

***Xanthostemon novoguineensis*: An Ethnobotany Perspective Towards Conservation of Endemic Species and Potentials for Renewable Energy**

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Abstract. There is increasing interest in conserving plant endemics because they face a high risk of extinction in their natural habitats and support traditional functions for local communities. This perspective review paper aims to provide a view of the future of the ethnobotany of *Xanthostemon novoguineensis*, which can be used to conserve this plant in the forests of Papua Province, Indonesia. Thus, it is presented as a personal view on critical thinking about future challenges to protecting this plant. First, the history of this plant is described, from its invention in Papua New Guinea. Subsequently, a discussion of the ethnobotanical perspective on the conservation of *X. novoguineensis*, based on a recent literature review, is provided. The final section discusses the near-future challenge associated with *X. novoguineensis* and how the ethnobotanical perspective of Papuans, especially the Sentani tribes, may hold vital value for the sustainability of *X. novoguineensis*.

Keywords: Conservation; Ethnobotany; Renewable Energy Resources; *X. novoguineensis*

I. INTRODUCTION

Papua Island, the second-largest island in the world after Greenland, has a high biodiversity of plants [1]. The geological structure of Papua Island has a direct contribution to the endemism of plants in Papua Island. As a result, it causes the geological variation structure from the surface of the land, which causes the isolation of organisms. Therefore, there are many different species of timber plants that can be found in different regions in Papua Island, especially Papua Province, Indonesia. One of the endemic plants from Papua Province is *X. novoguineensis* (vernacular name: *Sowang*) [2-5]. Sidiyasa et al. [6] stated that *X. novoguineensis* is an endemic of Papua Island. Wilson and Pitisopa [7] claimed that *X. novoguineensis* is a species from West New Guinea with very limited information. The distribution of *X. novoguineensis* is near Lake Sentani and the Cycloop

Nature Reserve Conservation Area in Jayapura Regency, Papua Province, Indonesia. *X. novoguineensis* provides a nursery ground for specific insects (eg, ants and wasps) [8]. Their population grows naturally at ultramafic soils [9] in the forest at the foothills of the Cycloop Mountain Nature Reserve Conservation Area [2, 3, 9]. Also, this plant has been found in the university's forest or park of Cenderawasih University, Jayapura, Papua Province [10].

Xanthostemon novoguineensis has been recognized by local communities (LCs), especially Papuan (Sentani tribes) who lived near Lake Sentani and Cycloop mountain [2-4, 11]. They recognize *X. novoguineensis* because of its role in supporting daily life, and it has been embedded in their cultural life. Thus, *X. novoguineensis* has played an important role not only for ecological functions but also for cultural aspects. However, recently it has become more difficult to find then on their natural habitat, potentially leading to high extinction risk [2]. Although *X. novoguineensis* has high potential values, as will be

discussed in sections of this review, what is required to overcome the extinction of *X. novoguineensis*?

This perspective review paper is not written as a classical or systematic review paper for specialists, but rather to offer a personal perspective for non-specialists, especially for different stakeholders and broader readers. Hopefully, this perspective review paper will provide insight to the education and government sectors (LCs) on the importance of preventing the extinction of *X. novoguineensis* in Papua Province, Indonesia. In particular, focusing on the ethnobotany of the Sentani tribes associated with *X. novoguineensis*. Therefore, it does not cover the specific aspects and functions of these plants, e.g., phytoremediation, carbon dioxide regulation, ecology, taxonomy, and genetics. It only gives a bird's-eye view of ethnobotany perspectives. Then, why is the ethnobotany perspective focused on in this perspective review paper? There are three reasons as follows: (1) Mostly, the study of *X. novoguineensis* starts with an exploration study in the field, and the area of study is limited prior to being expanded to laboratory study or engineering research; (2) High cultural value for the Sentani tribes, who use *X. novoguineensis* from their ancestors, and this knowledge is inherited by generation to the next generation. In other words, *X. novoguineensis* has a higher value for the Sentani tribes; (3). The Sentani tribes will make a significant contribution to protecting this plant, not only because of its cultural value, but also because the habitat of this plant grows naturally on their traditional land, which is their land rights. In this case, the role of the Sentani tribes in participating will be high. In fact, although a previous exploration study claimed that the population of *X. novoguineensis* is declining due to anthropogenic issues [2]. There is no government conservation action to cultivate this plant. As a result, it is important for the non-specialist to understand the possible conservation of *X. novoguineensis* and what the impact would be if this plant were to become extinct in the forest from a cultural perspective and in the absence of conservation actions.

