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Acclimatization of plant collection from Moyo Island, West Nusa Tenggara, Indonesia in Purwodadi Botanic Gardens

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Abstract. *Trimanto, Rahadiantoro A. 2017. Acclimatization of plant collection from Moyo Island, West Nusa Tenggara, Indonesia in Purwodadi Botanic Gardens. Trop Drylands 1: 43-49.* There is limited knowledge on the handling of plant specimens for botanical garden collection following field exploration. One key step is called acclimatization with the aim to adapt the newly collected specimens from their natural habitat into a new environment of Botanic Gardens. This research aimed to observe acclimatization process of living plant specimens collected from Moyo Island, West Nusa Tenggara in Purwodadi Botanic Gardens, East Java, Indonesia. We observed the acclimatization of 123 accession numbers of general collection and 17 accession numbers of orchid collection collected from Moyo Island. We investigated successfully adapting plants from the exploration site in Purwodadi Botanic Gardens as well as the non-survived specimens and analyze the mechanism of their adaptation. The study was conducted at a nursery unit in 2013, with an observational method. The results show that 75% of plant living specimens (i.e. 96 accessions of the general plant and nine accessions of orchid) collected from Moyo Island could adapt in Purwodadi Botanic Gardens, while the rest were unable to survive in the garden. Similarity in environmental variables between Moyo Island and Purwodadi Botanic Gardens seemed to influence the comparatively high survivorship of the plant specimens. Nonetheless, the orchid collection was harder to adapt in the garden compared to the general plant collection.

Keywords: Acclimatization, Moyo Island, Purwodadi Botanic Gardens

INTRODUCTION

Botanical exploration is a key activity to support conservation programs particularly in the context of *ex-situ* conservation such as Botanic Gardens, arboretum, etc. This activity is aimed to collect plants from their natural habitat (e.g. forest) with special attention is focused on rare and endemic species. Most of the botanical collections conserved in botanical gardens in Indonesia were originated from exploration activities including plant collection in Purwodadi Botanic Gardens in East Java, Indonesia.

During the last few years, botanists of Indonesian botanical gardens have chosen Nusa Tenggara region as the location for exploration because of its uniqueness due to its location in the Wallacea region. This biogeographical context has led to very diverse flora and fauna (Monk et al. 2007) in Nusa Tenggara. Nonetheless, in Purwodadi Botanic Gardens, there were 44 accessions of general plant (Lestarini et al. 2013) and eight accessions of orchid (Lestarini et al. 2009) from Nusa Tenggara that was conserved until 2013. This number is comparatively low than the high diversity and endemism of flora of the region. Therefore, in 2013, exploration was conducted in Moyo Island, West Nusa Tenggara Province, aiming to add botanical collection in the Purwodadi Botanic Gardens.

Moyo Island is located in Sumbawa Besar, Labuan Padas District, West Nusa Tenggara (8º9'36"-8º23'19" S latitude and 117º27'45"-117º35'42" E longitude). In 1972, Moyo Island was designated as a conservation area with a total extent of 18,765 ha and lowland altitude up to 600 m a.s.l. This area consists of a Mediterranean soil type with sandy soil texture, poor soil nutrient content due to rapid soil permeability and soil leaching. The Moyo Island climate type is similar to that of Botanic Purwodadi Garden which is categorized as dry lowland areas and share similar environmental factors such as rainfall, temperature, soil pH, humidity and light intensity (Trimanto et al. 2013).

After botanical exploration and before plant collection in the Botanic Gardens, there is one key step to ease the adaptation of plant specimens in the garden which is so-called acclimatization. Acclimatization process will determine to what extent the plants can adapt since the native species need a suitable climate to be able to grow in a new environment. A proper method of acclimatization is required to increase the survivorship of the plant when planted in the garden for *ex-situ* collection. Nonetheless, there is limited knowledge on the techniques of acclimatization of plant for collection in botanical gardens. This research aimed to observe acclimatization of living plant specimens collected from Moyo Island at the Purwodadi Botanic Gardens. The results of this research might enrich the understanding of acclimatization process of plant collection in Botanic Gardens, especially in context of the dry tropical lowland ecoregion.

