



Faculty of Resource Science and Technology

Genus *Archidendron* F.Muell. (Fabaceae) in Southeast Asia (SEA) : Distribution of the species and its flowering-fruiting pattern based on the specimens from Kew Herbarium (K)

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Bachelor of Science with Honours
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A thesis submitted in partial fulfilment of the Requirement of The Degree Bachelor of Science with Honours
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2022

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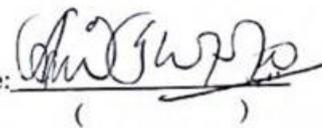
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ABSTRACT

The genus *Archidendron* is a large genus in Fabaceae family. However, this genus is still poorly studied and understood. In this study, the distribution in Southeast Asia (SEA) and the flowering-fruiting pattern of this genus based on digital specimens from Kew Herbarium (K) were determined. The distribution maps were generated using ArcView GIS 3.3 software based on the longitude and latitude coordinates stated on the specimen's label. The flowering and fruiting pattern bar chart was produced using Excel Spreadsheet. From the 278 specimens documented, there are 32 *Archidendron* species recorded in SEA. *Archidendron* is widely distributed in SEA where Malaysia has the most species recorded with 10 species while Myanmar and Singapore have the least species recorded with one species respectively. Philippines has the most specimens collected with 179 specimens recorded. The habitat preferred by genus *Archidendron* is lowland rainforest and only a few species could be found in swamp or montane forest. In general, this genus flowers and fruits throughout the year. In this study, the flowering and fruiting pattern of only one species, *Archidendron clypearia* (Jack) I.C. Nielsen was determined. This is due to insufficient data to determine the pattern. The flowering and fruiting pattern for *A. clypearia* shows that it flowers and fruits throughout the year except for November and December where there was no record for the fruiting specimens. More specimens should be observed to have a better understanding of the distribution and the flowering-fruiting pattern of this genus.

Keyword: *Archidendron*, *A.clypearia*, distribution, fruiting pattern, SEA,

ABSTRAK

Genus *Archidendron* adalah genus yang besar di dalam keluarga Fabaceae. Walau bagaimanapun, genus ini masih belum dikaji dan difahami dengan lebih dalam. Dalam kajian ini pemetaan taburan spesis di Asia Tenggara dan musim buah bagi genus *Archidendron* dikenalpasti menggunakan spesimen digital daripada Kew Herbarium (K). Pemetaan taburan spesis ini dihasilkan menggunakan ArcView 3.3 software berasaskan koordinat longitud dan latitude yang dinyatakan dalam label spesimen. Carta bar musim pembungaan dan pembuahan telah dihasilkan menggunakan Excel Spreadsheet. Daripada 278 spesimen yang telah didokumentasikan, terdapat 32 spesis *Archidendron* yang telah direkodkan di Asia Tenggara. Malaysia telah merekodkan 11 spesis *Archidendron* manakala Myanmar dan Singapura merekodkan bilangan spesis paling kurang iaitu satu spesis sahaja bagi setiap negara. Filipina telah merekodkan bilangan spesimen terbanyak iaitu 179 spesimen. Habitat bagi genus *Archidendron* adalah hutan hujan beraltitud rendah dan hanya beberapa spesis dapat dijumpai di hutan paya atau pergunungan. Secara umumnya, genus ini berbunga dan berbuah sepanjang tahun. Dalam kajian ini, musim bunga dan musim buah bagi hanya satu spesis iaitu *Archidendron clypearia* (Jack) I.C. Nielsen telah dikenalpasti. Hal ini demikian kerana kekurangan data untuk mengenal pasti musim-musim tersebut. Musim bunga dan musim buah bagi *A. clypearia* menunjukkan bahawa ia berbunga dan berbuah sepanjang tahun kecuali pada bulan November dan Disember dimana tiada rekod spesimen direkodkan. Untuk mendapatkan kefahaman yang lebih berkenaan taburan dan musim bunga-buah bagi genus ini, pengumpulan lebih banyak spesimen *Archidendron* perlu dilakukan.

Kata kunci: *Archidendron*, *A. clypearia*, musim bunga-buah, taburan, SEA.

