SPECIES AND ECOTYPES (CULTIVARS) OF ARECANUT

By

K. N. Murthy and K. V. A. Bavappa

Central Arecanut Research Station, Vittal

SPECIES

ARECANUT or betelnut which has been under cultivation for the past many centuries has attracted the attention of Botanist from systematic point of view. The commonly cultivated species in almost all the countries is *Areca catechu* Linn. In Ceylon, however, the fruits of *Areca concinna* Thw., are reported to be occasionally chewed as a substitute for arecanut (Lewis 1934). Beccari (1919) states that there are thirty six species of *Areca* known to him. But, a comprehensive description of the same are not available. Hooker (1894) reports the existence of twenty four species but has described only four, namely *Areca catechu* Linn., *Areca concinna* Thw., *Areca triandra* Griff. and *Areca nagensis* Griff, which, according to him, are indigenous to India. The description as given by Blatter (1926) is furnished below:

1. Areca catechu Linn. Trunk solitary, quite, straight, 40–100 feet high, usually about 20 inches in circumference, uniformly thick. Leaves 4–6 feet, leaflets numerous 1–2 feet upper confluent, glabrous.

Spathe double, compressed, glabrous. Spadix much branched, bearing male and female flowers. Rachis stout, compressed; branches with filiform tips. Male flowers very numerous, sessile, without bracts; calyx 1-leaved, small, 3-cornered, 3-parted, petals 3, oblong, rigid, striated; stamens 6, anthers sagittate. Female flowers solitary, or 2 or 3 at or near the base of each ramification of the spadix, sessile, without bracts; sepals 3, cordate, rigid, fleshy, permanent; petals 3, like the sepals, permanent; staminodes 6, connate; style scarcely any; stigmas 3, short, triangular.

Fruit 1½–2 inches long, smooth, orange or scarlet.

2. Areca concinna Thw. Trunk 8–12 feet high, 1½–1¾ inches in diameter, cylindric, green. Leaves few, 3–3½ feet long, spreading, subglabrous. Leaflets 2 feet long, 2½ inches broad, lanceolate, falcate, caudate-acuminate, lower simple, 1-costate, upper of 2 or more confluent, acuminate or toothed at the apex, terminal shorter, more or less confluent in toothed laminae.

Sheath 16 inches long; spadix paniculately branched, a foot or more long, very shortly peduncled; rachis short, stout, compressed, smooth, braches filiform, terminating in pendulous male spikes. Male flowers biseriate, 1/10 inch long; sepals oblong, obtuse; petals nearly thrice as long; obliquely ovate-lanceolate, acuminate, striate; stamens 6; anthers subsessable, linear-oblong, acute, cells parallel; pistillode trigonous. Female flowers 1/4—1/3

inch long; calyx an obsure unequally 3-lobed cup; petals broadly ovate, oblong, obtuse.

Fruit 1½ inch long, subfusiformly ovoid, umbonate, scarlet.

3. Areca nagensis Griff: This species not well known, Griffith deriving the description of it from imperfect specimens of leaves, an imperfect spadix with immature fruit, and a perfect fruit.

The trunk rises from 30-40 feet high and is attached to the soil by innummerable black fibrus roots. The leaf stalk is naked for about three feet, the blade measuring about four. Pinnules sub-opposite or alternate, falcate, very acuminate, nineteen or twenty inches long, about one and a half inch broad, above with two or three stout keels; the terminal one deeply bilobed, variously partite, the laciniae or division bidentate; the less divided broader part i obliquely truncate with irregular teeth. To this description Griffith has added the note: 'The leaves may be open to doubt, from their resemblance to those of Areca gracilis'. (*Pinanga gracilis* Blume.)

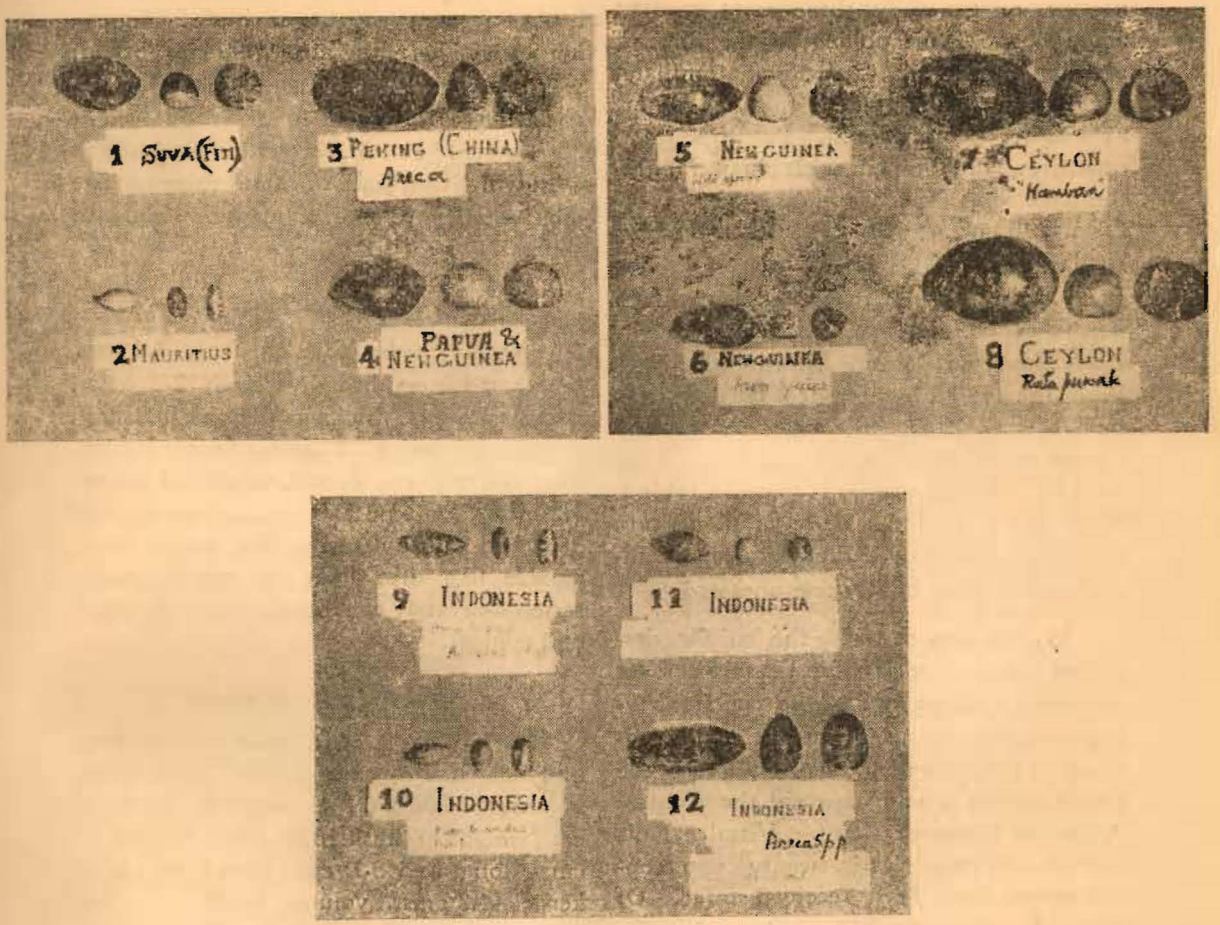
The spadix measures about one foot; the compressed peduncle is divided from near the base into stout flexuose branches. The female flowers are on the lower parts of the branches, each with a scale-shaped bract. "Sepals round, oblong, obtuse; petals larger, sub-cordate with a short obtuse cuspis".

'Fruit oblong-ovate, one inch long and 5 lines wide, attenuated to both ends, base surrounded by the perianth, apex rostrate-mammillate, truncate, with a small mammilla in the centre; fibres numerous, stout, whitish. Seed erect, ovate, half an inch long, marked with many veins arising from the hilum, these are generally dichotomous, anastomosing reticulately on the dorsal face. Albumen cartilaginous, horny, ruminate, opaque white. Embryo basilar'. (Griffith).

