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B Laubblätter bis zu 5 cm lang und 3 mm breit, vom Stengel in einem spitzen Winkel abstehend. Rhachis kurz und weich behaart. Stengel an der Basis in einige meist nur wenig verzweigte Äste geteilt. Infloreszenzen end- und achselständig. Blüten 10-12 mm lang. Tepalen mit etwa zwei Dritteln ihrer Länge verwachsen. Seitenabschnitte des freien Filamentteils die Antheren weit überragend. Fruchtknoten länglich-eiförmig, nach oben zu stark verjüngt; Griffel kurz, aber deutlich abgesetzt, Narbenäste kurz und kräftig, dick-pfriemenförmig.

.....G. angustiflora Mart.

Eine Aufzählung der Arten folgt im nächsten Heft.

GENERA AND GENERIC RELATIONSHIPS IN MUSACEAE

by

IRWIN E. LANE

The Musaceae, sensu latu, have received an extremely varied treatment, although the genera have generally been uniformly circumscribed and contrasted, as the genera are very distinct. As a result of intensive study of the genus Heliconia and a consideration of the relationships of the genus, a review of the entire family, at least as to the genera, has been necessary. Although this has not resulted in a completely new rearrangement of the family, some of the observations are new and are here presented with a discussion of the generea.

Endlicher (Gen.Pl. 227-229. 1836-40), following Richard (Comment.Musac. 1831), divides the family into two tribes; Heliconieae, with the single genus Heliconia, seeds solitary in a locule and septicidal dehiscence of the capsule; and Uranieae containing the other genera of Musaceae, characterized by seeds many in a locule and de-

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hiscence loculicidal. Later Eichler (Blütendiagramme 167 -169. 1875) pointed out the difference in orientation of the flower of the Heliconieae, thus emphasizing the differences in the two tribes.

Bentham and Hooker (Gen.Plant. III: 639 & 655-657. 1880) have treated the Musaceae as a tribe of their Ordo (family) Scitamineae. Baker (Annals of Botany VII: 189-222. 1893) does not divide the family, though in his key to the genera, the separation of Musa on the basis of the unisexual flowers, groups the genera in the same manner as the later workers have divided the family into subfamilies. Heliconia is divided into the subgenera Platychlamys and Stenochlamys. Ravenala is divided into the subgenera Urania and Phenakospermum. And Musa separated into the subgenera Physocaulis, Eumusa and Rhodochlamys. Orchidantha was not included with the family though he had included it under the tribe Museae in Hooker's Flora of British India (VI: 200 & 263-264. 1892).

Petersen (in Engler & Prantl, Natürliche Pflanzenfamilien II-6: 1-10. 1889) adopted the Richard classification and placed Orchidantha at the end, as probably belonging to the family. But Schumann (Das Pflanzenreich IV: 1-42. 1900) divided the family into three subfamilies: Musoideae, with spirally arranged vegetative structures and unisexual flowers: and the Strelitzioideae and Lowioideae with distichous vegetative parts and hermaphroditic flowers. The latter two subfamilies were separated from each other by the flowers being solitary or in panicles, and the sepals connate into a tube in the Lowioideae. Strelitzioideae was divided into two tribes, the Strelitzieae with pluriovulate locules, a loculicidal, three-valved capsule and arillate seeds, and the Heliconieae, with uniovulate locules, a capsule of three cocci and exarillate seeds. The division of the genera followed Baker for the Museae and Strelitzieae, and reduced the subgenera of Heliconia to the status of sections, replacing the subgeneric name of Platychlamys with the previously published Taeniostrobus of Kuntze. This classification was accepted by Winkler (Natürliche Pflanzenfamilien 2.Auflg. 15a, 505-545. 1930), with the only change being the placing of Ravenala in a separate tribe, the Ravenaleae.

Hutchinson (The Families of Flowering Plants, Monocotyledons 71-73. 1934) has divided the Musaceae of Schumann into three families: Musaceae with the single genus Musa; Lowiaceae with only Orchidantha (Lowia); and Strelitziaceae with Ravenala, Phenakospermum, Strelitzia, and Heliconia. No attempt was made to divide the last family into smaller units; and the basis for the separation was the same characters used by Schumann for separation into subfamilies.

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Perhaps the extreme in classification of the Musaceae has been reached by Nakai (Journal of Japanese Botany Vol. 17 No. 4, unfortunately not seen; and Bulletin of the Tokyo Science Museum No. 22: 5-24. July 1948), in which he separates off the genus Heliconia as the Heliconiaceae; presumably accepts the Lowiaceae; and definitely accepts the Musaceae and Strelitziaceae sensu Hutchinson. In the latter publication, the Strelitziaceae are divided into the three subfamilies, Strelitzioideae; Ravenaloideae, and Phenakospermoideae, with the last subfamily divided into two tribes, the Phenakospermeae, and the Musidendreae, to take the newly described genus Musidendron which he separates from Phenakospermum. The distinctness of the genus Ensete is accepted, and it is divided into two sections. Musa is divided into 11 subgenera and within which 9 sections and subsections are placed.