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LIST OF ABBREVIATIONS

K Kew Herbarium

SEA Southeast Asia

cm centimeter

m meter

Mt. Mount

NY New York Herbarium

NI Naturalis Biodiversity Center

GBIF Global Biodiversity Information Facility

var. variation

subsp. subspecies

CHAPTER 1

1.0 INTRODUCTION

Archidendron F.Muell is a genus belonging to the family Fabaceae (the pea family) and order Fabales. This genus is in subfamily Caesalpinioideae (Mimosoid clade) and the largest group of the tribe Ingeae that occurs in lowland rainforest of Southeast Asia (SEA), Australia and New Guinea (Brown, 2014). There are 94 species recorded (Nielsen, 1981) but based on Plants of The World Online (POWO) (2019), *Archidendron* now has at least 98 described species. There are 60 species collected from SEA, Australia and New Guinea and deposited in Kew Herbarium (K). From 60 species recorded, 34 species are recorded from SEA.

Based on de Wit (1952) and Nielsen (1979; 1992), the species of *Archidendron* are usually found in various habits such as tree or shrubs and often with low branches. Genus *Archidendron* species can be easily recognized as a genus with unisexual flower with more than ovary and with presence of extra-floral nectaries on the petiole or glands. The leaves are compound and bipinnate. The flowers are either simple or often compound but always (tri-or) bi- or unisexual flowers. The stamens are numerous and monadelphous and united into a tube from the base. The ovaries are usually 1 - ∞ ovaries per flower, which is sessile or stalked. The style is often longer than the filaments and the stigma is either inconspicuous or small knob-shaped. The seeds are numerous, wingless with black or bluish-black.

SEA is a subregion of Asia, consist of 11 countries – Malaysia, Brunei, Indonesia, Myanmar or Burma, Cambodia, Timor-Leste, Thailand, Singapore, Vietnam and the Philippines. The largest country in SEA is Indonesia with total area 1904569 km² followed by Myanmar (676578 km²) and Thailand (513120 km²). Singapore is the smallest country in SEA with only 719 km area (Shvili, 2021; Central Intelligence Agency, 2021). SEA is a

well-known area of high biodiversity due to its uniform temperature year-around, high humidity and high precipitation due to its location. In addition, SEA also well-known with its variety of forests such as Dipterocarp Forest, Mangrove Forest, Montane Forest, Peat Swamp Forest etc. The northern part of rainforests in SEA has four season – winter northeast monsoon, summer southwest monsoon and another two intermonsoon seasons. However, all the seasons are actually hot and humid with only small difference of temperature.

The genus *Archidendron* in SEA is still understudy even though there are few species that are well-known with its economic importance. Based on ‘A Revision of the genus *Archidendron* F.Muell. (Mimosaceae)’ by De Wit (1952) and ‘Mimosaceae (Leguminosae-Mimosoideae)’ by Nielsen (1992), conclude *Archidendron* considered as not fully studied even from morphological point of view due to specimens collected is not enough to describe especially the leaves, floral and fruits specimens. In addition, the complex taxonomic history of family Fabaceae itself also cause the complication to study about genus *Archidendron*. The distribution of *Archidendron* species is randomly distributed in SEA and the highest distribution based on recorded specimens is in Philippines. There are only few studies regarding phytochemistry and pharmacology of some *Archidendron* species but there is no publication regarding the distribution and flowering or fruiting pattern of *Archidendron* species in SEA.

Therefore, the objectives of this study were: 1) to determine the distribution of *Archidendron* species in SEA and 2) to determine the flowering or fruiting pattern of *Archidendron* species in SEA.

CHAPTER 2

2.0 LITERATURE REVIEW

2.1. Kew Herbarium

Kew Herbarium (K) is located at Royal Botanic Gardens Kew, one of the largest in the world, containing around 95% of vascular plant genera and 330,000 type of specimens that use as standards for identifying the correct name of a plant. The specimens' collection in K were collected by Kew Staff with partners around the world and almost 12% of the collections has been digitalized in database (Kew Royal Botanical Website, 2006).

In the herbarium, the specimens are organized systematically according to taxonomic levels. The data such as collector's name, date of specimen collected, type of specimen and its location also recoded as herbarium details. Kew specimens record the leaves, stem, bark, flower, fruits and any plant parts. The online database of Kew Herbarium specimen collection is accessible <http://apps.kew.org/herbcat/navigator.do>. The online database contains the images of pressed or dried specimens and information taken from the collection labels (Kew Royal Botanical Website, 2006). The data such as the date and the location of specimen collected of genus *Archidendron* observed in this study to determine its fruiting pattern and distribution.

