

# Inventory of Annonaceae in Abasig-Matogdon-Mananap Natural Biotic Area, Camarines Norte, Bicol, Philippines

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**Abstract.** Retuerma-Dioneda A, Alejandro GJD. 2022. Inventory of Annonaceae in Abasig-Matogdon-Mananap Natural Biotic Area, Camarines Norte, Bicol, Philippines. *Biodiversitas* 23: 2213-2224. The Abasig-Matogdon-Mananap Natural Biotic Area (AMMNBA) is a protected area home to endemic plants; however, Annonaceae remains understudied. The study provided a checklist of Annonaceae species in the area and their taxonomic keys, endemism and conservation status. Field surveys were conducted in January 2020 and July 2021 in San Vicente and Labo, Camarines Norte. The 110 species identified belong to 11 genera- *Artabotrys*, *Drepananthus*, *Fissistigma*, *Friesodielsia*, *Goniothalamus*, *Meiogyne*, *Monoon*, *Phaeanthus*, *Polyalthia*, *Popowia*, and *Uvaria* and five (5) tribes: Ambaviodeae, Annoneae, Miliuseae, Uvarieae, and Xylopieae. Four (4) endemic species were recorded: *Friesodielsia lanceolata*, *Polyalthia luzonensis*, *Polyalthia lanceolata* and *Goniothalamus elmeri*. This study provides baseline information on Annonaceae species in AMMNBA for appropriate conservation policies and proper management of the potential economic benefits.

**Keywords:** AMMNBA, Bicol, conservation, floristic inventory, protected area

## INTRODUCTION

Annonaceae is a pantropical family of trees, shrubs and lianas comprising 109 genera and approximately 2,440 species (Chatrou et al. 2012; Couvreur et al. 2012; Handayani 2018). It contributes significantly to the tree diversity found in rainforests worldwide (Punyasena et al. 2008). The family is recognized with the following distinct characters: extipulate distichous leaves, a trimerous perianth with two whorls of petals, numerous stamens, mostly free carpels, large seeds with ruminate endosperm (van Huesden 1992; Mols et al. 2004) and strong, distinctive floral scents (Goodrich 2011). The family is largely distributed in the Asia-Pacific region, particularly in Peninsular Malaysia, Philippines, Borneo and Thailand (Saunders 2003, Surveswaran et al. 2010; Turner 2011; Johnson et al. 2021).

In the Philippines, significant plant collections were made by Merrill (1912-1926). His renowned works were published in his books *Flora of Manila* and *Enumeration of Philippine Flowering Plants*. After Merrill, only a few studies were conducted, and most of the plant collections are now antiquated and need updating and upgrading. Very few studies were made after Merrill, particularly on Annonaceae. Floristic studies across the country are available (De Guzman et al. 2014; Castañares et al. 2017; Malabrigo et al. 2017; Lillo et al. 2018; Ordas et al. 2019; Suba et al. 2019; Paclibar and Tadosa 2020; Moran et al. 2020; Batuyong et al. 2020; Biag and Alejandro 2021;

Batuyong et al. 2021; Biag and Alejandro 2021; Cordero and Alejandro 2021). Results of these inventories were general listings of different plant families, their distribution, ecology and conservation status. Despite these inventories, there is still insufficient data on the present status of plants in the country, particularly on Annonaceae (Ong et al. 2002). Studies conducted on Annonaceae, however, identified some endemic species. Some of these works were a revisionary study on *Cyathocalyx* which identified two (2) endemic Annonaceae species- *Cyathocalyx crissepetalus* R.J. Wang & R.M.K. Saunders and *Cyathocalyx samarensis* R.J. Wang & R.M.K. Saunders (Wang and Saunders 2006); *Uvaria valderramensis* Cabuang, Exconde & Alejandro, from Antique (Cabuang et al. 2012); *Goniothalamus palawanensis* C.C. Tang & R.M.K. Saunders from Palawan (Tang et al. 2013); *Goniothalamus luzonensis* Ferreras & Arriola from Bataan (Arriola et al. 2020). There are 30 known Annonaceae genera with 147 species listed in Co's Digital Flora of the Philippines. Out of 147 Annonaceae species, 97 are considered endemic (Pelser et al. 2011 onwards).

The Abasig-Matogdon-Mananap Natural Biotic Area (AMMNBA) remains unexplored, and Annonaceae are understudied. This study provides a checklist of noteworthy Annonaceae, taxonomic keys, endemism, and conservation status. This data will provide baseline information that would be used for appropriate conservation policies and proper management of their potential economic benefits.

## MATERIALS AND METHODS

### Study area

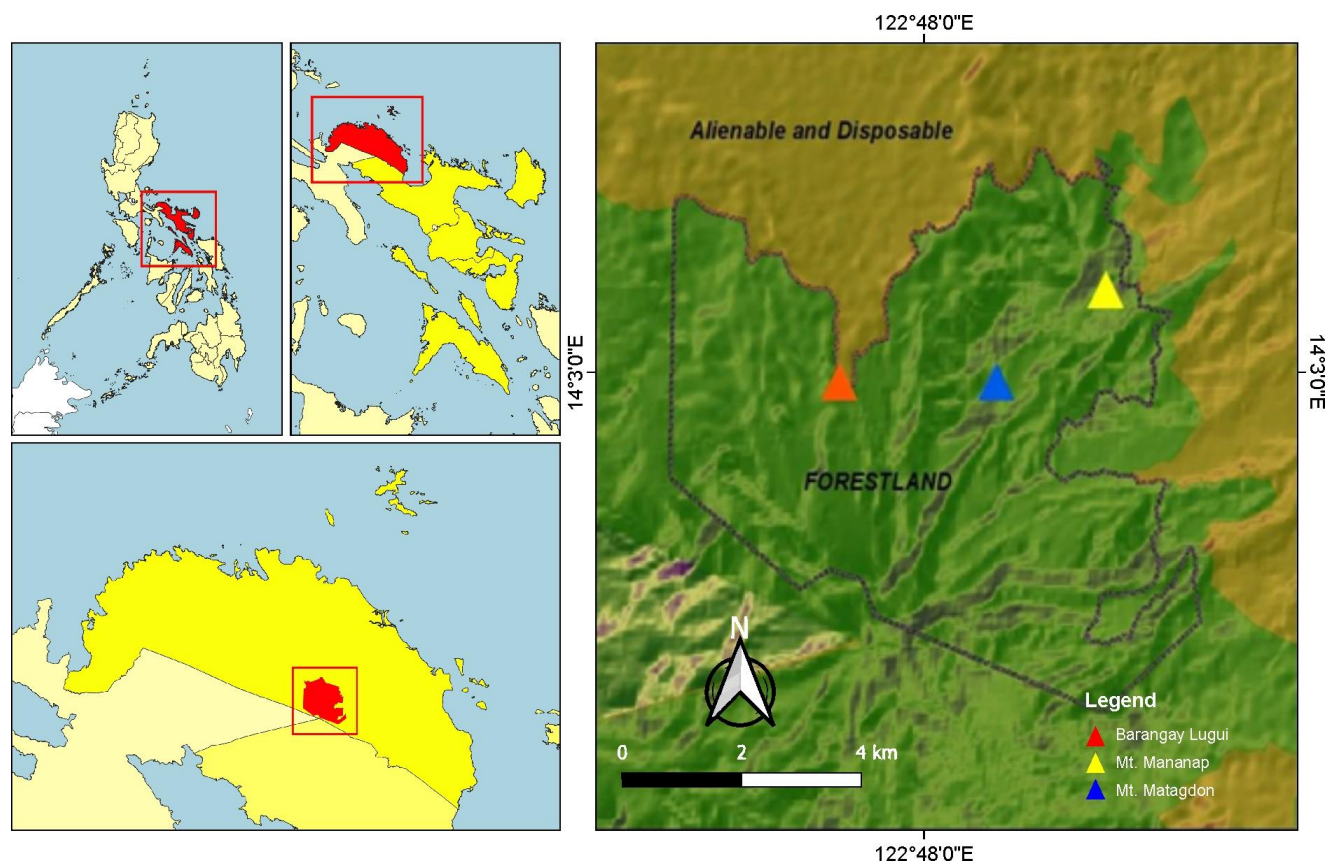
AMMNBA covers area of 59 km<sup>2</sup> in San Lorenzo Ruiz, San Vicente, and Labo (Figure 1). It is mountainous with rolling to rugged, mostly steep sloping terrain with diverse vegetation formations such as mossy/montane, forest, brushland and agroforestry/grasslands. It was considered the major watershed forest reserve in November 1991 and declared a natural biotic area in May 2000 under Presidential Proclamation No. 318, and in June 2018, it was declared legitimate AMMNBA as a protected area under Republic Act No. 7586. The nature reserve comprises a large patch of the rainforest of around 46 km<sup>2</sup> around Labo Volcano extending to an elevation of 1,539 meters above sea level, an important watershed for eight municipalities of Camarines Norte. It has three types of soil-Louisiana clay soil in the upper elevation, aluminous clay loam in mid-elevation and the lower portion and San Miguel soil in the forest reservation of the protected area. It has no pronounced dry season, but a very wet period can be observed from October to January. Mean annual rainfall from northeast and southwest monsoons ranged from 69.1