MATERIALS AND METHODS

This research was conducted at the greenhouse in nursery complex of Purwodadi Botanic Gardens from April to December 2013. The plant specimens included 140 accession numbers from Moyo Island, West Nusa Tenggara, Indonesia. An observation method was used to

determine the acclimatization process and determine the number of non-adapting plants in Purwodadi Botanic Gardens. Observed temperature, humidity, medium pH, and light intensity were used to determine and compare the environmental factors in the nursery unit.

Acclimatization process was divided into two groups of plants, the general collection (non-orchids) and the orchid collection (Trimanto 2013). General treatment steps of plant materials from exploration (seedlings, plant cuttings and seeds) in the nursery of Purwodadi Botanic Gardens included: (i) Trimming the leaves of plant materials to minimize evaporation and wrapping the roots with moss to maintain moisture content, (ii) Dipping the plant materials in a plant growth regulator (i.e. Rootone-F) with a concentration of 100 mg L^{-1}, (iii) Putting the plant materials in a plastic bag, blowing and covering tightly to keep the plant fresh, (iv) Growing the plant materials on pure sand, (v) Covering the plant materials with plastic until the plants grow well (indicated with the appearance of leaf buds), (vi) Transplanting the plant on polybag media with a mixture of soil, compost, sand and rice husk of 1:1:1:1/2 ratio, (vii) Maintaining the plant in paranet house including watering, adding media and pest control. For orchid collection, the treatment step of plant materials included planting of the orchid collection in the orchid greenhouse. Planting medium for epiphytic orchids was tree fern fiber (or sphagnum moss) and that for the terrestrial orchid was a mixture of compost, soil, and sand medium in a ratio of 1:1:1 (Figure 1).

RESULTS AND DISCUSSION

The present study results showed that the majority of plant specimens collected from Moyo Island were able to adapt well at Purwodadi Botanic Gardens. There were 78 accession numbers of general collection (non-orchid) and 12 accession numbers of orchid that can survive in Purwodadi Botanic Gardens (Table 1), while only 22% of the general collection of plants and 29% of orchid collection were unable to adapt at the garden until December 2013. During April 2013 to February 2014, the vegetative growth was very good in the nursery unit which also applied to the terrestrial orchid collection.

Figure 1. Steps of procedure in handing plant specimens collected from botanical exploration in Purwodadi Botanic Gardens, Pasuruan, East Java, Indonesia. A. Reducing leaves and wrapping the seedlings roots with moss, B. Dipping the seedling materials into a root one solution, C. Covering the plant materials with plastic immediately after they arrived in the nursery, and D. Growing the plant materials in pure sand, E-F. Covering the plant materials with plastic, G. The growth performance of plant materials, H. Transplanting the growing plants into polybags and maintaining them in paranet house, I. Treatment of epiphytic orchid in field

There are three most important environmental factors that influence plant growth, namely temperature, water (precipitation), and light (Liwellin 2001). Documenting the environmental factors in the nursery unit of Purwodadi Botanic Gardens is needed to know the condition of acclimatization. Environmental conditions of acclimatization in the nursery such as temperature, humidity, and pH were favorable for the plants to survive (Table 2). The survival rate of the plant collection from Moyo Island was equal to that of Waru-waru coast, Sempu Island, East Java but was higher than those of Egon forest and Mutis Mountain, East Nusa Tenggara. This similar survival rate is likely influenced by environmental factors of Purwodadi Botanic Gardens that are similar to those of Moyo Island and Sempu Island. The acclimatization of plants originating from East Nusa Tenggara (Egon Forest and Mutis Mountain) with different environmental conditions (altitudes above 800 m asl) indicated lower adaptation rates in which only half the collected plants survived in Purwodadi Botanic Gardens. The result of our study is in line with the previous findings (Trimanto 2013; Permatasari and Rahadiantoro 2015) that the elevation of exploration site affects the adaptability of living collections.