Although this personal perspective paper gives a status on the *X. novoguineensis*, a state-of-the-art review is not given in this review. This personal perspective review paper refers to previous exploration studies and is mostly based on qualitative data [4, 8-12], and a personal perspective of Sanito [13] in folk taxonomy. This personal perspective paper also refers to group studies of Wilujeng [2,3,14,15] and Aisoi [16]. The goal of this personal perspective paper is to give a glimpse into the conservation effort based on the author's personal perspective. For this reason, this personal perspective paper mostly covers the recent results from *X. novoguineensis* in Papua, including

the ethnobotany perspectives, and also gives supporting information on *Xanthostemon* sp. from different literature. However, based on the author knowledge, the information conservation study of *Xanthostemon* sp. is still lack of information. Thus, another exploration studies of *Xanthostemon* sp. [17-23] from another review will be used to support this perspective review paper.

This perspective review paper will be divided into three sections (1). History of *X. novoguineensis* since this plant has been found in New Guinea Island (previously, the name New Guinea refers to Papua Province before integration as a Province in Indonesia); (2). Discussion on the ethnobotany perspective towards the conservation of *X. novoguineensis*; (3). Challenge in the near future associated with *X. novoguineensis*, and how the ethnobotany perspective of Papuans may realize the vital value for the sustainability of *X. novoguineensis*.

II. METHODS

Data from this review paper are collected from strong, evidence-based sources across all references available in ScienceDirect, Web of Science, and Google Scholar. The references are collected in broader scopes and are not always specific to support an overview of the ethnobotany perspectives [24]. The type of references is mostly focused on the social and ecological perspectives [5].

III. EXPLORATION STUDY OF XANTHOSTEMON IN NEW GUINEA

Focusing on *X. novoguineensis*, studies on this species have been reported in the literature, especially since its description by Merrill [25] in 1952. Some studies are unpublished due to the lack of new reports. Jamlean (1998), cited by Aisoi [16], Gunawan and colleagues (2005) (report is unpublished), cited by Wilujeng [2], Tanjung and co-workers' report is cited by Aisoi [16]. Yawan (2007) and Kareni (2008) (both are unpublished) are cited by Sanito [12], and Mumbo (2010) (unpublished) is cited by Sanito [11]. Studies are mostly focused on the assessment of the potential wood of *Xanthostemon* sp., as well as the exploration studies from the perspective of ethnobotany by indigenous communities (ICs). Perspective of ethnobotany will be discussed in section three in this perspective review paper. Distribution *X. novoguineensis* near Jayapura City, Papua Province, Indonesia has been reported by many scholars [2, 3]. It can be described at locations as follows: Depapre, Dosay, Maribu, Netar, Harapan Village, Kota Raja, and Pasir II

[26]. This plant is also distributed in Waena, since the last exploration near Cenderawasih University confirmed that this plant exists naturally in the learning forest [9]. All of these locations are in Jayapura Regency and Jayapura City. Figure 1e gives the example of *X. novoguineensis* habitat and distribution near the foothills. As can be seen, this plant can be found near the foothills of the Cycloop Mountain Nature Reserve Conservation Area. In addition, this plant can be found near the foothills of Cycloop. Information on *X. novoguineensis* habitat is described in Figure 2.

Recently, it has been difficult to find this plant in the forest, especially at the Cycloop Mountain Nature Reserve Conservation Area. It can be assessed from the density value of the plant at different growth levels of the plant. Seedling was 88%. Moreover, saplings and poles were 67% and 53%, respectively. Lastly, the tree was 42%. From this point of view, it can be understood that the distribution of trees is rare in the location. Also, the variation distribution of *X. novoguineensis* is caused by factors, eg, the use for traditional building constructions, equipment, and forest openings [26]. However, recently, there has been no update report about this plant. Aiso [16] claimed that ICs do not exploit this plant in specific locations in the Cycloop Mountain Reserve Area at Jayapura Regency because they are not likely to use this plant. However, the specific standpoint is the wood, which probably has a good performance as charcoal and construction that attracts the attention of stakeholders outside the ICs in Sentani.

