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CONSERVATION DILEMMAS CONFRONTING THE POPULATION OF PELAJAU (PENTASPADON ANNAMENSE) TREES ON LAUT ISLAND, SOUTH KALIMANTAN PROVINCE, INDONESIA

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ABSTRACT

Pelajau, Pentaspadon annamense (Evrard and Tardieu) P.H. Hô. is an endangered tree species of the Malesian region with fruits similar in eating quality to the walnut. The fruit has potential as a food ingredient in lieu of walnut. Laut Island in South Kalimantan Province, of Indonesia is one of its habitats but forests there are being converted to tree plantations and to settlements, thus the pelajau populations are being reduced. The purpose of this study was to observe the conditions of these populations; to grow out seeds of the tree at Banua Botanical Garden in Banjarbaru, South Kalimantan; and to determine the overall conservation issues for the species in this location. The method used was exploratory, with counts made in 20 x 20 m quadrats in populations separated by a distance of 100 m to 500 m. The treatment of seedling media (soil, husks, compost, sand and mixture) by Complete Random Design (CRD) used for analysing of germination parameters. The number of seedlings in each population varied from 10 to 202 seedlings. Seed germination experiment results showed that the average germination rate was 23.8% (low germination). Soil is the best seedling media, because of its superior in response to germination (28.6%) and rate germination (day 16th).

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INTRODUCTION

Pelajau or plajau (botanical name *Pentaspadonannamense* (Evrard and Tardieu) P.H. Hô) is a species of tree in the family Anacardiaceae (Mango family). The binomials *Pentaspadonmotleyi* Hook. f. and *P. officinalis* Holmes ex King (The Plant List 2016) are synonyms that have sometimes been used for the species. Pelajau is one of the great trees of the Anacardiaceae. It grows up to 50 m tall, with a branch-free trunk reaching 20 m and a trunk diameter (dbh) of 70 cm and with buttresses up to 5 m high. The leaves are alternate and imparipinnate;with leaflets penniveined, serrate-edged, caudate, and finely haired on the under-surfaces. Flowers are small (less than 4 mm in diameter), white, and arranged in panicles. The fruit is a drupe, 3-5 cm long, and green-brownish-black in colour.*Pentaspadonannamense* is found in Peninsular Malaysia, Sumatra, Kalimantan, Maluku, Papua New Guinea and the Solomon Islands.

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The conservation status of pelajau, according to the IUCN Red List (2014), is categorized as Data Deficient (DD - meaning there is inadequate information to make an assessment of the species' risk of extinction, and suggesting the need for more research. In Borneo it is an indigenous species but is threatened with extinction. The plant's distribution includes rivers or swamps at a height of 75-300 m above sea level. The peoples of Laut Island, a small island off the coast in South Kalimantan Province, consume pelajau seed (endocarp), eaten raw or as fried nuts (Lakitan1995). Burkill (1966), reported that the seeds are eaten as a delicacy and the oil is expressed onto food. The trunk of the pelajau tree is straight, and wood from it has good quality, strong enough and without cracks, suitable for use as building material. According to Heyne (1987), the wood is soft, rough, and vulnerable to insects but not easy to split. The timber is non-durable but suitable for cheap flooring (Slik 2016). The sap is used as an oil against skin diseases. The fruits are edible (fresh or roasted) (Maherawati *et al.,* 2008). Maherawati *et al.,* (2008) has determined that on average, the oval fruit of pelajau have a length of 4.1 cm; a diameter of 2.5 cm; and a weight of 5.09 g.

