

Taxonomical position of Annonaceae species from East Java, Indonesia: Collections of Purwodadi Botanic Garden based on morphological character

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Abstract. Lestari DA, Azrianingsih R, Hendrian H. 2017. Taxonomical position of Annonaceae species from East Java, Indonesia: collections of Purwodadi Botanic Garden based on morphological character. *Biodiversitas* 18: 1067-1076. Morphological characters are one of the most consistent of taxonomical markers are used in Annonaceae today. One of the plants collections from Annonaceae species which came from East Java and conserved in Purwodadi Botanic Garden-Indonesian Institute of Sciences, Purwodadi, and East Java has some problems in morphological characters. It has some problems that causing the taxonomical position of these species are not clear, i.e. presence of unidentified plant until level species. The aim of this study is to classify and identify of species that have not been identified in order to taxonomical position be clearly. Material samples are used Annonaceae collection from East Java and Magnoliaceae as out-group. Samples of these plants were observed qualitatively and quantitatively through morphological characters were analyzed using cluster analysis and then synapomorphy, autapomorphy and apomorphy character analysis to identify and to determine the taxonomical position. The results showed that there are 4 tribes and two sub-families in the dendrogram. Tribe includes Miliuseae, Xylopieae, Annoneae and Uvariae, as well as sub-family of Malmeoideae and Annonoideae. Sub-family distinguished by inner petal and habit, sub-family of Malmeoideae has connate inner petals and trees habit, sub-family of Annonoideae has free inner petal and woody climber habit, some of the trees. Species are unidentified suspected as a different species based on the proximity of group formed. There are five plant species that have not been identified to the species level. These species can be recommended the taxonomical position and proposed of species name through dendrogram with the name of the specimen. Specimen 1 is predicted to have close relations with *Annona muricata*, specimen 2 is predicted to have close relations with *Miliusa macropoda*, specimen 3 is predicted to have close relations with *Artabotrys uncinatus* and identified as *Uvaria micrantha*, specimen 4 is predicted to have close relations with *Fissistigma latifolium* and specimen 5 is predicted to have close relations with *Saccopetalum horsfieldii*, because these species are in one group.

Keywords: Annonaceae, morphology, taxonomical position, Purwodadi Botanic Garden

INTRODUCTION

Morphological character is one of the markers used for the grouping of plant taxonomy besides of the other characters such as anatomy, micromorphology, histology, cytology, palynology, embryology, chemistry, and biogeography. This is caused by morphological characters have a consistent character, can be derived, non-susceptible to environmental changes, showing clear delineation of other similar character and character states, and have valuable evolution (Bhattacharyya, 2009). Generally, these characters are specifically derived in certain groups and one of them is Annonaceae family. According to the Engler and Prantl classification system, the family of Annonaceae belongs to the sub-class of Dialypetalae is belonging to primitive plants and characterized by unclear boundaries between *sepals*, *petals*, and parts of fruit (Tjitrosoepomo, 2013).

Hutchinson (1973) states that Annonaceae is an ancestor of Magnoliaceae, but it has more advanced characters. Some similarities between morphological

characters between Annonaceae and Magnoliaceae includes numerous of hollow, type of *stomata* is parasitic, bisexual flowers and trimerous, adhere microspores, type of *pollen* is *monosulcate*, free and spiral *carpels*, type of *endosperms* is cellular and follicle fruits. This similarity of character indicates the close relationship between Annonaceae and Magnoliaceae. Morphological characters are belonging only to Annonaceae family includes distichous leaves arrangement, cross-section of stem is striate, stems or twigs when exfoliated will produce a unique aroma (aromatic), leaves have no *stipules*, aestivation of *petal* is *valvate*, *endosperm* *ruminate*, arillus seeds, berries or drupe fruits, and vessels with simple perforated fields (Kessler, 1993; Maas et al. 2007; Bhattacharyya, 2009; Wu et al. 2011). According to Chatrou et al. (2012), Annonaceae family is divided into four sub-families i.e. Anaxagoreoideae, Ambavioideae, Annonoideae and Malmeoideae based on the molecular marker. The four subfamilies are distinguished by the morphological characteristics of habit, leaf arrangement, carpels of flowers and fruit, the form of apical connective

prolongation, connective extension of *anthers*, internal *staminodia*, *orbicules*, *ovules*, *endosperm ruminations*, tip shape of *stamen*, monocarp abscission, monocarp dehiscent or indehiscent, shape of seed, integument of middle seed and the number of basic chromosomes. This distinguishing character of subfamilies refers to many observations and research from Maas and Westra (1984), Westra (1985), Morawetz and Le Thomas (1988), van Heusden (1992), van Setten and Koek-Noorman (1992), Johnson and Murray (1995), Doyle and Le Thomas (1996), Svoma (1998), Johnson (2003), Maas, Westra and Chatrou (2003), Tsou and Johnson (2003), Scharaschkin and Doyle (2005, 2006), Su and Saunders (2006), Maas, Westra and Vermeer (2007), Couvreur (2009), Huysmans et. al. (2010), Surveswaran et. al. (2010) and Weerasooriya and Saunders (2010). This morphological character becomes a distinctive character in sub-family of Annonaceae. Sub-families of Annonoideae and Malmeoideae are divided into several tribes and distinguished by characteristics from structure of *gynoecium*, aestivations of *petals*, sum of *petals*, relatively size of outer and inner *petals*, sympetalous flowers or inflorescence, tip of connective, *placenta* and number of *ovules*, position of flowers or inflorescence, phyllotaxis type, *pollen* form and absence or present of indumentum (Koek-Norman et al. 1990; Chatrou et al. 2012; Doyle and Thomas, 2012).

