The family of Annonaceae: the important role in forest ecosystems and human being life

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Abstract. Forest, as a natural resource, plays an important role for all living organisms which are living inside or outside the forest. Various plant species are found living in the forest, including the Annonaceae family which consists of 109 genera and 2440 species that are also playing an important role in the environment and human life. The purpose of this study was to reveal the importance of the Annonaceae family for the life of human beings and the life of organisms in the forest. Using the exploration method by analyzing exploration data, including secondary data, this study was conducted. The results showed that members of the Annonaceae family are those essentially controlling the balance of forest ecosystems, environment control for organisms, and provide food for creatures in the forest. Others such as ecological, hydrological, and climatological functions are provided by the members. Besides, several members are timber sources for human interest as well as a raw material of traditional medicine, cosmetics, and perfume. Another usage of the members is used in traditional ceremonies. Moreover, Annaceous acetogenin compound found in Annonaceae can be used as an antitumor and also as a pesticide, which will lead to a promise in the future.

1. Introduction

Annonaceae is a quite large family, mostly formed bushes, shrubs, and trees, with 109 genera and 2440 species worldwide [1]. Tropical forests are the home of the Annonaceae family. Unfortunately, the populations of the family are continuously threatened in their natural habitat. These are caused by illegal logging and harvested medicinal plants directly from the forest. Consequently, the Annonaceae populations decreased and have an effect on animal life which depends on this family. Apart from this, it also affects the balance of the ecosystem in the forest [2,3]. Moreover, the tropical forests are also threatened due to over exploitation of forest products and forest conversion into plantations, agriculture, housing, and mining [4,5].

The members of Annonaceae family, unquestionably, play an important role in human being life. However, only certain species have been cultivated by the local communities, such as Annona muricata L., A. squamosa L., and Cananga odorata (Lam.) Hook.f. & Thomson. Those plants are often used as raw materials for cosmetic and perfume industries as well as for fruit, ornamental plants, and even for research materials that lead the demand for these plants to increase. On the other hand, most of the less economic plants value is not much paid attention by the communities, sometimes they cut it down [6], for example, Annona montana Macfad, A. glabra L. and Stelrichocarpus burahol (Blume) Hook.f. & Thomson.
Some advantages of the members of this family for human life viz. as timbers [7], traditional medicine materials [8-10], raw material for food and beverage industries [11,12], raw material for cosmetic and perfume industries [13,14] and traditional ceremonies [15]. Therefore, the main objective of this study was to reveal the importance of the Annonaceae family for the life of human beings and the life of organisms in the forest.

2. Materials and Methods
The occurrence of the Annonaceae family in forests was observed directly, including its potentials, during flora explorations throughout Indonesian forests. Among Indonesian forests that have been explored were Lembah Anai Nature Reserve, Kerinci Seblat National Park, Bukit Dua Belas National Park, Mount Seminung Regist 48-B and Regist 9-B Protected Forest and surrounding forests in Kepahiyang, Bengkulu (Sumatera); Ujung Kulan National Park, Halimun Salak National Park, surrounding forest in Mount Tangkuban Peralu, Mount Merbabu and Mount Mego (Java); Sungai Wain Protected Forest, Kutai National Park, the forest surrounding Mount Ketam, and conservation forest area in PT Shabantara Rawa Sentosa (Kalimantan); Morowali Nature Reserve, Lore Lindu National Park, Faruhumpenai Nature Reserve, Mangolo Nature-Recreation Park (Sulawesi); surrounding forests in Yapen Island (Papua). Besides, research has also been conducted in the Bogor Botanic Gardens. As an ex-situ conservation, the Gardens collected 83 species of the Annonaceae of which 40 species has been selected for sampling i.e., liana (1 species), shrubs (15 species), and trees (24 species). Additional data were also obtained from various sources in order to support this study viz. journals (online and printed journals), books and exploration reports. All of the data were analyzed using an MS Excell spreadsheet.

3. Results and Discussion
3.1. The role of Annonaceae family in the forest ecosystem
The members of Annonaceae family are components of natural and artificial forest ecosystems. Both played essentially to provide forest ecosystem services, notably provisioning services, cultural services, relating services, and supporting services.