In their native habitat in Moyo Island, the collected plants can grow well in low rainfall and dryland conditions. The altitude of the native habitat is not higher than 600 m a.s.l., which is similar to that of Purwodadi Botanic Gardens. Overall, the climatic condition in Purwodadi Botanic Gardens is similar to that of Moyo Island so that many plants collected in Moyo Island could survive in Purwodadi Botanic Gardens, although several of the collected plants could not survive at Purwodadi Botanic Gardens (Table 3).

Since 2006, the nursery in Purwodadi Botanic Gardens has developed several methods of acclimatization to adapt plant material from various locations in Indonesia. Every plant material needs a different way to survive in Purwodadi Botanic Gardens because of their different original climate type. The observation of plant specimens collected from East Nusa Tenggara (Egon Forest, Mutis, and Camplong Park) during 2011-2012 showed that only 50% of plants survive in Purwodadi Botanic Gardens. In contrast, there were 78% of the general plant collection (non-orchid) and 71% of the orchid material collection from Moyo Island, West Nusa Tenggara could survive, implying that the acclimatization of plants from Moyo Island is better than that of Egon Forest, Mutis, and Camplong Park (Trimanto 2013).

Acclimatization of general collection (non-orchid)

The acclimatization provided a favorable condition for the successful adaptation of the tested plants. Our research results revealed that most of the acclimated plant materials grew well in the sand growing media; especially those received the first treatment. The majority of plant materials included in this study were seedling materials, most of which were able to survive in the sand growing media. The successfully adapting seedling materials included *Alstonia spectabilis* R.Br. *Adenanthera microsperma* Teijsm, *Aglaia*

Table 1. Survival percentage of plant collection from Moyo Island

Category	Plant collection	
	General	Orchid
Total accession number	123	17
Survival accession number	96	12
Survival percentage	78%	71%

Table 2. Environmental factors of sites in Purwodadi Botanic Gardens and Moyo Island

Location	Environmental factors			
	Temp. (^{0}C)	Hum. (%)	pH	Light intensity (Lux)
Greenhouse (sand media)-Purwodadi Botanic Gardens	27-28	72-88	6.2	500-8.820
Paranet house (polybag media)-Purwodadi Botanic Gardens	26-29	76-82	6.0	180-3.800
Orchid house-Purwodadi Botanic Gardens	28-29	76-82	6.4	820-17.500
Moyo Island Forest	29-31	70-90	4.8-6.2	4.300-131.000

Table 3. List of plant collections that were not able to adapt in Purwodadi Botanic Gardens

Category	List of accession plant (species)	Family
General collection	*Abrus precatorius*	Fabaceae
	Aglaia lawii	Meliaceae
	Alstonia macrophylla	Apocynaceae
	Bambusa sp.	Poaceae
	Barringtonia racemosa, *Barringtonia* sp.	Lecythidaceae
	Bauhinia purpurea	Fabaceae
	Buchanania arborescens	Anacardiaceae
	Casearia grewiifolia	Samydaceae
	Clausena excavata	Rutaceae
	Clerodendrum paniculatum, *Clerodendrum* sp.	Verbenaceae
	Dioscorea bulbifera, *Dioscorea* sp.	Dioscoreaceae
	Diospyros malabarica	Ebenaceae
	Elatostema rostratum	Urticaceae
	Ficus sp.	Moraceae
	Gigantochloa atter	Poaceae
	Memecylon edule	Melastomataceae
	Palaquium rostratum	Sapotaceae
	Piper retrofractum	Piperaceae
	Pittosporum moluccanum	Pittosporaceae
	Sandoricum koetjape	Meliaceae
	Schoutenia ovata	Tiliaceae
	Syzygium gracilis, *Syzygium* sp.	Myrtaceae
	Uvaria javana	Annonaceae
Orchid collection	*Corymborchis* sp.	Orchidaceae
	Eria sp.	Orchidaceae
	Pteroceras javanica	Orchidaceae
	Dendrobium sp.	Orchidaceae
	Habenaria sp.	Orchidaceae
	Phreatia sp.	Orchidaceae