The taxonomical position of Annonaceae species is still debatable, especially in Annonaceae species are grouping based on morphological characters. Chatrou et al. (2012) classify Annonaceae species based on characters of generative organ, while Couvreur et al. (2012) grouped by characters of vegetative organ and fertile characters during their generative phase. Several categories in his infra-family have problems. The classification at these levels is very far when compared to another family, although the grouping of Annonaceae family tends to be stable (Kessler, 1995). Therefore, determination of taxonomical position for unidentified species in Annonaceae family could be identified by a dendrogram. The importance of taxonomical position is crucial to the classification of species in plant taxonomy for its clear identity.

Some species of Annonaceae are ex-situ conserved and collected by Purwodadi Botanic Garden (PBG) - Indonesian Institute of Sciences as one of the plant conservation institutions. Annonaceae family are collected from various regions in Indonesia, such as Java (especially East Java), Borneo, Sumatra (Riau), Sulawesi, Maluku (Buru and Seram Island), Papua and East Nusa Tenggara (Lestari et al. 2011). One of the Annonaceae collections has problems and especially are originates from East Java, where the generative character does not fully appear, have variations in certain species such as *Orophea* (Lestari, 2011) and unidentified species. Unidentified species from Annonaceae collections that originate from East Java in PBG are five specimens. Through morphological character analysis, the taxonomical position of Annonaceae species from East Java can be identified and determined further.

The aim of this research is to classify and identify the unidentified species as name verification so that the taxonomical position of it can be clearly known. If species

identity of it has been known, it is useful in conservation effort of Annonaceae especially are originates from East Java in PBG.

MATERIALS AND METHODS

Study site

Research was conducted in Purwodadi Botanic Garden (PBG), Indonesian Institute of Sciences, Pasuruan, East Java, Indonesia, for morphological observation) and Laboratory of Plant Taxonomy, Department of Biology, Faculty of Mathematics and Natural Sciences, University of Brawijaya, Malang, East Java, Indonesia (for data analysis of morphological characters), since 2011 until March 2017. This research takes a long time because flowering time of material samples are not simultaneously and most of the Annonaceae in PBG are flowering at the end until beginning of the year.

Materials

Plant material used for the studied were a collection of Annonaceae species explored from East Java (Figure 1) and conserved in PBG. As many as 28 species of Annonaceae from East Java (as in-group) and two species of Magnoliaceae (as out-group) are shown in Table 1.

Procedures

Morphological characters were observed by phenetic character includes qualitative and quantitative characters. Qualitative characters are observed fifty-five characters and quantitative characters are observed fifteen characters (van Heusden, 1992; Kessler, 1993; Priyanti, 2001; Bioversity International, 2008; Folorunso and Olorode, 2008). Each plant sample is repeated based on a number of plant specimens in PBG.

Data analysis

Data are obtained included in determination table and further scored with a reference number "0" for characters that are not found in samples of plants were observed and the number "1" for the characters that encountered in plant samples was observed (Table 2). Data that has been scored then analyzed using statistical program PAST (Paleontological Statistics) ver. 1.34 by cluster analysis method (Jukes-Cantor similarity index) to produce a dendrogram. The result of dendrogram then analyzed with synapomorphy, autapomorphy and apomorphy characters to know the distinguishing character of each taxon of Annonaceae species collections from East Java.

RESULTS AND DISCUSSION

Dendrogram of Annonaceae species based on morphological character

Based on data analysis results, it can be seen that outline is formed from dendrogram showing the division of four tribes and two sub-family. Tribes include Miliuseae,

Xylopieae, Annoneae and Uvariae, as well as sub-family of Malmeoideae and Annonoideae (Figure 2).

Differences of morphological character from Malmeoideae and Annonoideae sub-family

Differences of morphological character from Malmeoideae and Annonoideae sub-family are indicated by character of inner *petal* (Figure 3) and habit (Figure 4). Sub-family of Malmeoideae has connate inner *petal* and mitriform shape, but sub-family of Annonoideae has free inner *petal* and valvate shape. Besides that, Habit of Malmeoideae sub-family is tree but Annonoideae sub-family is woody climber.

Suggestion of species identity from unidentified plant samples of Annonaceae

Unidentified species of Annonaceae from East Java are 5 species and namely is specimen 1, specimen 2, specimen 3, specimen 4 and specimen 5. Morphological flowers of unidentified species are shown in Figure 5. The first and second row show the unidentified species of Annonaceae from East Java, then the third and fourth row show the species predicted from unidentified species based on analysis of dendrogram (Figure 2).