to 525.8 mm from 2015 to 2018. The length of the dry season is from April to midway of August. The climatic factors affect AMMNBA: average rainfall of 280 mm and an average temperature of 29.70C to 35.0C (DENR-AMMNBA Protected Area Management Plan (APAMP) 2021-2030).

### Plant and data collections

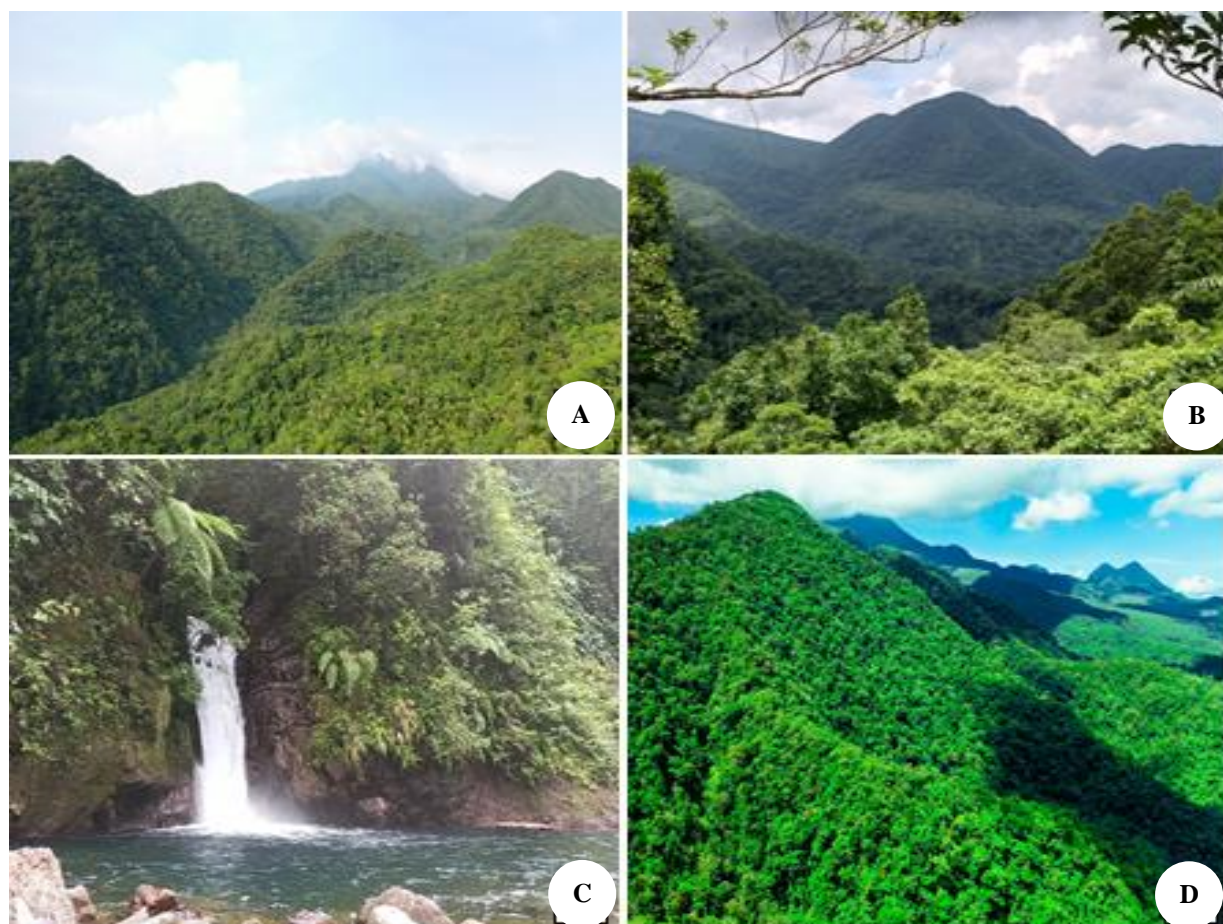
Permit for plant collection and fieldwork was issued by the Protected Area Management Board (PAMB) of AMMNBA and the Provincial Environment and Natural Resources Office (PENRO) of Camarines Norte, and the Department of Environment Natural Resources (DENR) Region V.

Plant collections were conducted along the slopes of Mt. Mananap in San Vicente, Mt. Matogdon, Labo, Camarines Norte (Figure 2). Opportunistic samplings were done in January 2020 and July 2021. Collected plants were pressed, dried and mounted as herbarium vouchers. All field data were recorded, and the collected samples' morphological and anatomical features were documented for proper identification.



**Figure 1.** Location of the study site (A) AMMNBA, Camarines Norte, Bicol, Philippines marked green in color, (B) Municipalities surveyed: Mt. Mananap, San Vicente marked yellow; Mt. Matogdon, Labo marked blue and Barangay Lugui, Labo marked orange. The map was prepared using Arc-GIS (DENR-APAMP 2021-2030)





**Figure 2.** Collection sites in AMMNBA, Camarines Norte. (A) View of Mt. Mananap; (B) View of Mt. Matogdon; (C) Mananap Falls; (D) Forest slopes Mt. Matogdon in Barangay Lugui, Labo. Photos taken by A.R. Dioneda and PENRO-Camarines Norte

**Table 1.** List of identified Annonaceae species in AMMNBA, Camarines Norte

Species	Habit	Conservation	Endemicity	Lat	Lon
<b>Tribe Ambaviodeae</b>					
<i>Drepananthus acuminatus</i> (C.B. Rob.) Survesw & R.M.K. Saunders	T	NE	N	14°2'56"N	122°48'33"E
<b>Tribe Uvarieae</b>					
<i>Fissistigma latifolium</i> (Dunal) Merr	L	NE	N	14°3'4"N	122°47'47"E
<i>Friesodielsia lanceolata</i> (Merr.) Steenis	L	NE	E	14°3'39"N	122°49'38"E
<i>Uvaria monticola</i> Miq.	L	NE	N	14°3'33"N	122°49'50"E
<b>Tribe Miliuseae</b>					
<i>Monoon grandifolium</i> (Elmer) B. Xue & RMK Saunders	T	NE	N	14°3'37"N	122°49'43"E
<i>Meiogyne cylindrocarpa</i> (Burck) Heusden	T	NE	N	14°3'13"N	122°49'43"E
<i>Phaeanthus ophthalmicus</i> (Roxb. Ex G. Don) J. Sinclair	T	NE	N	14°3'2"N	122°47'13"E
<i>Polyalthia luzonensis</i> (Merr.) B. Xue & R.M.K. Saunders	T	NE	E	14°3'33"N	122°49'22"E
<i>Polyalthia lanceolata</i> S. Vidal	T	NE	E	14°3'28"N	122°47'36"E
<i>Polyalthia suberosa</i> (Roxb.) Thwaites	T	NE	N	14°3'32"N	122°47'37"E
<i>Popowia pisocarpa</i> (Blume) Endl. Ex Walp.	T	NE	N	14°3'40"N	122°49'38"E
<b>Tribe Annoneae</b>					
<i>Goniothalamus elmeri</i> Merr.	T	NE	E	14°4'5"N	122°49'34"E
<b>Tribe Xylopieae</b>					
<i>Artabotrys sauevolens</i> (Blume) Blume	L	NE	N	14°3'50"N	122°48'27"E