Provisioning services provided by the Annonaceae family such as timber sources, animal feed in the forest, or raw material for traditional medicine. Large trees are found in some species of the family, Cyathocalyx sumatranus Scheff., Mezzetia parviflora Becc., and Platymitra macrorcarpa Boerl. for instance, can be used for timber production which can earn foreign exchange. In addition, almost all the members of the Annonaceae family can be used as firewood or charcoal. This firewood becomes an important component particularly for forest peoples [16]. Using traditional knowledge, they carefully selected the tree with less smoke and not poisonous firewood. As a result, it more efficiently worked in collecting firewood and also reduced respiratory infection risk during cooking. However, the member of the Annonaceae family is non-toxic firewood therefore it supports the forest people’s life, indirectly.

As a provider of food and maintain the sustainability of living organisms in the forest as well, therefore, the members of Annonaceae will produce flowers, fruit, and seeds. The flowers attract several insect visitors such as bees, fruit flies, beetles, and mites [17]. These insect’s life is assisted by the occurrence of the Annonaceae. Some of them are pollinators, either plants growing in the forest or agricultural crops nearby. Once the Annonaceae disappear, it can eliminate these pollinators which will negatively impact pollination services. Subsequently, the loss of pollination services will affect to yields of wild fruit in the forest as well as agricultural crops of forest peoples. Some insects (Aphis spp. and Trigona spp.) produce honey which is important for health and also the economic improvements of the forest peoples. Moreover, the wild fruit, which is produced by the Annonaceae family, plays an important role in providing the wild animal feed. Stellocarpus burahol, Polyalithia spp. and Saccopetalum horsfieldii Benn. for instance, are among the Annonaceae’s fruit preferred by bats, squirrels, birds, and civets as a source of their food. Besides, some members of the genera Annona, Goniothalamus, Mitrella dan Pseudovaria are essential substances of raw material for traditional medicine [18]. The forest peoples are usually taken medicinal plants either for themselves or for sale.
The forest also provided cultural services [19]. It is closely related to forest function as recreation, sport, nature lover, and healing forest. In general, cultural services are held in the forests where its function as nature tourism, such as protected forest, nature-recreation park, and national park, even in artificial forests, for instance botanic garden, and urban forest. However, artificial forests, Bogor. Botanic Gardens for instance, most obviously contributed to the cultural services of the Annonaceae, compared to natural forests. This because the members of Annonaceae family are planted in a certain location, therefore the function of cultural services is easier to observe. In addition, a diverse habitus, a conspicuous young leaf colour, the beauty and fragrance of flower are the main attractions for this service. Some species are considered an important role in providing cultural services viz. Stelechocarpus burahol, Meiogyne virgata (Blume) Miq., Platymitra macrocarpa, Cananga odorata, Monodora myristica (Gaertn.) Dunal., and Artabotrys hexapetalus (L.f.) Bhandari.

Another service that is provided by the forest is regulating services. It is related to climatological function, hydrology, and ecological function [20]. The role of the Annonaceae in managing climate is mainly undertaken by large trees, such as Cananga odorata, Platymitra macrocarpa, Cyathocalyx sumatranus, and Meiogyne virgata. The large tree is worthwhile in maintaining air humidity, keeping the un-rise of air temperature, and reducing evaporation of groundwater. The occurrence of the Annonaceae either in Botanic Gardens or urban forest plays an important role in controlling the climate surrounding, for example reducing air temperature, providing fresh air, and maintaining the availability of ground water. Besides, the large trees possessed deep and broad roots. The roots are helpful to absorb and store rainwater into the soil. This water reserve can be used as clean water that of beneficial to forest people’s life as well as urban communities. By storing up rainwater in the ground so can reduce water flow surface, as a result, it can decrease flooding. The roots are also able to bind soil particles to prevent landslides.

As a component of the forest ecosystem, the trees which belong to the Annonaceae family contributed to providing fresh and clean air. It would absorb carbon dioxide during the day for photosynthesis purposes and releases oxygen in turn. The more carbon dioxide is absorbed, the more oxygen will produce. Moreover, it can also absorb pollutants that cause air pollution. Hence, better air quality is results. Clean air is crucial for human beings to breathe.