Discussion

Tribes of Miliuseae divided into 4 groups: group of *Pseuduvaria reticulata*-*Mitrephora reticulata*-*Orophea hexandra*, group of *Orophea enneandra*-*Mitrephora javanica*-*Meiogyne cylindrocarpa*, group of *Popowia* sp.-*Miliusa macropoda*-*Saccopetalum horsfieldii*-*Polyathia* sp., and *Mitrephora polypyrena* is separately but still incorporated in tribes of Miliuseae. Morphological characters in Miliuseae tribes based on similarity (synapomorphy) of habit of trees, development of the main stem is monopodial, location of branches on the main stem is rhythmic, direction of stem growth is perpendicular (erectus), direction of branch growth is plagiotropic, smell of bark is fragrant, composition of leaves is compound leaves, leaf arrangement is alternate, texture *sepals* is not fleshy, *sepals* thickness is thin, number of whorls is two, no hooked, number of *petals*, stem diameter and width of leaves. The similarity of these characters is grouped in sub-family Malmeoideae. Genus of *Saccopetalum* is a synonym from genus *Miliusa* thus included in one group (Bennett 1840). According to Chatrou et al. (2012), sub-family of Malmeoideae is characterized by a distinctive character in their sub-family that have habit of trees, flower

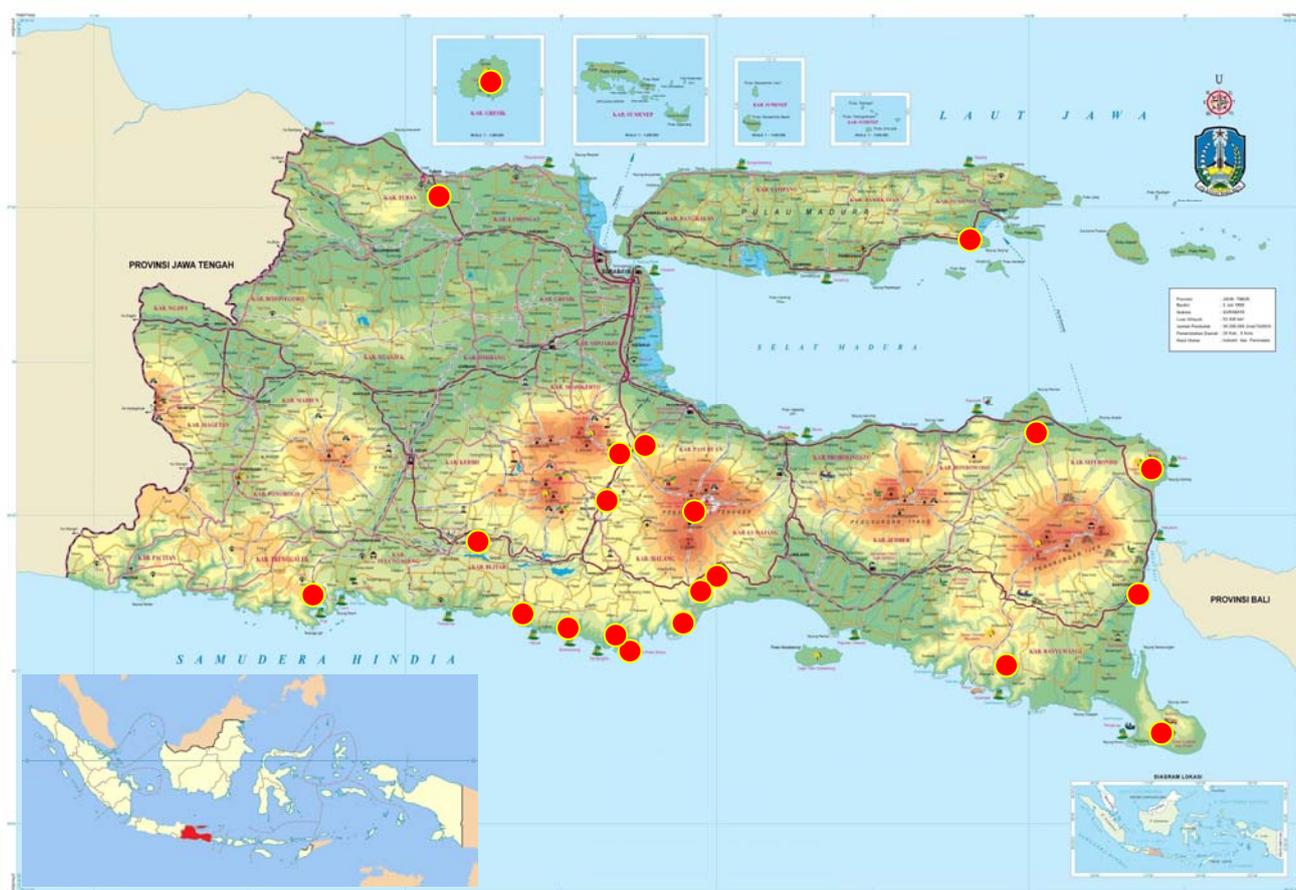


Figure 1. Study sites of material sampling of Annonaceae species from East Java, Indonesia and conserved in PBG (symbol: red circle)

Table 1. Plant material samples of Annonaceae collection from East Java, Indonesia and outgroup are observed (Lestari et al. 2011)