4. Areca triandra Roxb. The palm is shrubby and throws out offsets at the base. The green, distinctly annulate stem grows five to seven feet high and is one inch and a half in diameter. The leaves are bright green and comparatively large, being four to five feet long. The pinnules are alternate, linear-ensiform, often falcate, obliquely acuminate, thirteen to sixteen inches long, one and a half to two inches broad, with one, two or three keels above; the upper ones are more or less split at the apex; the terminal leaflets are broadly cuneate, deeply bipartite, forked, the lobes themselves truncate and having as many bidentate lobes as there are keels on their undersides.

The green smooth spathe has a short blunt point, and is from six inches to a foot long and from two to three inches broad. The peduncle and branches of the much divided spadix are compressed. A linear bract, half an inch in length, is to be seen at the base of the lowermost branch. The branches are spreading and much divided; the secondary divisions are stoutish towards the base, where they bear a female flower, close to which they branch into two slender flexuose spikes, from which the male flowers arise, or oftener are attenuated into one. Male flowers angular, small cream-coloured, in pairs pressed together and secund on the outer side of the spikes Sepals three, minute, ovate-oblong, unequal. Petals oblong, obtuse, valvate, three or four times longer than the sepals. Stamens three, opposite the sepals; filaments stout, short, united at the base; anthers sagittate. Rudiment of the pistillum conical-subulate. Female flowers rather large, generally placed between a pair of rudimentary males, suffulated by two broad, short, pointed bracts. Sepals roundish

Nuts of different species of arecanut



green. Petals similar, but smaller and less tough. Six very small rudimentary stamens. Ovary ovate, one-celled, white. Ovule one, ascending. Style O. Stigma of two, or generally three erect unequal acute lobes. Fruit oblong, of the form of an olive, but longer, distinctly mammillate, smooth, when ripe of a lively orange colour, at length becoming red. Pulp in small quantity, and mixed with many longitudinal strong, ligneous fibres. Seed coniform. Albumen much ruminated. Embryo basilar (Griffith). But a few species like *Areca madagascariensis* Mart are grown in gardens as ornamental plants (Firminger 1947, Hooker 1894 and Lushington 1915). From the available references on the systematics, it appears that there are seventy six species of *Areca* recorded so far. A list of these different species is given in table I. How many of these specific names are synonyms can only be known after a comprehensive study of all these species.

With a view to verify the so far described species, reclassify them wherever necessary and use such of the species having desirable characters in various hybridisation programmes, a collection of the above species is being made at the Central Arecanut Research Station, Vittal. Nuts from eleven countries in twenty two consignments have been received so far. Of these *Areca catechu* Linn., *Areca triandra* Roxb., *Areca macrocalyx* Zypp., *Areca concinna* and *Areca flavescens* are the only known species. Nuts of the other consignments have either been described as *Areca* or by the local names. The nuts on receipt were described noting their complete morphological features such as weight, volume, length and breadth of both whole fruit and kernel, anatomy and taste of the kernel and size of embryo. The data recorded with respect of nuts of different consignments are given below:

1. Suva (Fiji)

Areca catechu Linn (Fig. 1, 1-A). Fruit 4.63 cms. long and 2.56 cms. broad, weight 14.74 gms., volume 15.00 c.c., thickness of husk 0.3 cm., weight of husk 9.04 gms., kernel 1.96 cm. long and 1.90 cm. broad, weight of kernel 5.7 gms., volume 5.9 c.c. percentage of kernel to fruit by weight 38.7, kernel brittle, brownish endosperm with white thin lines of ramifications, taste more astringent; embryo medium sized and conical.

2. Mauritius

Areca triandra (Fig. 2). Fruit 3.4 cm. long and 1.2 cm. broad, weight 2.5 gms., volume 1.5 c.c., thickness of husk 0.15 cm., weight of husk 1.3 gms., kernel 1.6 cm. long and 0.95 cm. broad, weight of kernel 1.2 gms., volume 0.8 c. c., percentage of kernel to fruit by weight 48.0; kernel hard, marble like thin lines of ramifications, taste moderately astringent; embryo small and conical.

3. Peking (China)

Areca. (Fig. 3, 3-A). Fruit 5.3 cms. long and 3.68 cms. broad, weight 30.35 gms., volume 33.00 c. c., thickness of husk 0.6 cm., weight of husk 16.05 gms., kernel 2.7 cms. long and 3.1 cms. broad, weight of kernel 14.3 gms.. volume 16.00 c. c., percentage of kernel to fruit by weight 47.1; kernel hard, close ramifications, taste moderately astringent; embryo medium sized; oval.

4. Papua and New Guinea:

(a) *Areca catechu* Linn. (Fig. 4). Fruit 5.00 cms. length, 3.5 cms. breadth, weight 18.13 gms; volume 23.5 c.c; thickness of husk 0.5 cm., weight of husk 6.03 gms, kernel 2.4 cms. length and 2.9 cms. breadth, weight of kernel 12.1 gms; volume 13.00 c.c., percentage of kernel to fruit by

weight 66.1; kernel with sparse ramifications and a white core in the centre, taste less astringent; embryo big, conical.

(b) **Wild species of** *Areca*. (Fig. 5). Fruit 4.8 cms. long, 2.4 cms. broad, weight 8.3 gms., volume 9.35 c.c; thickness of husk 0.15 cm; weight of husk 1.69 gms: kernel 2.4 cms. length and 2.1 cms. breadth, weight of kernel 6.7 gms. and volume 6.0 c.c., percentage of kernel to fruit by weight 70.98, kernel with sparse ramifications, taste more astringent; embryo medium sized and oval.

(c) *Areca* sp. (Fig. 6). Fruit 3.9 cms. long, 2.00 cms. breadth, weight 5.11 gms. volume 7.10 c.c; thickness of husk 0.18 cm., weight of husk 0.5 gms; kernel 1.5 cm. length and 1.6 cm. breadth, weight of kernel 5.6 gms. and volume 6.00 c.c., percentage of kernel to fruit by weight 90.0, kernel soft with close ramifications, taste slightly more astringent; embryo small, oval.

5. Ceylon

(a) **Arecanut** var **'HAMBAN'** (Fig. 7, 7-A). Fruit 5.9 cms. length, 4.1 cms. breadth, weight 42.68 gms; volume 54.3 c.c., thickness of husk 0.45 cm., weight of husk 26.58 gms; kernel 2.6 cms. length and 3.0 cms. breadth, weight of kernel 16.1 gms., volume 15.00 c.c., percentage of kernel to fruit by weight 30.8%, kernel with a long central white core, taste astringent; embryo big, oval.

(b) **Arecanut** var **'RATA PUWAK'** (Fig. 8, 8-A). Fruit 6.2 cms. long, 4.4 cms. broad, weight 41.35 gms., volume 52.4 c.c; thickness of husk 0.7 cm. weight of husk 22.95 gms; kernel 3.0 cm. length and 3.0 cm. breadth, weight of kernel 18.4 gms., volume 15.0 c.c., percentage of kernel of fruit by weight 40.4, kernel with sparse ramification, taste slightly more astringent; embryo big and oval.

(c) *Areca concinna* Thw. Fruit 3.0 cms. length, 1.20 cm. breadth, weight 1.3 gm., volume 1.7 c.c., thickness of the husk 0.1 cm. weight of husk 0.5 gm. kernel 1.6 cm. length and 1.0 cm. breadth fruit with a persistent red coloured coat, weight of kernel 0.84 gms., volume 0.6 c.c., percentage of kernel to fruit by weight 64.6; kernel hard with close ramifications, taste less astringent; embryo small.