Note: Habit (T: tree; S: shrub; L: Liana), proposed status based on the Threatened Species of the \*DENR Administrative Order 2017-11 (NE: Not Evaluated; DD: Data Deficient; OTS: Other Threatened Species; LC: Least Concern; VU: Vulnerable; CR: Critically endangered), Endemicity based on Co's Digital Flora of the Philippines (E: Philippine Endemic; N: Non-endemic), GPS Coordinates

### Identification of materials

Identification of specimens was done using literature sources of van Huesden (1992); Couvreur et al. (2012); Chatrou (2012); Turner (2018) and compared to online databases in Co's Digital Flora of the Philippines (CDFP) (<http://www.phytoimages.siu.org>), Plants of the World Online (<http://www.plantsoftheworldonline.org>), JSTOR Plants ([plants.jstor.org](http://plants.jstor.org)) and Naturalis Biodiversity Center (NL), Botany, Global Biodiversity Information Facility Naturalis Biodiversity Center <https://www.GBIF.org>, eFloras at <http://www.efloras.org> and foreign databases such as Royal Botanic Gardens Kew (K), Arnold Arboretum Harvard University (A), Smithsonian Institutions (US), Missouri Garden (MO) and with local collections from the Philippine National Herbarium (PNH), College of Agriculture Herbarium University of the Philippines (CAHUP) and Jose Vera Santors Memorial Herbarium (JVSMH) in University of the Philippines, Diliman. The curators from the University of Santo Tomas Herbarium (USTH) and Royal Botanic Gardens Kew verified the identification. The voucher specimens were then deposited at the USTH. The scientific names of the plants were cross-checked with the World Checklist of Selected Plant Families (<http://wcsp.science.kew.org>; WCSP 2021).

## RESULTS AND DISCUSSION

The taxonomic descriptions are provided for each genus based on their morphological characters, distribution, phenology and materials examined. The endemism and conservation status of each collected species are also presented.

### List of Annonaceae species in AMMNBA

The present study identified 110 individuals of Annonaceae belonging to 11 genera: *Artabotrys*, *Drepananthus*, *Fissistigma*, *Friesodielsia*, *Goniothalamus*, *Meiogyne*, *Monoon*, *Phaeanthus*, *Polyalthia*, *Popowia*, and *Uvaria*. These genera belong to five (5) tribes Ambaviodeae, Annoneae, Miliuseae, Uvarieae, and Xylopieae. The tribe that has the highest recorded species is Miliuseae (7), followed by Uvarieae (3), Annoneae (2), Ambaviodeae (1) and Xylopieae (1) (Table 1).

The results of the present study most resemble the study of Malabrigo et al. (2017) recorded ten (10) species in Mt. Calavite, Occidental Mindoro, such as *Dasymaschalon clusiflorum*, *Miliusa vidalii*, *Mitrephora lanotan*, *Monoon oblongifolium*, *Polyalthia mindorensis*, *Uvaria littoralis*, *Xylopiea*, *Goniothalamus elmeri* var. *gitingensis* and *Polyalthia suberosa* and *Polyalthia* sp. and Medecillo and Lagat (2017) collected ten (10) species in the remaining forests of Cavite such as *Anaxagorea luzonensis*, *C. odorata*, *Artabotrys suaveolens*, *Uvaria grandiflora* and *U. littoralis*, *D. clusiflorum*, *Goniothalamus amuyon*, *M. vidalii*, *Mitrephora lanutan*, *Platymitra arborea*.

The presence of different endemic plants in AMMNBA is attributed to the inherent effects of soil types, altitude and variation in moisture distribution (Guezo and Badayos

1996). It has a mean relative humidity of 80%. It has an average monthly rainfall of around 280mm, but August and the driest month of April are the wettest months, typically occurring in November and December (DENR-APAMP 2021-2030). These seasonal conditions greatly influence the flowering and fruiting of Annonaceae, coinciding with the seasonal phenomenon (Lestari 2009; Azeez and Folorenzo 2014; Lestari and Sofiah 2015). Thus, flowering occurs in January after the rainy season up to May when fruiting starts and lasts up to September before the rainy season. Taxonomy of Annonaceae species found in AMMNBA, Camarines Norte, Bicol Peninsula.

### Key to the species of Annonaceae in AMMNBA, Camarines Norte

- 1a. Lianas..... 2
- 1b. Trees..... 5
- 2a. Indument of stellate hairs on the main stem; petals imbricate..... *Uvaria monticola*
- 2b. Indument of simple hairs; petals valvate .....3
- 3a. Peduncles with hook; petals cylindric to clavate .....*Artabotrys suaveolens*
- 3b. Peduncles without hook; petals not cylindric ..... 4
- 4a. Flowers in solitary inflorescences, outer petals elongate and longer than inner petals, connivent ..... *Friesodielsia lanceolata*
- 4b. Flowers in multiflowered inflorescences, outer petals broadly ovate, equal in length with inner petals, spreading ..... *Fissistigma latifolium*
- 5a. Venation eucamptodromous, lateral veins 15–18 pairs, scalariform tertiary veins ..... 6
- 5b. Venation brochidodromous, lateral veins 6–12 pairs, reticulate tertiary veins ..... 7
- 6a. Leaves lanceolate, petiole 0.5 mm long; monocarps elongate, 25 mm; inner petals warty with corrugated patches at the base ..... *Meiogyne cylindrocarpa*
- 6b. Leaves elliptic-oblong, petiole 15 mm long; monocarps fusiform, 60 mm long; inner petals glabrous at the base ..... *Monoon grandifolium*
- 7a. Leaves elliptic to oblong; outer petals longer than inner petals ..... 8
- 7b. Leaves lanceolate; outer and inner petals equal in length ..... 11
- 8a. Petals connivent forming mitriform dome; monocarps 20 mm in diameter..... *Goniothalamus elmeri*
- 8b. Petals free, spreading; monocarps 5–20 mm in diameter .....9
- 9a. Sepals ovate; pedicel 30 mm long ..... *Drepananthus acuminatus*
- 9b. Sepals triangular; pedicel 20 mm long ..... 10
- 10a. Flower ovate-lanceolate forming mitriform dome, 20 mm long; leaves 100–150 × 30–50 mm; monocarps 15–35..... *Phaeanthus ophthalmicus*
- 10b. Flower ovate-triangular, 6 mm long; leaves 35–60 × 25–40 mm; monocarps 3..... *Popowia pisocarpa*
- 11a. Pedicel 50 mm; petals 50 × 30–50 mm ..... *Polyalthia lanceolata*
- 11b. Pedicel 25–30 mm; petals 14–50 × 16–25 mm ..... 12

- 12a. Inflorescence leaf-opposed; monocarps 5 mm in diameter ..... *Polyalthia suberosa*  
 12b. Inflorescence axillary; monocarps 20 mm in diameter ..... *Polyalthia luzonensis*

### *Artabotrys suaveolens*

*Artabotrys suaveolens* Blume, Fl. Jav. Annon. (1828)

62

Climbers about 15m long, older twigs pubescent with simple hairs. Leaves chartaceous, elliptic to oblanceolate, dark shining green on both sides 8–13 × 2.5–3 cm, apex obtuse and base cuneate, petiole slender, 0.5–1 cm long, 8–10 pairs of looped veins. Sepals 3, valvate, triangular, ovate, apex short acuminate. Inflorescence peduncle formed into a hook, recurved, laterally compressed with 3–5 flowers. Flowers cream-white, 6 in 2 whorls, 1–2.5 mm, cylindric, slightly incurved, apex obtuse. Torus flat, glabrescent. Stamens 10–20 oblong, minutely tomentose. Carpels 3–4 per flower, stigma tongue shape and flat. Monocarps ellipsoid, 1–1.5 × 0.5–0.8 cm, apex obtuse (Figure 4.H).