To conclude, an exploration study in the Cycloop Mountain Nature Reserve Conservation Area is necessary to understand the status of *X. novoguineensis*. Also, it will give a whole lot of information on the current situation related to specific locations and their distributions, populations, and deforestation in the Cycloop Mountain Nature Reserve Conservation Area.

IV. ETHNOBOTANY PERSPECTIVE TOWARDS CONSERVATION

Ethnobotany focuses on the study of the interrelations between humans and plants. It includes indigenous knowledge of plant classification, cultivation, and shelter. A study of ethno-botany is not always limited to medical plants by indigenous cultures. Mostly, it covers or records the relationship between indigenous communities and plants [27]. Ethnobotany provides proper information about the function of plant species by indigenous people (IP). In general, it is a combination of two knowledges, i.e., anthropology and botany. In other words, the interdisciplinary field between plant science and

ethnology. In addition, these terms “multidisciplinary science” connection between IP and their knowledge should be associated with interdisciplinary, i.e., ethnomedicine, ethnotaxonomy, ethnotoxicology, ethnoecology, and ethnoforestry [28]. Thus, it is clear that ethnobotany is always associated with interdisciplinary sciences.

The ethnobotany perspective from this perspective review paper, in particular, the IP will be focused on the Sentani tribes, or the Sentani tribes as the ICs, who have a special relationship with *X. novoguineensis* from their ancestors and a high cultural relationship. According to Suroto [29], the ancestor of the Sentani tribes is non-Austronesian, and they immigrated from Sandaun Province and East Sepik Province in Papua New Guinea. Most of them settled near Lake Sentani or the islands in Sentani Lake. They live as groups and then establish villages near Lake Sentani and on islands in Lake Sentani, with an area of 96.30 km², a depth of 52 m, and located 72 m above sea level [30]. In terms of rules, ICs have a strict rule to use forests [30]. From this point of view, timber from the forest is not allowed to be taken directly. It should have permission from the ICs as the owner of the lands, especially the tribal chief of the village.

Wood of *X. novoguineensis* is used widely by the ICs to support their life. Aiso [16] reported that ICs used the wood of *X. novoguineensis* as follows: (1) cutting sago trees, (2) agriculture, and (3) creating utensils. The grouping of wood is divided based on function to build a traditional house near Lake Sentani. (1) Small size of wood (at approximately 4-6 m) for the pile, (2) Medium size (approximately at 8 m) for the foundation of the house roof framework, (3) Largest size (approximately at 12 m) for the main pillars and ridge. Gunawan [26] noted that wood can be used as the pile in fresh water, in saline water, and even on land. Furthermore, the wood of *X. novoguineensis* is used for a paddle [4], traditional forks (Figure 3a) [12, 16], specific spoons (Figure 3b) [12, 16], axes [12], ritual activities [2], traditional equipment for wars and fences [26] and pillars or woods with special crafting [13] (Figure 3c). For example, specific spoons and forks are used to consume *papeda* (vernacular name of sago after becoming a staple food), the staple food of ICs [12]. *Papeda* is made from the extract of Sago Palm (*Metroxylon sagu*).

Information is obtained from interviews and exploration studies directly to meet the ICs in their village. ICs play a pivotal role as an informant, the source of information. Interviews were conducted to obtain the information associated with *X. novoguineensis*. From the evidence, woods have a high cultural value since the main pillars with a specific pattern of crafting represent the

authority of the chieftain [16]. Thus, it is clear that the woods of *X. novoguineensis* play an important role in supporting their traditional life and cultural activities. Conservation of *X. novoguineensis* based on the ethnobotany perspectives can be used as a strong reason to protect this plant. *X. novoguineensis* has been used traditionally by LCs, particularly those who live near the Lake Sentani and foothills of Cycloop Mountain Nature Reserve Conservation Area. After that, an informant from ICs assists all the stakeholders in the process of protection of this plant due to their knowledge to recognize not only based on the folk taxonomy [13] but also the natural location and function in a social status.