Schumann grouped Heliconia, Ravenala, Strelitzia, and Phenakospermum (as a subgenus of Ravenala) together on the basis of the distichous arrangement of the leaves, and the hermaphrodite flowers. Winkler and Hutchinson accepted this grouping. These treatments are based only on the appearence of the vegetative plant: "denn Ravenala und Strelitzia zeigen in allen Verhältnissen bis auf die angebliche Stellung des berührten Organes für jeden unbefangenen Beobachter ausschliesslich Beziehungen zu Heliconia.....", disregarding the basic differences of the orientation of the flower which is as Eichler described: the presence or absence of the aril; and the anatomical differentiation afforded by the lack of xylum and phloem strands in the central parenchyma of the root of only Heliconia. With the lack of information of the genus Heliconia, and the general prevalence of an apparent distichous arrangement of the vegetative parts, the similarity between the members of this group is understandable. However with the discovery of certain species of Heliconia which do not have a distichous arrangement of the vegetative parts, and others which have only a pseudo-distichous arrangement, the entire basis for the separation of Musa from the other members is reduced to the lack of unisexual flowers in other than Musa.

In fact, there is some question in my mind as to whether distichy exists in Heliconia; only a careful morphological examination of many or all species will reveal the answer. There also exists the possibility that the distichy observable in Strelitzia and the other genera may be only pseudo-distichy. By pseudo-distichy is meant the appearance of distichy in the mature members, here the leaves, but the arrangement of the buds or of the bases of the leaves indicates that the insertion is actually spiral. In Heliconia (e.g. H.hirsuta L.f. or H.psittacorum L.f.), though the leaves appear to be distichous, the buds and the leaf bases on the rhizome as well as the scales which

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cover the elongate rhizomes of the latter species, are arranged in a definite spiral. The later formed buds on the erect portion of the rhizome of H.psittacorum become more and more apparently distichous as the developing previous leaves exsert more and more pressure.

In spite of what Winkler states, the inflorescence of Musaceae is not mostly terminal. That it is terminal in Heliconia, Phenakospermum, and Musa, there is no doubt. But in Ravenala and Strelitzia it is not terminal. As evidence one needs note only that successive leaves, as many as 5 or 6, in Str.reginae, Str.parvifolia, Str. Nicolai, and Ravenala madagascariensis will subtend inflorescences.

Excluding the genus Orchidantha, which has been referred to another family, and for which a discussion and data are presented further on, the family Musaceae, and the component genera may be characterized as follows.

M U S A C E A E

Large or giant herbs or lignified stemmed plants from a corm or rhizome. The leaves are either spirally or distichously arranged and consist of a sheathing base, which forms the pseudostem found in certain genera, usually a well differentiated petiole and a dorso-ventral blade with a midrib composed of the veins in a ground-tissue. This midrib is gradually lost toward the apex as the lateral veins diverge from it at regular intervals, pass to the margin where they conflue into an intramarginal vein, and with the stomata oriented perpendicular to the longitudinal axis of the blade. The inflorescence is terminal or lateral, composed of spathes distichous or spirally arranged, each enclosing a group of flowers. The flowers are bracteate or ebracteate, and perfect except in most species of Musa. The ovary is inferior, three celled, with axial placentation (possible exception in certain species of Musa), or basal in Heliconia. The perigone forms a tube at the base and all parts may form a cushion. The sepals and petals, of three members each,may be free or variously connate and adnate. The stamens are six in number, or five by reduction, the sixth being absent or replaced by a staminode. This is always in the 'ad-inflorescence-axial' position. The style is simple. Fruit and seed various.

MUSA - ENSETE

Erect herbs with a pseudostem composed of the sheathing bases of the leaves. The leaves are spirally disposed. The terminal inflorescence is composed of a more or less elongate axis on which the clusters of flowers are spiral-