**Phenology:** Flowering in March to May and fruiting from May to July

**Distribution:** Philippines, Luzon: Albay, Bataan, Laguna, Quezon, Zambales, Rizal, Zambales,

**Distribution:** It is not endemic in the Philippines and also distributed in Madagascar, Thailand, Vietnam, China, Papua New Guinea to Australia (efloras, 2008; Moeliono et al. 2009)

**Specimens Examined:** Philippines, Mt. Mananap, Abasig-Matogdon-Mananap Natural Biotic Area, San Vicente, Camarines Norte Province, at 14°3'50"N, 122°48'27"E, elevation 517m asl, 26 July 2021, A. Dioneda AMB070 (USTH); Landagan-bitbit, District of Benguet, Luzon Philippines S. Vidal K[barcode] 000691331 digital image!

### *Drepananthus acuminatus*

*Drepananthus acuminatus* (C.B. Rob.) Survesw & R.M.K. Saunders comb. nov. Taxon 59 (2010) 1730; = *Cyathocalyx acuminatus* C.B. Rob.--Turner, Gard. Bull. Singapore 70 (2018)

It is a small woody tree 20m tall. Leaves oblong or elliptic 11–18 × 4–6.5 cm, apex acuminate and base oblique, subcoriaceous adaxially and glabrous abaxially, primary veins impressed adaxially, looped venation with 8 pairs of lateral veins, petiole 15–20 mm. Inflorescences 1–6 ramiflorous, leaf opposed flowers green-yellowish in old branches, peduncle inconspicuous, pedicel 30 mm, pedicel bracts elliptic in the lower half of the pedicel. Sepals free, 1.5–6 mm sparsely pubescent adaxially and abaxially. Outer petals 10–30 mm long, 3–6 mm above constriction, 15–30 mm wide below constriction, apex acute. Inner petals 10–30 mm long, 1–5 mm above the constriction. Torus flat. Stamen numerous. Carpels 9–14 per flower, hairy, stigma ellipsoid. Monocarps are cylindrical with constrictions between seeds, glabrous, apex acuminate (Figures 3.A and B).

**Notes:** *D. acuminatus* is mostly similar to *D. apoensis* by triangular sepals, inner petals with obtuse apex, conspicuous peduncle and seed with grooved raphe. But they differ in several characters. *D. acuminatus* has hairy abaxial laminas, petioles, stipes and carpels 9–14 per flower while *D. apoensis* has glabrous abaxial laminas, pedicels and stipes and carpels 13–19 per flower (Wang and Saunders, 2006).

**Phenology:** Flowering in June to July and fruiting in July to September.

**Distribution:** This species is widely distributed in primary and secondary tropical lowland forests of Southeast and its native range is Central Malesia: Philippines and Sulawesi. It was also recorded in Paracale, Camarines Province.

**Specimens Examined:** Philippines. Mt. Matogdon, Abasig-Matogdon-Mananap Natural Biotic Area (AMMNBA), Labo, Camarines Norte Province, Bicol Region at 14°2'56"N, 122°48'33"E, 521.20m asl, Mt. Matogdon, Labo, 9 July 2021, AR. Dioneda AMB020 (USTH). Paracale, Camarines Province, Luzon, Philippines, F. Alamba, December 1918. K[barcode] 000691308, Ramos M. Edaño, 1 November 1918 GE BS L[barcode]1755525, E. Samar, Bo. Sta. Rosa, Balongiga, Madulid DA et al. PNH 1 May 1971 L[barcode]1753738 digital image!.

### *Fissistigma latifolium*

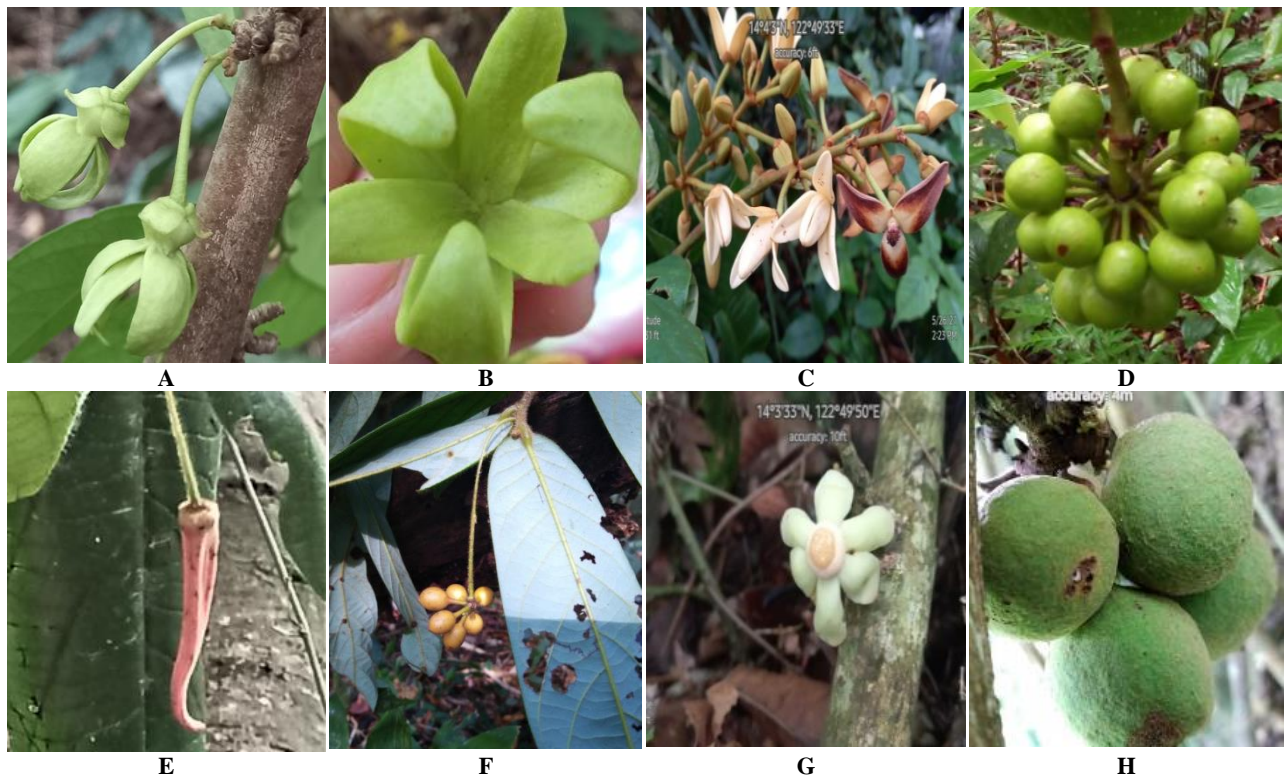
*Fissistigma latifolium* (Dunal) Merr. Philipp. J. Sci. 15:132 (1919)

Woody climbers, 10m tall with simple hairs, tomentose dark brown stems. Leaves oblong-elliptic 15–25 × 4–9 cm, base obtuse or rounded, apex acute, chartaceous, coriaceous, dark green, glabrous above, brownish tomentose beneath, almost parallel, fine and close lateral 18–24 pairs of secondary veins, scalariform venation, petiole pubescent, 1–1.5 cm. Sepals 3, valvate, connate at the very base, ovate, apex acute, brown tomentose adaxially and glabrous abaxially, 2–4 × 2–2.5 cm. Inflorescences are leaf-opposed, terminal, many flowers forming branched panicles, pedicel tomentose with bracteoles at the lower part to the middle. Flower buds are oblong-conic, cream color. Petals 6 in 2 whorls, valvate, leathery, margin thickened, outer petals tomentose outside, glabrous inside, broadly ovate, spreading, inside flat to convex, acute apex, 2–2.5 cm long, inner petals 3-edged, base concave, cream smaller and shorter, 1.5–2 cm long. Stamens many, oblong, connectives enlarged, apex obtuse. Carpels many, free, style slightly curved, grooved on the inner side, stigma narrowly clavate, apex entire. Monocarps 23, stipitate, spherical, thickened walls. Seeds 1 to 10 per monocarp (Figures 3.C and D).

