

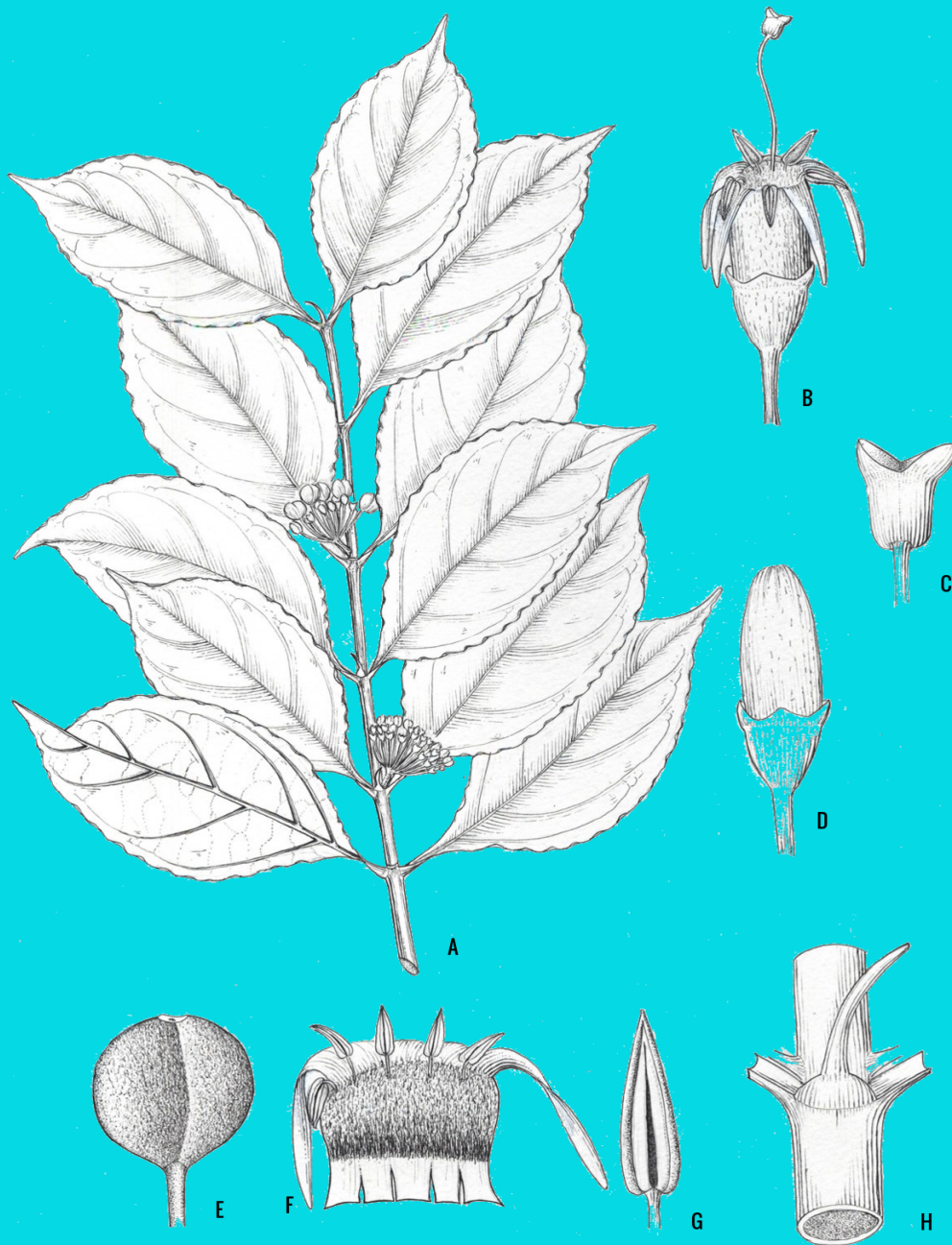


LIPI

REINWARDTIA

A JOURNAL ON TAXONOMIC BOTANY, PLANT SOCIOLOGY AND ECOLOGY

ISSN 0034 – 365 X | E-ISSN 2337 – 8824 | Accredited 792/AU3/P2MI-LIPI/04/2016



2018 17 (1)

REINWARDTIA

A JOURNAL ON TAXONOMIC BOTANY, PLANT SOCIOLOGY AND ECOLOGY

Vol. 17 (1): 1 – 85, June 29, 2018

Chief Editor

Kartini Kramadibrata (Mycologist, Herbarium Bogoriense, Indonesia)

Editors

Dedy Darnaedi (Taxonomist, Herbarium Bogoriense, Indonesia)

Tukirin Partomihardjo (Ecologist, Herbarium Bogoriense, Indonesia)

Joeni Setijo Rahajoe (Ecologist, Herbarium Bogoriense, Indonesia)

Marlina Ardiyani (Taxonomist, Herbarium Bogoriense, Indonesia)

Himmah Rustiami (Taxonomist, Herbarium Bogoriense, Indonesia)

Lulut Dwi Sulistyarningsih (Taxonomist, Herbarium Bogoriense, Indonesia)

Topik Hidayat (Taxonomist, Indonesia University of Education, Indonesia)

Eizi Suzuki (Ecologist, Kagoshima University, Japan)

Jun Wen (Taxonomist, Smithsonian Natural History Museum, USA)

Barry J. Conn (Taxonomist, School of Life and Environmental Sciences, The University of Sydney, Australia)

David G. Frodin (Taxonomist, Royal Botanic Gardens, Kew, United Kingdom)

Graham Egleton (Wagstaffe, NSW, Australia)

Secretary

Ruslan Bukhori

Layout

Liana Astuti

Illustrators

Subari

Wahyudi Santoso

Anne Kusumawaty

Correspondence on editorial matters and subscriptions for Reinwardtia should be addressed to:

HERBARIUM BOGORIENSE, BOTANY DIVISION,
RESEARCH CENTER FOR BIOLOGY– INDONESIAN INSTITUTE OF SCIENCES
CIBINONG SCIENCE CENTER, JLN. RAYA JAKARTA – BOGOR KM 46,
CIBINONG 16911, P.O. Box 25 CIBINONG
INDONESIA

PHONE (+62) 21 8765066; Fax (+62) 21 8765062

E-MAIL: reinwardtia@mail.lipi.go.id

<http://e-journal.biologi.lipi.go.id/index.php/reinwardtia>

Cover images: *Psydrax undulatifolius* K.M.Wong & Mahyuni *spec.nov.*, A. Habit; B. Flower; C. Stigma; D. Flower bud; E. Young fruit; F. Corolla cut open to reveal inside; G. Anther; H. Stipule. A, E, H from *H.N. Ridley 6475* (SING); B, C, D, F, G from *D.B. Arnot 30665* (KEP), drawing by Anne Kusumawaty (BO).