There are three main reasons why *X. novoguineensis* must be conserved. First, it represents the culture and local knowledge of the Sentani Tribes [4, 9, 10, 12]. LCs, which live near Lake Sentani, use *X. novoguineensis* as their main raw material to support their life traditionally [4, 5]. Second, the use of this plant has become part of the indigenous knowledge of the LCs. Then, it is shifted from the previous generation into the next generation. After that, it is developed as an identity and a tradition that symbolizes the relationship between people and nature. As the illustration by Aiso [16] Men are more directly involved in cutting trees in the forest than women. Owing to this reason, men are better in terms of the knowledge of

X. novoguineensis rather than women. Also, Aiso [16] stated that entrance permits from specific clans, eg, Puraro clans, one of the clans from the Sentani tribes, have the land rights of *X. novoguineensis* in Jayapura Regency (Harapan Village). Thus, special permission is required due to the manners of LCs, where the distribution of *X. novoguineensis* is in the foothills near the Cycloop Mountain Nature Reserve Conservation Area [11]. Finally, there are huge factors that contributed to the decline of the population of *X. novoguineensis*. The fragmentation of habitats, deforestation, unlimited use of wood, and slow regeneration of the plant are the factual conditions, which are recognized as an incontrovertible fact that must be prevented and reduced for the sustainable development of biodiversity in Papua (including any species of endemic plants) [2].

To summarize, in terms of the function of wood for the Sentani tribes, *X. novoguineensis* has a significant impact to support daily life based on the perspective of ICs. Involving ICs is important because their relationship with *X. novoguineensis*, which can protect the plant locally, suggests to the government the plant's significant value. Thus, Conservation actions should be implemented as soon as possible to ensure the sustainability of *X. novoguineensis*.



Figure 1. a. Morphology of the flower of *X. novoguineensis*, b. Fruit swelling *X. novoguineensis*, c. Habitat of *X. novoguineensis*, d. Flower of *X. novoguineensis* on the twig, e. *X. novoguineensis* habitats and distributions near the foothills. Photos are taken by Raynard Christianson Sanito.