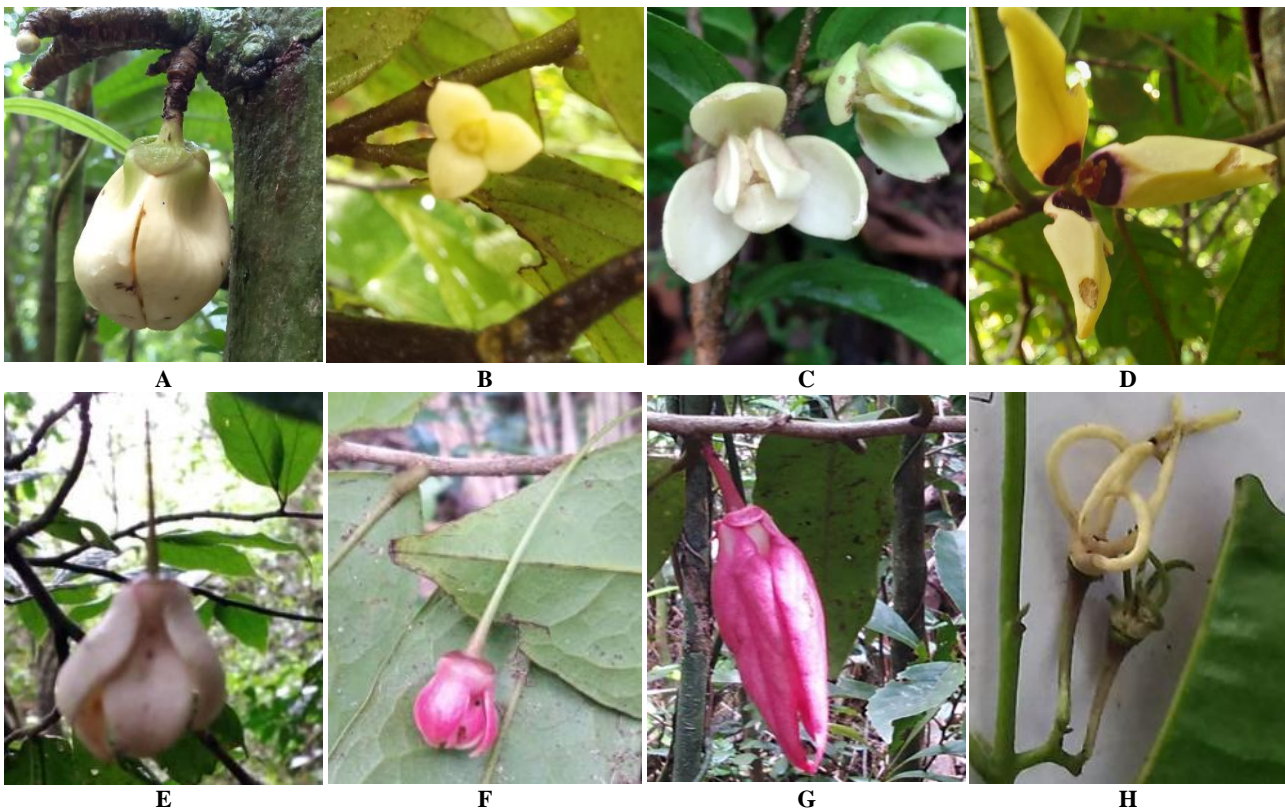
**Notes:** *F. latifolium* differs from *F. fulgens* by having leaf with tomentose beneath, longer hairs >1mm, pubescent above while *F. fulgens* has puberulous beneath the leaf with shorter hairs 1mm long (Irawan, 2002).

**Phenology:** Flowering in April to May and fruiting June to August.





**Figure 3.** Tribes Ambaviodea (A-B) and Uvarieae (C-H). (A-B) *Drepananthus acuminatus* (C-D) *Fissistigma latifolium* (E-F) *Friesodielsia lanceolata* (G-H) *Uvaria zschokkei*. Photos were taken by A.R. Dioneda



**Figure 4.** Tribes Miliuseae (A-F), Annoneae (G-H), and Xylopieae (H). (A) *Monoon grandifolium*, (B) *Popowia pisocarpia*, (C) *Meigyne cylindrocarpa*, (D) *Phaeanthus opthalmicus*, (E) *Polyalthia luzonensis*, (F) *Polyalthia lanceolata*, (G) *Goniotalamus elmeri*, (H) *Artabotrys sauvelens*. Photos were taken by A.R. Dioneda

**Distribution:** Early collections were made by M. Ramos in 1917 at the forest slopes of Calolbong, Catanduanes. *F. latifolium* is the only known species in the Philippines and it is found in the localities of Catanduanes, Isabela, Laguna, Bataan, Rizal, Sorsogon, Mindoro, Mindanao. In Asia, Borneo had the highest number of species (12), followed by Sumatra and Malay Peninsula (9 each), Celebes (3), whereas Philippines, Java and Mollucas with one (1) each (Irawan, 2002).

**Specimens Examined:** Philippines. Mt. Matogdon and Mt. Mananap, Abasig-Matogdon-Mananap Natural Biotic Area (AMMNBA), Camarines Norte Province, Bicol Region at 14°3'4"N, 122°47'47"E 663.3m asl, San Vicente, 26 July 2021, AR. Dioneda AMB018 (USTH). Tanay, Rizal, Morong, Luzon, Philippines by E. D. Merrill, May 1903, K[barcode] 03900131, Philippine Islands, Irosin (Mt. Bulusan) Province of Sorsogon, Island of Luzon, Elmer ADE 16704, 1 June 1916, L[barcode]1754453\_1828485027 digital image!

### *Friesodielsia lanceolata*

*Friesodielsia lanceolata* (Merr.) Steenis Blumea 12 (1964) 360

Woody climbers, 5m high. Leaves lanceolate to oblong-lanceolate, 11–18 × 3–4 cm, looped venation, glaucous adaxial and papery, white abaxial with simple hairs, raised the main vein, apex attenuates and base subcordate, 12–18 pairs of lateral veins. Flower solitary, three outer petals elongate 3cm, longer than inner petals 1 cm. Three inner petals apically connivent forming a pollination chamber with three apertures. Fruit yellow, monocarp stipe 6cm, globose 2.8 cm with simple hair, stipitate 0.6 cm long. Seed 1 per monocarp (Figures 3.E and F).

**Notes:** *Friesodielsia* in Asia differs from the African genus by having elongated flowers with short inner petals, apically connivent forming pollination chamber. The African genus has broader flowers and loosely coherent inner petals (Gou et al. 2017).

**Phenology:** Flowering in May to July and fruiting in July to September.

**Distribution:** First collected in Dagami, Leyte in August 1912 and Mt. Irig, Rizal Province, Luzon in February 1923. Previous collections found them in the lowland and medium elevation (Pelser et al. 2011 onwards).