| Species name | Voucher number | Location | Origin | Sum of specimen |
|--|----------------|--------------|----------------------------|-----------------|
| Specimen 1 | P19770246 | IV.A.I.5 | East Java | 3 |
| <i>Stelechocarpus burahol</i> (Blume) Hook.f. & Thomson | P197704130 | XVIII.C.10 | Cowek, Purwodadi | 1 |
| <i>Annona muricata</i> L. | P1977091 | XVIII.C.28 | Lawang, Malang | 3 |
| <i>Saccopetalum horsfieldii</i> Benn. | P1978074 | XVIII.C.2 | Prigi, Trenggalek | 2 |
| Specimen 2 | P19790732 | XVIII.C.24 | Pulau Sempu | 4 |
| <i>Artabotrys blumei</i> Hook.f. & Thomson | P19790775 | XVIII.C.8 | Sendangbiru, Malang | 1 |
| <i>Mitrephora reticulata</i> (Blume) Hook.f. & Thomson | P19810125 | XVIII.C.20 | Pulau Sempu | 2 |
| <i>Orophea enneandra</i> Blume | P198105274 | XVIII.C.25 | Meru Betiri, Banyuwangi | 1 |
| <i>Mitrephora polypyrena</i> (Blume) Miq | P19811116 | XVIII.C.7 | Gn. Kukusan, Lumajang | 1 |
| <i>Fissistigma latifolium</i> (Dun.) Merr. | P19820362 | XVIII.C.30 | Tuban | 1 |
| <i>Anomianthus dulcis</i> (Dun.) J. Sinel | P19820611 | XVIII.C.6 | Bawean Island | 2 |
| <i>Orophea enneandra</i> Blume | P19821169 | XVIII.C.26 | Lebakharjo, Malang | 2 |
| <i>Magnolia candolli</i> (Blume) H.Keng | P19821171 | XVIII.D.II.2 | Lebakharjo | 1 |
| <i>Monoon lateriflora</i> (Blume) Miq. | P198302228 | XVIII.C.19 | Situbondo | 1 |
| Specimen 3 | P19840317 | XVIII.C.35 | Banyuwangi | 1 |
| <i>Uvaria schizocalyx</i> Back. | P19840321 | XVIII.C.23 | Banyuwangi | 1 |
| <i>Uvaria concava</i> Teijsm. & Binn. | P19840389 | XVIII.C.39 | Blitar | 1 |
| <i>Uvaria purpurea</i> Blume | P198501315 | XVIII.C.56 | Ht. Jolo Sutro, Blitar | 1 |
| Specimen 4 | P19850160 | XVIII.C.40 | Ht. Tumpak, Malang | 1 |
| <i>Mitrephora javanica</i> Back | P19850167 | XVIII.C.38 | Ht. Tumpak, Malang | 1 |
| <i>Artabotrys uncinatus</i> (Lam.) Merr. | P19850227 | XVIII.C.34 | Ngliyep, Malang | 1 |
| <i>Orophea hexandra</i> Blume | P198502409 | XVIII.E.8 | Banyuwangi | 2 |
| <i>Orophea enneandra</i> Blume | P19860266 | XVIII.E.3 | Tempursari, Lumajang | 2 |
| <i>Uvaria rufa</i> Blume | P198803196 | XVIII.C.47 | TN. Baluran, Situbondo | 1 |
| Specimen 5 | P1989043 | XVIII.C.62 | Sumenep, Madura | 1 |
| <i>Pseuduvaria reticulata</i> (Bl.) Merr. | P19910930 | XVIII.C.55 | Tempursari, Lumajang | 4 |
| <i>Michelia champaca</i> (L.) Baill. Ex Pierre var. alba | P1997110091 | XIV.G.I.10 | Malang | 1 |
| <i>Milusa macropoda</i> Miq. | P199712239 | XVIII.E.36 | TN. Alas Purwo, Banyuwangi | 2 |
| <i>Meiogyne cylindrocarpa</i> (Burck) Back. | P19991125 | XVIII.E.43 | TN. Baluran, Situbondo | 2 |
| <i>Meiogyne cylindrocarpa</i> (Burck) Heusden | P2005118 | XIX.B.I.62 | TN. Alas Purwo, Banyuwangi | 3 |

Table 2. Character and character state in Annonaceae species

| Character and character state |
|---|
| Habit; 1. tree, 2. shrub, 3. woody climber |
| Crown shape; 1. irregular, 2. cone, 3. cylindrical, 4. umbrella, 5. graded |
| Presence or absent of hooked ; 1. absent, 2. present |
| Age of the plant (year); 1. 1-15 years, 2. 16-30 years, 3. 31-45 tahun |
| Crown diameter (cm); 1. 1-250 cm, 2. 251-500 cm, 3. 501-750 cm, 4. 751-1000 cm, 5. 1001-1250 cm |
| Plant height (cm); 1. 1-500 cm, 2. 501-1000 cm, 3. 1001-1500 cm, 4. 1501-2000 cm, 5. 2001-2500 cm |
| Stem |
| Stem diameter (cm); 1. 1-25 cm, 2. 26-50 cm, 3. 51-100 cm, 4. 101-150 cm, 5. 151-200 cm |
| Development of main stem; 1. monopodial, 2. sympodial |
| Location of branches on main stem; 1. rhythmic, 2. constantly |
| Direction of stem growth; 1. perpendicular (<i>erectus</i>), 2. climbing (<i>scandens</i>) |
| Direction of branch growth; 1. ortotrophic, 2. plagiotrophic |
| Stem color; 1. light green, 2. grey, 3. dark grey, 4. brown, 5. other |
| Color of young branches; 1. light green, 2. green, 3. dark green, 4. other |
| Color of bark; 1. light grey, 2. grey, 3. dark grey, 4. brown, 5. other |
| Smell of bark; 1. fragrant, 2. not fragrant |
| Outer bark; 1. light brown, 2. brown, 3. dark brown, 4. grey, 5. light green, 6. green, 7. dark green |
| Inside bark; 1. light green, 2. green, 3. dark green, 4. green yellowish, 5. light brown, 6. yellow, 7. yellow brownish |