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ly disposed. Each cluster of flowers subtended by a spathe. According to Nakai the spiral may be either sinistral or dextral and of 2, 3, or 5 series. The flowers, normally female at the base of the inflorescence and male at the apex with frequently hermaphroditic flowers between, develop laterally in one or two rows. The individual flowers lack bracts. The female flowers have an inferior ovary, three celled, with three axial placentae. Nakai has indicated that certain species have a one celled ovary with parietal placentae; other species have six placentae, each attached to the center of a septum wall, and still other species characterized by the development of the placenta and multiple rows of ovules (vide fig. I). The sepals, when distinct or distinguishable, (in some species five members of the perigone are fused into a single structure), consist of a pair of 'ad-inflorescence-axial' sepals, and a single 'ab-axial' sepal. The paired-sepal margins overlap one over the other. The petals consist of a pair of 'ab-axial' petals, alternating with the sepals and more or less fused to them to form a single plate of tissue, and a free 'ad-axial' petal proportionately much wider than the other petals or sepals. Enclosed within these structures is a ring of five or six stamens, (in some cases of cultivated forms the number of stamens may be as high as 8, probably due to proliferation); with the reduced or absent stamen opposite the unpaired petal: the stamens are reduced and non-functional in the female flower. The style is reduced and non-functional in the male flower. The fruit is a many seeded berry with a more or less leathery exocarp, the seed is spherical to distinctly elongate, and may be angled by compression. The embryo, lying in a copious endosperm is straight (vide fig. II).

The genus consists of probably 60 - 70 species of the Tropics and Subtropics of Africa, Asia and Oceanea.

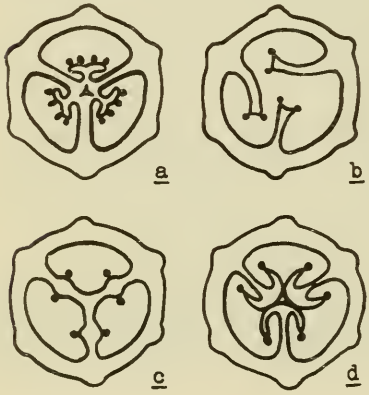

Fig. I: Diagrams of ovaries in *Musa* subgenera (after Nakai)

a. Spermomusa
b. Pallidimusa
c. Episeptalia
d. Corniculata

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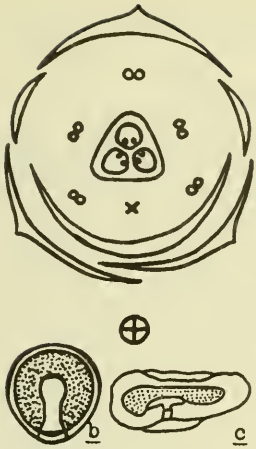

Fig. II:

Floral Diagram of Musa and Ensete
× The stamen in this position may be reduced or absent

b. Seed of Musa Basjoo Sieb. & Zucc.

c. Seed of Ensete ventricosum (Welw.) Cheesman

Cheesman (Kew Bulletin 1947: 97-106. 1948) has re-established the genus Ensete for the species formerly included in Musa with an haploid chromosome number of 9; and a monocarpic habit. The other character, a larger seed size, does not hold. Musa has a seed size of 3-11 mm in diameter, while Ensete has a seed size of 5-17 mm in diameter. Two of the thres species of the latter, accepted by Baker and Simmonds for Africa, (Kew Bulletin 1953: 405 -416. 1953), have a seed size well within the range of variation of Musa.

On the sole basis of the above characters, this genus would hardly seem distinct. However there appear to be two other characters which may be utilized. The pollen of E. ventricosum is recorded as granulose-papillose, and Nakai states that it is a character of the genus. The published drawings of the seeds of Ensete all show a "T" shaped embryo. By personal investigation, it has been established that at least some species of Musa have a straight embryo. Unfortunately it has not been possible to check the occurence of these characters in more than a few species, but with them the genus Ensete is accepted. The description of Musa then satisfies for Ensete with the addition of the characters: a monocarpic habit; pollen granulose-papillose: embryo "T" shaped.

The classification proposed by Nakai must be checked and correllated with the genetical and morphological details before it may be properly evaluated. It is certain that some of the criteria used are not of sectional value, nor even of specific value; e.g. the color of the pseudostem and leaves, the persistance or deciduousness of the spathes, the glaucousness of the leaves (known to vary ac-

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cording the ecology or genetic makeup of the particular population), and the presence or absence of an indument on the rhachis.