**Specimens Examined:** Philippines. Mt. Matogdon, Abasig-Matogdon-Mananap Natural Biotic Area (AMMNBA), Labo, Camarines Norte at 14°03'39"N 122°49'38"E, elevation 403.54m asl, 27 January 2020, AR. Dioneda AMB021 (USTH); Mt. Irig, Rizal, Province, Luzon 1 February 1923, M. Ramos, L[barcode] 1765244\_1192680291, Dagami, Leyte, August 1912, *Oxymitra lanceolata* Merr., M. Ramos, Bur. Sc. 15342, K[barcode] 000691755 digital image!

### *Gniothalamus elmeri*

*Gniothalamus elmeri* Merr. Publ. Bur. Sci. Gov. Lab. 29:13-14 (1905)

Small tree about 8m high. Young branches glabrous. Sepal 10 mm long. Leaves elliptic-oblong, 20–24 × 3–4

cm, apex acuminate, base cuneate to attenuate, glabrous adaxially and abaxially, midrib prominent abaxially, midrib impressed adaxially, secondary veins 8–13 pairs. Flower comprising unequal petals, outer petal longer 3.5–5.5 × 2 cm and inner petal 2 × 1.5 cm apically connivent with basal claw, flower pedicels 2 cm. Infructescence stipe 2 cm, monocarp globose, 20 mm in diameter (Figure 4.G).

**Phenology:** Flowering from January to May and Fruiting from May to July.

**Distribution:** Philippines: Luzon, Benguet prov., Sorsogon, Mindanao: Zamboanga, Mt. Giting-giting.

**Specimens Examined:** Philippines. Mt. Mananap, San Vicente, Camarines Norte Province, Abasig-Matogdon-Mananap Natural Biotic Area at 14°4'5"N, 122°49'34"E, elevation 325m asl, 26 July 2021, A. Dioneda AMB022 (USTH). Sablan, Prov. of Benguet, Luzon April 1904 isotype K [barcode] 000608181 digital image!

### *Meiogyne cylindrocarpa*

*Meiogyne cylindrocarpa* (Burck) Heusden, Blumea 38: 499. (1994)

Shrub up to 3m high. Branches with sparse hairs. Leaves lanceolate 10–15 × 3.5–4 cm, petiole very short 0.5 mm, pubescent and simple hairs, apex acuminate and leaf base obtuse, looped, scalariform venation with 10–15 lateral veins. Sepals imbricate, triangular. Petals 6 in 2 whorls, inner petal imbricate; warty and corrugated patches at the base of the adaxial surface of the inner petals. Infructescence stipe 3–5 mm long. Monocarp shape elliptic-ovoid, elongate, 25 mm with apical beak, densely appressed-hirsute, pericarp thin. Seeds up to 5 per monocarp in a single row. (Figures 4.C and 5.E)

**Notes:** It has white flowers and Green to bright red ripe monocarps collected in the 310m asl of Mt. Mananap, San Vicente, Camarines Norte.

**Phenology:** Flowering in March to May and Fruiting in May to July.

**Distribution:** Philippines. Luzon: Nueva Ecija, Rizal, Palawan.

**Specimen Examined:** Philippines. Mt. Mananap, San Vicente, Mt. Matogdon, Labo, Camarines Norte Province, Abasig-Matogdon-Mananap Natural Biotic Area (AMMNBA) at 14°3'13"N, 122°49'43"E, elevation 310.9m asl, 26 July 2021, A. Dioneda AMB011 (USTH); Province of Rizal, Luzon August 1911 M. Ramos 13617 K[barcode]000608187 digital image!

### *Monoon grandifolium*

*Monoon grandifolium* (Elmer) B. Xue & RMK Saunders, Taxon 61 (2012) 1031. Synonym: *Enicosanthum grandiflorum* (Becc.) Airy Shaw.

Medium-sized tree, 10m high. Leaves elliptic-oblong, 22–27 × 6.5–8 cm, acuminate apex and rounded leaf base, petiole 15 mm, 11–14 lateral veins, eucamptodromous with decurrent secondary and scalariform tertiary veins. Sepals imbricate, connate, 4.5–10 mm long, fleshy. Flower white, imbricate, 6, free, both whorls equal in length, indument present, simple hairs, inner petals basally glabrous at the base. The torus is shallowly conical with flat a apex. Stamens numerous, extrorse, apex discoid, fleshy. Carpels



free, numerous, hairy. Monocarps 60 mm, fusiform with stipe 1cm (Figures 4.A and 5.A).

**Notes:** *Monoon* is mostly related to *Polyalthia* by having one ovule and larger flower than *Polyalthia* (Huesden 1992). It has eucamptodromous, decurrent insertion of secondary veins and percurrent leaf venation vs. brochidodromous venation, not decurrent, the reticulate pattern of tertiary leaf venation in *Polyalthia* (Xue et al. 2012).

**Phenology:** Flowering in June to July and fruiting in August to September.

**Distribution:** Philippines: Mt. Pulgar, Puerto Prinsesa, Palawan, Mt. Urdaneta, Cabadbaran, Agusan Prov. Previous collections were found in forests at low and medium elevations.

**Specimens Examined:** Philippines. San Vicente, Camarines Norte Province, Abasig-Matogdon-Mananap Natural Biotic Area (AMMNBA) at 14°3'37"N, 122°49'43"E, 446.2m asl, 27 July 2021, AR. Dioneda AMB031 (USTH). Alabat Island, Philippines, Ramos & M and Edaño, G. September 1926; *Enicosanthum grandifolium*, Elmer ADE 12854, K[barcode] 000691404, Irosin (Mt. Bulusan), Province of Sorsogon, Island Luzon, 1 November 1915 Elmer ADE 15467, coordinates 12.701388E, 124.038611N, L[barcode] 0049278 digital image!

#### *Phaeanthus ophthalmicus*

*Phaeanthus ophthalmicus* (Roxb. Ex G.Don) J. Sinclair Gard. Bull. Singapore 14 (1955) 374; --Turner, Gard. Bull. Singapore 70 (2018) 628. Synonym: *Phaeanthus ebracteolatus* (Presl) Merr.

Small-sized tree, about 5 m high. Leaves oblong-elliptic, 10–15 × 3–5 cm, petiole 2 cm, shiny adaxially, apex attenuate and base obtuse, leaf venation looped near the margins, lateral margins 10–12. Sepals are kidney-shaped, 2 cm long. One flowered inflorescence, petals yellowish-green, valvate, 30–50 mm long, ovate-lanceolate with mitriform dome 20mm, flower pedicel 20 mm with bracteole. Torus is slightly conical. Stamens ca 100, discoid, connectives apically truncate. Carpels 29 in number, ovary densely pubescent with stylus stigma. Monocarps globose, 1.5–3.5, 5–10 mm in diameter. Seeds 1 or 2 per monocarp (Figures 4.D and 5.F).

**Notes:** Previous studies recognized *P. ebracteolatus* as a synonym for *P. ophthalmicus* based on overlapping morphological characters axillary inflorescence, valvate inner and outer petals, truncate stamens, club-shaped carpels and globose monocarps (Mols and Kessler 2000). Bangcaya et al. (2017) validated the synonymy using *matK* and *rbcL* regions and acknowledged *P. ophthalmicus* as its correct name.

**Phenology:** Flowering in June to August and fruiting in August to September.

**Distribution:** Philippines: Luzon; Ilocos Norte, Burgos, Babuyan Islands and Mindanao, Borneo, India, Lesser Sunda Islands, New Guinea and Sulawesi. It is common in forest at low and medium elevation.