2.2. Fabaceae and Ingeae

2.2.1. Fabaceae

Fabaceae or previously known as Leguminoiseae is a legume, pea or bean family that one of the largest and economically important families among Angiosperm. Fabaceae family is classified under the order of Fabales and easily recognize with its legume (fruits). Morphologically, the Fabaceae family is easily recognized with its specialized follicles known as legume, compound and stipulate leaves and monocarpic (Wong, 2021). The

legume is actually a follicle but with two suture lines or modified fruits as one seeded fruitlet. The most common Fabaceae species that have obvious legumes are *Pisum sativum* L. and *Glycine max* L. Merr. The leaves either paripinnate, imparipinnate or bipinnately compound and have alternate arrangements with one to numerous pairs of leaflets. Based on Wong (2021), the monocarpic refers to the single superior carpel of the Fabaceae flower. Fabaceae also well-known with its economic importance such as food crops and could act as Nitrogen fixing bacteria crop. There are few examples of species from different subfamilies that are consumed as food or medicine - the *P. sativum* from Faboideae, *A. jiringa* and *A. bubalinum* from Caesalpinioideae..

2.2.2. Tribe Ingeae

Ingeae is one of tribes in Fabaceae family and the largest tribe of Mimosoideae with 36 genera distributed pantropical. The species of Ingeae could be found in Southern to Central America and SEA to Pacific Islands to Australia region. The tribe Ingeae was established by Bentham in 1865 with 9 genera – *Affonsea* A.St-Hill., *Albizia* Durazz., *Archidendron*, *Calliandra* Benth., *Enterolobium* Mart., *Inga* Mill., *Lysiloma*, *Pithercellobium* Martius and *Serianthes* Benth. However, after 10 years, in 1875, Bentham recognizing Ingeae with addition 5 genera/subgenera (Brown, 2008). Currently, there are 33 genera of Ingeae tribe and more than 900 species (LPGW et.al, 2013).

The taxonomic classification of Ingeae has changed a few times due to the complex and unstable taxonomic history. The ‘Advances in Legume Systematics’ by Nielsen in 1981 is well-known study as revision for tribe Ingeae, however numerous taxonomic changes were proposed in the subsequent year that caused incongruent classification schemes to arise and creating taxonomic confusion of legume systematics.

2.3. Genus *Archidendron* F.Muell

2.3.1. General Characteristics of *Archidendron*

The genus *Archidendron* can be found in various forms and has woody habit such as trees or shrubs. It is rarely large but usually cauliflorous. For example, *A. apoense* (Elmer) Nielsen is a small 10-meter (m) woody tree with 25-centimetre (cm) diameter and *A. borneense* (Benth.) Nielsen is a shrub that grows up to 12 m high with only 12 cm in diameter. There are also other large *Archidendron* such as *A. clypearia* (Jack) I.C Nielsen which is a shrub that grows up to 23 m tall with 46 cm in diameter and *A. ellipticum* (Blume) I.C Nielsen which is a tree that can grow up to 20 m tall with 50 cm in diameter (Nielsen 1992).

Members of the genus *Archidendron* have bipinnate leaves and often with glands on petiole. The number of pinnae is low with 1-5 pairs only and the glands are various in terms of size and shape. The leaflets arrangement is opposite, alternate or unifoliate. The venation is pinnate either parallel or anastomose. The inflorescence either simple or compound, consisting of pedunculated glomerules, umbels, corymbs or racemes. The seeds are numerous, recalcitrant and does not have aril (Nielsen, 1979).

There are two striking characteristics of *Archidendron*, 1) unisexual flower with more than one ovary and 2) extra-floral nectaries or glands (DeWit, 1952; Nielsen 1979). However, based on Nielson (1992) the important characters to indicate the species of *Archidendron* are morphology of pods, presence of extra-flora glands on the floral bracts, morphology of inflorescence, and length of staminal tube and presence of the ovary stipe. In addition, these characters also show the dispersal mechanism of the species because it is related with plant reproductive parts.

The pod of *Archidendron* is often bright coloured to attract dispersal agent such as bird and mammals (Nielson 1979; 1992). For example, *A. fagifolium* (Blume ex Miq)

Nielsen has light yellow outer layer pod, orange flesh and small shiny black seed. The seeds are dispersed by birds. *Archidendron bubalinum* has green pods when young and turn yellowish or reddish when old with reddish thick fleshy. The black seed fill the entire cavity of pod and recorded dispersed by mammals (Nielsen, 1992).