RAVENALA - PHENAKOSPERMUM

In 1833 Endlicher suggested the name Phenakosperum (sic!), (in the index Phenakospermum) for Urania guyannensis L.C.Rich. This is not a description, nor even a differentiationof the genus: "Sic Urania guyannensis (L.C.Rich. Comment. de Musaceis t.6 et t.7) a Ravenala habitu non minus quam seminum numero, figura, funiculi et arilli conformatione ipseque embryonis directione adeo differt, ut speciem hanc, flore verisimiliter etiam diversam, distincti generis (Phenakosperum dicendi) typum habere nulli dubitemus." In his Genera Plantarum,1836-40, p. 229, he differentiated the genus from Ravenala and referred the above publication, giving the reference exactly as it appears in the original, i.e. Phenakosperum, but again referring in the index to Phenakospermum. " Musaceae Americanae capsulares polyspermae,quarum flores videre nondum contigit, typum distincti generis (Phenakosperum Endl.Prodr.Flor.Norf.34 in not.Urania guianensis (sic!) Richard Musac. t.6,7.), sistere videntur, habitu Heliconiae donati, a Ravenala seminibus in loculis pluriseriatis, obovato-subglobosis, funiculo longiusculo rigido, in arillum comoso-stuposum, hinc semen, illinc funiculum obvolventem fatiscente, embryone denique lineari, recta protenso distincti." Here he has not treated it in the same manner as the other genera which he has accepted. It is not directly named, a name is referred to only paranthetically, i.e. 'the Phenakosperum of Endlicher prodr. Flor. Norf. in a note'. The name is not accepted, it is only proposed, and under article 43 of the 1950 Code of Nomenclature, it must be rejected. Treatment in this manner also avoids the vexing problem of how to deal with the varient spellings (in both texts it is Phenakosperum but in both indexes it is Phenakospermum). Miquel in Mohl and Schlechtendahl's Botanische Zeitung p. 345. 1845, definitely accepted the genus, took up the name Phenakospermum, and gave an excellent description. Thus the authority for the genus should read, 'Phenakospermum Endlicher ex Miquel.'

Since then, the genus has almost universally been considered conspecific with Ravenala. Hutchinson however considered it a distinct genus of his proposed Strelitziaceae as was also Ravenala. The differentiation between the genera occurs in both the flowers and fruits. The floral diagrams are strikingly alike, the only noticable difference is the absence of the stamen opposite the unpaired petal in Phenakospermum. Other minor differences are present in the flower. The inflorescence is terminal in Phena-

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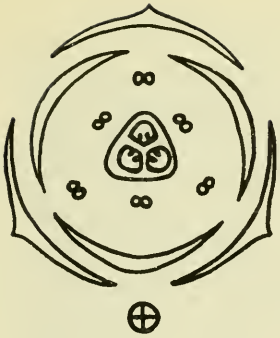
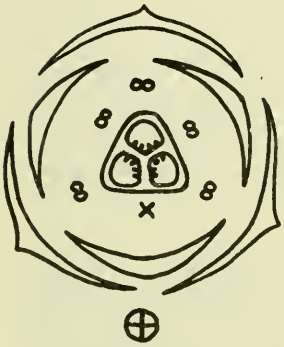


b

Fig. III:

Floral Diagram of Ravenala

b. Seed of R.madagascariensis Sonn.



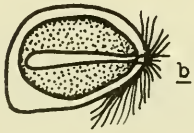


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Fig. IV:

Floral Diagram of Phenakospermum

× Position of absent stamen

b. Seed of P.guyannense Endl. ex Miq.

kospermum, lateral in Ravenala and many or most of the leaves bearing an inflorescence. The ovaries of both genera are pluriovulate, the ovules in Ravenala are in two rows while in Phenakospermum they are in four or more rows. the seed is arillate in both genera, but whereas it is composed of a sheet of tissue, blue in color with lacerate edges, in Ravenala, it is made up of many filaments, bright red-orange in color, in Phenakospermum. The embryo in Ravenala is "L" shaped: the micropylar opening from which the germinating seedling emerges, and around which the aril is attached, is on one of the longitudinal sides with the short arm of the "L" directed toward it. In Phenakospermum the embryo is straight, with the micropylar opening at the end of the somewhat elongate seed, with the aril attached beside it and along the under face of the seed (vide fig.III). There is no doubt but what two distinct genera are represented.

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R a v e n a l a

Erect tree, sprouting at the base, with ligneous stem and an apical crown of distichous leaves. Leaf sheaths short and not clasping except when very young. The inflorescence is lateral, composed of several distichous spathes, each enclosing a group of flowers. The flowers, each subtended by a bract, are arranged racemosely on a much shortened lateral branch and by compression assume a staggered, two-rowed position on the upper side. All are perfect. The calyx consists of a pair of 'ad-inflorescence-axial' sepals and an unpaired 'ab-axial' sepal. The corolla is formed of a pair of 'ab-axial' petals and an 'ad-axial' petal. The six stamens are free, the stigma is shortly lobed and hardly of greater diameter than the style. Fruit is capsular, with loculicidal dehiscence. The seeds are elongate, in two rows in each locule, attached laterally and nearly surrounded by a sheet of lacerate-margined tissue, blue in color which forms the aril. The embryo, lying in a copious endosperm is "L" shaped, with the short arm directed toward the micropyle which lies adjacent to the point of attachment to the placenta (vide fig.III).