The Editors would like to thank all reviewers of volume 17(1):

Sylvain Razafimandimbison - Swedish Museum of Natural History, Swedia

Wong Khoon Meng - Herbarium Singapore, Singapore Botanic Gardens, 1 Cluny Road, Singapore

Mien A. Rifai - Akademi Ilmu Pengetahuan Indonesia (AIPI), Jakarta, Indonesia

Harry Wiriadinata - Herbarium Bogoriense, Indonesian Institute of Sciences, Bogor, Indonesia

Joan Pereira - Sandakan Herbarium Forest Research Centre Sabah Forestry Department, Sabah, Malaysia

Johan Iskandar - Universitas Padjadjaran, Bandung, Indonesia

Andrew Powling -University of Portsmouth, Portsmouth, United Kingdom

BAMBOO RESOURCES, CULTURAL VALUES, AND EX-SITU CONSERVATION IN BALI, INDONESIA

Received March 28, 2017; accepted May 15, 2018

WAWAN SUJARWO

*Bali Botanic Garden, Indonesian Institute of Sciences-LIPI, Candikuning Baturiti, Tabanan 82191, Bali, Indonesia.
Email: wawan.sujarwo@lipi.go.id*

ABSTRACT

SUJARWO, W. 2018. Bamboo resources, cultural values, and ex-situ conservation in Bali, Indonesia. *Reinwardtia* 17 (1): 67–75. — This present study describes the diversity of bamboo resources, based on Bali Botanic Garden's bamboo collections, and its unusual uses, including complementary information on floristic region, and ex-situ conservation of bamboo resources on the island of Bali, Indonesia. Bamboo resources have played an important role in the economics and culture of rural communities in Bali. Bali Botanic Garden, Indonesian Institute of Sciences (LIPI), started to introduce bamboo species in 1982 and established the ex-situ conservation compartment (2 ha) of bamboo in the same year. Up to now, 52 species in 11 genera collected from mostly the Malesian region (67.44%) and the Eastern Asiatic region (20.93%) have been planted in the bamboo compartment, of which 5.77% bamboo species are woody climbers.

Key words: Bali, bamboo resources, ethnobotany, ex-situ conservation.

ABSTRAK

SUJARWO, W. 2018. Keragaman bambu, nilai kultural, dan konservasi eks-situ di Bali, Indonesia. *Reinwardtia* 17 (1): 67–75 — Studi ini menggambarkan keragaman bambu, berdasarkan koleksi bambu Kebun Raya Bali, dan kegunaan yang tidak biasanya, yang meliputi tambahan informasi mengenai wilayah floristik, dan konservasi eks-situ tanaman bambu di Pulau Bali, Indonesia. Bambu telah memainkan peran penting dalam ekonomi dan budaya masyarakat pedesaan di Bali. Kebun Raya Bali, Lembaga Ilmu Pengetahuan Indonesia (LIPI), mulai memperkenalkan bambu pada tahun 1982 dan mendirikan petak konservasi eks-situ bambu (2 ha) pada tahun yang sama. Hingga kini, 52 jenis bambu dari 11 marga yang sebagian besar dikumpulkan dari wilayah Malesia (67,44%) dan wilayah Asia Timur (20,93%) telah ditanam di petak bambu, sebanyak 5,77% jenis bambu merupakan tumbuhan merambat.

Kata kunci: Bali, bambu, etnobotani, konservasi eks-situ.

INTRODUCTION

There are more than 1250 bamboo species distributed in the humid tropical, sub-tropical and temperate regions of the world (Sharma, 1980; Dransfield, 1981; Qing *et al.*, 2008). The islands in the Malesian region have a rich diversity of plants and not all of those plants have been identified. Indonesia has approximately 17,000 islands; one of those is Bali. The country, with over 100 bamboo species, has rich bamboo diversity, third in the world only to China and India (Dransfield & Widjaja, 1995). Bamboo is an amazing grass in the Poaceae family (Wong, 2004), and generates offspring by a complex robust rhizome system with woody culms and branches (Soderstrom *et al.*, 1979). Bamboo is very adaptable, as it grows from lowland to highland. Its uses in construction, pulp and paper, for handicrafts and household utensils are well known by many people, but its cultural values are less known.

There is a uniqueness of bamboo on the island of Bali. Bamboo represents one of three living philosophies of the Balinese. Bamboo is an integral part of Bali life, particularly in the rural populations. The coconut and banana are also

used, but less commonly. The people of Bali depend upon bamboo for every aspect of life from birth to death. For instance, Balinese utilise the bamboo as a knife to cut the navel when a baby is born, and bamboo is used to transport the body of an individual to the cemetery upon his demise (Sujarwo *et al.*, 2012).

Bali Botanic Garden (BBG) has become one of the plant conservation centres in Indonesia, situated on the east slope of Bukit Tapak Hill, at an elevation of 1,250-1,400 m asl, adjacent to the Baturaru Nature Reserve (15,390 ha). The total area of BBG is 157.5 ha (Lugrayasa *et al.*, 2009). By December 2015, BBG had 2,386 species in its collection, consisting of 241 families, 1,069 genera and including 52 species of bamboo and 213 species of ceremonial flora (Kebun Raya Bali, 2015).

Learning the indigenous knowledge in every region about utilisation of bamboo will be useful for understanding the cultural values. Even for the same bamboo species, the parts that are used and the preparation and application methods are not the same in every region. These depend upon the local wisdom and culture in every region (Sujarwo *et al.*, 2014). Considering the diversity of bamboo,

discovering its unusual uses could be valuable, not only in Bali, and many scientists could take a role in this. It is possible that bamboo could become an industry worth millions of dollars, because of its rapid productivity and ease of cultivation in many environments. Therefore, the aims of this present study are to discuss and to analyse the diversity of bamboo resources in Bali Botanic Garden and its unusual uses, especially related to Balinese culture, including their floristic region, and conservation efforts.

MATERIAL AND METHODS

Study area

The study was conducted in Bali Botanic Garden (8°16'20"S, 115°9'7" E) in the middle part of Bali island, Indonesia. The island of Bali is located at the westernmost end of the Lesser Sunda Islands (Indonesia), between Java to the west and Lombok to the east (Fig. 1.). Altitude varies from 0 m at the coast line to 3,142 m at the top of highest mountain (Mount Agung) (Badan Pusat Statistik, 2015).