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Figure 2. Several plants from Moyo Island survived in Purwodadi Botanic Gardens nursery. A. *Tacca palmata*, B. *Amorphophallus paeoniifolius*, C. *Polyalthia* sp., D. *Dioscorea hispida*, E. *Adenanthera s*p., F. *Aglaia argentea*, G. *Clerodendrum chinense*, H. *Tacca leontopetaloides*, I. *Cissus javana*, J. *Begonia* sp., K. *Platycerium bifurcatum*, L. *Gymnema* sp., M. *Barringtonia racemosa*, N. *Tetrameles nudifora*, O. *Hymenodictyon excelsum*, P. *Abelmoschus moschatus*, Q. *Schefflera elliptica*, R. *Clausena excavata*

argentea Blume, *Antiaris toxicaria* Lesch., *Hymenodictyon excelsum* (Roxb) *Schefflera elliptica* Blume Harms, *Buchanania arborescens* (Blume), *Amphineuron marginatum* Roxb D.J. Midleton, *Uvaria littoralis* Blume, etc. The plastic used to cover the sand media protected plants from high evapotranspiration rate so that the humidity was preserved. The plant materials prepared in the form of cuttings were not successfully adapted, i.e. none of 10 specimens/cuttings of *Piper retrofractum* could grow while only one of 10 *Pleomele angustifolia* cutting materials were able to grow in sand media. Two species of Bamboo (genus *Gigantochloa, Bambusa*) survived only for one month in sand media. Araliaceae family such as *Schefflera elliptica* had high survivorship (up to 80%) as occurred in Bogor Botanic Gardens (Wawangningrum and Puspitaningtyas 2008). Benlate fungicide solution was successfully used to reduce the decay of the cutting materials (Danthu et al. 2002). When the stem cuttings were set in a convenient situation for rooting, the first adventitious roots that appeared from callus became the primary roots for cuttings. Callus contains a high amount of auxin. IBA (indole butyric acid) was found to increase the percentage of rooting in stem cuttings (Saffari 2012).

Several seed materials could grow in sand media. *Abelmoschus moschatus* and species from genus *Polyalthia, Ervatamia, Mucuna* also germinated and grew well in sand media. *Abelmoschus moschatus*, *Polyalthia* and *Mucuna* seeds sprouted one month after planting. More than 50 specimens of *Polyalthia* were able to germinate. Species from genus *Ervatamia* could grow only after three months. As with other species, seeds of *Amorphophallus paeoniifolius* also well germinated. The seeds from herbs such as species from genus *Passiflora* and *Ficus* were decaying and could not grow in the nursery. It is important to prevent seeds from rotting in the field. Seeds from the field must be clean and dry to make them prevented from decaying during the field collection. Seeds that are not capable of germinating can be overcome by addition of PGR (Plant Growth Regulators). The PGR was found to speed up the seed germination but gave no effect on the height, diameter and total number of leaves of the plant (Suparwoto et al. 2006). The effect of growth regulators on seed germination has been previously observed by Kumaran (1994), and that on herb seeds was found by Dhoran and Gudadhe (2012).

We found in the present study that epiphytic plants could survive and adapt in the nursery. The native habitat in Moyo Island is dry with low rainfall. *Epipremnum pinnatum, Hoya verticillate* and *Hoya elliptica* grew well in the nursery. The same was true for *Drynaria quercifolia*, *Adiantum caudatum, Platycerium bifurcatum, Lygodium flexuosum*, and species from genus *Asplenium.* The use of moss and potting soil made the epiphytic fern fresh. Tuber plant materials gave successful acclimatization. Five species of tuber plant could grow in the nursery, i.e. *Dioscorea hispida*, *Dioscorea pentaphylla*, *Tacca palmata*, *Tacca leontopetaloides*, and *Amorphophallus paeoniifolius*. Two tuber plant species planted in the garden, i.e., *Dioscorea pentaphylla* and *Tacca leontopetaloides* needed a long time (4 months) to grow. Bulbil planting materials of *Dioscorea pentaphylla* were also collected, and they took about six months to germinate. In Moyo forest habitat, tuber plants can grow well in dryland.