The edible component represents, on average 29.47% of the whole fruit. Proximate analysis of the edible part of the fruit reveals a protein content of 9.66%; fat 14.52%; carbohydrates 23.20%; ash content of 3.10%; and a water content of 9.96%. Of the carbohydrate portion, 45.32% is starch with a round-shaped molecule, and 3.22% is crude fiber. The dominant fatty acids are palmitic (C160), oleic (C 181), and linoleic (C182). All essential amino acids are present in pelajau seed (My Task 2014). Thus pelajau seed flour is fit for use as a food, with good nutritional value (Slik 2016).Laut Island (literally, Sea Island) is the largest island off the southern eastern coast of Borneo island, Indonesia (Fig. 1). The island is 1,873.36 km^2 in land area (Badan Pusat Statistik 2016). It is included in the jurisdiction of the District of Kotabaru in South Kalimantan Province. The Banjar Sultanate named it Laut Island or Pulau Laut (although it is known as Banjar, locally) (Sutopo 2002). Laut Island has a city, Kotabaru, which is the capital city of Kotabaru district. Based on data from 2014, the number of residents in Laut Island at that time totaled 127,665 inhabitants spread over six Districts (Badan Pusat Statistik 2016). The population is growing rapidly and forests are shrinking in extent. According to data released by the Ministry of Forestry, the amount of deforestation in Borneo as a whole from year 2000 to 2005 reached approximately 1.23 million hectares (Dodo and Sudarmono, 2014). That implies that about 673 hectares of forest in Borneo were deforested each day in the period. Indonesia's pledge to maintain at least 45% of the forest in the Indonesian part of Borneo (Kalimantan), was criticized by environmental groups reporting that Kalimantan retains only 30% forest cover (Dodo 2005), appreciably less than the 55% reported by Indonesia's Ministry of Forestry (Elisa 2006). The forest area in all provinces of Kalimantan amounts to 40.8 million hectares. The effect of direct impacts of this deforestation on the pelajau tree population in Borneo, and the fact that there is no cultivation or multiplication of the species (resulting in economic reliance on pelajau trees in the forest), has had the consequence that populations of the tree are declining and are threatened with extinction. According Mogea *et al.,* (2001) taxon in this category due to the distribution and population of data is not yet complete and can be included in one category of rare plants. Therefore, conservation efforts in the form of seed germination pelajau very important to anticipate the loss of the plant. According to Elisa (2006), germination is the reactivation process activity embryonic axis growth stalled in the seed to then form seeds. During the process of growth and ripening seeds, embryonic axis is also growing. Visually and morphologically, a germinating seed is generally characterized by images radikel or plumula protruding from seed. Good seedling media must have good physical properties, loose, able to absorb water and free of disease-causing organisms, especially fungi (Sutopo, 2002). Seedling media used in general is sand and / or soil (Smith *et al*., 1998). The study reported in this paper aimed to observe the status of the pelajau populations in a locality of Laut Island; to cultivate seeds of the tree in the Banua Botanic Gardens, Banjarbaru, South Kalimantan Province;and to assess the conservation issues.

MATERIALS AND METHODS

StudyArea

The forest research sites were in Inhutani II, Village Megasari, Kotabaru District, Laut Island, Indonesia, wherewe found four populations of the tree, each population containing threemature pelajau parent trees. The forest study was conducted over 20 days, March 19 to April 7, 2014. Germination experiments carried out in the Banua Botanical Gardens, Banjarbaru, South Kalimantan.

Methodology

The method used in the forest research was exploratory, with counts made in 20 x 20 m quadrats in the four populations separated from one another by a distance of 100 m to 500 m. Number of seedlings was determined in each pelajau population, for plants up to 50 cm in height. Associations with the surrounding vegetation were observed, as well as soil moisture conditions and soil pH. Ambient temperature and relative humidity were recorded at the time of observation using a Kestrel 4000 series Pocket Weather Tracker, which then combined these values to compute an estimate of heat index (i.e.'human perceived equivalent temperature') based on an approximation of the method described by Steadman (1979).Nursery germination experiments carried out in the Banua Botanical Gardens, with the treatment of seedling media such as soil, husks, compost, sand and mixtures (husk + soil + compost with a ratio of 1: 1: 1). Each treatment consists of 7 seed plajau were repeated 3 times. Pot laid out in the shade paranet (60% of incoming light). Structuring pot made in accordance Complete Random Design (CRD). Parameters measured were percentage of germination, time of germination and rateof germination.

Figure 1. Location of the study area on Laut Island in the forest of Inhutani II, Kotabaru District, South Kalimantan Province, in Indonesian (insert). The red ellipse indicates Laut Island where the pelajau tree population sites are located and the black circle indicates the location of Banua Botanic Gardens, in Banjarbaru, South Kalimantan Province

RESULTS AND DISCUSSION

Our study of pelajau populations at Inhutani II forest, Megasari Village ($3^0$21' S, $116^0$11' E), Kotabaru District, Laut Island showed that pelajau plants were growing on the banks of the Megasari River, at the base of Mount Bahalang. The populations were distributed at the edge of the river or in swamps at an altitude of 230 m above sea level. In each of four populations, there were three big parent trees, with a 5-10 m distance between trees.