6. Indonesia

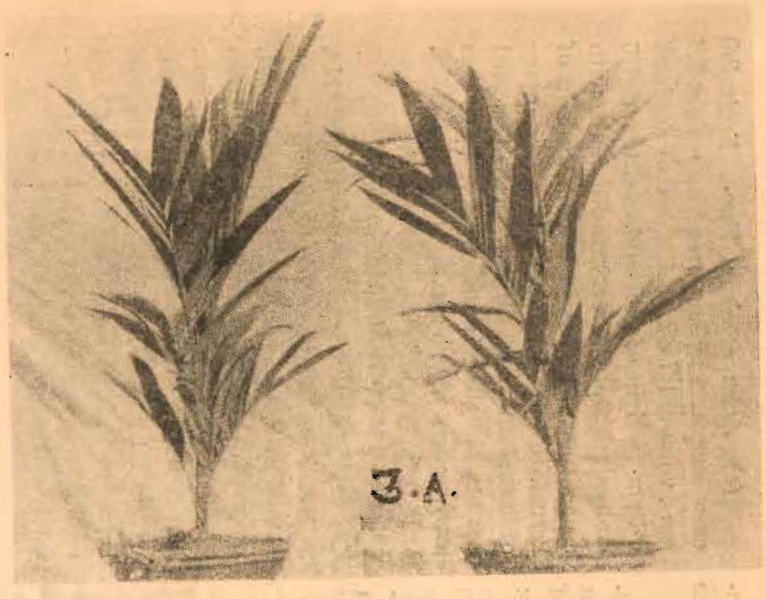
(a) *Areca triandra* var BANCANA SCHEFF ('BUAH MASIH MIDA') (Fig. 9, 9-A). Fruit 3.5 cms. long, 1.2 cm. broad, weight 1.3 gms., volume 2.02 c c. thickness of husk 0.1 cm , weight of husk 0.2 gm; kernel 1.9 cm. long and 0.9 cm. broad, weight 1.1 gm. volume 1.0 c.c. percentage of kernel to fruit by weight 84.6, kernel hard with a large central white core, taste moderately astringent; embryo small, oblong.

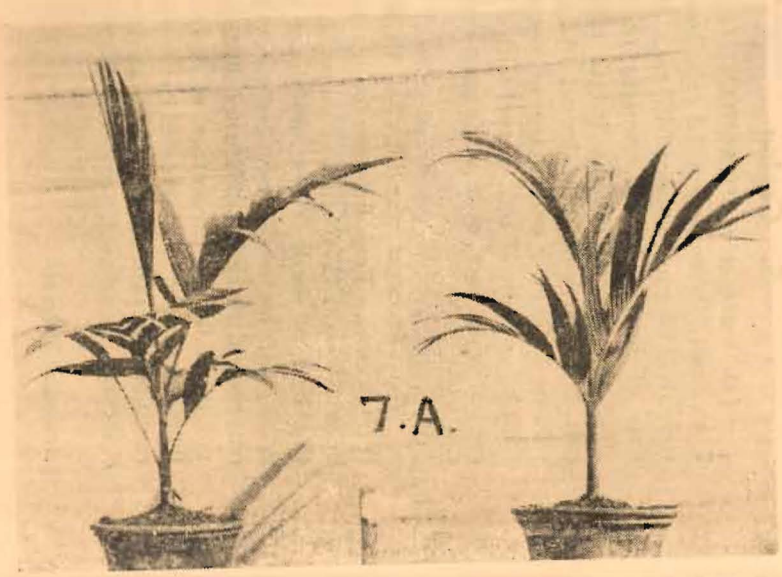
(b *Areca triandra* Rexb. (Fig. 10). Fruit 2.5 cms. long, 1.2 cm. broad, weight 1.27 gm. volume 1.79 c.c; thickness of husk 0.1 cm , weight of husk 0.07 gm; kernel 1.6 cm. long and 1.0 cm. broad, weight 1.2 gm. volume 1.0 c c., percentage of kernel to fruit by weight 90.4, kernel hard with close ramifications, taste moderately astringent: embryo small and oblong.

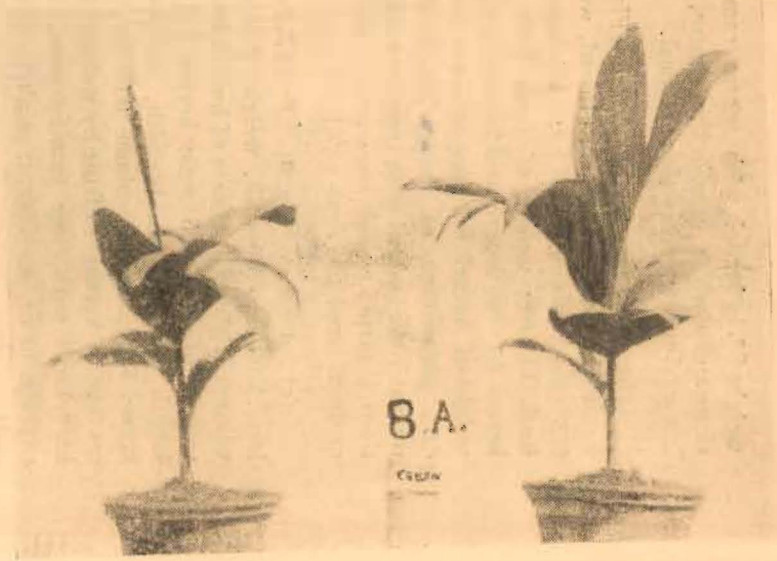
(c) *Areca macrocalyx* Zipp. (Fig. 11). Fruit 2.9 cms. long, 1.3 cm. broad, weight 1.17 gms. volume 3.0 c.c; thickness of husk 0.1 cm., weight of husk 0.17 gm; kernel 1.1 cm. long and 1.1 cm. broad, weight 1.0 gm. volume 1.2 c.c., percentage of kernel to fruit by weight 85.5, kernel hard with close ramifications, taste moderately astringent; embryo small, oval.

(d) *Areca* species. ('BUAH MASIH MIDA') (Fig. 12, 12-A). Fruit 5.3 cm. long 3.1 cm. broad, weight 11.9 gms., volume 22.00 c c; thickness of husk 0.5 cm. weight

Species of arecanut (seedlings)







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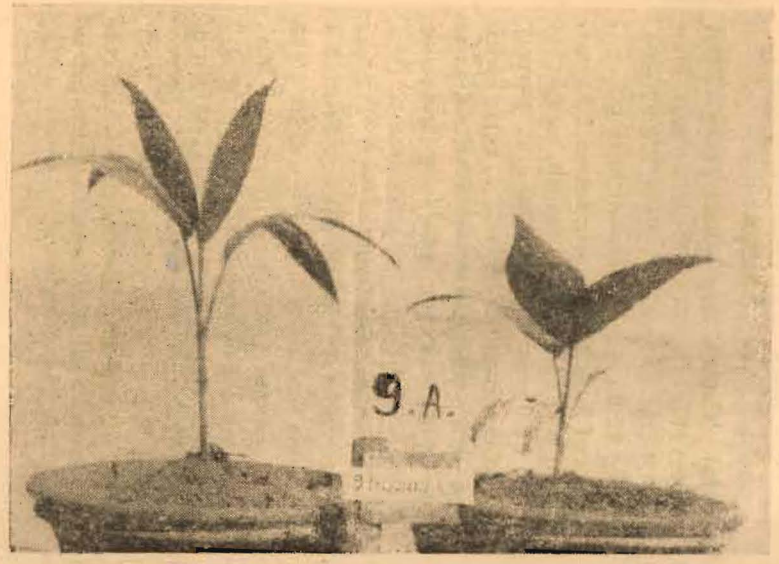