Bali has a tropical climate with a bimodal seasonality (dry season from May to October and rainy season from November to April). The total annual rainfall can vary across the island spanning from around 1,200 to around 3,700 mm. The average annual temperature also varies throughout the year, and ranges from 23 to 33°C. The soil is alluvial and dominated by *latosol*, *regosol*, and *andosol* (Badan Pusat Statistik, 2015; Sujarwo & Caneva, 2015). Bali has also rich biological

diversity. The flora of Bali is characterised by 1595 species of *Spermatophyta*, 173 species of *Pteridophyta*, and 169 species of *Bryophyta* (Girmansyah *et al.*, 2013).

Data collection

Information on the number of bamboo resources was obtained through Bali Botanic Garden's catalogue (Lugrayasa *et al.*, 2009; Kebun Raya Bali, 2015), and their floristic regions were obtained through the book of floristic region of the world, written by Armen Takhtajan (1986). That is important information to understand the origin/distribution of bamboo resources. For each species of bamboo, the author reviewed available literature for utilisation and cultural values using scientific databases (such as Science Direct, Google Scholar). Scientific names of the bamboo species were verified using online sources (*e.g.* The Plant List, 2018).

RESULTS

This present study recorded 52 bamboo species belonging to 11 genera as being collected by Bali Botanic Garden, of which 5.77% bamboo species are woody climbers. The most common genera are *Gigantochloa* (20 species), *Bambusa* (11 species), and *Schizostachyum* (8 species). However, nine bamboo species are still unidentified. The native floristic region of the 52 recorded bamboo species covers Malesian (67.44%), Eastern Asiatic (20.93%), Indochinese (4.65%), and other tropical and sub-tropical Asian (6.98%) regions. In total,

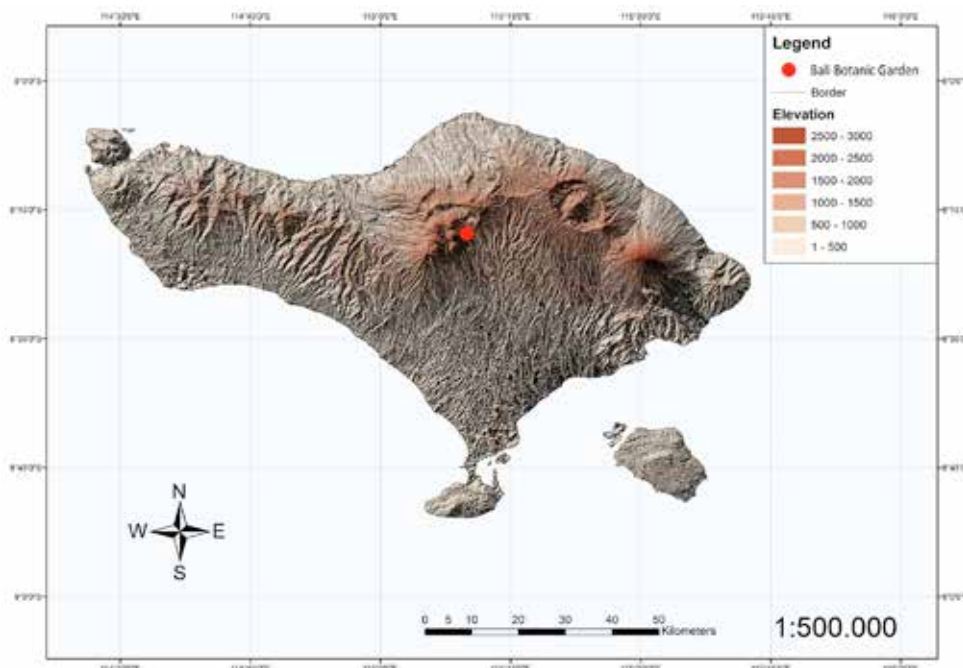


Fig. 1. The location of Bali Botanic Garden

only three bamboo species are not native to the tropical and sub-tropical areas of Asia. A list of bamboo species together with their floristic region is provided in Table 1. This present study also recorded cultural values and ex-situ conservation of bamboo resources on the island of Bali, Indonesia.

DISCUSSION

Bamboo resources and their floristic region

Dransfield (1981) estimated that sixty-four percent of world bamboo species are native to Southeast Asia, thirty-three percent grows in Central and South America, and the rest is in Africa and Oceania. In Indonesia, over 100 bamboo species are mostly distributed in Sumatra, Java, Bali and the Lesser Sunda Islands (Dransfield & Widjaja, 1995; Widjaja, 2001; Widjaja *et al.*, 2005).

The floristic region of this present study covers Malesian (67.44%), Eastern Asiatic (20.93%), Indochinese (4.65%), and other tropical and sub-tropical Asian (6.98%) regions. This geographical derivation might be strongly in connection with cultural influences within the tropical and sub-tropical Asiatic region. Pringle (2004) and Sujarwo & Caneva (2016) mentioned that the island of Bali is not only a species-rich tropical area, but also its people have a rich cultural history. On the contrary, the arrival in Indonesia of plants native to Central and South America was made by seed exchange among botanic gardens, and might have been introduced by the Dutch starting in the 16th century (Simmonds, 1976).

Even though the surface area of Bali Island is around 5,780 km², and only 0.2% of the whole area of Indonesia, six bamboo species were identified native to the island. They are *Bambusa ooh* Widjaja & Astuti, *Dinochloa sepang* Widjaja & Astuti, *Gigantochloa aya* Widjaja & Astuti, *Gigantochloa baliana* Widjaja & Astuti, *Gigantochloa taluh* Widjaja & Astuti, and *Schizostachyum castaneum* Widjaja (Arinasa & Sujarwo, 2015). Arinasa & Peneng (2013) stated not all bamboo species on the island have been identified. In Bali, bamboo generally grows in the natural forests and home gardens. One of the well-known bamboo forests is situated in Penglipuran traditional village, a large area of bamboo belongs to the local communities and individual landowners, and it varies between 40 and 50 hectares (Sujarwo, 2016).