We found in the present study that many plants died after being transferred to polybags. Transferring plants into polybags caused the plants' roots to adapt again with the new growing media; therefore, there is an urgent need for appropriate techniques to grow the plants without changing the growing media/polybag very often. The planting materials should be first planted in polybag media to reduce the stress condition. Growing media consisted of soil: rice husk with a ratio of 1:1/2 could make successful acclimatization. Growing media can be added to compost to supply nutrition for the plant. A good growing media is the one with good water holding capacity, good aeration, good drainage, a pH corresponding to the type of plant, and contains nutrients to support the plant growth. A suitable composition of growing media is needed for a plant to thrive. Dewi (2005) reported that the planting medium with a mixture of sand, cattle dung, and soil in a ratio of 1:1:2 was the best for total plant height and length of shoots in mango nurseries. Susilawati (2007) reported that the media composition of husk charcoal media, soil, and compost in 1:2:1 ratio best influenced the vegetative and generative growths of *Helichrysum bracteatum*. Experiments on the mixture of appropriate growing media are required to determine a suitable growing media in the process of acclimatization in the Purwodadi Botanic Gardens. The addition of fertilizer or compost in the growing media is required to support plant growth. Several researchers found that addition of fertilizer provided significant effect on the growth of a plant. Applying organic-N fertilizer gave the vigorous plants expressed as plant height, leaves size as well as dry weight (Karanatsidis and Berova 2009), and growth and flowering (Bi et al. 2010).

Endemic and rare species are important to be collected in Purwodadi Botanic Gardens. Several threatened species based on IUCN (International Union for Conservation of Nature) Red List can survive in Purwodadi Botanic Gardens. *Canarium littorale* Blume, *Aglaia argentea* Blume, *Tacca leontopetaloides* (L.) Kunze, *Calophyllum soulattri* Burm f, *Alstonia macrophylla* Wall ex G.Don plants with the least concern status in IUCN that were able to survive in Purwodadi Botanic Gardens. *Cycas rumphii* is only one of the Gymnospermae collected from Moyo Island which is listed as near threatened in IUCN. The study about acclimatization is needed to make plant material from their natural habitat able to survive in

Purwodadi Botanic Gardens so that many plant species can be conserved. Several plants from Moyo Island were identified as new collection in Purwodadi Botanic Gardens.

Acclimatization of orchid collection

There were 17 accession numbers of the orchid collection. The diversity of orchids in the exploration site was considered low and more terrestrial orchid species were found than epiphytic orchids. The low diversity of orchids might have been caused by the dry and low rainfall conditions in the forest. The orchid from Moyo Island adapted well to Purwodadi Botanic Gardens climate, although several orchids could not survive in the greenhouse. The acclimatization of orchids resulted in 12 orchids collection could survive while five accession numbers were not able to adapt in Purwodadi Botanic Gardens. The terrestrial orchid bulbs took about four months to germinate as seen in their morphological growth in Figure 3.

Some orchids were found to have dried up, especially the epiphytic type. Epiphytic orchid was acclimatized with fern media watered using sprinkling water without any addition of nutrients. Epiphytic orchids need additional nutrients to grow properly because in their habitat these orchids obtain nutrients from humus in their medium. Tirta (2006) reported that a mixture of ferns and kadaka media (1:1) plus 2.5 mL of fertilizer inabio L^{-1} provided a good growth on *Dendrobium*. Micronutrients are given through the leaf by spraying or watering the plants, so it can be absorbed to cover the nutrition requirements for growth and development. Watering is a major factor for epiphytic orchids' acclimatization. *Vanda limbata* Blume and *Vanda* sp. survived well in the nursery, but the leaves grew poorly.