Leaf

Leaf composition; 1. single, 2. compound
 Leaf arrangement; 1. alternate, 2. opposite, 3. spiral
 Length of leaf stalk (petiole), (cm); 1. 0,1-0,5 cm, 2. 0,6-1 cm, 3. 1,1-1,5 cm, 4. 1,6-2 cm, 5. 2,1-2,5 cm
 Diameter of leaf stalk (petiole), (mm); 1. 0,1-1 mm, 2. 1,1-2 mm, 3. 2,1-3 mm, 4. 3,1-4 mm
 Indumentum of leaf stalk; 1. glabrous, 2. simple hairs, 3. *stellate* hairs
 Leaf texture; 1. *membranaceous*, 2. *herbaceous*, 3. *perkamentous*, 4. *coriceus*
 Leaf indumentum; 1. glabrous, 2. simple hairs, 3. *stellate* hairs
 Shape of leaf blade; 1. *ovate*, 2. *elliptic*, 3. *obovate*, 4. *lanceolate*, 5. other
 Shape of leaf base; 1. *acute*, 2. *rounded*, 3. *obtuse*, 4. *cordate*
 Shape of leaf tip; 1. *acute*, 2. *rounded*, 3. *acuminate*
 Leaf length (cm); 1. 1-10 cm, 2. 11-20 cm, 3. 21-30 cm
 Leaf width (cm); 1. 1-5 cm, 2. 6-10 cm, 3. 11-15 cm
 Leaf thickness (mm); 1. 0,1-0,2 mm, 2. 0,21-0,3 mm, 3. 0,31-0,4 mm, 4. 0,41-0,5 mm, 5. 0,51-0,6 mm
 Pubescence on surface of adaxial leaves; 1. absent, 2. present
 Pubescence on surface of abaxial leaves; 1. absent, 2. present
 Color of mature leaves; 1. light green, 2. green, 3. grayish green, 4. dark green, 5. other
 Color of young leaves; 1. yellow, 2. light Green, 3. green, 4. dark green, 5. red, 6. purple, 7. red purplish, 8. other
 Edge of leaf; 1. entire, 2. *undulate*
 Number of lateral nerves; 1. 1-5 pairs, 2. 6-10 pairs, 3. 11-15 pairs, 4. 16-20 pairs
 Leaf-blade venation; 1. submerged, 2. intermediate, 3. Raised

Flower

Length of flower stalk (peduncle), (cm); 1. 0,01-1,5 cm, 2. 1,51-3 cm, 3. 3,01-4,5 cm, 4. 4,51-6 cm
 Floral glands; 1. absent, 2. present

Sepal

Sepal pubescence; 1. absent, 2. present
 Type of *sepal*; 1. *valvate*, 2. *reduplicate-valvate*, 3. *imbricate*, 4. *Apert*
 Fusion of *sepal*; 1. *free*, 2. *connate at the base only*, 3. *connate*
 Shape of *sepal*; 1. *depressed to narrowly ovate*, 2. *triangular*, 3. *connate cup*, 4. *circular*
 Texture of *sepal*; 1. not fleshy, 2. fleshy
 Thickness of *sepal*; 1. thin, 2. thick
 Size of *sepal*; 1. short (0-25 mm), 2. long (>25 mm)
 Indumentum of *sepal*; 1. glabrous, 2. simple hairs, 3. *stellate* hairs

Petal

Expansion of *petal*; 1. *reflexed*, 2. *spreading*, 3. *erect*, 4. *connivent*
 Aestivation of *petal*; 1. *valvate*, 2. *reduplicate-valvate*, 3. *imbricate*, 4. *transversely folded*, 5. *apert*
 Number of *petal*; 1. 1-5 pcs, 2. 6-10 pcs, 3. 11-15 pcs
 Number of whorls; 1. one, 2. two, 3. three
 Fusion of *petal*; 1. *free*, 2. *connate*
 Color of outer *petal*; 1. white, 2. yellow, 3. yellowish, 4. green, 5. greenish, 6. red, 7. reddish to pinkish, 8. pink, 9. brown, 10. purple, 11. purplish, 12. orange, 13. grey, 14. black, 15. dot with colored spot, 16. other
 Color of inner *petal*; 1. white, 2. yellow, 3. yellowish, 4. green, 5. greenish, 6. red, 7. reddish to pinkish, 8. pink, 9. brown, 10. purple, 11. purplish, 12. orange, 13. grey, 14. black, 15. dot with colored spot, 16. other
Petal pubescence; 1. absent, 2. present
Petal length (cm); 1. 0,1-1 cm, 2. 1,1-2 cm, 3. 2,1-3 cm, 4. 3,1-4 cm, 5. 4,1-5 cm, 6. 5,1-6 cm
Petal width (cm); 1. 0,1-1 cm, 2. 1,1-2 cm, 3. 2,1-3 cm, 4. 3,1-4 cm
 Size of *petal*; 1. small (<0,5 cm), 2. intermediate (0,5-14,5 cm), 3. big (>14,5 cm)
 Texture of *petal*; 1. not fleshy, 2. fleshy
 Thickness of *petal*; 1. thin, 2. thick
 Shape of *petal*; 1. *ovate*, 2. *elliptic*, 3. *spoon-shaped*, 4. *mitre-shaped*
 Shape of inner *petal*; 1. *valvate*, 2. *mitriform*
 Indumentum of *petal*; 1. glabrous, 2. simple hairs, 3. *stellate* hairs
 Torus of *petal*; 1. *flat*, 2. *shallowly conical torus with a flat apex*, 3. *deeply concave*, 4. *concave apex and ovoid apicule*, 5. *cushion shape torus*