Cultural values of bamboo

History and folklore

In the past, *Bambusa blumeana* Schult.f. grew abundantly throughout the coastline of the northern part of Bali Island. It formed a natural

barrier, which prevented the Dutch from entering the island when they wanted to colonise Singaraja (the former capital city of Bali) (Sujarwo, 2012). According to the ancestors, the Dutch threatened Singaraja many times, but they could not enter Singaraja due to *Bambusa blumeana*. Therefore, Singaraja could not be colonised by the Dutch for a long time. However, the Dutch were very smart and they were relentless in their quest to colonise Singaraja, so they were always devising new techniques to accomplish their goals. They came up with the idea of destroying the forest of *B. blumeana*, where it grew well and was sturdy. Many coins (money) were thrown by helicopter at the bamboo forest over a long period of time. Local people were overjoyed at this, because they did not have much money. As a result, they began to cut down all clumps of *B. blumeana* throughout the coastline in pursuit of these coins. The livelihood of the Balinese people living in Singaraja gradually began to change. Consequently, this provided an opportunity for the Dutch to clear the forest of *B. blumeana*. Once that had been removed from the coastline, it was vulnerable and the Dutch moved in easily. The Dutch used weaponry and warships to attack Singaraja. In the end they were able to colonise Singaraja. The local people were saddened by this, because they realised, after it was too late, that the Dutch had used this strategy to conquer them.

Folk feast

Galungan is one of the biggest feasts for Hindus in Bali, as are the *Nyepi* and *Kuningan* days. Bali's Hindus celebrate *Galungan* twice a year, as well as *Kuningan* but *Nyepi* is held only once a year. A day before the day of *Galungan*, Balinese Hindus in celebration set *Penjor* in front of their own houses (Sujarwo, 2011).

Penjor is made from entire bamboo culms and the curved ends are garnished with an assortment of ornaments. *Penjor* is one of the most important tools in the *Galungan*'s ceremony. This has resulted in increasing demand of bamboo in Bali, which affects the selling price in the market. The meaning of *Penjor* is as gratitude for blessings that have been given and also an offering to God that is symbolised in all the crops used in it. *Penjor* is always installed the day before *Galungan* and is attached in front of the entrance to the house with its end facing the street. It is removed a month after the day of *Galungan*.

The types of bamboo that are often used to make *Penjor* are *bambu bali* (*Gigantochloa baliana*), *bambu tali* (*G. apus* (Schult.) Kurz), *bambu tabah* (*G. nigrociliata* (Buse) Kurz), and *bambu tamblang gading* (*Schizostachyum brachycladum* (Schult.) Kurz) (Sujarwo, 2011). *Bambu bali* is Bali endemic species that has been developed in many local communities in Bali and has been

Table 1. The *ex-situ* conservation of Bamboo in Bali Botanic Garden

Species of bamboo	Life form	Collected from	Number of specimen (clump)	Floristic region
Bambusa				
<i>Bambusa blumeana</i> Schult.f.	Tree	Bali	5	Malesian
<i>Bambusa maculata</i> Widjaja	Tree	Bali	21	Malesian
		W. Nusa Tenggara	5	
<i>Bambusa multiplex</i> (Lour.) Raeusch. ex Schult.	Tree	Bali	16	Eastern Asiatic
<i>Bambusa ooh</i> Widjaja & Astuti	Tree	Bali	9	Malesian
<i>Bambusa tuldooides</i> Munro	Tree	Bali	6	Eastern Asiatic
<i>Bambusa vulgaris</i> Schrad.	Tree	Bali	11	Eastern Asiatic
		E. Nusa Tenggara	4	
		S. Sulawesi	2	
		W. Nusa Tenggara	4	
<i>Bambusa vulgaris</i> var. <i>striata</i> (Lodd. ex Lindl.) Gamble	Tree	Bali	7	Eastern Asiatic
<i>Bambusa vulgaris</i> f. <i>waminii</i> T.H.Wen	Tree	Bali	11	Eastern Asiatic
		E. Java	1	
		W. Nusa Tenggara	1	
<i>Bambusa</i> sp.1	Tree	E. Nusa Tenggara	2	
		S. Sulawesi	3	
<i>Bambusa</i> sp.2	Tree	Bali	12	
		S. Sulawesi	4	
		S.E. Sulawesi	1	
		W. Nusa Tenggara	12	
		S. Sulawesi	2	
<i>Bambusa</i> sp.3	Tree	S. Sulawesi	2	
Dendrocalamus				
<i>Dendrocalamus asper</i> (Schult.) Backer	Tree	Bali	23	Indochinese
		E. Nusa Tenggara	1	
		W. Nusa Tenggara	1	
<i>Dendrocalamus</i> sp.	Tree	Bali	6	
Dinochloa				
<i>Dinochloa kostermansiana</i> S.Dransf.	Woody Climber	E. Nusa Tenggara	1	Malesian
<i>Dinochloa sepang</i> Widjaja & Astuti	Woody Climber	Bali	3	Malesian
<i>Dinochloa</i> sp.	Woody Climber	Bali	6	
		N. Sulawesi	1	
		S. Sulawesi	1	
Gigantochloa				
<i>Gigantochloa apus</i> (Schult.) Kurz	Tree	Bali	42	Indochinese
<i>Gigantochloa atter</i> (Hassk.) Kurz	Tree	Bali	4	Malesian
		C. Sulawesi	2	
		E. Nusa Tenggara	2	
		S. Sulawesi	2	
<i>Gigantochloa atroviolacea</i> Widjaja	Tree	Bali	4	Malesian
		Java	5	
<i>Gigantochloa aya</i> Widjaja & Astuti	Tree	Bali	13	Malesian
<i>Gigantochloa baliana</i> Widjaja & Astuti	Tree	Bali	1	Malesian
<i>Gigantochloa manggong</i> Widjaja	Tree	Bali	12	Malesian
<i>Gigantochloa hasskarliana</i> (Kurz) Backer	Tree	Bali	4	Malesian
<i>Gigantochloa kuring</i> Widjaja	Tree	Bali	7	Malesian
		Sumatera	9	
<i>Gigantochloa luteostriata</i> Widjaja	Tree	Bali	3	Malesian
<i>Gigantochloa magentea</i> Widjaja	Tree	Bali	1	Malesian
<i>Gigantochloa nigrociliata</i> (Buse) Kurz.	Tree	Bali	5	Malesian
<i>Gigantochloa pubinervis</i> Widjaja	Tree	Bali	9	Malesian
		Borneo	5	
		Sumatera	5	
<i>Gigantochloa pubipetiolata</i> Widjaja	Tree	Bali	1	Malesian

Table 1. The *ex-situ* conservation of Bamboo in Bali Botanic Garden (continued)

