

FREYCINETIA GAUD. (PANDANACEAE) IN WEST NEW GUINEA
(Full Paper for The 8th Biology NEW Guinea Conference in Waigani Campus,
UPNG, Port Moresby, PNG, September 26-28,2006)

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MANOKWARI
2006

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Abstract

Freycinetia is one genus belonging to Pandanaceae Family. This genus have many variation in New Guinea include west part. Approximately New Guinea is a central of biodiversity and central origin of *Freycinetia*. Ben Stone 1967 mention for about 60 species of *Freycinetia* present in here, but until now many specimen herbarium collected from the area are unknown species so it need revision study to find how many species and also know about distribution and their relationship.

Introduction

Pandanacea have 4 genus e .i. *Pandanus*, *Freycinetia*, *Sararanga* and *Martelidendron*. There are all occur in old tropical area come from Africa on south area to India, Indo China, Malaya, Sumatera to New Guinea Area include some islands surroundings like Salomon islands and Japan until Australia.

Freycinetia was describe in 1824 by the French botanist Gaudichaud. The genus come from name Loise de Freycinet who as a captain on French Exploring Expedition Vessels L'Uranie and La Physicienne. Approximately about 200 species in the world. This genus is not so widespread. The real home of *Freycinetia* is in Malesia Malaya, Sumatera, Java, Boerneo, Sunda Island, Celebes, Philippines, New Guinea, The Salomon Islands, New Hebrides, New Caledonia, Queensland, Formusa, Okinawa, The Marianas and Carolines, Hawaii, Society Island and New Zealand. The centre of *Pandanus*, *Freycinetia* and *Sararanga* certainly in Philipine to New Guinea (Ben Stone, 1970).

Ben Stone 1970 mention New Guinea Island may be have about 60 species of *Freycinetia* compare with Malaya 8 species and Borneo 24 species. Numerical species

name according to few literature were published by some botanist like Warburg, Merrill and Perry, Ben Stone, Hyunh and Kanehira also according to International Plant Nomenclature Index for about 135 names present . Perhaps some are synonymous name, but its show that many species have been published from New Guinea Island. Species that were published almost all come from East part of the island. Ben Stone, Hyunh or Kanehira worked in the place but in west part some expert like L.J. Brass and Odoardo Beccari found *Freycinetia* that later were published by Martelli, Warburg also Merrill and Perry. However West New Guinean *Freycinetia* need to be explore.

Freycinetia like other genus under Pandanaceae family has more utilities. All of plant part are used. Roots for rope to make handicraft ; stem for lance to catch fish, to hunt animals; leaves for roof, to make some traditional cloths and for handicraft too; fruits for food and medicine. Aesthetic flower and leaves make some people using them as a ornamental plant. Its also are used for perfume.

This genus area climbing Pandan except *F. arborea* in Hawaii. Living from the sea area to the mountain at 2400 m above sea level don't make species are find every where but restricted in their place. For example a ovate small laves species *F. elegantula* found only in mountain area. Some species could be found both because It is bring by the water flood for example *F. funicularis*. Many species found abundant only near river or on humid area especially under canopy.

Deforestation and open forest for other reason like agriculture or plantation, transmigration and for building new district, new town, etc make our working need doing more to find some information before species gone without knowing . Therefore the aim of this study were to find out diversity of *Freycinetia* in West New Guinea and

islands surroundings, to make a revision of all West New Guinean *Freycinetia* and put them into their place on classification also to give their true name according to ICBN (International Code of Botanical Nomenclature), to know Filogenetic classification of West New Guinean *Freycinetia* and islands surroundings and to know about distribution of the genus and their pattern in West New Guinea. All species which is found are studying more help by PAUP analysis to understand evolution among them.

MATERIAL AND METHOD

Survey were done at several area in west New Guinea e.i. Manokwari, Japen Island, Timika, Sarmi and Jayapura .

Ecological observation was done in the field was followed by morphological observation in herbarium Bogoriense in Bogor. Speciment from herbarium Manokwariense in Manokwari , herbarium PTFI di Timika and LAE herbarium in Lae, Morobe Province – PNG were examined too.