Stamen

Number of *stamen*; 1. little (1-5), 2. intermediate (6-12), 3. many (>12)
 Shape of *stamen*; 1. long and narrow, 2. short and broad, 3. distinct, 4. a shield-like apical prolongation of the connective, 5. broad connective shielding the anthers
 Type of *stamen*; 1. *uvarioid*, 2. *miliusoid*
Stamen length; 1. short (0,1-7 mm), 2. long (>7 mm)
 Color of *stamen*; 1. white, 2. cream, 3. (orange-)yellow, 4. orange, 5. red, 6. (red-)brown, 7. brown, 8. purple
 Texture of *stamen*; 1. not fleshy, 2. fleshy

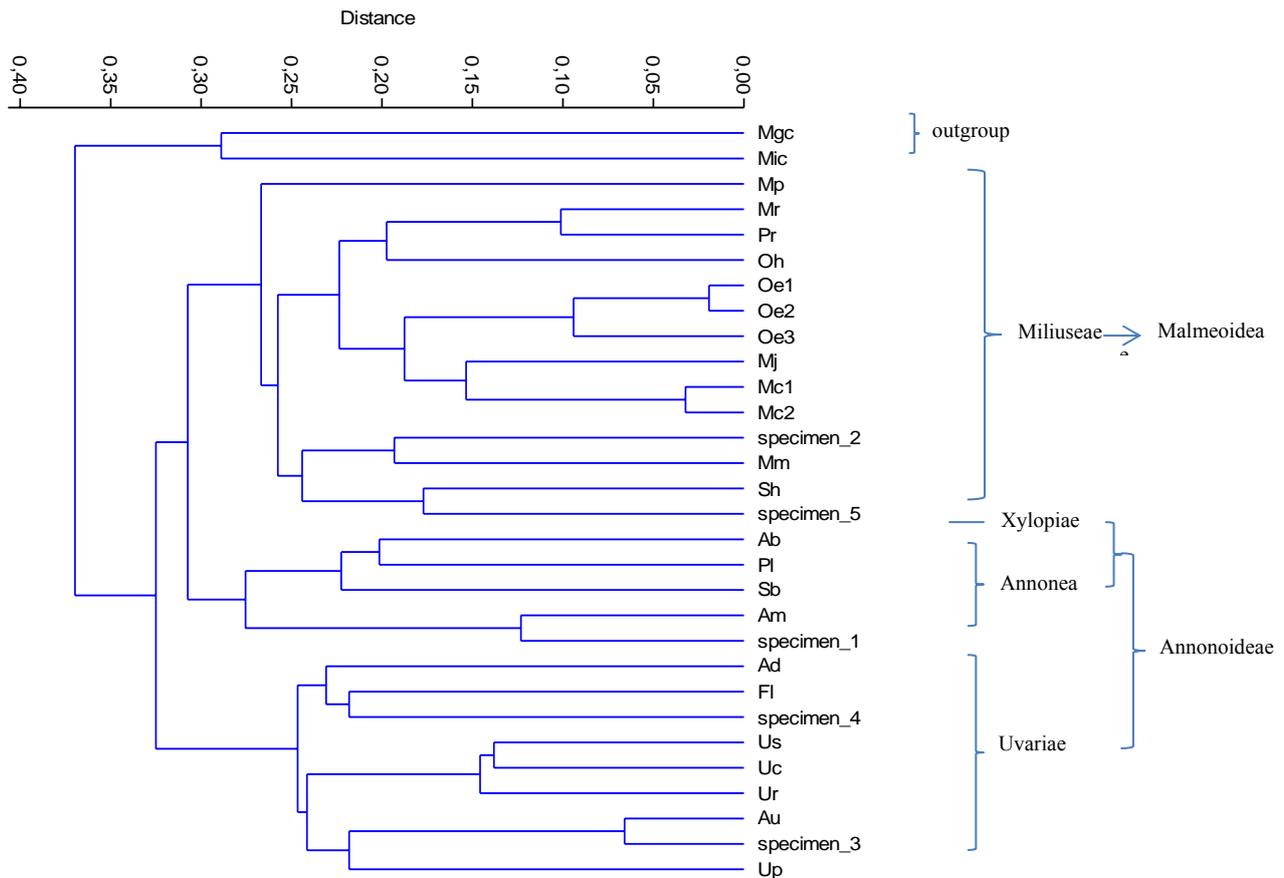


Figure 2. Dendrogram of Annonaceae species from East Java; Mgc=*Magnolia candollii* and Mic=*Michelia champaca* var. *alba* (outgroup), Mp=*Mitrephora polypyrena*, Mr=*Mitrephora reticulata*, Pr=*Pseuduvaria reticulata*, Oh=*Orophea hexandra*, Oe=*Orophea enneandra*, Mj=*Mitrephora javanica*, Mc=*Meiogyne cylindrocarpa*, Mm=*Miliusa macropoda*, Sh=*Saccopetalum horsfieldii*, Ab=*Artabotrys blumei*, Pl=*Monoon lateriflora*, Sb=*Stelechocarpus burahol*, Am=*Annona muricata*, Ad=*Anomianthus dulcis*, Fl=*Fissistigma latifolium*, Us=*Uvaria schizocalyx*, Uc=*Uvaria concava*, Ur=*Uvaria rufa*, Au=*Artabotrys uncinatus*, and Up=*Uvaria purpurea* (in-group)