2.3.2. Distribution of *Archidendron*

The species of *Archidendron* are widely distributed but some species have restricted distribution in the subtropical to tropical region especially in SEA. Based on Nielsen (1992), *A. contorum* (Mart) I.C Nielsen, *A. bubalinum*, *A. microcarpum* (Benth.) I.C Nielsen, *A. kuenstleri* (Prain) I.C Nielsen, *A. globosum* (Blume) I.C Nielsen, *A. ellipticum* and *A. jiringa* are species that are widely distributed in Malaysia and Indonesia. *Archidendron ellipticum* and *A. jiringa* also recorded widely distributed in Thailand and Myanmar. Some species with restricted distribution are *A. pahangense* (Kosterm) I.C Nielsen (Peninsular Malaysia), *A. kinabaluense* (Kosterm) I.C Nielsen (Borneo), *A. dalantense* (Kosterm) I.C Nielsen (South Vietnam) and *A. laoticum* (Laos). These restricted species are still rarely collected due to its endemic to certain area. One species, which is *A. clypearia* can be found occurring all over SEA (Nielsen, 1992).

The genus *Archidendron* grows in primary and secondary lowland forest with only few species can grow in 1500 m altitude. For example, *A. havilandii* (Ridley) Nielsen can be found in terrain flat or slop up to 1550 m altitude and *A. pahangense* can be found in 600 m to 1500 m altitude. Based on K specimens, *A. jiringa* can be found growing up in 1627 m altitude in Java. Besides, there are also small number of species recorded from swampy habitat such as *A. borneense*, *A. kunstleri* and *A. oppositum* (Miq) I.C Nielsen. There are three species recorded from limestone habitat or habitats with coral sand, which are *A. fagifolium*, *A. tjendana* (Kosterm) I.C Nielsen and *A. palauense* (Kaneh.) I.C Nielsen (Nielsen, 1992).

2.3.3. Flowering and fruiting pattern of *Archidendron*

Based on De Wit (1952), the flowering of *Archidendron* is around November. In other hand, Nielsen (1992) indicated that the flowering and fruiting pattern of *Archidendron* is different in each species. *Archidendron bubalinum* expected to flower around January to October, while the *A. clypearia* is expected flower and fruit throughout the year. There are also some other species such as *A. apoense*, *A. kinabaluense*, *A. merrillii* (J.F.Macbr.) I.C. Nielsen and *A. palauense* where flowering or fruiting season could not be determined due to low number of complete herbarium specimens especially the inflorescence and pods of the *Archidendron*.

2.3.3. Economic Importance and uses of *Archidendron*

Fabaceae represents one of the most important families utilized by human cultures worldwide. In term of *Archidendron*, the species are commonly known with their medicinal uses even though they have very strong pungent smell of legumes and seeds. Based on Hanafi et. al (2018), the young seeds of *A. bubalinum* consumed salad or *ulam* that eaten raw and consumed traditionally as diuretic in Malaysia and Indonesia community especially due to its djenkolic acid. This acid is a Sulphur-containing non-protein amino acid that naturally also found in other *Archidendron* legumes such as *A. jiringa*, and *A. pauciflorum*. Based on D'Mello (1991), the toxicity of the djenkolic acid in human arises from poor solubility under acidic condition in human body after consumption of any *Archidendron* fruits. In addition, the study of *A. bubalinum* also found that it has high moisture and protein content with low fat content but being limited in valine, 9 methionine and tyrosine. *Archidendron bubalinum* also contain the anti-nutrient such as tannins, trypsin inhibitors and hemagglutinin (Hanafi et. al, 2018).

Archidendron bark, leaves and fruit pericarp are also used as other purposes. The bark and leaves were extracted to obtain black dye while some of *Archidendron* pods such as *A. jiringa* were extracted to obtain silk purple dye. There is also a study conducted by Masyasriyah et. al (2020) that extracted and used the bark of *A. pauciflorum* as natural Dye-Sensitized Solar Cell (DSSC) base that use to convert visible light into electrical energy.

CHAPTER 3

3.0 MATERIALS AND METHOD

The study of distribution and flowering or fruiting pattern of *Archidendron* only conducted by observing the herbarium records in Kew (K) that are accessible online at <https://www.kew.org/> and <https://powo.science.kew.org/>. There are 278 specimen records of 33 taxa from Southeast Asia (SEA) in the herbarium. For each species, all information of plant specimens such as the name of the species, collection number, collector, date, locality, habitat and notes were recorded in Microsoft Excel.