The genus is monotypic and endemic to Madagascar.

P h e n a k o s p e r m u m

Erect herbs, with or without a ligneous stem, and an apical crown of distichous leaves. Leaves have sheathes much shorter than the other genera, and in some species not or hardly sheathing except when young. The inflorescence is terminal, (? pseudo-lateral with a sympodial type of growth in the caulescent species?), and formed of many distichous spathes, each subtending a shortened lateral branch which carries many flowers. Flowers, each subtended by a bract, racemosely disposed in two rows on the upper side of the branch, all perfect. The calyx has a pair of 'ad-axial' sepals with the adjacent margins coherent, and a free 'ab-axial' sepal. The corolla consists of three somewhat shorter parts with the adjacent margins of the 'ab-axial' pair connate. The stamens are five in number with the one opposite the 'ad-axial' petal missing. The anthers, about 5 cm long, connate about the long-lobed, deeply cleft stigma which is twice the diameter of the style. The fruit is a capsule with loculicidal dehiscence, with elongate seeds in four to many rows in each locule. The seeds are attached by one end with the aril, a mass of filiform bright red-orange threads, attached here and along the under side of the seed. The embryo, lying in a copious endosperm is straight, and oriented with the long axis of the seed, the micropyle lies adjacent to the point of attachment. (vide fig.IV).

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The genus consists of about two species of the tropical rain forest of eastern South America.

Nakai has separated as a distinct genus, Musidendron, the species with a ligneous trunk. Further characters are the lack of an elongate peduncle, differently colored bracts and flowers, the lack of a geniculate filament and a globose connective to the stamen, a non-sulcate stigma, and the ovules in a greater number of rows (8-12 rows). The variability of each of these characters in the other genera of the family, except for the number of rows of ovules, makes the recognition of a genus on such a basis extremely doubtful. The character of the number of rows of ovules (contrasted to the number 4-6 for Phenak.guyannensis recorded by Nakai) must be verified, but even so this can hardly be considered a distinct genus.

STRELITZIA

Erect herbs with or without ligneous stems, sprouting at the base, and with a crown of distichous leaves. Leaves with sheaths relatively short, especially in the stemmed species. Inflorescence is lateral of one to few (2-3) distichous spathes, each subtending a group of flowers. The flowers, each subtended by a bract, are arranged racemosely in two rows with the flowers staggered on the upper side of the much shortened lateral branch; all flowers are perfect. The calyx consists of a pair of 'ad-axial' sepals, and an 'ab-axial' sepal, the lateral margins of which are enclosed by the lateral margins of the paired sepals in the bud, and of the proximal margins of the paired sepals, one overlaps the other. The petals consist of a pair of 'ab-axial' petals, each strongly oblique with their proximal margins woody-thickened, overlapped and coherent. These petals are keeled, the keel forming the so-called "wings" of the petals. The 'ad-axial' petal is much shorter, and with the lateral margins enclosing the adjacent margine of the paired petals. Above the unpaired petal, the lateral margins of the paired petals approximate each other and surround five stamens and style. The position of the missing stamen is opposite the 'ad-axial' petal. The pollen is intermixed with long unicellular filaments. The fruit is a capsule, loculicidal in dehiscence, with many seeds arranged in two rows in each locule. The seeds are subspherical with an aril of orange filaments attached at the micropylar end and along the under side of the seed. The embryo is straight, with one end directed toward the micropyle which is adjacent to the point of attachment of the seed (vide fig. V).

The genus consists of about 6-8 species, endemic to southern Africa.

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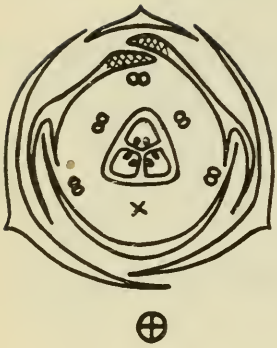

b

Fig. V:

Floral Diagram of Strelitzia

× Position of absent Stamen

b. Seed of Str. reginae Ait.