Figure 3. The character of inner petal as differences sub-family of Malmeoideae and Annonoideae; a. *Mitrephora polypyrena*, b. *Pseuduvaria reticulata*, c. *Orophea enneandra* and d. *Meiogyne cylindrocarpa* - connate inner petal, e. *Uvaria schizocalyx*, f. *Anomianthus dulcis*, g. *Mitrephora* sp. and h. *Fissistigma latifolium* - free inner petal



Figure 4. The character of habit as differences sub-family of Malmeeoideae and Annonoideae; A. *Saccopetalum horsfieldii*, B. *Mitrephora polypyrena* - habit of the tree, C. *Uvaria schizocalyx*, D. *Mitrephora* sp. - habit of woody climber

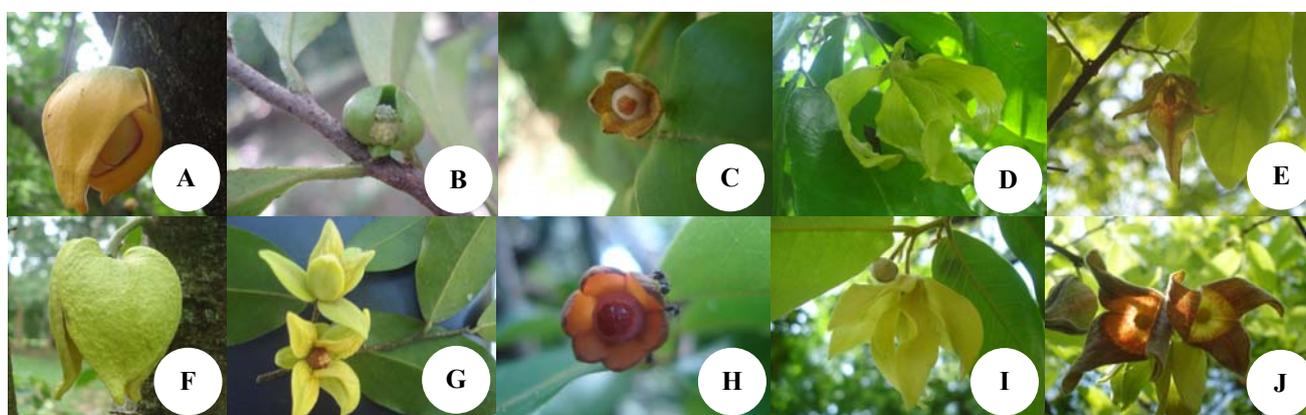


Figure 5. Species predicted from unidentified species in material samples of Annonaceae from East Java, Indonesia. A. Specimen 1, B. Specimen 2, C. Specimen 3, D. Specimen 4, E. Specimen 5, F. *Annona muricata*, B. *Miliusa macropoda*, C. *Artabotrys uncinatus*, D. *Fissistigma latifolia*, E. *Sarcopetalum horsfieldii*

arrangement is spiral phyllotaxis, genital flowers is hermaphroditic (sometimes (andro) dioecious, rarely (andro) monoecious, shape of the apical connective prolongation is peltate-truncate, peltate-apiculate, tongue-shaped or not, connective extension of anthers nonseptate, staminodes inside part in a rare, indumentum simple hairs and rarely T-shaped hairs, no bracts and location of flowers in parts of plant is terminal or axillary. Chaowasku et al. (2014) classify each genus in tribes of Miliuseae based on forms of *pollen*, which is genus of *Mitrephora* and *Pseuduvaria* has the form of *pollen* disulcate; tetrad, genus of *Orophea*, *Meiogyne*, *Popowia*, *Miliusa* and *Polyalthia* has the form of *pollen* is disulcate; monads, and genus of *Stelechocarpus* has form of pollen is cryptoaperturate/disulcate; monads. Based on both of these groupings, it is dominant distinguished by habit and generative character especially on flowers (especially in staminodes, connective apical prolongation and *pollen* characters). Results of this study is adding the other characters to grouping by each genus, there are development of the main stem is monopodial, location of branches on the main stem is rhythmic, direction of stem growth is perpendicular (erectus), direction of branch growth is plagiotropic, smell of bark is fragrant, composition of leaves is compound, leaf arrangement is alternate, texture *sepals* is not fleshy, *sepals* thickness is thin, number of whorls is two, no hooked, number of *petals*, stem diameter and width of leaves.

Tribes of Annoneae are divided into two groups: a group of *Polyalthia lateriflora*-*Artabotrys blumei*-*Stelechocarpus burahol* and group of *Annona muricata*-*Annona* sp. Both of groups are grouping based on similarity of smell bark is fragrant, composition of leaves is compound, leaf arrangement is alternate, indumentum of leaf and petiole is glabrous, shape of leaf tip is acuminate, pubescence on abaxial and adaxial leaf surface do not exist, color of mature leaves is dark green, leaf margin is entire, *sepals* and *petals* pubescence does not exist, size of *sepals* is short, number of whorls is two, fusion of *petal* is free, size of *petal* is intermediate, forms of inner *petal* is valvate, floral glands do not exist, indumentum on *petals* is glabrous, number of *stamens* is many, indumentum of *peduncle* flowers is glabrous, number *petal*, age of the plant and stem diameter. According to Chatrou et al. (2012), *Artabotrys blumei* included in tribes of Xylopieae (sub-family Annonoideae), *Polyalthia lateriflora* and *Stelechocarpus burahol* included in tribes of Miliuseae (sub-family Malmeoideae). But in this study, a grouping of both species showed differences. Additionally, a tribe of Annoneae in dendrogram was one group with tribes of Miliuseae. Chatrou et al. (2012) partially breaks into tribes of Annoneae, and joined by tribes of Uvariae who are grouping in sub-family of Annonoideae. This is because in this study using a combination of vegetative and generative character (i.e. flowers), so that possibility of this groups can be different.