**Specimen examined:** Philippines. Mt. Mananap, Abasig-Matogdon-Mananap Natural Biotic Area, San

Vicente, Camarines Norte Province, at 14°3'2"N, 122°47'13"E, elevation 342.3m asl, 27 July 2021, AR. Dioneda AMB046 (USTH); Mt. Concord, Samar, 10 May 1969 coordinates 11.316667E, 125.05N Gutierrez HG et al. L.1758744; Marinduque, Matalim, Brgy. Dampulan, Romero EM et al. 29199 L[barcode] 1758785 digital image! Province of Isabela, San Mariano, Sierra Madre Mountains c. 17.00N 122.00E L[barcode] 1758757 digital image!

#### *Polyalthia lanceolata*

*Polyalthia lanceolata* S. Vidal, Phan. Cuming. Philip. (1885) 170

Small tree, 8m tall. Sepals small triangular. Leaves lanceolate, leaf length 10–15 × 3.5–4.5 cm, petiole sessile, apex acuminate and base obtuse, looped venation with 10–15 lateral veins. Flower petals valvate, inner and outer petals equal in length 50 × 30–50 mm, flower pedicel 50 mm. Torus is rounded or ovoid. Stamens are numerous with apex flat. Carpel pubescent. (Figure 4.E).

**Distribution.** Philippines Luzon: Ilocos Norte, Cagayan, Isabela, Aurora, Nueva Ecija, Laguna (Mt. Makiling), Batangas, Sorsogon, Catanduanes. Also present in Visayas and Mindanao: Bohol, Leyte, Samar and Agusan del Norte (Pelser et al. 2011). Previous collection was in Mt. Guinatungan in Camarines Norte prov. Municipality of San Isidro Ruiz, 13 April 2013 (Phytoimages).

**Specimen examined:** Philippines. Mt. Mananap Abasig-Matogdon-Mananap Natural Biotic Area, San Vicente, Camarines Norte Province, at 14°3'28"N, 122°49'36"E, elevation 434m, 26 July 2021, AR. Dioneda AMB028 (USTH); Alabat Island, Philippines Asia-tropical September to October 1926 Ramos M & Edaño G, Barcode L[barcode] 03896247 digital image!

#### *Polyalthia luzonensis*

*Polyalthia luzonensis* (Merr.) B. Xue & R.M.K. Saunders, Taxon 61 (2012) 1035

Small tree about 6m high. Leaves lanceolate, 11–15 × 3–5 cm, apex acuminate and base obtuse, looped venation, subsessile petiole. Sepals 3 triangular, valvate, 3mm. Inflorescences axillary. Petals 6, free, inner and outer petals almost equal in length, 14 × 16 mm, flower pedicel 30 mm. Stamens numerous, truncate with flat apex. Carpels, 12 in number, pubescent brown hairs. Monocarps globose, 20 mm in diameter with persistent sepals (Figures 4.E and 5.D).

**Phenology:** Flowering in March to May and fruiting in June to August.

**Distribution and habitat:** Endemic to the Philippines. Luzon: Ilocos Norte, South Luzon and Bicol. This species thrived in dry, low elevation and riverbank forests.

**Specimens Examined:** Philippines. Mt. Matogdon, Abasig-Matogdon-Mananap Natural Biotic Area, Labo, Camarines Norte Province, at 14°3'33"N, 122°49'22"E, elevation 346m asl, 26 July 2021, AR. Dioneda AMB036 (USTH); Ilocos Norte, Burgos, July 1918 Ramos M. 32853, isotype K[000691706] digital image!



***Polyalthia suberosa***

***Polyalthia suberosa*** (Roxb.) Thwaites. Enum.Pl. Zeyl. (1864) 398

Small tree, 10m high with branchlets densely rusty tomentose. Leaves 5–14 × 2–4.5 cm elliptic-oblong, membranous to papery, 8–10 pairs of secondary veins, reticulate, inconspicuous looping near the margin, leaf base narrowly acute, slightly oblique, leaf apex acuminate, petiole 2–4 mm long, puberulent slightly below the leaf. Sepals are ovate-triangular, glabrous within and puberulent outside. Solitary flower, leaf-opposed, pedicel 25 mm. Petals oblong-lanceolate, outer petals slightly shorter than inner petals, inner petals 50 × 25 mm oblong curved, leathery, flat and spreading. Carpel cylindrical-triangular. Stamen numerous convex at the apex. Monocarps globose, spherical 5 mm diameter. Seeds 1 per monocarp (Figure 5.B).

**Notes:** *P. suberosa* is closely similar to *P. malabarica* with unequal petals whorls and globose monocarps and distinctly differs in having corky, ridged bark, 8–10 pairs of secondary veins and rounded-subcordate leaf base, shorter pedicel while *P. malabarica* not corky and smooth bark, 8–12 pairs of secondary veins, narrowly acute and oblique leaf base and longer pedicel (Kumar et al. 2016).

**Phenology:** Flowering in March to May and fruiting in May to July.

**Distribution:** Philippines: Cagayan to Laguna and Mindanao. It is thriving in lowland and medium elevations. It is widely distributed in Southeast Asia, India, Sri Lanka, Thailand, Indochina, and Peninsular Malaysia.

**Specimens Examined:** Philippines. Mt. Mananap, Abasig-Matogdon-Mananap Natural Biotic Area, San Vicente, Camarines Norte Province, at 14°3'32"N, 122°47'37"E, elevation 530m asl, 26 July 2021, A. Dioneda AMB040 (USTH); Manila, Philippines S. Vidal K[barcode]000691631 digital image!

***Popowia pisocarpa***

***Popowia pisocarpa*** (Blume) Endl. Ex Walp. Bot. Syst. 1:252.1842

Understory shrub, 5m tall. Leaves leaf blade, simple, elliptic, 3.5–6 × 2.5–4 cm, penni-veined, adaxially glabrous but slightly pubescent midvein, petiole 3 mm, secondary vein 6–10 pairs, base sub-rounded, pedicel 2–3 mm long, slender, pubescent. Sepals 3, ovate, slightly smaller than the petals, valvate. Flowers are small ovate-triangular 6 mm long yellowish-green, petals, outer and inner petals united at the base forming sympetalous corolla, pubescent, valvate, spreading, inner petals connivent. Stamen many; connectives apically truncate, puberulent. Carpels few, puberulent; stigmas subcapitate. Monocarps globose, 6 mm in diameter (Figures 4.B and 5.C).

**Notes:** *P. pisocarpa* is mostly similar to *Popowia bachmaensis* Ngoc, Tagane & Yahara by having subgranular leaves with asymmetric bases, inner petals being

larger than the outer ones, but *P. pisocarpa* distinctly differs having habits 3–7m taller, larger leaves 5.5–14 × 2.5–7cm, shorter petioles 2–5mm and shorter sepals 3mm long (Moeliono et al. 2009; Li and Gilbert 2011; Ngoc et al. 2016).

**Phenology:** Flowering April to June and fruiting June to August.

**Distribution:** Philippines Camarines, Sorsogon, Polilio, Panay, Negros, Leyte, Samar, Mindanao. It is also found in Madagascar. Thailand, China, Papua New Guinea to Australia (efloras 2008).

**Specimens Examined:** Philippines, Mt. Mananap, San Vicente, and Mt. Matogdon, Camarines Norte Province, Abasig-Matogdon-Mananap Natural Biotic Area (AMMNBA) at 14°3'40"N, 122°49'38"E, elevation 517m asl, 26 July 2021, A. Dioneda AMB038 (USTH); Cabadbaran (Mt. Urdaneta), Prov. of Agusan, Island of Mindanao October 1912 Elmer ADE 13544 K[barcode] 000699101 digital image!