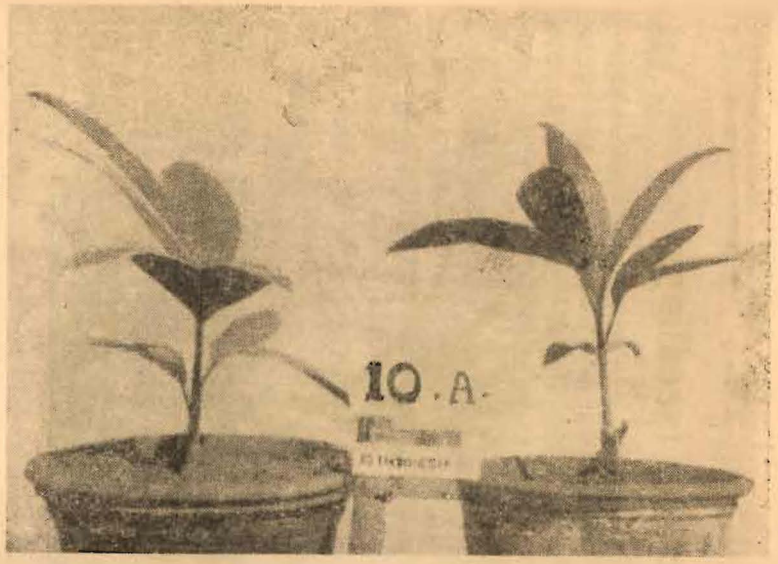

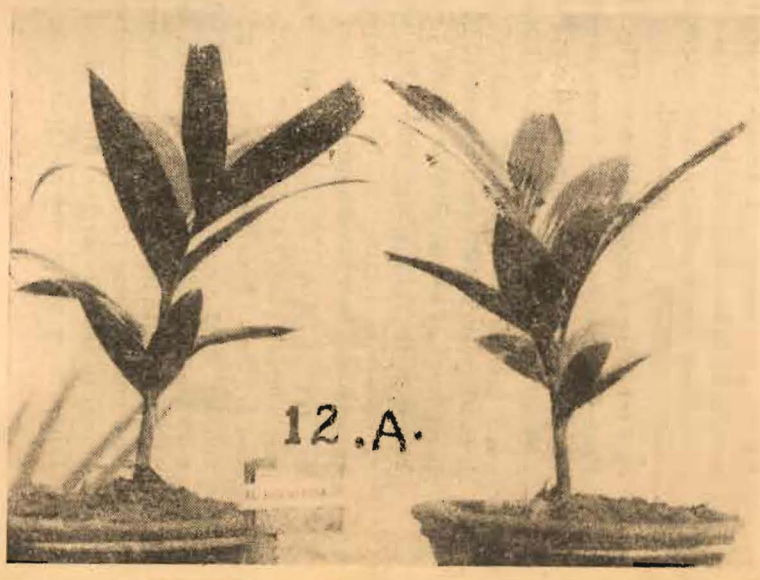

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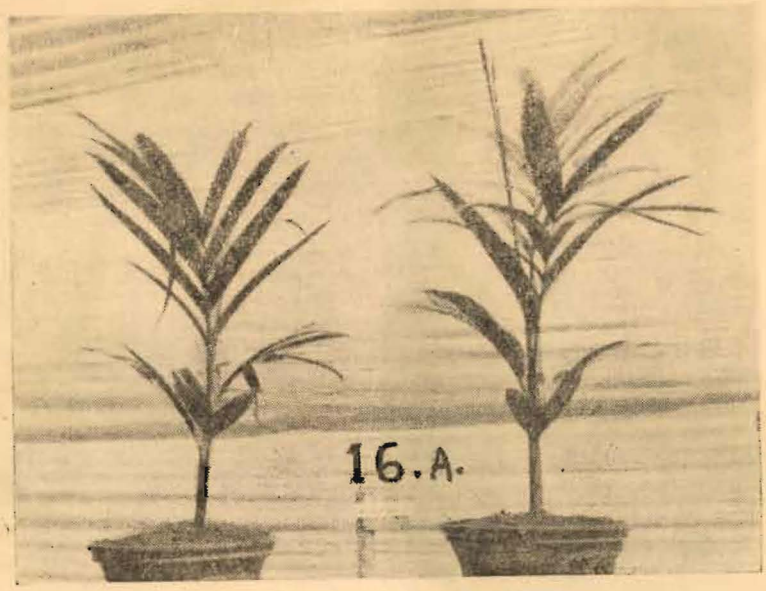


of husk 5·1 gms; kernel 2 8 cm. length and 2.1 cms. breadth, weight 6·8 gms., volume 7.0 c.c., percentage of kernel to fruit by weight 57.1, kernel with big central white core, close ramifications, taste astringent; embryo medium sized and oval.

(e) *Areca catechu* Linn. (Fig. 13)· Fruit 6.2 cms· length and 3·5 cms. breadth weight 21.9 gms·, volume 11.00 c.c; thickness of husk 0·4 cm., weight of husk 8.4 gms; kernel 2.8 cm. length and 2·7 cms· breadth, weight 13·5 gms; volume 11.00 c c; percentage of kernel to fruit by weight 61.6 kernel with thin white core and sparse ramifications, taste slightly astringent; embryo medium sized and oval.

(f) *Areca catechu* var alba Bl. (**'Buah masih mida'**) (Fig· 14)· Fruit 5·3 cms· length and 3·7 cms· breadth, weight 21 23 gms volume 32·2 c.c.; thickness of husk 0·35 gms., weight of husk 6·93 gms , kernel 2·8 cms· length and 3·0 cms. breadth, weight 14·3 gms. volume 12.00 c. c., percentage of kernel to fruit by weight 60·7, kernel with fairly large white core and sparse ramifications, taste slightly astringent; embryo big, oblong.

7. Saigon

(a) **'Cauhon Day'**—*Rout Trang*—(Red variety) (Fig· 15, 15-A) Fruit 5·0 cms. long and 4.6 cms. broad, weight 29.87 gms. volume 32.2 c.c.; thickness of husk 0·3 cm , weight of husk 12·87 gms.; kernel 2.75gms. length and 4·0 cms. breadth, weight of kernel 17.0 gms. volume 17·0 c. c. percentage of kernel to the fruit 50.7, kernel with large white core sparse ramifications, taste more astringent; embryo long and cone shaped·

(b) **'Cau hon day'**—*Rout Trang*—(White variety) (Fig 16, 16-A). Fruit 5·4 cms. long and 4.5cms. broad, weight 50 51 gms , volume 41.2 c.c.; thickness of husk 0·2cm. weight of husk 8.51 gms; kernel 3.2 cm. length and 4·1 cms. breadth, weight of kernel 32.0 gms., volume 32.8 c. c , percentage of kernel to fruit by weight 70·9, kernel with a centrally located white core and compact ramifications, taste less astringent; embryo big and oval.

(c) 'Cau vu bo'—(*White variety*) (Fig.17) Fruit 5·1 cms. long and 3.6 cms. broad, weight 28.01 gms., volume 29·00 c.c.; thickness of husk 0.3 cm., weight of husk 9.51 gms.; kernel 2.5 cm. long and 3·2 cms, broad, weight of kernel 18·5 gms , volume 17.00 c.c., percentage of kernel to fruit in weight 60·6, kernel with centrally located white core having close ramifications, taste moderately astringent; embryo medium, oblong.

8. Aden Protectorate

Unspecified (Fig 18) Fruit 4·6 cms. long and 3·4 cms. broad, weight 22.4 gms. volume 24.6 c.c.; thickness of husk 0.3cm., weight of husk 11.4 gms.; kernel 2.3 cms. long and 2.6 cms. broad, weight of kernel 11.0 gms., volume 15.00 cc., percentage of kernel to fruit by weight 40.9, kernel with very large white core soft with compact ramifications, taste less astringent; embryo big, oval.

9. Singapore

Arecanuts (Fig. 19). Fruit 5·0 cms. long and 3·3 cms. broad, weight 21.4 gms., volume 24.4 c.c.; thickness of husk 0.4cm.; weight of husk 4.9 gms ; kernel 2·8 cms. long and 2·6 cms. broad, weight of kernel 16·5 gms., volume 12.00 c.c , percentage of kernel to fruit by weight 70·7, kernel with white core concentrated in the middle; compact ramification, taste less astringent, embryo big, oblong.