The Annonaceae also acts as supporting services in the forest ecosystem, for example as a habitat for various plants and animals. Weaver ants (Oecophylla smaragdina), one of the insects which are often found living in Polyalthia lateriflora (Blume) Kurz., Polyalthia rumpfii (Blume ex Hensch), Goniothalamus ridleyi King, Cananga odorata and Cyathocalyx sumatranus. These ants are living, breeding, looking for food, building nests, laying eggs, and raising young ants on those trees. On the other side, members of the Annonaceae family, Cananga odorata for instance, is often used for the habitat of nest-bird ferns, pigeon orchids, ant plants, and dragon-scale ferns.

3.2. The role of Annonaceae family for human being life

Human being life cannot be separated from plants. Humans need plants for a living and to fulfill their daily needs, notably clothing, food, and shelter. Even the quality of human being life is sometimes determined by the occurrence of plants. Humans usually use the Annonaceae to meet various necessities of their life e.g., for wood, food, traditional medicine, perfume, cosmetics, and insecticide.

Timber or any products made from wood is used by humans in their living activities such as firewood, building, and furniture. Economic growth and the increasing number of human populations directly escalated timber consumption in the world. In developing countries, timber consumption is dominated by firewood for cooking while in developed countries is used for furniture, energy supply during winter as well as the pulp and paper industry [20]. Furthermore, the timber which obtained from the members of Annonaceae can be applied for various human need i.e., construction, house building, ship, and boat building, furniture, household utensils, agricultural implements, tool-handles, packing cases, matchboxes, plywood and firewood [7]. Several genera are potentially used as timber production viz. Alphonsea, cananga, Cyathocalyx, Meiogyne, Mezzetta, Mitrephora, Polyalthia, Platymita and Xylopa.
The fact that all of these genera can be used for construction and firewood. Three of them (Mezzettia, Meiogyne, and Polyalthia) are essential plywood sources for paper manufacture. The other two genera (Cyathocalyx and Polyalthia) are used for building a house.

Figure 1. The usage of nine genera of Annonaceae timber.

![Chart showing usage of nine genera of Annonaceae timber.](image)

Human needs vitamin and mineral which is many found in fruit and vegetable. Some of the Annonaceae members produce fruit whether it can eat directly as fresh fruit or through processing, such as Annona muricata (Soursop), A. squamosa (Sweetsop), Alphonsea teysmannii (Boerl.), A. javanica (Scheff.), Melodorum fruticosum (Lour.), and Stelechocarpus burahol. Soursop and sweetsop, among others, have largely consumed. Both are rich in nutrients such as carbohydrates, proteins, ash, fiber, phosphorus, calcium, magnesium, potassium, and sodium [21]. Apart from being used for fresh fruit, it can process into various kinds of food, for example, ‘dodol’, jam, jelly, ice cream, syrup, and candy. Even though the last four species above yield fruit but only locally used.

It is also known that some of the members contain various chemical compounds i.e., alkaloids, diterpenes, flavonoids, and polyketide compounds which are essential for medicine [8-10, 21]. The following reveals the usage of traditional medicine of some members of the Annonaceae family as seen in Table 1.

Humans also used the Annonaceae for pesticides. Seeds extraction of Annona squamosa dan A. muricata are reported to eradicate moths (Plutella xylostella and Trichoplusiani) [29] and A. squamosa can inhibit Spodoptera litura larve growth. Besides, it also takes pest control of tomato, silverleaf whitefly (Bemisia argentifolii Bellows & Perring), as well as cotton aphid (Aphis gossypii Glover). Moreover, corn crop pests (Spodoptera frugiperda Smith.) can be managed by using the extraction of seed A. montana. Another piece of information said that the essential oil of cananga’s flower was used to eradicate corn beetles (Sitophilus zeamais) [9]. Meanwhile, African nutmeg powder applied for insecticide against bark beetle, Derestid maculatus (Coleoptera) [30].

A fruit of burahol (Stelechocarpus burahol) has long been used as a deodorant by consumption of its fresh fruit [31]. Traditionally, princesses of Yogyakarta and Solo Palace usually ate this fruit in order their sweat, breath, and urine are fragrant [6]. Besides, Cananga odorata essential oil is used in various kinds of beauty products viz. perfume, shampoo, and pomade. Another species like Artabotrys hexapetalus can also be used for perfume.
Table 1. The usage of traditional medicine in the Annonaceae family.