Table 1. Conditions of humidity and temperature during the day, the pH of the soil and the heat index affecting pelajau population growth on the banks of the Megasari River, Laut Island, in South Kalimantan Province

Population	Humidity (%)	Temperature during the day (T ºC)	Soil pH	Heat Index
1	94.7	26.9	6.5	32.2
2	94.4	27.0	6.4	31.7
3	97.1	26.3	6.3	31.6
4	97.9	26.6	6.2	32.2

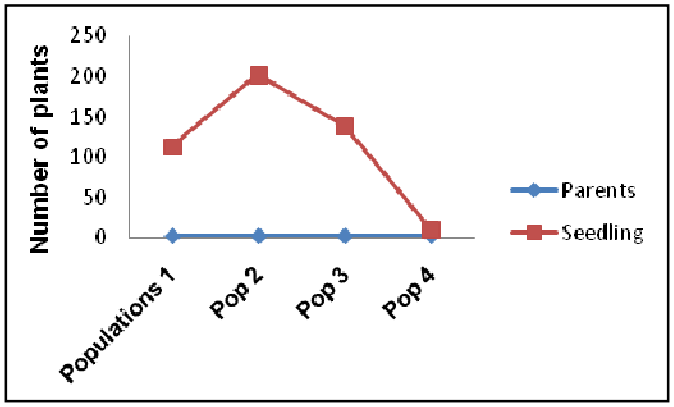

Figure 2. The relationship between the number of parent trees and the number of seedlings in four pelajau populations in the community forest of Megasari village of Kotabaru District, Laut Island, in South Kalimantan Province

Figure 3. Fruit and seedlings of pelajau (*Pentaspadonannamense*). Left. Fruit and seed in cross-section showing the edible portion. Right. Saplings grown from seed at Banua Botanic Gardens

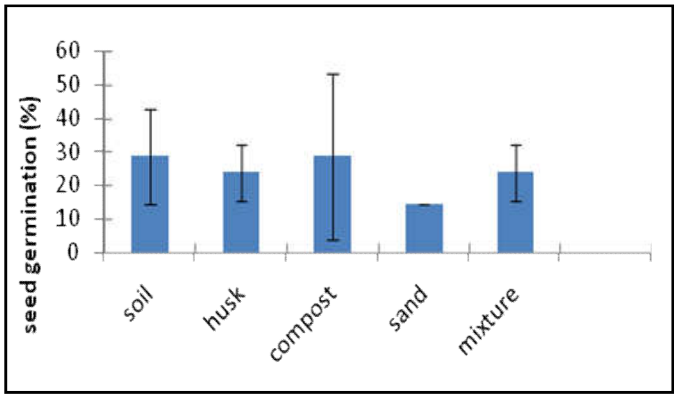

Figure 4. The percentage average and standard deviation of pelajau germination on a variation of growing

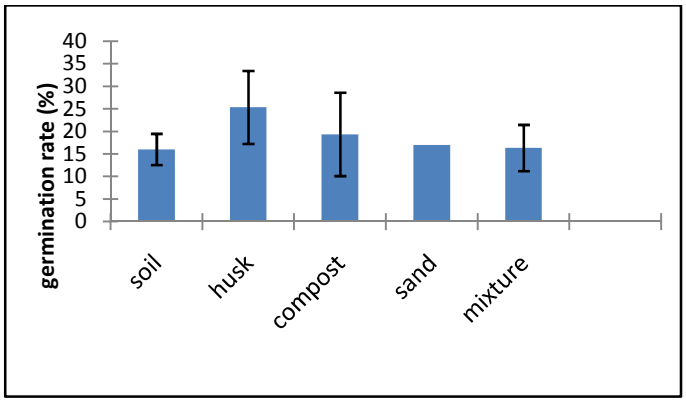

Figure 5. The average days and standard deviation in germination rate of pelajau seeds on a variation of growing media

The pelajau parent trees had heights reaching 40-50 m, with a branch-free trunk of20-30 m and a trunk diameter (dbh) of about 70 cm with buttresses 1-5 m high.The distance from the parent trees to the edge of the Megasari River was from 1 to 10 m. The number of parents of pelajau trees has 3 trees in each populations (Fig. 2). The number of seedlings varied between the four populations from 10 up to 202, with the greatest number being recorded in Population 2, which was 202 seedlings. Here, the greater number of seedlings was growing on flat land and in swampy conditions. The temperature during the day was warmer, at 27 ºC, than in the other populations; the humidity was 94.4% (Table 1).Seed germination is influenced by the type of seedling media used. The effect is demonstrated by the high percentage of germination of each seedling media used. Based on the test F (Analysis Of Variance), treatment of seedling media such as soil, husks, compost, sand and mix shows no different treatment significantly affected the percentage of germination, the rate of germination, and time of germination seed of pelajau for the treatment of F value is smaller than F table. Based on decision rule (Gaspersz, 1991), if the value of F smaller than F table means the difference between the real treatment.