Morphological characters have been studied throughout the entire range of the taxon to determine any inter-gradation between two or more taxa. Analysis data using PAUP version 4.1 with *Pandanus tectorious* and *Pandanus dubius* as outgroup species.

RESULT

Study of west New Guineas *Freycinetia* show that about 86 species occur in the area. All characters are analysis to find their relationship among them and understanding their evolution mechanism which happen in all species. Tree species from PAUP version 4.1 show 4 main groups of *Freycinetia* (Fig 1) . There are imbricate

group, semi imbricate group, un-imbricate group and grass group. *Freycinetia* which all grouping are divided by strong character that easy to see on leaves characters. All morphological character tell more about *Freycinetia* variation that will guide to understand diversity of the species.

Morphological Characters and Their Evolution

Stem

Stem is a part of *Freycinetia* that has few variation but its one really important character which is put west New Guinean species into four groups. Size of stem include diameter and length of internodes are strength on the group. Imbricate group are the biggest and grass group are the smallest. Slightly imbricate and un-imbricate in the middle size. Almost all species has irregularly rings of nodes except few un-imbricate species, in this group also found slightly ob-ovoid nodes.

As a whole imbricate group have strong and erect stem which is supported by minimize branching or less branching, make them strongly standing on trunk. Grass and un-imbricate groups are different from that imbricate one, abundant branching make them falling down from tree trunk so that there build shrub on the ground .

Leaves

Leaves characters is a good characters that bring us to find how exactly characters change among species. Four big groups of leaves c.i true imbricate leaves, slightly imbricate leaves , un-imbricate leaves and grass leave are the group strongly spread by PAUP analysis method. Imbricate leave refer to the species that has a continue over lapping arranged leaves but sometimes are still found leaves not so

close, its called slightly imbricate group, compare than some un- imbricate group . Un- imbricate leaves arrange regularly tri-tichous too but not overlapping although some species are often found so closely. Another group is grass group which have leaves seems like grass with rossete arrange of leave. Beside shape, size and density of leaves, specific character of lamina are used to search how deeply its show variety of species.

Evolution done by 3 process , fusion, reduction and change of symmetry . In leave reduction of size happen from biggest to small. We suggest that imbricate big species preceded unimbricate because we have found leaves with base linear and lancet tip on unimbricate group.

Shape of leaves differs from density because its depend on group . Imbricate leaves only have linear or lanceolate shape and un- imbricate have many variation of leaves shape e.i oblong, ovate, ob-ovate, ellips and lancet. Character of tip lamina for example caudate and cuspidate tip commonly belongs to imbricate one, on the other hand mucronate tip commonly found on un – imbricate group. About lamina surface, horizontal lines usually found on true imbricate leaves not on grass leaves but this character also belongs to both un- imbricate and slightly imbricate species.

Decorative of lamina surface are vary and not species have same type . Its character really specific on itself. Abaxial and adaxial lamina aren't same for some species. Sometimes on abaxial are found distinct nerves but adaxial are terrace sometimes smooth on adaxial but terraces on abaxial.

Terminal imbricate group have mechanism growing leaves that are start again from the tip after maturing fruits or falling down of staminate flower. But other 3 groups

develop their own new branching. New branching sometimes are known by spatha leaves which has auricle too, its put bellow young leaves.

Auricle

Auricle is specific character, just belong to *Freycinetia*, which is not found on other Pandanaceae groups. It is completely shown when leaves still young because some species has easy falling auricle that could not see anymore on next stage of growing leaves. Shape, size, texture, margin, lines on auricle, fiber that build auricle and color shown their variation.

Variation of shape start from tapered, triangularis to rounded tip and hanging tip; size variatif from less than 1 cm to 20 cm tall, 2 mm to 10 cm wide; texture are membranaceous to lamina texture; margin vary from soft prickles to stout prickles with closely each other or not; vertical and horizontal lines present or not and numbers of them are different too. Some auricle when dry leaves their fiber only, some are easy falling down. Only unimbricate group have later character, easy falling auricle make base of the leave looks like short petiole. Reduction in leaves make short leaves have mechanism to find their really shape close to other short commonly leave. Color of auricle are vary and its looks so beauty. Easy to see and strong character too but cannot find on herbarium specimen.