10. Br. Solomon Islands Protectorate

Arecanut (Three samples) (Fig. 20). Fruit 5.8 cms. long and 3.8 cms. broad, weight 35.59 gms., volume 39·1 c. c. thickness of husk 0.5 cms., weight of husk 13·59 gms., kernel 2.7 cms. length and 2.7 cms. breadth. weight of kernel 22·0 gms. and volume 20.00 c c., percentage of kernel to fruit by weight 60·1, kernel having compact ramifications, taste more astringent; embryo big, oval.

11. Madagascar

Areca flavescens Hort. Syn. *Chrysalidocarpus lutescens*· H. Wendl· Fruit 1·3 cm. long and 1.0 cm· broad, weight 0.4 gm., volume 0.5 c· c·, thickness of the husk 0·05 cm., weight of the husk 0.04 gms.; kernel 1.1 cm· long and 0·8 cm. broad, weight of kernel 0·3 gm·, volume 0.3 c·c , percentage of kernel to fruit by weight 75·0, kernel hard and white without any ramification with a narrow slit in the centre, taste copra like; embryo small and tapering, located on one side of the kernel·

The germination of seednuts was recorded· The seednuts from one consignment of nuts from New Guinea, two from Indonesia and that of Aden failed to germinate. The morphological features of the seedlings recorded along with percentage of germination are furnished in table II.

Out of the 76 recorded species of areca the distribution of two species i. e., A. *umbrosa* and A. *vestiaria* is not known·

From the description of the above collections, it is seen that there is wide variation in the size and weight of the nuts, the biggest being the Ceylon varieties (Arecanuts), the smallest being Madagascar (*Areca flavescens*) and the smaller being Indonesia and Mauritius (*Areca triandra*). Many of these samples, which are showing certain special characters like complete non-splitting of leaves ('Rata Puwak' of Ceylon) may possible be different species which are yet to be identified· Due to the varied time taken by the nuts for their transit from their country of origin, it has not been possible to compare their viability efficiency· The nuts received from Singapore had sprouted in transit. Seedlings of certain species are exceptionally vigorous and based on these characters, cytological evidences etc., the unspecified ones will have to be named. The seedlings of *Areca triandra* were found to be very slow in getting acclimatised to this locality and the mortality of the seedlings was as high as 45·4% under the best of conditions against 100% establishment in the case of other species.

Out of the four seedlings introduced at the Central Arecanut Research Station, Vittal earlier, from Andaman, Nicobar and Indonesia, three seedlings (one Andaman and two Indonesia) have flowered at the age of seven. All the plants are found to be similar to the local *Areca catechu* Linn. in their morphological features excepting in the case of Indonesia seedlings, which have a shorter internodal distance of 3". However, the flowers of the Andaman variety were found to have a very strong aroma. The female flowers of one of the Indonesian plants are also found to be yellow in colour.

Ecotypes (Cultivars)

Even though *Areca catechu* Linn. is the only cultivated species, it has been observed that there is a wide range of variation existing in size, shape and colour of fruit, fruitset, size and shape of the kernel etc. between different arecanut growing regions and in the same region between different palms. Based on the size and shape of fruit, the delimitation of which is somewhat arbitrary, Beccari (1919), Sands (1926) and Raghavan & Baruah (1956) have described the variation in arecanut existing in Philippines, Malaya Ceylon and India (Assam) respectively. The same is summarised in following table.

TABLE

Types of arecanuts described from different countries.

India	Ceylon	Malaya	Philippines
Round big, Round small, Convex shaped, Pointed top, Narrow base, Long (Aiyer, 1850; Sands, 1926) A. *catechu* var. *deliciosa* (Rau, 1914–15), Big round, Apex round, long, small ellipsoid, Small oblong, Small apex pointed, Small round (Raghavan and Baruah, 1956).	Sinhalapuwak, Ratapuwak, Himbapuvak, (Molegode, 1944; Nambiar, 1949) *A. catechu* var. Alba (Kew Bull 1887)	Pinang wangi Pinang telor, Pinang jambu, Pinang lemak Pinang kining, Pinang betel Pinang malan, Pinang bentotabon, Pinang small round, Pinang ranggoung, Pinang selung, Pinang rambai. Pinang kerdu, (Grist, 1950; Nambiar, 1954; Sands, 1926).	*Areca catechu* forma communis, *A. catechu* var. *longicarpa* (Beccari, 1919), *A. catechu* var. *Batanensis* (Brown, 1951).

Sands (1926) has stated that since observations on the flowering of the betelnut palms have shown that the flowers are normally cross-pollinated and that in all plantations and gardens there are numerous types, it will be realised that in the absence of breeding experiments, it is an almost hopeless task endeavouring to decide which of the large number of forms are distinct varieties or races which are merely unstable hybrids, but in as much as the studies undertaken so far in the classification

of varieties has been limited to a single arecanut growing tract the correctness of the above statement becomes rather limited.

Raghavan and Baruah (1956) have published a descriptive list of the characters employed by them to describe the types of arecanuts from Assam. Several growth and structural characters of arecanuts are relatively reliable in classifying and identifying the types. The nature of the rumination of the endosperm, the pattern of the network on the seed-coat and the range in proportion of the husk and the endosperm have been regarded as relatively constant for identification purposes. Certain of the inflorescence characters, namely, colour of the emerging inflorescence, nature of the inflorescence, axis and taste and degree of hardness of the kernels have also been used by some to determine a particular type of arecanut (Doraswami, 1956–57, Rau, 1914–15). The types may also differ in the colour of the mature fruits. Differences have also been noted in the maturity of the palms, some bearing early and others late. Work on the morphology of the pollen grains (Raghavan and Baruah, 1956), anatomy of the fruit stalks and cytology of the different types (Raghavan, 1958) have further given a clue to the understanding of the probable genetic status of the types of arecanuts occurring in nature. The pollen grain of the types show a similar morphology in having monocolpate grains. The anatomy of the fruit stalks shows that all the types are similar with minute variations in the frequency of occurrence of the bundles and length of the vessel elements, whereas the types show a similar chromosome number, all having 2n=32, with minute differences in the length of the chromosomes and position of the constrictions. It has thus become apparent that the range of variation in *A. catechu* is limited in so far as there are many types with borderline affinities and, therefore, standing at the same level of evolution. In view of the minute cytological differences delimiting the types, it is possible that the types of arecauuts existing today have originated from ancestral ones through gemutations. Furthermore, the compatibility between the types being very close due to the close similarity in their karyotypes, hybridization occurring freely in nature induces the production of new types. This seems to be supported by the fact that the arecanut palms bearing different types of fruits occur freely intermixed in the plantations, thereby giving ample opportunities for hybridization.

The extent of genetic variation existing with reference to the morphological characters of the nut (length and breadth) has not so far been determined in the case of the arecanut under cultivation in the Southern States. The desirable characters associated with these genetic variations have also not been worked out. The extent of occurrence of such variations has also not been investigated. A detailed survey of arecanut gardens in the States of Kerala, Mysore and Bombay with the above object in view was taken up.

The States of Mysore, Kerala and Bombay were classified into different arecanut tracts depending upon the area of the crop under cultivation, taking the revenue districts as the main units and reclassifying these units with reference to geographical, climatic and cultivation practices. Gardens in these tracts were surveyed and a garden of average maintenance with at least 500 trees was fixed up for the study. One hundred palms selected at random were marked out in the garden. Five nuts of full maturity (about nine months) for each of the marked out trees were collected and their length and breadth recorded. Thereafter, a suitable range of length and breadth for the particular tract was fixed and the ecotypes classified. Ecotypes having less than 10% occurrence excepting for those

ones having special desirable characters were rejected. A comparative statment on the measurements of the ecotypes from different tract, their percentage of occurrence and germination percentage is given in table III.

It will be seen from table III, that there is a gradual increase in size of nuts from South to North as far as the West Coast region of Kerala and South Kanara is concerned. The nuts in this region are medium to big in size. It will also be seen that in the 'Malnad' parts of shimoga and Chickmagalore Districts, the nuts are small in size, whereas the region of North Kanara, Ratnagiri and Kolaba districts show altogether a different size, that is nuts which are broader than long. It is interesting to note that the above three regions form three distinct topographic zones isolated by natural barriers. It is thus evident that the size of ecotypes which are under cultivation in these distinct zones for the past many centuries have been maintained.