HELICONIA

Erect herbs with a pseudostem of the long sheathing bases of the leaves. Leaves generally appearing distichous, though not always so. The inflorescence is terminal on a leafy, or leafless stem, (i.e. the sheaths lacking blades), and consists of few to very many spathes either distichous or spirally disposed. The spathes, mostly brightly colored, enclose few(2) to very many flowers. Flowers, each subtended by a bract, are staggered in two rows on the upper side of the short branch, or clustered and sessile on a short protuberence, all are perfect. The calyx consists of a single 'ad-axial' sepal and a pair of 'ab-axial' sepals which show varying amounts of adherence to the petals. The lateral margins of the paired sepals overlap the margins of the 'ad-axial' sepal. The pair of 'ad-axial' petals show varying amounts of cohesion with the unpaired petal, which their margins overlap, and adhesion with the sepals. The free margins of the paired petals are overlapped and thickened. The stamens are five, the position of the sixth, opposite the unpaired sepal is replaced by a staminode. The style is straight or geniculate at the apex, and with a capitate, shortly lobed stigma; (vide fig. VI). The fruit is a 1-3 seeded berry, the seeds of various sizes and shapes in various species, all with a stony seed coat and mostly roughened, without an aril. The embryo, lying in a copious endosperm is straight and oriented on the longitudinal axis of the seed. The end is located at the micropyle, which is usually well differentiated and elaborated into a portical, the micropyle itself being plugged by an operculum.

The genus consists of approximately 150 species, mostly distributed in the tropics and subtropics of Central and South America, but with several species ranging from Indonesia through New Guinea, New Caledonia to Samoa.

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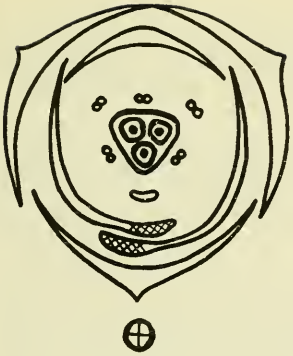

Fig. VI:

Floral Diagram of Heliconia

⌣ position of staminode

Heliconiopsis, proposed by Miquel, and recently accepted by Nakai, has no characters nor combination of characters which will distinguish it from Heliconia, the only exception being in the red color of the berry, and that is not red in all the species found in the Indo-Melanesian region. It is not a capsule as Nakai records. The segregate cannot even be upheld as a section of the genus.

The division of the genus into subgenera or sections is at present unsatisfactory, and a more natural classification may result from the completion of study now underway.

RELATIONSHIPS OF THE GENERA

On the three basic charcters of: ovule number; flower orientation; and anatomical structure of the root, Heliconia is certainly widely separated from the rest of the family. It is the most divergent genus, and although the flower itself has not been modified to as great an extent as some other genera, nor formed an aril, and comparatively small habit for the family, it may be considered the most derived genus. The loss of the caulescent habit, the terminal inflorescence which is brightly colored, the reduced ovule number and a basal placentation, and the well differentiated micropylar end of the seed together with the often elaborately roughened seed coat all indicate this derived state

Then apparently Musa has been derived, losing the stemmed habit, and developing the terminal inflorescence and, at least in part, unisexual flowers and non bracteate flowers; and a berry; but retaining the pluriovulate ovary and the lack of an aril. It may be speculated that both Musa and Heliconia have been derived together, from

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a stock early divergent from the rest of the family; on the basis of the terminal inflorescence, the lack of an aril, the berry fruit, and the same habit. However the different orientation of the flower is a very strong argument against this.

The presence of a similar, in fact nearly indistinguishable, type of aril in Phenakospermum and Strelitzia, and the straight embryo, contrast with the blue-colored plate-like laciniate margined aril and bent embryo of Ravenala. The former genera are therefore considered more closely allied to each other than to the latter; the more zygomorphic flowers, the presence of species in each genus with the acaulescent habit, and the comose aril indicate that these are more derived. Of the two, in spite of the lateral inflorescence of Strelitzia, it is considered the more advanced genus on the basis of the very highly zygomorphic flowers, the ovules reduced to two rows in each locule, the presence of sterile filaments in the pollen mass, and the adaption to a less uniform climatic condition.

Ravenala is considered the least derived genus on the basis of the caulescent habit, the nearly regular flower, lateral inflorescences, the presence of six stamens, and the simpler plate-like aril. The attainment of a distichous arrangement of the vegetative organs, and the bent embryo and the aril are certainly derived characters.

The division of the family as Richard has done, is thus much more natural; but within the Musoideae (Uranieae of Richard as a tribe), the genus Musa represents a distinct tribe, Strelitzia and Phenakospermum compose a second tribe, and Ravenala a third tribe.

MUSACEAE

subfam. Musoideae (Musoideae and for the greater part also Strelitzioideae of Schumann), unpaired sepal 'ab-axial'; locules with several axillary ovules.

tribe Ravenaleae Winkler in part: seed arillate, aril laminate; stamens 6; fruit a capsule; embryo bent.

tribe Strelitzieae Schumann in part: seed arillate; aril comose; stamens 5; fruit a capsule: embryo straight.

tribe Museae (Musoideae Schumann as subfam.) fruit a berry, seeds exarillate.

subfam. Heliconioideae (Heliconieae Richard as tribe), unpaired sepal 'ad-axial'; locule with one basal ovule; fruit a berry, seed exarillate.