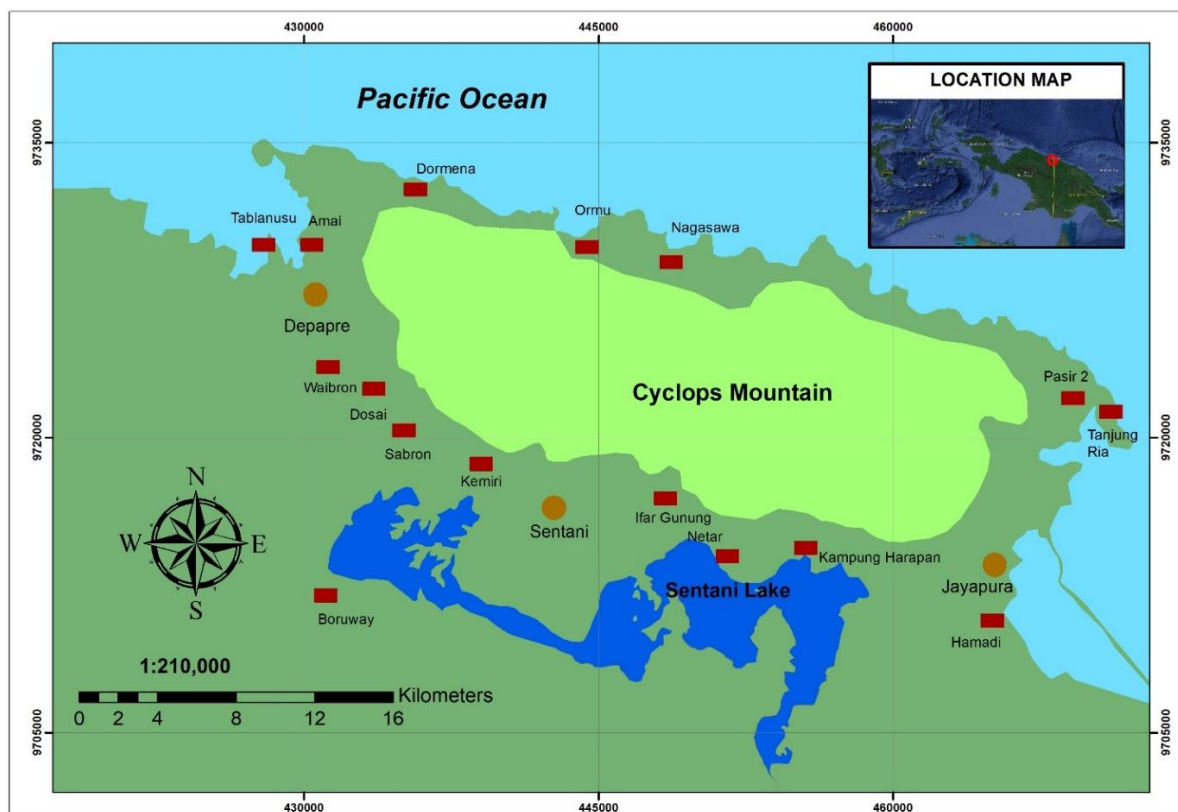


Figure 2. Cycloop Mountain Nature Reserve Conservation Area at Jayapura Regency, Papua Province, Indonesia. Populations of *X. novoguineensis* can be found in the foothills.

The final section of this perspective review paper will discuss the challenges in the near future associated with *X. novoguineensis* and how important the ethnobotany perspectives will play a major role in protecting this plant in its natural habitat.

V. CHALLENGE NEAR THE FUTURE FOR CONSERVATION STRATEGIES

A challenge in the near future for protecting *X. novoguineensis* is the continued association with anthropogenic issues and the plant's own ability to grow in nature. With the large potential of deforestation, it is a primary issue. Conservation strategies must be established to keep the existence of this plant in the future, revealing its ecosystem service and ecosystem functions. Awareness and responsibility from each stakeholder are required to establish the conservation actions. Awareness levels may vary in the LCs. However, researchers and local government also require support for LCs. In other words, the synergism of cooperation will play an important role in conservation actions. Thereby, conservation efforts start from research, and the modification of policy is suggested.

In terms of the perspective of ethnobotany, since researchers have confirmed that the timber of *X. novoguineensis* has a high value to support the culture [2, 3]. It is necessary to take a look at how ethnobotany, as a multidisciplinary science, has a direct impact on the sustainability of *X. novoguineensis*. Since the strong relationship of *X. novoguineensis* with LCs has been revealed, a sense of belonging from LCs is clear because of their connections and knowledge toward this plant, with the cultural perspective [4]. From this point of view, it can be understood that, in terms of conservation and multidisciplinary science, ethnobotany will greatly influence conservation efforts, starting from LCs, with the support of academics and local governments. However, further studies should be conducted to reveal the real potential of this plant in ecosystem functions.

An increase in comprehensive sensitivity and awareness is required. It is related to the vital roles of this plant in the social context and even endemism. It should be considered as an important value on how urgent this plant must be protected. If there are no conservation efforts, it is not only a loss of biodiversity but also a loss of high cultural value. Recommendations that can possibly be applied to the conservation of *X. novoguineensis* to escalate the awareness of LCs and local governments.

Various strategies can be proposed to protect the sustainable development of biodiversity in Papua Province. Adding a suggestion from Gua [34] from the perspective of conservation of *X. melanoxylo* in Solomon Islands, which is recommended by expert researchers. *X. melanoxylo* also faces similar conservation issues in Indonesia due to high potential extinction in its natural habitat. Lists of strategies are pointed out as follows:

- a. Establishing an in situ conservation area at the foothills with the participation of the Sentani tribes and design a conservation plan based on the knowledge of local communities [9, 10];
- b. Cooperation with academician and research institute at the university, conservation at ex-situ [16, 31, 32];

- c. Location can be established, including regeneration plot and seed collections [14-16, 32];
- d. Design a conservation plot for protecting this plant and start to collect seeds [14-16, 32].

To summarize, in terms of the function of woods for the Sentani tribes, *X. novoguineensis* has a significant impact on daily life, as seen from the perspective of ICs. Involving ICs is important because their relationship with *X. novoguineensis*, which can protect the plant locally, suggests to the government the plant's significant value. Thus, conservation actions should be implemented as soon as possible to ensure the sustainability of *X. novoguineensis*.