Bractea

Freycinetia have 4 kinds of bractea c.i true bract, leaves bract, a half leaves bractea and Small bractea. True bractea is a really bractea that are surrounding

inflorescence. Its usually build by 3 levels tritichous bractea ci centre bractea that separated flower and 2 levels bractea that protection bractea from outside .

Leaves bractea is a leaves that have differential function as a bractea by changing color of them as an instrument to make animal interest and come to plant for breeding time. A half leave bractea is a really bractea on function but in physical are mixed form, base part are bractea physic but tip one is a leave form. Small bractea is a bractea that has a small size.

Groups on *Freycinetia* has their own bractea. Imbricate group have true bract and leaves bract, Semi imbricate have true bract and small bract and Unimbricate group have a true bract only but small leaves surrounding true bractea without changing color. The last grass group only have true bractea include a half leaves bractea on out side. Mechanism in bractea is interesting one. Reduction leave in semiimbricate make them has mechanism change of symmetry with addition their number of bractea although only small bractea. In unimbricate group small bractea are not found but small leaves above bractea present. In grass group small bractea or leaves below was gone but true bractea mixed with leaves tip .

Bractea tip of unimbricate group looks like a leaf tip additionally by green color of tip. Its interesting because on grass group tip not only looks like a leaf tip but also looks like all lamina of leaf. Bractea leaf tip character born on unimbricate group and increasingly strong on grass group.

Shape of bract usually ovoid spread from broadly ovoid to thin ovoid or cymbiform until involute because of margin but color are vary . Some species only have one color but other have mixed two or three colors. Surface of bract commonly

terrace with closely each other or not, rarely smooth. Tip often caudate or acuminate except *F. wijayana*, It has bi-lobed. Margin usually entire, some have soft prickles and other stout prickles.

Peduncle and Pedicle.

Even though diameter of peduncle are straight on four group, length are vary because axillary species need longest one. Peduncle is commonly terete but pedicle is often semi terete although triangular or square pedicle are found too. Stout pedicle usually present on imbricate group but un-imbricate group often have thin pedicle seems like grass group. Surface of pedicle sometimes covered by prickles in all part or just in lines, but not rarely same in both staminate and pistillate flower. Many peduncle shorter than pedicle except on *F. plana* and most species on semi imbricate group.

Inflorescence

Freycinetia are commonly monoceous plant where staminate flowers and pistillate flowers place on one individu but stay at different flower, only few species are hermaphrodite flowers. West New guinea species along our research are monoceous only. Kind of inflorescence divided all plant on 2 groups e.i. terminalia arranged and axillary arranged. Axillary arranged belong to semiimbricate group, never found on imbricate and grass group but unimbricate group have both axillary and terminalia arranged of inflorescence. Our study found that axillary on unimbricate different with semiimbricate. Small bractea are commonly found on semi imbricate not found in here. Bractea that is put on axillary unimbricate group are really bractea belong to the group, its same with terminalia inflorescence bractea. This mechanism show that unimbricated group have reduction character of semiimbricate as support by PAUP analysis.

Staminate Flower

Staminate flower are vary from pedicle: shape, size, surface come to filament : long, wide and go to anther shape or size. Stamen stay on rachis that vary on color and high . Rachis often long than pedicle except few species like *F. longerifolia* . Color of rachis depend on filament and usually different on pedicle color. Filament commonly is more longer than anther but not all. Ovoid and oblong ather are found with androcial types vary from stamens monadelphous, tetradynamous to stamens with distal appendage.

Pistillate Flower

Ovary and stigma have many variation that remains on fruits . It could be seen both on flowers and fruits , for fruit is easy find than flowers so the character more discusses on fruit. Ovary usually ob-ovoid or cylindrical. Many pistil has no style , some has just slightly style.

Fruits

Some important character on *Freycinetia* are found on fruits start from position of fruits on stem e.i . terminalia or axillary; numbers of fruits are one number, 2, 3 to 4 numbers and more than 4 numbers ; shape of fruits commonly oblong, cylindrical, globose, falcate; color of mature fruits like yellowish green, yellow, orange, red, black red; and finally surface of fruits e.i flat or not flat.