The flowering and fruiting pattern of *Archidendron* were determined using graphic interpretation in Microsoft Excel. The data of any specimens with flowers or fruits, the name of the species and date of collection (day, month, year) were recorded.

The information of all specimens in the herbarium were first compiled in tabular format using Microsoft Excel. The first part of the table contains each specimen's collection ID; and pairing of latitudinal-longitudinal coordinates. The other part enlists other attributes such as name and locality name (country, region, state, district and other localities information) of the species. In order to map the distribution of *Archidendron* in SEA, the table is imported into ArcView 3.3 software to create a geodatabase. Structure of the geodatabase data dictionary is shown in Table 1. For collection ID without Attribute 2 values, its location is determined based on locality data (Attributes 5-8).

Table 1 Data dictionary of geodatabase of *Archidendron*

Attribute	
1	Collection ID
2	Longitude/Latitude
3	Species Name
4	Country
5	Province
6	State
7	District
8	Species ID

CHAPTER 4

4.0 RESULTS

4.1 The Distribution of genus *Archidendron* F. Muell in SEA

A total of 33 taxa and 32 identified species of *Archidendron* from 278 specimens from Kew (K) herbarium recorded in this study. The distribution and flowering-fruiting pattern of the genus were observed and analysed. The distribution of *Archidendron* species is scattered throughout SEA (Figure 1). Most of the specimens recorded in K were collected in Philippines (172 specimens or 61.65%). It then followed by Malaysia (30 specimens or 10.75%), Thailand (24 specimens or 8.60%) and Indonesia (22 specimens or 7.88%). There are no specimens recorded in Cambodia and Timor-Leste. The list of countries and number of collected specimens are given in Table 2.