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Unfortunately it has not been possible to see Nakai, Journal of Japanese Botany, Vol. XVII No. 4, in which he separated out the family Heliconiaceae. While admittedly an excellent argument may be made for such a course of action, especially with regard to the orientation of the flower, Heliconia is much more closely allied to Musa and the other members of the Musaceae than to any other genus or family in the Scitamineae or any other order. I feel that it is not advisable to separate it as a distinct family.

Concerning the position of the family Musaceae, there is considerable doubt. In the face of the evidence that the Zingiberaceae, Marantaceae and Cannaceae, (the other families of the Scitamineae), have a cymose type of inflorescence, whereas the Musaceae apparently has a a racemose type of inflorescence, Eichler and Schumann not withstanding, it cannot be considered to be closely related to the other families.

Schumann, following Eichler, attempted to interpret the branch of the inflorescence on incomplete and incorrect observations of Heliconia and Strelitzia. He concluded that these branches or groups of flowers were cincinni, i. e. a modification of the cymose type of inflorescence. Unfortunately he had seen branches of only a very few members of the genus, the one figured, H. psittacorum is quite exceptional for the genus in having very small bracts and the first flower is apparently lacking a bract. The inflorescence organization of Heliconia, Strelitzia, and Phenakospermum is of the same type, only the flower orientation differs in the first genus. This has been verified by examination of many species in the three genera.

Briefly described it is: there are two rows of partially conduplicate bracts, those of one side alternating with those of the other. The 'dorsal' halves, (in contrast to the half of the bract that lies on the side of the inflorescence), overlap each other; in the axil of each bract there is a flower. (In some species of Heliconia, there may be one or more empty bracts, or the flower may be replaced with a sterile cord-like structure which represents the flower.) That the bract subtending each flower is actually the bract of the flower there is little doubt. The principal vascularization of the bract is directly basipetal to the flower vascularization and there are relatively strong vascular connections with the flower, and only very weak, incidental lateral vascular connections with the flower next below. Therefore the in-

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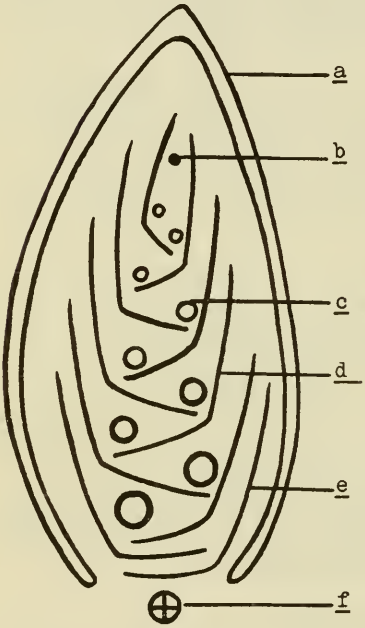
florescence can hardly be interpreted as a modification of a cyme, and is most easily, perhaps only, explainable by being considered as of a racemose type, either the 'partial inflorescence' of Baumgarten and Thompson, or a raceme which by compression has had the flowers and bracts pushed to the 'dorsal' side (vide fig.VII).



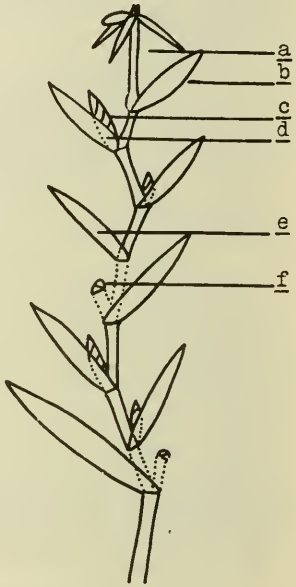


Fig. VII and VIII:

Fig.VII: Diagram of Heliconia inflorescence branch

a. spathe
b. branch axis
c. flower
d. floral bract
e. empty bract
f. inflorescence axis

Fig. VIII:Diagram of Orchidantha inflorescence
dotted lines indicate shortened internodes

a. flower
b. floral bract
c. branch bud
d. bract subtending branch bud
e. empty bract
f. aborted flower and bract

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Fahn (Kew Bulletin 1953: 299-306. 1953), very correctly stated that it is only reasonable to interpret the inflorescence of Musa, admittedly more specialized than other members of the family, by comparision with the inflorescence branches of these other genera. Then he proceeds to interpret the inflorescence branch of Musa as a cincinnus, based on the faulty assumption of Schumann that Heliconia and Strelitzia, (and presumably Ravenala and Phenakospermum also), have cincinnoid branches. Knowing that they probably possess, on the other hand, racemose branches, there is no evidence presented which opposes this view except possibly the time of development of the vascularization. The observations on the single form of an admittedly derived type of banana are incomplete and hardly a conclusive argument against an interpretation of the branch as racemose, especially in the face of the morphological evidence of Heliconia, Strelitzia and Phenakospermum. However much more work must be done on the inflorescence and inflorescence development before more than tentative suggestions can be put forth.

