.33	20	25	20	21.67
	younger	160	171	150	160.33	21	19	22	20.67
	Mean	152.5	170.5	155.0	159.33	20.5	22.0	21.0	21.17
Female:	older	152	131	165	149.33	23	21	23	22.33
	younger	154	145	161	160.00	22	22	23	22.33
	Mean	153.0	138.0	163.0	154.67	22.5	21.5	23.0	22.3

leaves and two more leaves at the spear-stage. The number of leaflets per leaf, and lengths of petiole and lamina were measured for about 40 leaves, each from six palms. The data are presented in Table 6. The male palms bear more leaflets than the females even though the difference is not statistically significant. Also the overall length of leaves of male palms is greater than that of the females. In this species, the petiole occupies 57.18% of the length of the whole leaf.

Size of Inflorescences and Number of Fruits

The inflorescence of *Pigafetta* is a massive, axillary structure bearing many bracts. About 6–10 inflorescences are produced between the leaves during September–October. By the time the inflorescences mature, their supporting leaves are already shed. At this stage, the bunches appear below the leaves. The size of male and female inflorescences and the number of fruits per infructescence were recorded at Bogor on 12 inflorescences from six palms. The data are given in Table 7.

The male inflorescences are slightly longer than the female, but the latter are stouter (Fig. 11).

The rachis produces several first-order branches, all of which hang downwards. These branches are longest at the base of the inflorescence and subsequent branches become shorter and shorter. They bear second-order branches which are the rachillae. Each rachilla in the infructescence may bear 5–15 fruits (Fig. 12).

Numbers of Secondary and Tertiary Branches

The number of first- and second-order branches varies between 22 and 24 in the male inflorescence while in the female there are 17 to 23 first-order branches. The mean length per inflorescence was also calculated which for the males ranges from 88.18 cm to 94.58 cm and for the females, from 88.00 cm to 117.29 cm. The number of rachillae per first-order branch was also counted. They range in the male from 36.86 to 41.68 and in the female between 29.48 to 34.59.

Number of Fruits per Infructescence

From 3 female palms, 5 complete infructescences laden with ripe fruits were pulled down carefully and the number of fruits per infructescence counted (Table 8).

Table 8. Number of fruits per bunch.

Infructescence 1	4,824 fruits
Infructescence 2	3,740 fruits
Infructescence 3	12,452 fruits
Infructescence 4	14,237 fruits
Infructescence 5	19,918 fruits
Mean per infructescence	11,034.2 fruits

Literature Cited

Darian, M. E. 1973. *Pigafetta filaris*. Principes 17: 32–33.

Dransfield, J. 1973. *Pigafetta filaris* in Sibolangit. Principes 17: 105–107.

———. 1976. A note on the habitat of *Pigafetta filaris* in North Celebes. Principes 20: 48.

Fairchild, D. 1943. Garden Islands of the Great East. Charles Scribner's Sons, New York.

Holbrook, N. M., F. E. Putz, and P. Chai. 1985. Above-ground branching of the stilt-rooted palm, *Eugeissona minor*. Principes 29: 142–146.

Sneed, N. W. 1981. *Pigafetta* and other palms in Sulawesi (Celebes). Principes 25: 106–119.