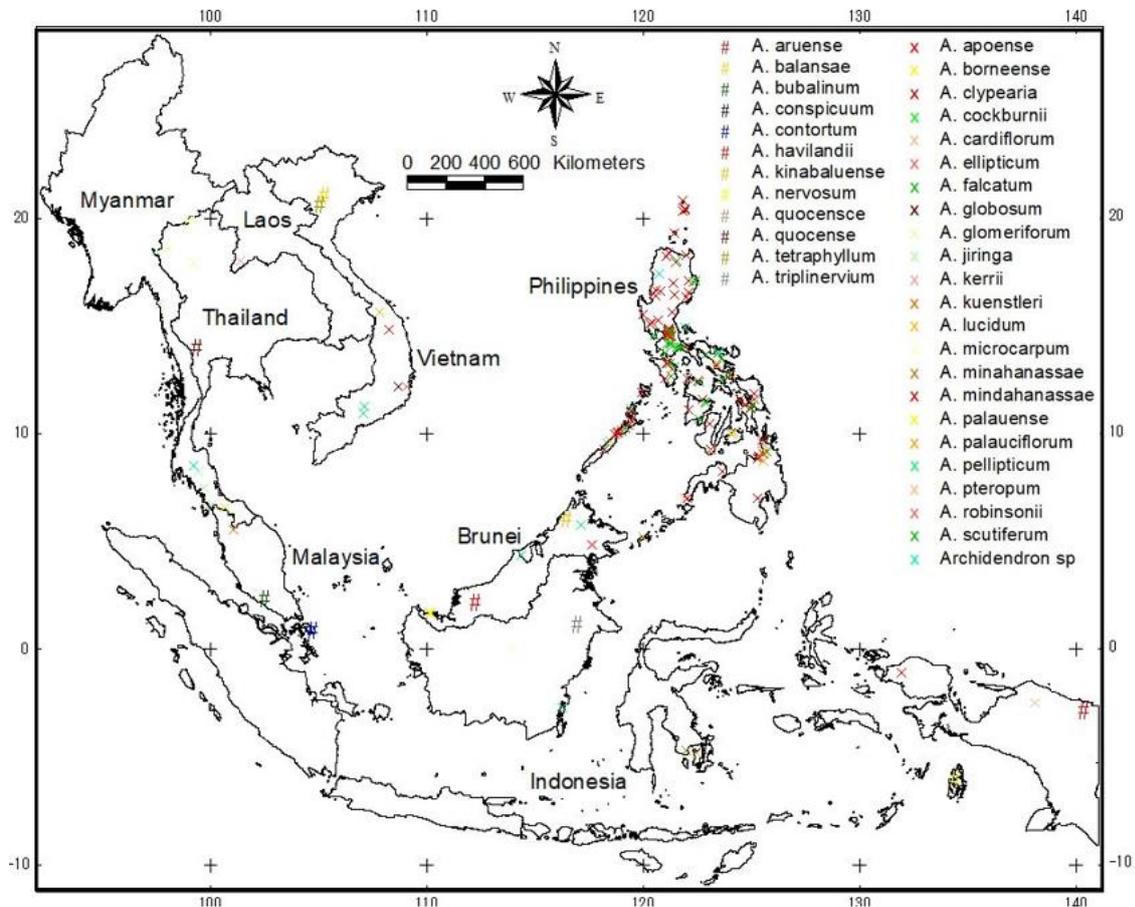


Figure 1: The distribution of *Archidendron* species in SEA

Table 2 The list of collected *Archidendron* species in SEA and its number of collected specimens based on its species and country

	Number of Specimens									
	Brunei	Indonesia	Laos	Malaysia	Myanmar	Philippines	Singapore	Thailand	Vietnam	SEA
1. <i>Archidendron apoense</i> (Elmer) I. C. Nielsen	-	-	-	-	-	2	-	-	-	-
2. <i>Archidendron aruense</i> (Warb.) de Wit	-	5	-	-	-	-	-	-	-	2
3. <i>Archidendron balanse</i> (Oliver) I.C. Nielsen	-	-	-	-	-	-	-	-	3	-
4. <i>Archidendron borneense</i> (Benth.) I.C. Nielsen	-	-	-	3	-	-	-	-	-	-
5. <i>Archidendron bubalinum</i> (Jack) I.C. Nielsen	-	-	-	2	-	-	-	-	-	-
6. <i>Archidendron clypearia</i> (Jack) I.C. Nielsen	-	4	-	3	-	79	-	-	2	-
1) <i>Archidendron clypearia</i> subsp. <i>clypearia</i>	-	-	-	-	-	10	-	-	-	-
2) <i>Archidendron clypearia</i> var. <i>velutinum</i> (Merr. & L.M.Perry) I.C.Nielsen	-	-	-	-	-	-	-	-	3	-
3) <i>Archidendron clypearia</i> var. <i>casai</i> (Blanco) Nielsen	-	1	-	-	-	14	-	-	-	-
4) <i>Archidendron clypearia</i> var. <i>sessiliflorum</i> (Merr.) Nielsen	-	-	-	-	-	1	-	-	-	-
5) <i>Archidendron clypearia</i> (Jack) I.C.Nielsen subsp. <i>velutina</i>	-	1	-	-	-	-	-	-	-	-

7.	<i>Archidendron cockburnii</i> I.C. Nielsen	1	1	-	2	-	-	-	-	-	-
8.	<i>Archidendron conspicuum</i> (Craib) I.C. Nielsen	-	-	-	-	-	-	-	-	-	1
9.	<i>Archidendron contortum</i> (Mart.) I.C. Nielsen	-	-	-	-	-	-	2	-	-	-
10.	<i>Archidendron ellipticum</i> (Blume) I.C. Nielsen	-	-	-	3	-	5	-	1	-	-
	1) <i>Archidendron ellipticum</i> subsp. <i>cordifoliolatum</i> I.C. Nielsen	-	-	-	-	-	2	-	-	-	-
11.	<i>Archidendron fagifolium</i> (Blume ex Miq.) I.C. Nielsen	-	-	-	-	-	-	-	-	-	-
	1) <i>Archidendron fagifolium</i> var. <i>mindanaense</i> (Merr.) I.C. Nielsen	-	-	-	-	-	5	-	-	-	-
12.	<i>Archidendron falcatum</i> I.C. Nielsen	-	-	-	-	-	3	-	-	-	-
13.	<i>Archidendron globosum</i> (Blume) I.C. Nielsen	-	1	-	3	-	-	-	-	1	-
14.	<i>Archidendron glomeriflorum</i> (Kurz) I.C. Nielsen	-	-	-	-	-	-	-	11	-	-
15.	<i>Archidendron havilandii</i> (Ridley) I.C. Nielsen	-	-	-	1	-	-	-	-	-	-
16.	<i>Archidendron jiringa</i> (Jack) I.C. Nielsen	-	-	-	1	1	-	-	7	-	-
17.	<i>Archidendron kerrii</i> (Gagnepain) I.C. Nielsen	-	-	2	-	-	-	-	-	-	-
18.	<i>Archidendron kinabaluense</i> (Kosterm.) I.C. Nielsen	-	-	-	3	-	-	-	-	-	-