Species of bamboo	Life form	Collected from	Number of specimen (clump)	Floristic region
<i>Gigantochloa robusta</i> Kurz	Tree	Bali	2	Malesian
<i>Gigantochloa serik</i> Widjaja	Tree	Bali	1	Malesian
<i>Gigantochloa taluh</i> Widjaja & Astuti	Tree	Bali	5	Malesian
<i>Gigantochloa thoi</i> K.M.Wong	Tree	Bali	1	Malesian
<i>Gigantochloa velutina</i> Widjaja	Tree	Bali	3	Malesian
<i>Gigantochloa</i> sp.1	Tree	Bali	47	
<i>Gigantochloa</i> sp.2	Tree	Bali	61	
		Borneo	4	
		E. Java	3	
		E. Nusa Tenggara	1	
		Maluku	8	
		W. Nusa Tenggara	4	
Guadua				
<i>Guadua chacoensis</i> (Rojas Acosta) Londoño & P.M.Peterson	Tree	Bali	10	Amazonian
Neololeba				
<i>Neololeba atra</i> (Lindl.) Widjaja	Tree	Papua	2	Northeast Australian
Oatea				
<i>Oatea acuminata</i> (Munro) C.E.Calderón ex Soderstr.	Tree	Mexico	15	Madrean
Phyllostachys				
<i>Phyllostachys aurea</i> Rivière & C.Rivière	Tree	China	4	Eastern Asiatic
<i>Phyllostachys nigra</i> (Lodd. ex Lindl.) Munro	Tree	China	3	Eastern Asiatic
<i>Phyllostachys</i> sp.1	Tree	S. Sulawesi	2	
Schizostachyum				
<i>Schizostachyum brachycladum</i> (Kurz) Kurz	Tree	Bali	6	Malesian
		C. Sulawesi	1	
		E. Nusa Tenggara	8	
		Java	4	
		S.E. Sulawesi	2	
<i>Schizostachyum castaneum</i> Widjaja	Tree	Bali	1	Malesian
<i>Schizostachyum caudatum</i> Backer ex K.Heyne	Tree	Bali	1	Malesian
<i>Schizostachyum cuspidatum</i> Widjaja	Tree	Bali	1	Malesian
<i>Schizostachyum lima</i> (Blanco) Merr.	Tree	Bali	34	Malesian
		C. Sulawesi	1	
		E. Nusa Tenggara	7	
		Philippines	3	
		S.E. Sulawesi	1	
<i>Schizostachyum silicatum</i> Widjaja	Tree	Bali	23	Malesian
<i>Schizostachyum zollingeri</i> Steud.	Tree	E. Java	2	Malesian
<i>Schizostachyum</i> sp.1	Tree	Bali	14	
		Borneo	1	
		Papua	4	
		Sumatera	2	
		S.E. Sulawesi	4	
		W. Nusa Tenggara	14	
		W. Papua	2	
Shibataea				
<i>Shibataea kumasasa</i> (Steud.) Makino	Tree	Bali	3	Eastern Asiatic
Thyrsostachys				
<i>Thyrsostachys siamensis</i> Gamble	Tree	Bali	6	Eastern Asiatic

Abbreviations. C. Sulawesi = Central Sulawesi; E. Java = East Java; E. Nusa Tenggara = East Nusa Tenggara; N. Sulawesi = North Sulawesi; S. Sulawesi = South Sulawesi; S.E. Sulawesi = South East Sulawesi; W. Nusa Tenggara = West Nusa Tenggara; W. Papua = West Papua.

conserved in the Bali Botanic Garden.

Bamboo and myths

Bambu pingit (*Gigantochloa hasskarliana* (Kurz) Backer) is well known to the indigenous people in eastern parts of Bali (Sujarwo, 2010b). It is found there only in the holy area of the *Lempuyang Luhur* temple, which is one of the biggest temples in Bali. It is located on the mountain *Lempuyang Luhur*, which is 1,200 m asl. The local people in this area believe that this bamboo can cure breast cancer, insomnia, and heart problems. A Hindu priest at the temple says that the water inside the culms of this bamboo can cure those diseases. Local people say that many have been healed by drinking the water from inside the culm (Sujarwo *et al.*, 2010a). In addition to being used as a medicine, the water inside the culm is used as holy water by Hindu people in Bali (Sujarwo, 2010b). This is an example of local indigenous knowledge. On top of this mountain five clumps of *bambu pingit* are growing. While bamboos can grow from the lowlands to the highlands, this bamboo is growing only on top of this mountain.

The roof of Balinese traditional buildings

Most Balinese have known that clay was usually used as raw material for the roof. But, in Penglipuran traditional village in Bali the roof is unique. In that village bamboo is used. The roof is made from laths of bamboos (*Gigantochloa aya*, *G. taluh* and *G. apus*) with the dimensions of 5–7 cm wide, 25–54 cm long, and 0.5–1.2 cm thick respectively.

In Penglipuran, most holy buildings such as *pura* (temple), *bale gong*, *bale piasan*, *bale kulkul* and *bale paruman* (these holy buildings are parts of the Hindu temple) have bamboo roofs. Besides holy buildings, houses, kitchens, and *angkul-angkul* (private entrance gates) also use bamboo for roofs especially from *bambu aya* (*G. aya*).

The utilisation of bamboo for roofs is found not only in Penglipuran (Bangli regency), but also in other villages in Bali such as Tigawasa and Sidatapa villages (Bulleleng regency), Angsri and Wongaya Gede villages (Tabanan regency), Pempatan and Tenganan villages (Karangasem regency). Arinasa & Peneng (2013) stated that, in recent times, restaurants, hotels and houses in Bali have utilised the laths of bamboo for the roof.

Making and preserving bamboo laths is simple. Although the bamboo roof is made traditionally and without preservative, many people began to like it, because it gives freshness. The air circulation is better. Also, the bamboo roof has been reported as lasting 25–30 years or more.

Bamboo charcoal

In Bangli regency, 18 species of bamboo grow. These include *Gigantochloa aya*, *G. taluh*, *G. apus*, and *Dendrocalamus asper* (Schult.) Backer. Those bamboos have been utilised by traditional charcoal makers to produce charcoal. This is a product that has been developed as a sustainable product. It could be made from all parts of bamboo, but the traditional charcoal maker uses only bamboo waste. This includes rhizomes, internodes, small branches and waste from the bamboo home industry (Astuti & Arinasa, 2002).

A few iron makers still exist in Bali. They burn bamboo charcoal to make knives, sickles *etc.* They said that bamboo charcoal yields higher heat than other kinds, such as that made from coconut shells. This may be due the high silica content in bamboo. Bamboo has a significant impact and is used in many aspects of the lives of local people, particularly in the Bangli regency.