Number of fruits vary on groups. Grass group always have 1 or 2 numbers, Unimbricate have 2, 3 or 4 numbers, semi imbricate have 3 numbers rarely has 2 or 4 numbers and Imbricate group have 3, 4 or more than 4, it could be 10 numbers. Their arranged usually on umbel or spirally . Species with 2,3 or 4 usually arranged on umbell

but more than 4 is on spirally arranged except for Imbricate group *F. frutacyllindrica* that arranged spirally on their 4 numbers of cephalia.

Spirally arranged are preceded than umbel one, on unimbricate group *F. frutonumerous* have 10 to 12 numbers of fruits and arranged spirally, *F. frutacyllindrica* with 4 numbers keep their character different with unimbricate group although they have 4 numbers but arranged only umbel.

Surface of fruit are different when young and mature phase. Some species when young are flat and have closely berries but other not flat and berries be a part each other, further when mature few of not flat berries became flat and other going to stout, on the other hand some flat became not flat. Flat surface of fruit only found on unimbricate group but not on all species and the other hands flat young surface fruits belong only to semi imbricate group.

Berries

Berries shape and their stigmatic remains tell more about what characters belonging to *Freycinetia* and their changing. Berries are found commonly ovoid, cylindrical, oblong, ob-ovoid and some unusual shape like pyriform calvate and napiform. Some species has long berry like *F. sarimensis* and other short one but not all part of berry could be seen on surface fruits because more than a half berry conjugate at the base as *F. marantifolia*, Its make napiform berry looks globose or pyriform looks pyramidal. Some species have all part seen as *F. decipiens*. Fusion of 2,3 or more berries and ovary present but in some species its become a character because fusion of berries have finished and it build a multiple berries their looks became one.

Some berries have two heads but other berries fusion from more than one berries. Evolution berries further build them became one berry but hole in the midst of them show the way of evolution. Finally berries stout with many stigmatic remains as the result of the evolution. Fusion berries often happen in semiimbricate group and all the group has be a part berries. In imbricate only few species are fusion berries same with unimbricate but its not found on grass group .

Density of berries only rarely on grass group and abundantly belong to imbricate group but unimbricate group have both rarely and abundantly, for example *F. gitaanggiana* with numerous berries and *F. tembagaपुरana* with few numbers of berries. Imbricate group has thin berries and abundantly , the characters reduce in numbers in semiimbricate and unimbricate but the size are increase on them.

Other variation of berries found on segment berries as indicator of fusion if it looks many parts . Variation on segment just find when its became widely so it looks like a wings. Some species has soft wings like *F. cuspidegera* but other have stout. Surface of berries not always smooth, few species has rugose surface.

Stigmatic Remains

Stigmatic remains on berries have more variation not only on their numbers and type of stigma but also margin and position on stigma at the side of tip berries. Number of remains stigma not always same on the species. Some species on going at their evolution numbers of stigma and other have finished. For example *F. langerifolia*, its one species under evolution . At the first it have two stigmatic remains then two other come on the opposite of their position make them became fourth stigma and later

connection between them build only one stigma. Type of stigma include two kinds e.i brokoli stigma and true stigma. Only few species have brokoli stigma for example *F. wijayana* .

Evolution process on brokoli species, start from clearly stigmatic remains further dot stigma look on brokoli stigmatic and finally dot stigma reduce leave brokoli stigma . Brokoli stigma present on unimbricate group.

Margin surrounding stigmatic remains have variation too. Of course brokoli stigmatic remains doesn't have margin but not all true stigmatic remains have margin too like *F. prismatica* . Some species have margin covered a half part only like *F. millikemus* different on commonly circular margin. Descendent bold margin which is found on *F. decendata* is a tipe of advance margin. Its born on *F. frutasola* belong to imbricate group and really be a character on unimbricate group. Next its found on grass group but start to reduce again so its not so broad . Not only widely of margin but also position of margin have been reduce. One species of *Freycinetia* have cuneate margin which is place on the centre surface so stigma put on other side may be longitudinal or radial compare with commonly ransversal position. Its happen because a surface tip not only flat but also concave or convex surface. Semiimbricate group have both concave and convex surface of stigma.