During the course of this survey an attempt was made to correlate the microclimatic factors with the quality of the ripe nuts and 'chali' (dry nuts) prepared out of it. It was observed that in the two tracts of Wynad and Thirthahalli, ripe nuts on drying were found to shrink giving very low quality 'chali'. In addition, ripe nuts of Wynad were found to be soft to cut. The high altitude of between 2,000 and 2,500 feet and the low temperature of 55°F to 60°F prevailing in these tracts appear to be the possible causes for this behaviour of the nut. Further investigations in this direction are, however, underway.

Venkata Rau (1915) has described one variety of arecanut which is said to have been in existance in the Western Ghats of Mysore State as *Areca catechu* L. var *delicioas* which is said to be fairly sweet to eat and is further distinguished by the fact that the endosperm is much lighter in colour and softer. On account of the latter character, it becomes pulpy and does not lend itself to the treatment which the arecanut undergoes before being sent to the market. The cultivators find it a loss to propagate these plants and it only grows occasionally in the areca gardens. Tree is 40–80 feet high with leaves and flowers similar to those of *Areca catechu*.

The above observations have been confirmed during the recent survey by the Central Arecanut Research Station. The variety has been found to be called locally as "Tengu Adike".

Palms allied to arecanut

In the regions where arecanut is cultivated two kinds of palms are found to be growing widely. Even though these palms are similar to *Areca* in many of their morphological characters, it has been found that botanically they belong to a different genera altogether. In spite of this, in all places of their occurrence, they are termed as "Wild Arecanut." Botanical description along with other particulars is given below:

1. **Actinorhytis calapparia** Wendl. & Drude.

Local name:	"Rama Adike", "Pandavara Adike", "Katadike", "Kam Supari".
Characters: Cultivation:	Not cultivated, found in groups along the Western ghats in forest areas and arecanut gardens.
Stem:	Erect, unbranched, annulate.
Trunk:	Solitary, ornamented with scars of fallen leaves. Height 40 to 100 feet, Circumference 20", Greyish brown

in colour. Internodal distance at the crown and 9th node portions are half an inch and six inches respectively.

Leaves: Leaves formed at the tip end of the stem in a compact crown. Pinnate leaves about 11. Peteole: Plano-convex, length of leaf 86 inches lanceolate acuminate in outline, leaflet about 178, free and alternately arranged, length of leaflet: namely tip leaflet 8", middle leaflt 27" and basal leaflet 11". Maximum breadth of the leaflet being $1\frac{3}{4}$". Leaflet linear, accuminate, unequally bipartite, shining, very smooth. Length of leaf sheath 44" and maximum breadth of sheath 16".

Inflorescence: Covered by a boat shaped spathe, glabrous, compressed, in two whorls.

Spadix: Ascending, altogether green, branches stiff, stout, opened spadix measures about 26"x24 with 103 rachis approximately.

Male flowers: Many immute, triangularly shaped, situated on either sides of the female flowers and also in pairs at the tips of spadix, sepals imbricate, hard, shorter than petals, petals valvate hard oblong - lanceolate and sub-obtuse, stamens 24-30, anther linear, pistillode, small.

Female flowers: Number of female flowers in a spadix being about 1000 big, situated at the base and half the length of the rachis, sepals and petals imbricate with very broad bases staminode 3 or none, ovary large, white, oblong, one celled subcompressed divided at the apex into three, ovule one. Fruit: Colour of the tender fruit will be green and the fully tree ripe nut will be crimson red, shape large oval; size: 2.7" length x 1.9" breadth. Outer skin of the fruit being brittle.

Kernel: Very hard 1.5" length and 1.4" breadth, with a truncate base. Central white core extended to the periphery at certain points in between the brown lines. The outer cuticle of the kernel is highly fibrous and is hard. Thickness of the husk is 0.4". Embryo: basilar.

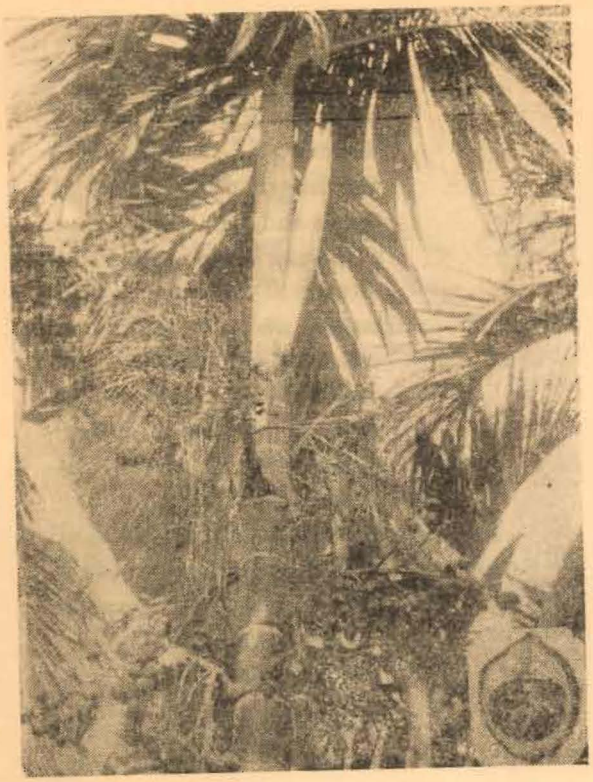
Taste: Astringent.

The nut is not normally used for chewing. The tender nuts are husked, mashep and boiled to extract the tannin ("chogaru") which is used for colouring the boiled tender arecanuts. Of late, it has also been observed that tender nuts husked, sliced and dried are being chewed in certain areas of Malnad.

2. Pinanga dicksonii Bl.

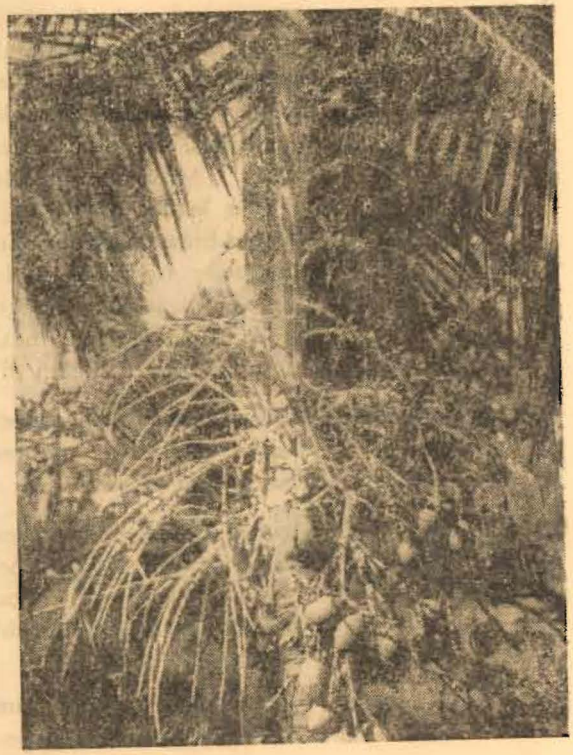
Local name: "Kadu Adike" "Jinjadike"

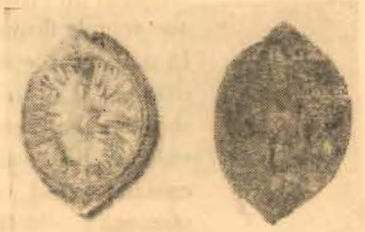
Cultivation: Not cultivated, found in group in the forests of Western Ghats.



← *Areca catechu* Lin.

Actimorhytis Calapparia
Wendl & Drude →





← ***Penanga Dicksoni***, Bl

Stem: Short, erect, slender unbranched, sending out basal off shoots.