In general, the average germination of seeds pelajau on all five of those treatments is 23.81% (Fig 4). The greatest response occurred in soil and compost, which both have a germination rate of 28.57%. However based test Z-score, the soilhas a value of 33.3% and 19.2% valuable compost. Thus, the soil becomes the best seedling media rather than compost as a Z-score greater than compost soil. This is shown by the standard deviation (STDEV) of soil which is smaller than compost, so the soil is the best media for seedlings in response to germination pelajau. Sand media were less well used to germinate on pelajau seeds. Pelajau germination in sand media is 14.3%. The results are the lowest score compared with others. The lack of sand media is caused by a lack of granule bind water, whereas in the process of germination is necessary to imbibition water. By the entry of water into the seed will increase grain moisture content and causes an increase in hydraulic pressure internal to the cells of the seed, so that there will be enlargement of the cells of seeds and seed finally be broken (Lakitan, 1995).In general, the average rate of seed germination of pelajau in all 5 treatments (Fig 5) was 1.04 seeds per day. Fastest response is the seed in husks i.e. 1.33 seeds per day but the influence was not significantly different among treatments. The average initial pelajau seed germinated of all five treatments tested showed different results (Figure 3). In general, the average initial pelajau germinated seed is the

18th day, which earlier occurred in the soil, namely the 16th day, but the effect of treatment was not significantly their differences. So, if you want to reproduce the seeds pelajau quickly and in large numbers then according to this study soil media is the best choice. These results can be used to estimate the number of seeds that will be required. By using soil media can be produced seedlings pelajau as much as 28.7% for one month.

That is, if the sow 1000 seed propagating pelajau living in the age of a month is as much 287 seedlings. At the end of the study all over the seeds have germinated and most experienced rotten seeds, it might be for irrigation water and / or rain water that so many seedling media i.e. soil, husk, compost, and the mixture becomes too wet. According to Sutopo (2002) media excessively wet conditions can hinder aeration and stimulate the emergence of diseases and rotting fungi or bacteri. Meanwhile seed in less sand to bind water so that the water imbibition of the seed becomes blocked (Lakitan 1995). Throughout Borneo (Sarawak, Brunei, Sabah, West Kalimantan, South Kalimantan, East Kalimantan, as well as in the associated small islands) the growing sites for pelajau is much the same, along river and swamp edges at an altitude of less than 200 meter above sea level (Maherawati *et al.,* 2008). Communities in such localities throughout Borneo take pelajau fruit from the forest and yet do not cultivate the tree from seed. The wood of pelajau is recognized to be of quite good quality; straight, quite strong, and not subject to cracking, so the tree has significant use for building materials, as well as for its edible fruit (Maherawati *et al.,* 2008). Our research reported elsewhere (Dodo 2005; Dodo and Sudarmono 2014) to cultivate pelajau in the Banua Botanic Gardens (Fig. 1), focusing on efforts to germinate the seed, has resulted in saplings growing 30 cm tall by the age of 10 months. However, the Bogor Botanic Gardens has only a single large pelajau tree growing in its *ex situ* collection, namely at the location VII E (Anacardiaceae) planted in 1978 (Sari, Ruspandi, Ariati 2010). It has never bloomed and the trunk is hollowed out in the middle. It is clear that we need to rejuvenate the collection with a new collection of planted pelajau trees. The results of this study of pelajau tree populations indicate that the *in situ* populations are very limited and fragile. The local community takepelajau fruit from the forest but they do not yet cultivate the plant. It is feared that such practices, if left to continue, will threaten the existence of the plant populations. According to the IUCN Red List (2014), the plant is categorized as data deficient (DD). Taxa are placed in this category when the data about their distribution and population is inadequate (Badan Pusat Statistik 2016); such taxa may need to be included in the category of rare plants. In summary, *ex situ* conservation efforts have attempted to transplant pelajau tree saplings collected from Inhutani II Forest area in Megasari village, Laut Island, into Banua Botanic Gardens. Also, *ex situ* conservation effort focused on the germination of pelajau seeds has been an important step in the response to the threatened loss of the plant in the wild (Sutopo 2002). However, our results have shown that the average germination rate is only 23.8%.According to Dodo (2005) of rice husk is a good media for seedlings in the propagation of seedlings of walnut. Compost is a good media for seedlings in seed germinate ironwood (Wihermanto and Dodo, 2008). Very low germination should therefore be anticipated in the propagation of seedlings in the Banua Botanic Gardens. Thus effort must continue to address direct *in situ* attempts to protect populations from extinction in existing community forest areas (Elisa 2006).

Conclusion

Pelajau tree population numbers are shrinking because of the use of its wood for building. Until now, communities that use it have not brought the tree into cultivation. Seedling media treatment of soil, husk, compost, sand and a mixture did not give significantly different responses to percentage of germination, rate of germination and time of germination on pelajau. Average pelajau germination rate is 23.8% (low). Soil is the best seedling media, because of its superior in response to germination (28.6%). Plant conservation efforts to cultivate it, by planting seeds in BanuaBotanic Gardens and in community gardens, arenow underway.

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