Based on local people information, bamboo charcoal usually sells for 60,000 IDR per sack (1 USD = 13,200 IDR). Traditional charcoal makers can make five sacks in two days, for which they will get IDR 300,000. However, they must buy the bamboo waste from craftsmen for IDR 30,000 for one sack of bamboo waste. So the traditional charcoal makers get only IDR 150,000 for two days or IDR 75,000 for one day. They do not earn much, although this is a bit higher than for day workers, because labour pay is usually about IDR 50,000 to IDR 60,000 per day.

Bamboo and medicine

The use of modern medicines and pharmaceuticals has spoiled humans, so that the knowledge of ancestral traditional medicines has been slightly overlooked. One potential alternative medicine material is bamboo.

Bamboo is well known, but its utilisation as medicine is less known. Previously, the shoots of *bambu kuning* (*Bambusa vulgaris* Schrad.) were used to heal liver problems (Sujarwo *et al.*, 2012). Balinese ancestors used the water in *Dinochloa scandens* (Blume ex Nees) Kuntze as medicinal eyewash and for tuberculosis (Tengah *et al.*, 1995). Sujarwo *et al.* (2012) mentioned that some indigenous knowledge of bamboo was found through interviews with *Balian Usada*, an indigenous medical practitioner who is knowledgeable on plant uses, and eight species were found as medicine. The eight species of bamboo and their medicinal uses were: shoots of *D. asper*, used to reduce hypertension; shoots of *Gigantochloa nigrociliata*, used to relax muscle and for heartburn; roots of *G. aya*, used to reduce fever; culms of *Bambusa vulgaris* var. *vulgaris*, used to cure liver problem; shoots of *Schizostachyum lima* (Blanco) Merr. used to increase memory; shoots of *Bambusa vulgaris* var.

striata, used to cure liver problems; roots of *Schizostachyum brachycladum* (Kurz) Kurz used to smooth mother's milk (Sujarwo, 2010a; Sujarwo *et al.*, 2012); and roots and culms of *G. apus*, used to cure diabetes and for skin rejuvenation (Sujarwo *et al.*, 2010b).

Bamboo shoots

Bamboo grows more rapidly than any other plant on the planet, it has been clocked surging skyward as fast as 47.6 inches in a 24-hour period, but it can only happen in the rainy season, where shoot production becomes very abundant. However, there are only three types of bamboo shoots that are often traded in traditional markets in Bali, namely *bambu petung* (*Dinochloa asper*), *bambu tabah* (*G. nigrociliata*), and *bambu tali* (*G. apus*). Arinasa & Peneng (2013) stated that the first two species became very popular among local Balinese people.

Bamboo shoots contain a lot of protein, carbohydrates, fats, fibre, and vitamins A and C which are beneficial to the human body and health (Sujarwo *et al.*, 2012). Although it has many health benefits, it is rare to find dishes made from bamboo shoots in fancy restaurants and hotels in Bali. There is a stigma in Balinese communities that bamboo shoots are food for lower to middleclass society.

Peak harvesting season for bamboo shoots occurs in January; this made the selling price in traditional markets cheap enough. The bamboo shoots are sold at a price of 2000 IDR per plastic bag (250 grams) (Sujarwo, 2015a). With the many nutritional content and health benefits, as well as prices that are relatively affordable, bamboo shoots are very important for local Balinese.

Creating a new water spring

On the basis of studies conducted by Arinasa & Peneng (2013) and Sujarwo (2015b), the local inhabitants in several traditional villages in Bali, such as Angsri Village in Tabanan regency, and Tigawasa Village in Bulleleng regency, believe the bamboo forests that had been hundreds of years can create a new water spring. Such villages could be a model, how a strong tradition of local communities which has been passed down through generations of ancestors can maintain bamboo forests for hundreds of years. The bamboo forests in such villages are mostly owned by indigenous communities, and only a small quantity is owned by individuals. Local people only take a little direct benefit from selling bamboo culms, because they believe that the soil and water conservation is much more important than the direct value of bamboo culms itself.

On the contrary, Environmental Bamboo Foundation Bali has received reports from many countries in the world that the flow of water in a

region increases after a few years of planting bamboo and in some cases new springs appear (Bamboo Central, 2015). This is not surprising, considering the bamboo is a C3 plant and very effective in water conservation. As a comparison, trees absorb an average of 35-40% rainwater, while the bamboo can absorb up to 90%. That is the reason people in Colombia said that they planted water when they grow bamboo.

Ex-situ bamboo conservation

Ex-situ bamboo conservation by Bali Botanic Garden has been conducted since the 1980s. By 2015, the garden had managed to collect a total of 52 bamboo species or 30% of the total bamboo found in Indonesia. Nearly 33% of the present collection is a kind of introduced species native to outside the Malesian region (Kebun Raya Bali, 2015). Efforts to increase the types of bamboo received great attention as a multi-purpose function. Increasing the bamboo collection can be done by exploration, and exchange of material in the form of donations and index seminum among botanic gardens. Exploration is carried out in the rural areas and protected forests of Bali and eastern parts of Indonesia, including Lesser Sunda Islands, Sulawesi, Moluccas and Papua, while material exchange is performed by governments and private institutions, Botanic gardens, bamboo communities, and bamboo lovers. In the last ten years, BBG' botanists have conserved at least 30 new bamboo species in the garden.

On the basis of bamboo collection activities until the end of 2015, the garden has collected as many as 52 bamboo species that represent 11 genera, including six endemic bamboos. Arinasa & Sujarwo (2015) mentioned that in their wild habitat, five types of endemic bamboo can be found in either bamboo forests or home gardens, and one type, *D. sepang*, is only found in a protected forest area.

It is possible that more endemic bamboo species in Bali will be discovered, because many types of bamboo can be found in Bali. Bali Botanic Garden has not completely collected herbarium vouchers, especially in the genus of *Gigantochloa*. Field exploration is expected to be able to increase the number of new collection, including discovering new endemic bamboo species.

CONCLUSIONS

The number of species of bamboos in Bali island is similar to that throughout the Malesian region, and the island has six endemic bamboo species, indicating that Bali is one of the richest areas of bamboo in Indonesia. Until recently, Bali Botanic Garden has collected 52 species with 11 genera from mostly the Malesian region and the Eastern Asiatic region. These bamboo collections

are planted in a bamboo compartment with an area of two hectares. Bamboo has out-standing cultural values for Balinese people, and has a promising prospect to be developed into a large scale industry. With an increasing human population expanding its demands on bamboo resources, more approaches are required for conserving and managing bamboo resources. Scientific approaches have to be conducted toward a better understanding of the distribution and propagation techniques of bamboo. Establishing new botanic gardens should be strongly fostered to conserve more bamboo resources.