Trunk: Greyish brown colour with scars of fallen leaves 16–20 feet height, circumference 6″:

Leaves: Formed at the tip of the stem, 6 to 7 in number, three feet long, leaflets free and arranged alternately, and elongate, 12″ to 24″ long and ¾″ to 1″ broad with numerous spiral veins.

Inflorescence: Covered by a boat shaped glabrous spathe, spathe simple, rigid and compressed.

Spadix: Compound ramifications 4 to 8, alternate, simple, equal, 6″ to 8″ long stout, clothed with imbricating flowers. Male flowers are large pink in colour, triangular in shape, calyx three cleft arranged in two rows on either side of the female flowers, stamens 20 to 30, filaments short and anthers linear.

Female flowers: Small subtended by two male flowers arranged alternately in two rows, staminode – six, clavate, style short, stigma three lobed.

Fruit: Berry, green when tender slightly reddish when fully ripe, small, size 1.9 cm. long and 0.9 cm. broad number of fruits from 100 to 150, pointing at the tip and with persistant calyx.

Kernel: Hard, structure as in *Areca catechu*, size 1.4 cm. x 0.7 cm. with broad white core in the centre and broader lines at the sides. Embryo: small, situated at the basal centre. Taste: Astringent.

In certain areas it has been reported that the tendernuts are boiled and used for mastication.

Even though the above palms are not economically important, it has been reported that they are resistant to common pests and diseases that attack arecanut. The possibility of exploiting this character as well as other economic characters like size of nut, hardiness of the palm etc. for the improvement of arecanut crop can be thought of.

Summary

1. Different species of Arecanut recorded have been listed.

2. Twenty identified and unidentified species collected from ten foreign countries have been described with reference to their fruit and seedling characters.

3. The extent of variation in fruit size of *Areca catechu* Linn. existing in the States of Kerala, Mysore and Bombay was investigated and sixty four ecotypes based on the fruit size fixed.

4. The pattern of variation in the fruit size has been discussed in relation to topography of the tract.

5. An attempt has been made to correlate the microclimatic feature of a few tracts with the quality of the fruit.

6. Palms allied to arecanut have been described.

TABLE 1

Different Species of Areca

S. No.	Name of Species	Distribution
1	'Areca catechu' Linn.	Malaya, India, Phillippines, Canton, Amoy, Formosa, Socotra, Madagascar, East Africa, Central Pacific, Fiji Islands, Java, Borneo, New Guinea, Ceylon.
2	'A. concinna' Thw.	Ceylon.
3	'A. nagensis' Griff.	India—Assam (Naga hills).
4	'A. triandra' Roxb.	Chittagong Pakistan), Andaman, Indonesia, Malaya, Tennasserim and Mauritius.
5	'A. gladiformis' Lam.	Moluccas Islands.
6	'A. pumila' Blume.	Malaya, (From Langkawai to Neginsembilan), Java, Sumatra.
7	'A. ilsemanni' Hort. Ex. E. Andre.	Oceania Islands.
8	'A. aliceae' F. Muell; W. Hill.	Queens Land (Australia).
9	'A. gigantia' Hort.	Pinang (Malaya).
10	'A. gracilis' Roxb.	Pinang
11	'A. madagascariensis' Mart	Madagascar.
12	'A. angulosa' Gisekc.	Madagascar, Indian Ocean.
13	'A. arundinacea' Becc.	Borneo
14	'A. borneoensis' Becc.	Borneo
15	'A. cornuta' Giseke	Madagascar, Indian Ocean.
16	'A. costata Kurz.	Nicobar and Madagascar.
17	'A. furcata' Becc.	Borneo, Johore.
18	'A. jobiensis' Becc.	New Guinea
19	'A. lansiformis' Giseke.	Madagascar, Indian Ocean.
20	'A. laxa' Buck. Ham.	Madagascar and Andaman.
21	'A. macrocalyx' Zipp. ex. Bl.	New Guinea, Indonesia.
22	'A. madagascarica' Stadtmann.	Madagascar.
23	'A. minuta' Scheff.	Borneo.
24	'A. normanbyi' F. Muell.	Australia.
25	'A. oviformis' Giseke.	Madagascar, Indian Ocean.
26	'A oxycarpa' Miq.	Malaya.
27	'A. parva' Noronha.	Malaya.
28	'A Polystachys' Miq.	Malaya.
29	'A. purpurea' Hor.	Mauritius.
30	'A. tenella' Becc.	Porneo.
31	'A. sylvestria' Lour–Ins.	Moluccas Islands.
32	'A. appendiculata' F. M. Bailey.	Australia.
33	'A. ipot' Becc.	Philippines Islands.
34	'A. laosensis' Becc.	Indo China.
35	'A. macrocarpa Becc.	Phillippines.

36	'A. mamnillata' Becc.	Phillippines.
37	'A. montana' Riddely.	Malaya.
38	'A. rechingeriana' Becc.	Soloman Islands.
39	'A. vidalinna' Becc.	Phillippines.
40	'A. whitfordii' Becc.	Phillippines.
41	'A. guppyana' Becc.	Soloman Islands.
42	'A. niga-solu' Becc.	Solomon Islands.
43	'A. torule' Becc.	Solomon Islands.
44	'A. novo-hibernica Becc.	Bismarck Island.
45	'A warburgiana' Becc.	New Guinea.
46	'A. calso' Becc.	Phillippines (Mindanae, Luzon).
47	'A. camarinensis' Becc.	Phillippines (Luzon).
48	'A. costulata' Becc.	Phillippines (Ley te).
49	'A. hutchinsoniana' Becc.	Phillippines, previously known as 'A. mammilata' var. mindamacensis Becc.
50	'A. oarens' Beec.	Phillippines.
51	'A. congesta' Becc.	New Guinea.
52	'A. latiloba' Ridley.	Malay Peninsula.
53	'A. ledermanniana' Becc.	New Guinea.
54	'A. audiahi' Furtado.	Borneo.
55	'A. bongavensis' Becc. ex. Furtado.	Borneo.
56	'A. celebica' Burret.	Celebes.
57	'A. cuneifelia' Becc. ex. Marteli,	Borneo.
58	'A. hallieriana' Becc.	Borneo.
59	'A. henrici' Furtado.	Celebes.
60	'A. hewittii' Furtado.	Borneo.
61	'A. hullettii' Furtado	Borneo.
62	'A. kinabaluensis' Furtado.	Borneo, New Guinea.
63	'A. nannospadix Burret.	New Guinea.
64	'A. ridleyana' Becc ex. Furtade.	Malaya, New Guinea.
65	'A. restrata' Burret.	New Guinea.
66	'A. Banaensis' Burret Syn. Pinanga nannospadix Burret.	Indo China.
67	'A. leptopetala' Burret.	Celebes.
68	'A microspadix' Burret. Syn. 'Pinanga nannospadix' Burret.	Indo China.
69	'A. multifida' Burret.	New Guinea.
70	'A. salomonensis' Burret.	Solomon Island.
71	'A. nigra' Giseke.	Malaya.
72	'A. bacaba' Arruda.	Pernambuco (Brazil).
73	'A. flavascens' Hort. Syn. Chrysalidecarpus lutescens H. Wendl.	Madagascar.
74	'A. micholitzii' Hort.	New Guinea.
75	'A. umbrosa' Link.	?
76	'A. vestiaria' Giseke.	?