Several species of orchid such as *Dendrobium* and *Eria* adapted well in tree-fern media although the sprout of this plant grew slowly. The condition of several specimens of *Eria* and *Dendrobium* were dry and decaying. We found no pests and diseases in this plant species, presumably due to its malnourished state. Endemic orchid species collected from Moyo Island was *Pteroceras javanica*. This orchid presumably requires a particular host plant as it was only found in *Schleichera oleosa*. This species survived only for two months in Purwodadi Botanic Gardens. We collected this species several times, but none of them was able to survive, probably due to its need for particular growing media. Tree-fern media has weaknesses such as low water holding capacity, etc. The combination of tree fern with moss may provide water and keep humidity for a longer time, which makes it suitable for an epiphytic orchid.

The accessions of terrestrial orchids looked so fresh, probably due to the availability of nutrients in the soil. Orchids need nutrients to support their growth. The addition of fertilizer is required to satisfy the nutrient needs within the soil. Inorganic and organic fertilizers can support orchid plant development (Jenny et al. 2009). The addition of fertilizers can be done by spraying on the leaves or directly applied on the medium. The combination of growing media in a mixture of compost, soil, and sand in a ratio of 1:1:1 provides a suitable growing condition. The sand makes the media aeration well; the medium pH was normal (6-7) and is free from diseases. The good medium made the bulb of *Nervilia aragoana* Gaodich grow well. *Malaxis latifolia* Blume and *Calanthe triplicata* (Willemet) Ames also grew well in this media. This species could grow and flower after nine months in the greenhouse. There were species of terrestrial orchid that were hard to adapt such as *Corymborchis*. Although being acclimatized the *Corymborchis* could not survive. Similar case occurred to *Corybas ensiformis*, an endemic and terrestrial orchid collected from Egon, East Nusa Tenggara (Fiqa et al. 2011) which was found hard to adapt in the greenhouse of Purwodadi Botanic Gardens.

Figure 3. Orchid from Moyo Island in the nursery at Purwodadi Botanic Gardens. A. *Pteroceras javanica* only survive for two months. B. *Malaxis latifolia*, C. *Nervilia aragoana*, D. *Calanthe triplicata*, E. *Vanda limbata*

Several terrestrial orchids need to interact with mycorrhizae fungi to survive. The mycorrhizas are fungi associations required for the survival of orchids that live naturally in ecosystems since this group of plants depends on the fungi to germinate, as well as for their establishment (Victor 2013). Terrestrial orchids were taken along with soil from their native habitat to anticipate mycorrhizae presence in their possible interaction.

To conclude, the present study results showed that 75% of plants collected from Moyo Island were able to survive in Purwodadi Botanic Gardens. As many 96 accession numbers of the general collection and nine accession numbers of the orchid collection were found to be able to survive. Many of the general plant collections were dead after transplantation. The orchid collection was harder to adapt.

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REFERENCES

Bi G, William BE, James MS, Anthony LW. 2010. Effect of organic and inorganic fertilizers on marigold growth and flowering. Hortscience 45 (9): 1373-1377. DOI: 10.21273/HORTSCI.45.9.1373

Danthu P, Soloviev P, Gaye A, Sarr A, Seck A, Thomas I. 2002. Vegetative propagation of some West African Ficus species by cuttings. Agrofor Syst 55: 57-63. DOI: 10.1023/A:1020254808316

Dewi K. 2004. Stump Growth Response of Mango (*Mangifera indica* L.) var. Kelapa and Arumanis on Different Media Composition and Container Size. [Thesis]. Bogor Agricultural University, Bogor. [Indonesian]

Dhoran VS, Gudadhe SP. 2012. Effect of plant growth regulators on seed germination and seedling vigour in *Asparagus sprengeri* Regelin. I Res J Biological Sci 1 (7): 6-10.