ACKNOWLEDGEMENTS

The author would like to express his gratitude to Ida Bagus Ketut Arinasa, former director of Bali Botanic Gardens, for sharing his valuable knowledge, and to Dr. Francois Salomone for his help in preparing the map.

REFERENCES

- ARINASA, I. B. K. & PENENG, I. N. 2013. *Jenis-jenis Bambu di Bali dan Potensinya*. LIPI Press, Jakarta.
- ARINASA, I. B. K. & SUJARWO, W. 2015. The diversity of endemic bamboo in Bali and conservation efforts. *Bamboo Journal* 29: 85–92.
- ASTUTI, I. P. & ARINASA, I. B. K. 2002. Traditional bamboo charcoal in Bali, Indonesia. *Bamboo Journal* 19: 53–59.
- BADAN PUSAT STATISTIK. 2015. *Bali Dalam Angka 2015*. Badan Pusat Statistik Press, Denpasar.
- DRANSFIELD, J. 1981. *The Biology of Asiatic rattans in relation to the rattan trade and conservation*. In: SYNGE, H. *The Biological Aspects of Rare Plant Conservation*. John Wiley & Sons Ltd., London. Pp. 179–186.
- DRANSFIELD, S. & WIDJAJA, E. A. 1995. *Plant Resources of South-East Asia 7: Bamboos*. Backhuys Publishers, Leiden.
- GIRMANSYAH, D., SANTIKA, Y., RETNOWATI, A., WARDANI, W., HAERIDA, I., WIDJAJA, E.A. & VAN BALGOOY, M.M.J. 2013. *Flora of Bali: An Annotated Checklist*. Yayasan Pustaka Obor, Jakarta.
- <http://www.kebunrayabali.com>. Accessed 16 June 2015.
- <http://www.bamboocentral.org>. Accessed 26 September 2015.
- <http://www.theplantlist.org>. Accessed 12 March 2018.
- LUGRAYASA, I. N, WARNATA, I. W. & ARINASA, I. B. K. 2009. *An Alphabetical List of Plant Species Cultivated in Eka Karya Bali Botanic Garden Catalogue*. LIPI Press, Jakarta.
- PRINGLE, R. 2004. *A Short History of Bali: Indonesia's Hindu Realm*. Allen and Unwin, Crows Nest.
- QING, Y., ZHU-BIAO, D., ZHENG-LIANG, W., KAI-HONG, H. E., QI-XIANG, S. & ZHENHUA, P. 2008. Bamboo resources, utilization and ex-situ conservation in Xishuangbanna, South-eastern China. *J. Forestry Res.* 19: 79–83.
- SHARMA, M. L. 1980. *Bamboos in the Asia-Pacific Region*. In: LESSARD, G. (Ed.). *Bamboo Research in Asia*. IDRC, Ottawa. Pp. 99–120.
- SIMMONDS, N. W. 1976. *Evolution of Crop Plants*. Longman Scientific & Technical, Essex.
- SODERSTROM, T. R. & CALDERON, C. E. 1979. A commentary on the bamboos. *Biotropica* 11: 161–172.
- SUJARWO, W. 2010a. Potential use of bamboo as medicine in Bali, Indonesia. *Magazine of the American Bamboo Society* 31(2): 10–12.
- SUJARWO, W. 2010b. Indigenous knowledge on *Gigantochloa hasskarliana* in Karangasem District, Bali, Indonesia. *Magazine of the American Bamboo Society* 31(3): 10–12.
- SUJARWO, W., ARINASA, I. B. K. & PENENG, I. N. 2010a. Inventarisasi jenis-jenis bambu yang berpotensi sebagai obat di Kabupaten Karangasem Bali. *Buletin Kebun Raya* 13(1): 28–34.
- SUJARWO, W., ARINASA, I. B. K. & PENENG, I. N. 2010b. Potensi bambu tali (*Gigantochloa apus* Schult & Kurz) sebagai obat di Bali. *Buletin Penelitian Tanaman Rempah dan Obat* 21: 129–137.
- SUJARWO, W. 2011. Penjor: One tool of Hindu religious ceremonies at Galungan feast in Bali. *Magazine of the American Bamboo Society* 32 (1): 6–7.
- SUJARWO, W. 2012. History and folklore in Bali. *Magazine of the American Bamboo Society* 33 (5): 9–11.
- SUJARWO, W., ARINASA, I. B. K. & PENENG, I. N. 2012. Inventory and conservation of bamboos with medicinal properties in Buleleng district in Bali Indonesia. *Bamboo Journal* 28: 47–55.
- SUJARWO, W., ARINASA, I. B. K., SALOMONE, F., CANEVA, G. & FATTORINI, S. 2014. Cultural erosion of Balinese indigenous knowledge of food and nutraceutical plants. *Economic Botany* 68: 426–437.
- SUJARWO, W. 2015a. How cheap to get bamboo shoots in traditional markets in Bali (Indonesia). *Magazine of the American Bamboo Society* 36 (2): 6–7.
- SUJARWO, W. 2015b. Do the bamboo forests create a new spring. *Magazine of the American Bamboo Society* 36(2): 7–8.
- SUJARWO, W. & CANEVA, G. 2015. Ethno-

- botanic study of cultivated plants in home gardens of traditional villages in Bali (Indonesia). *Human Ecology* 43: 769–778.
- SUJARWO, W. & CANEVA, G. 2016. Using quantitative indices to evaluate the cultural importance of food and nutraceutical plants: Comparative data from the Island of Bali (Indonesia). *Journal of Cultural Heritage* 18: 342–348.
- SUJARWO, W. 2016. Stand biomass and carbon storage of bamboo forest in Penglipuran traditional village, Bali (Indonesia). *Journal of Forestry Research* 27(4): 913–917.
- TAKHTAJAN, A. 1986. *The Floristic Region of the World*. University of California Press, California.
- TENGAH, I. G. P., ARKA, I. W., SRITAMIN, N. M., GOTAMA, I. B. K. & SIHOMBING, H. (1995). *Studi Tentang: Inventarisasi, Determinasi dan Cara Penggunaan Tanaman Obat pada "Lontar Usada" di Bali*. Puslitbang Farmasi Balitbang Kesehatan Departemen Kesehatan Republik Indonesia, Jakarta.
- WIDJAJA, E. A. 2001. *Identikit Jenis-jenis Bambu di Kepulauan Sunda Kecil*. LIPI Press, Jakarta.
- WIDJAJA, E. A., ASTUTI, I. P., ARINASA, I. B. K. & SUMANTERA, I. W. 2005. *Identikit Bambu di Bali*. LIPI Press, Jakarta.
- WONG, K. M. 2004. *Bamboo the Amazing Grass: A guide to the Diversity and Study of Bamboos in Southeast Asia*. IPGRI and University of Malaya, Kuala Lumpur.