ORCHIDANTHA

As suggested previously, Orchidantha should properly be considered as belonging in a distinct family. Hutchinson, following Ridley (Flora of the Malay Peninsula IV: 291-292. 1924) has done so. The venation of the leaf, with several lateral pairs of longitudinal veins in the blade is much different from that found in Musaceae, or in any of the rest of the Scitamineae. The very zygomorphic flower is also different, but perhaps the most divergent part is the morphology of the inflorescence. As this has heretofore not been described, it may not be out of place to do so. Ridley considered it to be paniculate, or a solitary flower, as did Schumann. Hutchinson on the other hand correctly considered it to be a cyme.

The inflorescence, terminal on a one to few leaved lateral branch, is composed of a regularly branching cyme, the basic unit of which is a four-bracteate branch. The flowers are terminal on each branch, or these and the subtending bract are reduced. Below this there are two bracts, each of which carries a bud which can potentially develop, the uppermost first, and basally there is a sterile bract, in which no bud is present. If the terminal flower and bract are aborted, the subtending internode is much reduced or absent, and the basal internode is always eliminated. The first two or three flowers abort so that the first flower which develops is on the third or fourth branch. Successive flowers appear on the branches developing from the axils of the first bract below the previous flowers. There seems to be no doubt that the sterile knob at the tip of the sterile branch represents an aborted

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flower together with its bract. There is always a vestigial structure, correctly oriented and half covering this mound of tissue, and the fertile branch it is replaced by a flower and a bract (vide fig. VIII). Here also, though the vegetative parts appear distichous, the inflorescence shows a spiral arrangement.

The flower diagram shows the orientation of the flower to correspond with the subfamily Musoideae, of the Musaceae. However it should be noted that the lateral margins of the sepals, which are fused into a tube at the base, do not overlap each other, nor do the petals. Further in the plant it is very apparent that there is complete coalescence of all floral parts into a solid column, articulating to the ovary a short distance above the locules; i. e. it is composed of floral parts and is not a prolongation of the ovary. Ridley, followed by Hutchinson, Schumann and others, incorrectly stated it to be a tube. The above observations were made on living material of C.maxillarioides (Ridley) Ridley growing in the greenhouse of the Botanical Garden of München.

LOWIACEAE

The family, based on Lowia, a synonym of Orchidantha is a monotypic family of four or five species which are found in the Malay Peninsula and Borneo. The following description may serve as both a description of the family and the genus.

Acaulescent herbs, or seemingly acaulescent, with the lower portions prostrate and rooting as it is covered with litter. Roots are lacking vascular strands in the central tissue. Leaves apparently are distichous with sheathing bases and elongate petioles, the blade with distinct midrib and several pairs of lateral, longitudinal veins connected by prominent transverse cross-veins. Stomata are oriented perpendicular to the lateral transverse veins. Inflorescence is a regularly branched cyme, the individual branches of which bear a terminal flower, subtended by a bract; two buds bearing bracts, the upper of which normally develops; and a basal empty bract. The flower and its subtending bract of the first two or three branches abort. Flowers are hermaphroditic and very zygomorphic. Ovary is sessile, three celled with axial placentation, the several ovules in two rows in each cell, but very large and by alteration and pressure appear uniseriate. All floral parts are united into a long solid cylinder above the ovary. Sepals are three, united at the base into a short tube, the adaxial sepals form a pair.

Petals are three, the abaxial pair are small and the single adaxial petal large and forms a flat lip. The sta-

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mens are five, the sixth, opposite the lip, (adaxial petal), is lacking. Pollen is granular, very large. Style is as long as the stamens and only a little excerted from the calyx tube. The stigma is 3-lobed and the lobes are frequently laciniate. The fruit is a woody capsule and the seeds have a 3-lobed aril. The shape of the embryo is unknown.

There is little doubt that this family belongs with the Scitamineae, and probably as close to the Marantaceae or Zingiberaceae as to the Musaceae. However it can hardly be considered as closely related to any of these families.

The greater portion of the research on which the above is based, and the formulation of the ideas presented, were done at the Botanische Staatssammlung while I held a Fulbright stipendium for the year 1954-1955. Dr. Campos-Porto, director of the Botanic Garden of Rio de Janeiro has very kindly provided information and materials of Phenakospermum for study. I wish to thank the members of the staff of the Botanische Staatssammlung, and the Botanische Garten for the very many courtesies and help which they have extended to me.

INHALTSVERZEICHNIS

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