Fiqa AP, Askan, Santoso W, Goni A, Subekti D. 2011. Flora Exploration Report on Mount Egon, Sikka Regency, East Nusa Tenggara. Purwodadi Botanic Gardens, Pasuruan. [Indonesian]

Hartini S. 2006. Ferns in Sago Malintang Nature Reserve, West Sumatra and their acclimatization in Bogor Botanical Garden. Biodiversitas 7 (3): 230-236. DOI: 10.13057/biodiv/d070307

Jenny J, Rondonuwu, Pioh DD. 2009. Nutritional needs of ornamental plants orchids. Soil Environ 7 (1): 73-79. [Indonesian]

Karatnasidis G, Berova M. 2009. Effect of organic-N fertilizer on growth and some physiological parameters in pepper plants (*Capsicum annum*). Biotechnol Biotechnol Eq 23: 254-257. DOI: 10.1080/13102818.2009.10818413

Kumaran K, Palani M, Jerlin R, Surendram C. 1994. Effect of growth regulators on seeds germination and seedling growth of neem (*Azadirachta indica*). J Trop For Sci 6 (4): 529-532.

Lestarini W, Matrani, Sulasmi, Trimanto, Fauziah, Fiqa AP. 2013. An Alphabetical List of Plant Species Cultivated in Purwodadi Botanic Gardens. Purwodadi Botanic Gardens, Pasuruan.

Lestarini W, Tarmudji, Matrani, Santoso W, Supriantono. 2009. An Alphabetical List of Orchid Species Cultivated in Purwodadi Botanic Gardens. Purwodadi Botanic Gardens, Pasuruan.

Liwellin LM. 2001. Range Plant Growth and Development Are Affected by Environmental Factors. Annual Report Grassland Section. Dickinson Research Extension Center, North Dakota State University.

Monk KA, de Freter V, Reksodihardjo-Lilley G. 1997. The Ecology of Nusa Tenggara and Mollucas (The Ecology of Indonesia Series Volume V). Periplus Edition. Singapore.

Permatasari I, Rahadiantoro A. 2015. Acclimatization and Monitoring of Plant from Sempu Island Exploration: Waru-Waru region on Purwodadi Botanic Gardens. The Proceedings of National Seminar on Biology/Science and Learning. Universitas Negeri Malang, Malang. [Indonesian]

Saffari M, Saffari VR. 2012. Effects of media and indole butyric acid (IBA) concentrations on hop bush (*Dodoneae viscosa* L.) cuttings in greenhouse. Ann For Res 55 (1): 61-68.

Suparwoto, Waluyo, Jumakir. 2006. The effect of atonic on duku seed germination. Jurnal Agronomi 10 (2): 77-79. [Indonesian]

Susilawati E. 2007. Effect of Media Composition on Germination and Plant Growth of *Helichry bracteatum* and *Zinnia elegans*. [Thesis]. Bogor Agricultural University, Bogor. [Indonesian]

Tirta IG. 2006. The effects of planting media and leaf fertilizers on the growth of jamrud orchid (*Dendrobium macrophyllum* A. Rich.). Biodiversitas 7 (1): 81-84. DOI: 10.13057/biodiv/d070120

Trimanto. 2013. Acclimatization of plant collection from East Nusa Tenggara Exploration (Egon Forest, Mutis Mount, and Camplong Park) at Purwodadi Botanic Gardens. J Biol Res 19: 5-10.

Trimanto, Setyawan AD, Suhartono, Eko BPS, Saropah. 2013. Plant Exploration and Research Report on Moyo Island, West Nusa Tenggara. Purwodadi Botanic Gardens, Pasuruan. DOI: 10.23869/bphjbr.19.1.20132 [Indonesian]

Victor SP. 2013. Anatomical characterisation of mycorrhizal fungi in neotropical orchid. Adv Stud Biol 5 (5): 215-221. DOI: 10.12988/asb.2013.326

Wawangningrum H, Puspitaningtyas DM. 2008. Diversity of Araliaceae in Sulasih Talang Nature Reserve, West Sumatra, and its acclimatization. Biodiversitas 9 (2): 123-127. DOI: 10.13057/biodiv/d090210.