INSTRUCTION TO AUTHORS

Scope. *Reinwardtia* is a scientific regular journal on plant taxonomy, plant ecology and ethnobotany published in June and December. Manuscript intended for a publication should be written in English.

Titles. Titles should be brief, informative and followed by author's name and mailing address in one-paragraphed.

Abstract. English abstract followed by Indonesian abstract of not more than 250 words. Keywords should be given below each abstract.

Manuscript. Manuscript is original paper and represent an article which has not been published in any other journal or proceedings. The manuscript of no more than 36 pages by using Times New Roman 11, MS Word for Windows of A4 with double spacing, submitted to the editor through <reinwardtia@mail.lipi.go.id>. New paragraph should be indented in by 5 characters. For the style of presentation, authors should follow the latest issue of *Reinwardtia* very closely. Author(s) should send the preferred running title of the article submitted. Every manuscript will be sent to two blind reviewers.

Identification key. Taxonomic identification key should be prepared using the aligned couplet type.

Nomenclature. Strict adherence to the International Code of Nomenclature is observed, so that taxonomic and nomenclatural novelties should be clearly shown. English description for new taxon proposed should be provided and the herbaria where the type specimens area deposited should be presented. Name of taxon in taxonomic treatment should be presented in the long form that is name of taxon, author's name, year of publication, abbreviated journal or book title, volume, number and page.

Map/line drawing illustration/photograph. Map, line drawing illustration, or photograph preferably should be prepared in landscape presentation to occupy two columns. Illustration must be submitted as original art accompanying, but separated from the manuscript. The illustration should be saved in JPG or GIF format at least 350 pixels. Legends or illustration must be submitted separately at the end of the manuscript.

References. Bibliography, list of literature cited or references follow the Harvard system as the following examples.

- Journal : KRAENZLIN, F. 1913. *Cyrtandraceae* novae Philippinenses I. *Philipp. J. Sci.* 8: 163–179.
MAYER, V., MOLLER, M., PERRET, M. & WEBER, A. 2003. Phylogenetic position and generic differentiation of *Epithemateae* (Gesneriaceae) inferred from plastid DNA sequence data. *American J. Bot.* 90: 321–329.
- Proceedings : TEMU, S. T. 1995. Peranan tumbuhan dan ternak dalam upacara adat “Djoka Dju” pada suku Lio, Ende, Flores, Nusa Tenggara Timur. In: NASUTION, E. (Ed.). *Prosiding Seminar dan Lokakarya Nasional Etnobotani II*. LIPI & Perpustakaan Nasional: 263–268. (In Indonesian).
SIMBOLON, H. & MIRMANTO, E. 2000. Checklist of plant species in the peat swamp forests of Central Kalimantan, Indonesia. In: IWAKUMA, T. *et al.* (Eds.) *Proceedings of the International Symposium on: Tropical Peatlands*. Pp.179 – 190.
- Book : RIDLEY, H. N. 1923. *Flora of the Malay Peninsula* 2. L. Reeve & Co. Ltd, London.
- Part of Book : BENTHAM, G. 1876. *Gesneriaceae*. In: BENTHAM, G. & HOOKER, J. D. *Genera Plantarum* 2. Lovell Reeve & Co., London. Pp. 990–1025.
- Thesis : BAIRD, L. 2002. *A Grammar of Kéo: An Austronesian language of East Nusantara*. Australian National University, Canberra. [PhD. Thesis].
- Website : <http://www.nationaalherbarium.nl/fmcollectors/k/KostermansAJGH.html>. (Accessed 15 February 2012).



Reinwardtia

Published by Herbarium Bogoriense, Botany Division, Research Center for Biology,
Indonesian Institute of Sciences

Address: Jln. Raya Jakarta-Bogor Km. 46 Cibinong 16911, P.O. Box 25 Cibinong

Telp. (+ 62) 21 8765066; Fax (+62) 21 8765062

Email: reinwardtia@mail.lipi.go.id

***REINWARDTIA* Author Agreement Form**

Title of article :

Name of Author(s) :

I/We hereby declare that:

- My/Our manuscript was based on my/our original work.
- It was not published or submitted to other journal for publication.
- I/we agree to publish my/our manuscript and the copyright of this article is owned by Reinwardtia.
- We have obtained written permission from copyright owners for any excerpts from copyrighted works that are included and have credited the sources in our article.

Author signature (s)

Date

Name

J. F. VELDKAMP. A revision of <i>Isachne</i> in Malesia 2: Sect. Albentes (Gramineae, Isachneae)	1
I PUTU GEDE P. DAMAYANTO. <i>Dinochloa malayana</i> S. Dransf. (Poaceae: Bambusoideae), a new record for Indonesia	35
EDY NASRIADI SAMBAS, CECEP KUSMANA, LILIK BUDI PRASETYO & TUKIRIN PARTOMIHARDJO. Vegetation analysis and population structure of plants at Mount Endut forested area, Gunung Halimun Salak National Park, Banten, Java, Indonesia	39
IAN M. TURNER. A new combination in <i>Pseuderanthemum</i> (Acanthaceae)	55
YENI RAHAYU, TATIK CHIKMAWATI & ELIZABETH A. WIDJAJA. Nomenclatural study of <i>Tetrastigma leucostaphylum</i> and <i>Tetrastigma rafflesiae</i> (Vitaceae): two common hosts of <i>Rafflesia</i> in Sumatra	59
WAWAN SUJARWO. Bamboo resources, cultural values, and <i>ex-situ</i> conservation in Bali, Indonesia	67
KHOON MENG WONG & RIDHA MAHYUNI. Flora of Singapore Precursors, 2. A new species and two new combinations in <i>Psydrax</i> (Rubiaceae: Vanguerieae) for West Malesia	77
ERRATUM REINWARDTIA Vol. 16(2), 2017	85

Reinwardtia is a LIPI accredited Journal (792/AU3/P2MI-LIPI/04/2016)

<http://e-journal.biologi.lipi.go.id/index.php/reinwardtia>

Herbarium Bogoriense
Botany Division
Research Center for Biology – Indonesian Institute of Sciences
Cibinong Science Center
Jln. Raya Jakarta – Bogor, Km 46
Cibinong 16911, P.O. Box 25 Cibinong
Indonesia