CONCLUSSION

Morphological study of West New Guinean *Freycinetia* species found very diversified, about 68 species occur in the area. Analysis PAUP version 4.1 show that the plant are divided into 4 group i.e imbricate, semi imbricate, unimbricate and grass looks group. Stem, leave, bractea and inflorescence are mainly characters that will guide to

understand about their variation and evolution. Evolution so far come from biggest group to small group with imbricate group as a primitive group and grass group as an advance.

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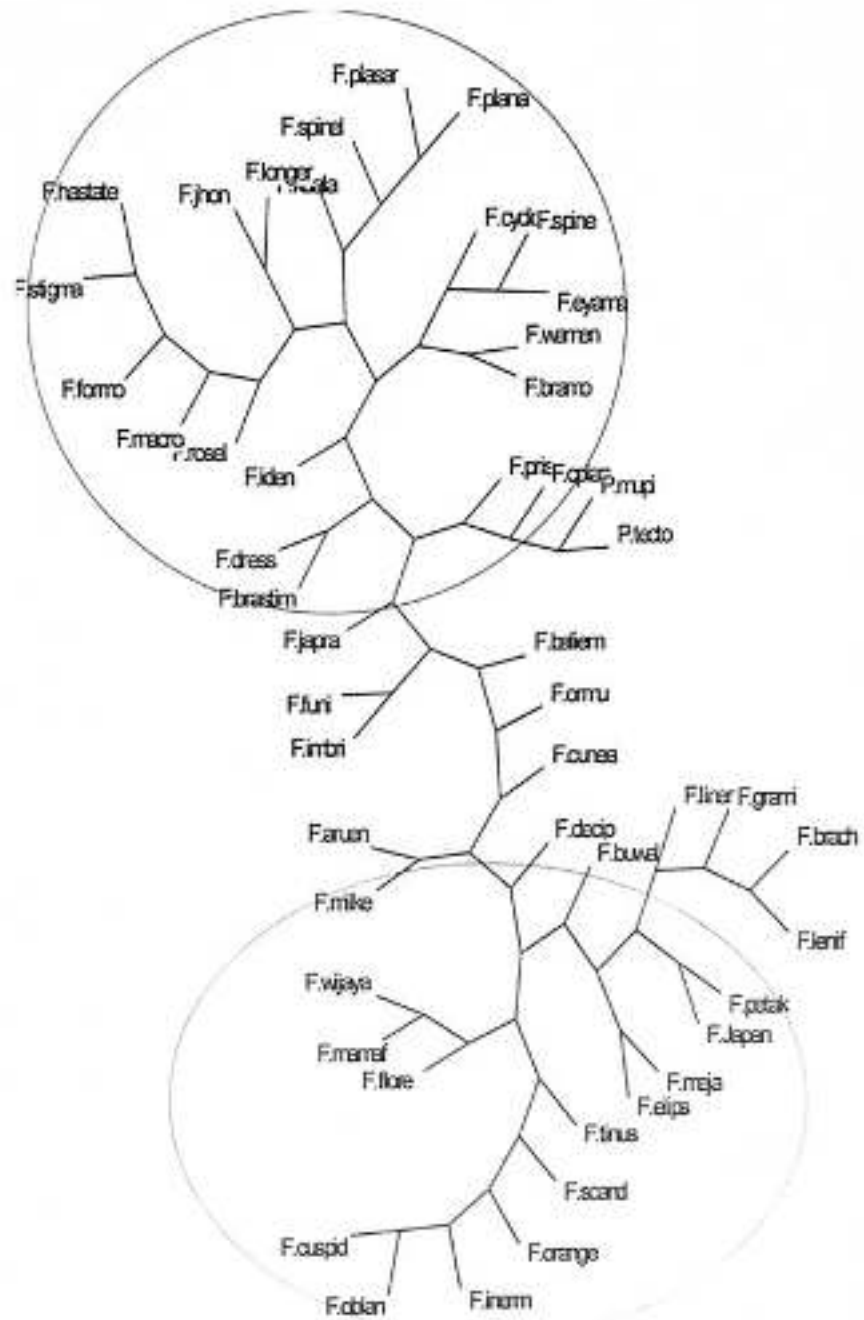


Figure 1. Tree phylogenetic show 4 groups of West New Guinea *Freycinetia*