***Uvaria monticola***

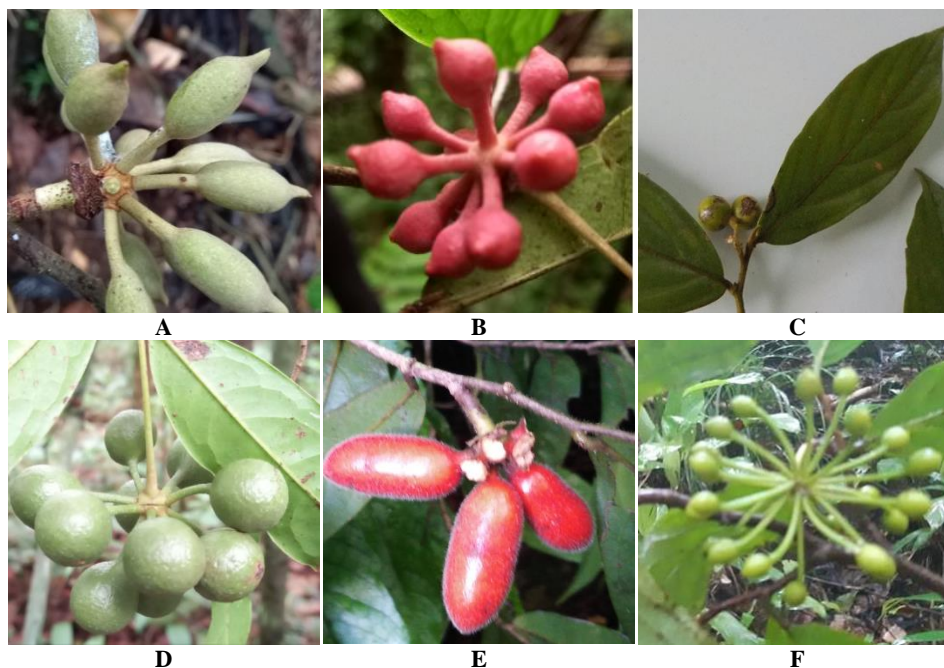
***Uvaria monticola*** Miq. Ann. Mus. Bot. Lugduno-Batavi 2: 5 (1865)

Woody climbers of 20m high, 8–10 cm diameter of the main stem, stellate hairs along veins and midrib above. Leaves ovate-oblong, 10–15 × 7–9 cm, apex acuminate, base round, petiole 3 mm, looped venations with 10–12 lateral pairs, glabrous adaxially, pubescent abaxially. Sepals 10 mm, valvate, united at the base. Inflorescences cauliflorous, 1–3 flowered. Pedicel 6 mm, 1 mm thick, densely brown stellate hairs. Flowers buds 1cm diameter, entirely closed within the calyx, splitting irregularly during anthesis, petals yellow-green, membranous, imbricate, oblong-ovate 15 × 10 mm, reflexing with age. Stamens are numerous. Carpels numerous Monocarps 5, irregularly cylindrical or oblong about 3–5 cm in diameter (Figures 3.G and H).

**Phenology:** Flowering in May to June and fruiting in July to August.

**Distribution:** Sorsogon, Mindoro, Biliran, Samar and in Mindanao: Agusan del Norte and Surigao del Norte

**Specimen examined:** Philippines. Mt. Mananap, Abasig-Matogdon-Mananap Natural Biotic Area (AMMNBA), San Vicente, Camarines Norte Province, at 14°3'33"N, 122°49'50"E, elevation 346m asl, 26 July 2021, A. Dioneda AMB051(USTH); Mindanao: Zamboanga del Norte Prov. Leon B. Postigo, Brgy. Tinuyop, Apr 2021, K. Mazo 8 5 16.69 N, 122 56 51.21 (Phytoimages.siu.edu.). Philippines: Mindanao, Prov. Davao, Santa Cruz, 5 May 1905, R.S. Williams 2764 (holotype NY [NY00059993]; isotypes NY, US).



**Figure 5.** Fruits of Annonaceae are found in AMMNBA. (A) *Monoon grandifolium*, (B) *Polyalthia suberosa*, (C) *Popowia pisocarpa*, (D) *Polyalthia luzonensis*, (E) *Meiogyne cylindrocarpa*, (F) *Phaeanthus ophthalmicus*. Photos were taken by A. R. Dioneda

#### Notes on endemic species and conservation status

Four (4) endemic species were recorded *Friesodielsia lanceolata*, *Polyalthia luzonensis*, *Polyalthia lanceolata* and *Goniothalamus elmeri* (Pelser et al. 2011 onwards), located at an elevation of 390 – 648 m. Both *P. luzonensis* and *P. lanceolata* were recorded in their type locality and found thriving in dry forests at low elevations and river banks in Sorsogon and Catanduanes (Pelser et al. 2011 onwards). *Friesodielsia lanceolata* was also found in the lowland, and medium elevation forests in Leyte and *Goniothalamus* is one of a large number of species and widely distributed in the country (Arriola et al. 2020). Out of 22 species of *Goniothalamus*, 16 are endemic in the Philippines.

In terms of their conservation status, most of the collected species were not included in the list of threatened species and were categorized as not evaluated in terms of their conservation status (DENR-DAO 2017-11). However, it is interesting to note that *Fissistigma latifolium* and *Goniothalamus elmeri* were most frequently observed in the area with 53 and 20 individuals, respectively, while *Phaeanthus ophthalmicus*, *Friesodielsia lanceolata*, *Monoon grandifolium* and *Polyalthia lanceolata* were recorded with 5 to 7 individuals and the least, *Uvaria monticola* with one individual. Moreover, it is worth mentioning that the species identified in AMMNBA were also identified in other parts of the Camarines provinces, Sorsogon and Catanduanes (Merrill 1912-1926; Pelser et al. 2011 onwards). Wang and Saunders (2006) considered *Dreprenantus acuminatus* vulnerable because only four species were collected from 1918 to 1986.

However, Fernando et al. (2008) recorded eight (8) Annonaceae species included in the national list of

threatened species or vulnerable species in 2008: *Dasymaschalon scandens* Elmer, *Mitrephora caudata* Merr., *Mitrephora fragrans* Merr., *Mitrephora lanotan* (Blaco) Merr., *Orophea creaghii* (Ridl.) Leonardia & Kessler, *Orophea cumingiana* Vidal, *Polyalthia elmeri* Merr., and *Polyalthia palawanensis* Merr. while 11 species were added to the IUCN Red List of Threatened Species in 2020: 1. Critically Endangered (CR): *Psuedovaria macgregorii* Merr., *Psuedovaria philippinensis* Merr. and *Psuedovaria unguiculata* (Elmer) Y.C.F. Su & R.M.K. Saunders; 2. Endangered (EN): *Goniothalamus luzonensis* Ferreras & Arriola; 3. Vulnerable (VU) *Huberantha palawensis* (Hook.f. & Thomson) Chaowasku, *Meiogyne mindorensis* (Merr.) Huesden, *Psuedovaria luzonensis* (Merr.) Y.C.F. Su & R.M.K. Saunders, and *Spaerocoryne affinis* (Taijism & Binn.) Ridl.j. as *D. scandens* Merr.; 4. Other Threatened Species (OTS) *Artabotrys vidaliana* Elmer, and 5. Least Concern (LC) *Psuedovaria pamaltonis* (Miq.) Y.C.F. Su & R.M.K. Saunders (DENR DAO-2017-11).

Although several floristic inventories were already conducted in the Philippines, there is still insufficient data on the present state of Philippine plants (Ong et al. 2002; Langerberger et al. 2006). Strategic planning and conservation efforts are much needed to address the problem of Philippine biodiversity. A biodiversity survey is urgently needed to provide data and understand species diversity to manage these vulnerable species sustainably.

In conclusion, the protected area Abasig-Matogdon-Mananap Natural Biotic Area has abundant Annonaceae species. The present study recorded 110 individuals belonging to 11 genera and five (5) tribes. Four (4) species are endemic to the Philippines. Most of the collected



species have not been evaluated for their conservation status. It is recommended that continuous and extensive taxonomic research and collection of Annonaceae species be conducted in different parts of the country. The present study provided new data and baseline information on Annonaceae that can be used to formulate important conservation policies and proper management, especially of the vulnerable species. Further study is also recommended to obtain valuable data on some potential benefits derived from the Annonaceae family.

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