Tribes of Uvariae are divided into three groups: a group of *Anomianthus dulcis*-*Fissistigma latifolium*-*Oxymitra* sp., a group of *Uvaria schizocalyx*-*Uvaria concava*-*Uvaria rufa* and a group of *Mitrephora* sp.-*Artabotrys uncinatus*-

Uvaria purpurea. The third groups are grouping based on similarity of habit of lianas (woody climbers), development of the main stem is sympodial, location of branches on the main stem is constantly, direction of stem growth is climbing (scandens), direction of branch growth is ortotropic, smell of bark is fragrant, composition of leaves is compound, leaf arrangement is alternate, leaf margin is entire, fusion of *sepals* and *petals* is free, texture *sepals* are not fleshy, thickness of *sepals* is thin, size of *sepals* is short, number of whorls is two, no floral glands, no glands, number of *petals*, High Plant Non Branch (or TTBC), stem diameter and amount of secondary vein leaves. According to van Heusden (1992) and Zhou et al. (2010), most of the genus of *Uvaria* have morphological characters stellate hairs, valvate aestivation of petal and basally connate. Genus of *Uvaria* has close relations with several other genera such as *Anomianthus*, *Cyathostemma*, *Ellipeia*, *Ellipeiopsis* and *Rauwenhoffia* in morphologically and genetically. This is consistent with results of Annonaceae species grouping are tested and predicted have a proximity kinship.

Tribes of Annoneae and Uvariae are included in sub-family of Annonoideae because it grouped by similarity character of habit (tree or liana), leaf arrangement is spiral or distichous phyllotaxis, genital of flowers sometimes (andro) dioecious and rarely (andro) monoecious, shape of apical connective prolongation is peltate-truncate, peltate-apiculate, rarely tongue-shaped or not, staminodes of inside part is rarely, indumentum is simple hairs (rarely stellate hairs) for Annoneae and stellate hairs for Uvariae, location of flowers is terminal or axillary, *pollen* is inaperture and sometimes sulcate (Chatrou et al. 2012).

Group has the closest distance (0,02) is *Orophea enneandra* 1 and 2, so that both of species have a high similarity and different (autapomorphy) in character of crown shape, leaf shape and amount of secondary vein leaves. The distance between sub-family Malmeoideae and Annonoideae is 0,37; so that similarity between this sub-family is small and has the same character on smell bark is fragrant, the composition of leaves are compound, leaf arrangement is an alternate, a number of whorls are two, stem diameter and a number of *petals*.

Apomorph character is a key character or distinctive characters which only have in in-group and can be inherited by his out-group. In this study, the character of outgroup are derived inside *pepagan* which was light brown, floral glands, the color of young leaves is red and color of the *outer petal* is yellowish. Their characters are derived fro outgroup has evolved especially on *Orophea enneandra* species, because has the closest distance.

Based on flowers morphological characters, a grouping of sub-family from Malmeoideae and Annonoideae are distinguished by the fusion of the *petal* character. Sub-family of Malmeoideae has connate inner *petal* (merged), while sub-family of Annonoideae has free inner *petal* (separately), as shown in Figure 3. The other characters that distinguish for both of sub-family are a habit, sub-family of Malmeoideae has tree habit and sub-family of Annonoideae mostly has a habit of woody climbers (lianas) and some of the trees (Figure 4). It can be used as an early

identifier to distinguish of both subfamilies, beside of the other vegetative and generative character.

Several species of material plant samples are used in this study have not been identified to species level; there are specimen 1, specimen 2, specimen 3, specimen 4 and specimen 5. However, species is same predicted with specimen 3 because it has the same physically in morphology and is in one group, namely *Artabotrys uncinatus*. *Artabotrys uncinatus* has a different character than the actual morphology description. Tan and Wiart (2014) said that description of *Artabotrys* morphology is a *woody climber*, leaves are single, alternate, coriaceous, orthotropic shoots, hooked is presence, white or yellow flowers, fragrant, *sepals* valvate and free, *petals* valvate and free that composed on two whorls, monocarps fruit, cylindrical and elliptical. This description is different with the real morphology character. This species is predicted to the species of *Uvaria micrantha*, based on morphological characters of *globose* flower buds, with *petal* size was small and free. This species distantly related to the genus of *Uvaria* because it has almost same morphological characters are *stellate* hairs, *valvate sepals*, all of *petals* part is *imbricate* on two whorls and *pollen* is *inaperture monads* (Utteridge, 2000; Zhou et al. 2009). Specimen 2 is predicted to have close relations with *Miliusa macropoda*, specimen 5 is predicted to have close relations with *Saccopetalum horsfieldii*, specimen 1 is predicted to have close relations with *Annona muricata* and specimen 4 is predicted to have close relations with *Fissistigma latifolium* because these species are in one group (Figure 5). Determination of material plant samples that have not been identified still requires further research, in order to more clearly identify so that the taxonomical position can be known. Besides of confirmation with morphological character, the taxonomical position of this species can be known based on confirmation from molecular marker to accurately species identity.

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