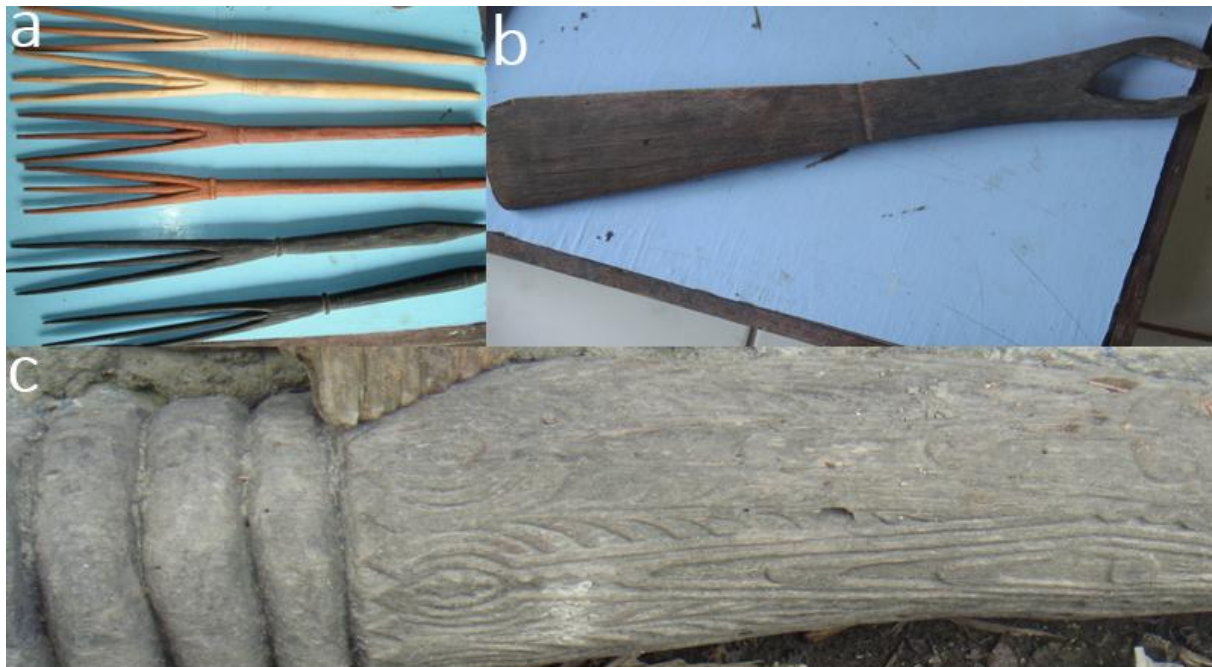


Figure 3. a. Traditional forks, b. Specific spoons, c. Special crafting of woods. Photos are taken by Raynard Christianson Sanito.

VI. CONCLUSION

In general, as an endemic species in Papua Province, Indonesia, *X. novoguineensis* plays an important role in supporting the cultural value of LCs (Sentani tribes). Since this plant had been classified by an exploration study in New Guinea, this plant has a high function to support LCs. A strong timber can be used as a wood in the perspective of ethnobotany to support their culture and life. The knowledge is known from their ancestor on how to use the wood, especially for daily activities and to support their cultural identity. Since the population of this plant is significantly decreasing in its natural habitat, a conservation effort should be conducted to prevent the

extinction of *X. novoguineensis*. Deforestation will significantly contribute to the extinction of this species and hinder its ability to regenerate in its natural habitat. Participations from each stakeholder are needed to establish the conservation actions, starting from LCs, academicians, researchers, and local governments.

Further exploration studies on *X. novoguineensis* as a recent update should be conducted, since there is no recent update information in recent publications related to conservation studies. A detailed exploration study is needed to understand the distribution pattern of *X. novoguineensis* in different locations at the Cycloop Mountain Reserve Conservation Area. Studies on conservation actions are also required to understand how

to protect this plant in the future (ex-situ and in-situ), with the support of LCs from an ethnobotanical perspective. From this point of view, the sustainability of *X. novoguineensis* can be obtained.

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