TABLE II

Germination and Morphological Characters of Seedlings

S. No. (1)	Country of distribution (2)	Name of species (3)	% of Germination (4)	Height in cms. (5)	No. of leaves (6)	Girth in cms. (7)	Remarks (8)
1	Suva (Fiji)	'Areca catechu' Linn.	10.8	68.7	5	10.2	
2	Mauritius	'A. triandra'	83.9	21 0	2	2.7	
3	Peking (China)	'Areca'	32.0	71.3	6	6.8	
4	Papua & New Guinea	(a) 'A. catechu' Linn	—	—	—	—	Not germinated
		(b) Wild sp. of 'Areca'	14.3	—	—	—	Planted late
		(c) 'Areca' species	12 5	—	—	—	Planted lale
5	Ceylon	(a) 'Areecanut' var 'Hamban'	89.1	63.4	5	6.1	
		(b) 'Arecanut' var 'Ratapuwak	96.5	62.0	4	7.4	Leaves non-splitting
		(c) 'Areca concinna' Thw.	—	—	—	—	Just received
6	Indonesia	(a) 'A. triandra' var bancana Scheff	75.0	24.3	2	2.9	Sending out basal off Shoots
		(b) 'A. triandra' Roxb	66.0	17.7	3	2.3	Sending out basal off shoots
		(c) Areca macrocalyx' Zipp.	—	—	—	—	Not germinated
		(d) 'Areca' species	26.3	57.5	5	6.6	
		(e) 'A. catechu' Linn	—	—	—	—	Not germinated
		(f) 'A. catechu' var alba Bl	92.9	60 5	3	3.7	
7	Saigon	(a) Cau Hon Day (Red)	97.9	80.5	6	8.2	
		(b) Cau Hon Day (White)	51.0	86.4	6	7.7	
		(c) Cau Vu Bo (White)	90.0	96.1	6	8.9	
8	Aden Protectorate	Unspecified	—	—	—	—	Not germinated
9	Singapore	Arecanuts	100.0	85.7	5	7.9	Sprouted in transit
10	Br. Solomon Island	Arecanuts	77.8	32.0	3	3.4	
11	Madagascar	'Areca flavescens' Hort.	—	—	—	—	Just received

Distribution of ecotypes, their percentage of occurance and germinatton percentage.

Sl. No.	Length/ Breadth range in cms.	Tract														
		Palode (Trivandrum District)	Elamon (Quilon Dist.)	Pengamukku (Trichur Dist.)	Kumara-nellur (Palghat Dist.)	Kurmathur (Cannanore Dist.)	Kottakkal (Kozhikode Dist.)	Wynad (Kozhikode Dist.)	Manjeri (Kozhikode Dist.)	Mani (South Kanara Dist.)	Sringeri (Chickman-galore Dist.)	Kallahalla Thirthahalli (Shimoga Dist.)	Kaladi (Sagar) (Shimoga Dist.)	Sirsi (Karwar) (North Kanara Dist.)	Depoli (Ratnagiri)	Diviagar (Shri-vardhan)
1	2·5-3.4/ 2.5-2.9												I* (17 0)** 100***			
2	2.5-3.4/ 3.0-3.4									VII (6.0) 100		V (3.0) 98		IV (14.0) 100		
3	2·5-3.4 3·5-3·9													II (22.0) 88		
4	2·5-3·3/ 4·0-4.4	..	—	—	..	..	—	..	—	—	..	—	..	—	..	..
5	3·5-4.4 2·5-2·9										I (50.0) 98	I (19·0) 98	II (13.0) 99			
6	3·5-4·4/ 3·0-3·4										II (42.0) 89	II (38.0) 88		V (12.0) 92		
7	3·5-4·4/ 3·5-3·9									II (12·0) 95		III (10.0) 49		I (28 0) 95	IV (10 0) 96	III (20.0) 98
8	3·5-4.4/ 4·0-4.4									VIII(15 0) 96			III (27.0) 96	III (20 0) 85		I (32.0) 98
9	4·5-5·4/ 2·5-2·9							II (20.0) 91			III (4·0) 98	VII (8.0) 98				
10	4·5-5·4/ 3·0-3.4	I (18.3) 99	I (28.3) 90					III (16.0) 86	I (36.0) 96		IV (4.0) 97	IV (11.0) 97			II (28.0) 99	
11	4·5-5·4/ 3·5-3·9		II (18.3) 96	I (36.6) 97	III (16.6) 96	I (62.0) 94	III (18.0) 97		III (20·0) 91	I (15.0) 95		VI (7·0) 98			I (46.0) 97	II (28.0) 97
12	4·5-5·4/ 4·0-4.4			II (11·6) 92	II (20.0) 96		II (24 0) 99			V (2.0) 94						IV (10.0) 92
13	5·5-6·4/ 2·5-2·9	..	..	—	—	—	..	..	..	—	..	..	..	..	..	..
14	5·5-6·4/ 3·0-3·4	II (23.3) 96	III (18.0) 96					I (56·0) 70	IV (16.0) 94	III (23.0) 100						
15	5·8-6·4/ 3·5-3·9	III (33.3) 100	IV (25.0) 94	III (26.6) 95	IV (15.0) 90	II (10.0) 95	IV (12·0) 97			IV (35·0) 85					III (16 0) 98	
16	5·6-6·4/ 4·0-4·4			IV (16.6) 98	I (25·0) 92		I (26,0) 95		II (24.0) 94		VI (10.0) 96					V(6.0) 95

* Ecotype. ** Percentage of Occurance. *** Germination percentage.

Explanation to Figures

1. Suva (Fiji) 'Areca catecu' Linn. (Figs. I, I-A.)
2. Mauritius· 'Areca triandra· (Fig. 2)
3. Peking (China)· 'Areca'. (Figs. 3, 3-A)
4. Papua and New Guinea'
   (a) 'Areca catechu' Linn. (Fig. 4)
   (b) Wild species of 'areca'. (Fig. 5)
   (c) 'Areca' sp. (Fig· 6)
5. 'Ceylon'
   (a) Arecanut var 'Hamban'. (Figs. 7, 7-A)
   (b) Arecanut var 'Rata Puwak'. (Figs· 8, 8-A)
6. 'Indonesia'
   (a) 'Areca triandra' var bancana Scheff. 'Buah Masih Mida'. (Figs, 9, 9-A)
   (b) 'Areca triandra' Rexb. (Figs. 10, 10-A)
   (c) 'Areca macrocalyx' Zipp. (Fig. 11)
   (d) 'Areca' species. 'Buah Masih Mida'. (Figs. 12, 12-A)
   (e) 'Areca catechu' Lin. (Fig. 13)
   (f) 'Areca catechu' var alba Bl. 'Buah Masih Mida'· Fig. 14)
7. 'Saigon'
   (a) 'Cauhon Day'—Rout Trang (Red variety) (Figs· 15, 15-A)
   (b) 'Cau Hon Day'—Rout Trang (White variety). (Figs· 16, 16-A)
   (c) 'Cau Vu Bo' (White variety) (Fig. 17)
8. 'Aden Protectorate'—Unspecified. (Fig· 18)
9. Singapore—Arecanuts. (Fig. 19)
10. Br. Solomon Islands Protectorate—Arecanut (Fig. 20)

References

1. Bailey, L. H. (1942) Standard Cyclopedia of Horticulture, Vol. I· pp. 388.
2. Beccari (1919) *Philipp, J· Sci.* 14: 295
3. Blatter, E. (1926) *The Palms of British India and Ceylon.* Oxford.
4. Burkill, I. H. (1935) A Dictionary of the Economic Products of the Malay Peninsula. Vol. I. 228–230.
5. Doraswami (1956–57) *Areca J·* 7· 58.
6. Firminger (1947) *Firminger's Manual of Gardening for India.* Calcutta.
7. Hooker (1894) *Flora of British India*—Vol. VI, London.
8. Index Kewensis and supplements.
9. Kew Bull. (1887) 9· 4·
10. Lushington (1915) *Vernacular list of trees, Shrubs and woody climbers in the Madras Presidency.* Vol· II-A. Madras.
11. Murthy K· N· and Bavappa K. V· A. (1960) *Floral Biology of* Areca. *Arecanut J·* 11.
12. Raghavan (1958) *Unpublished Thesis·* Gauhati University.
13. Raghavan, V and Baruah, H. K· (1956) *J. Univ. Gauhati.* 7, 23.
14. Rau, M· K. V. (1914–15) *J. Bombay Nat. Hist· Soc.* 23, 793.
15. Sands, W· N. (1926) *Malayan* Agric· J. 14. 202.
16. Stebbins, G. (1950) *Variation and Evolution in Plants.* Columbia University.