| No. | Species                  | Parts of plant usage | Effect/uses                                                                 | References |
|-----|--------------------------|-----------------------|-----------------------------------------------------------------------------|------------|
| 1   | *Annona glabra* L.       | leaves, seed, pulp    | Anti-cancer, bronchitis,                                                   | [22]       |
| 2   | *Annona muricata* L.     | leaves, fruits, seeds, roots, bark | Anti-cancer, anti-arthritic, anti-convulsant, anti-diabetic and hypolipidemic, anti-inflammatory and anti-nociceptive, anti-oxidant, anti-hypertensive, anti-parasitic, anti-plasmodial, malaria, fevers, liver ailments, headaches | [21,23] |
| 3   | *Annona reticulata* L.   | bark, leaves, stem,   | Anti-inflammatory agent in wound healing, anti-anxiety, anti-stress, anti-mutagenic, and spasmolytic agent. | [24]       |
| 4   | *Annona squamosa* L.     | leaves, bark, seeds, roots | Epilepsy, dysentery, cardiac problem, worm infection, constipation, hemorrhage, anti-bacterial infection, dysuria, fever and ulcer. It also has anti-fertility, anti-tumor and abortifacient properties, anti-cancer, anti-fertility, depressant, analgesic, wound anti-hyperglycemic, anti-inflammatory, anti-proliferative. | [25]       |
| 5   | *Annona montana* L.      | leaves, seeds, fruit  | Anti-tumor, anti-parasitic, anti-inflammatory, anti-microbe, immunosuppressant, anti-feedant, anti-malarial. | [8]        |
| 6   | *Cananga odorata* (Lam.) Hook. f. & Thomson | flower, bark, stem, leaves | Malaria, stomach ache, pneumonia, anti-depressant, managing hypertension, headaches, eye inflammation and gout, stomach ailments, rheumatism, phlegm, ophthalmia, ulcers and fevers. | [26]       |
| 7   | *Goniothalamus macrophyllus* (Blume) Hook.f. & Thomson | leaves, roots, bark | Anti-cancer, antidote for snake bites, flatulence, general fatigue, and body pain, typhoid fever, anti-aging. | [27]       |
| 8   | *Polyalthia longifolia* (Sonn.) Thwaites | bark                    | Anti-bacterial, anti-fungal, fever, skin diseases, diabetes, hypertension and helminthiasis. | [18]       |
| 9   | *Polyalthia ramphii* (Bl. ex Hensch.) Merr. | stem                    | Anti-cancer                                                               | [10]       |
| 10  | *Monodora myristica* (Gaertn.) Dunal | leaves, twig, stem bark | Headaches, sores, stomach-aches, febrile, pains, eye diseases and haemorrhoids, headaches, sores, stomach-aches, febrile, pains, eye diseases and haemorrhoids, anti-bacterial and antifungal activities, anti-plasmodial | [28]       |
| 11  | *Uvaria grandiflora* (Lesch.ex DC.) Roxb. | stem bark               | stomach-ache, abdominal pains and skin diseases                           | [18]       |
| 12  | *Xylopia aethiopica* (Dunal) A Rich, | leaves, twigs           | Buruli ulcer, cough, carminative, and as a postpartum tonic, stomach ache, treatment of bronchitis, biliousness and dysentery. | [28]       |

The beauty and fragrant flowers in the members of this family, such as *Artabotrys hexapetalus, Cananga odorata, Monodora myristica, M. angolensis* and *M. tenuifolia*, attract the attention of people to grow them as ornamental plants whether in garden or yard. Some of them are planted as roadside...
trees because having attractive habitus, beautiful flowers or bright and attractive young leaf colour, for example, Alphonsea teysmannii, Polyalthia lateriflora, Stelechocarpus burahol, and Polyalthia longifolia (Sonner.).

The Annonaceae is also applied for religious ceremonies and traditional ceremonies, notably ylang (Cananga odorata) and soursop (Annona muricata). Both species are used for welcoming new baby born in Nganjuk Regency (East Java), ‘Kesada’ ceremony by Tengger Tribe (East Java), a traditional ceremony for the beginning of month ‘Sura’ and ‘Sekaten’ traditional ceremony which is conducted in Solo and Yogyakarta [15].

4. Conclusion

The Annonaceae family is an important part of the forest ecosystem, particularly in providing provisioning services, cultural services, regulating services, and supporting services. In addition, the members of this family produced various kinds of products that are needed by humans to fulfill their daily life.

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