THE POLLEN MORPHOLOGY OF DRAGON'S BLOOD RATTANS (DAEMONOROPS SPP.) FROM SUMATRA

Revis Asra[1], UpikYelianti[2] & Joko Ridho Witono[3]
[1]Biology Department, Faculty of Science and Technology, Jambi University
Kampus Pinang Masak, Jalan Jambi-Muara Bulian KM. 15 Mendalo Darat,
Jambi, 36361 Indonesia
[2]Biology Department, Faculty of Education, Jambi University,
Kampus Pinang Masak, Jalan Jambi-Muara Bulian KM. 15 Mendalo Darat,
Jambi 36361, Indonesia
[3]Center for Plant Conservation Botanic Gardens, Indonesian Institute of Sciences (LIPI),
Jalan Ir. H.Juanda 13 Bogor 16003, Indonesia
Author for correspondence: revisasra@unja.ac.id

Revis Asra, UpikYelianti & Joko Ridho Witono. 2019. Morfologi Polen Rotan Darah Naga (*Daemonorops* spp.) dari Sumatra. *Floribunda* 6(2): 35–40. — Rotan darah naga (*Daemonorops* spp.) secara lokal dikenal sebagai jernang, adalah salah satu hasil hutan bukan kayu yang bernilai ekonomis dari Sumatra. Kelompok spesies ini menghasilkan resin merah pada permukaan buahnya dan merupakan salah satu sumber utama bahan baku dari obat-obatan dan pewarna. Karakteristik morfologi serbuk sari adalah salah satu hal yang penting dalam menentukan sistem penyerbukan spesies diesis seperti rotan darah naga. Tujuan dari penelitian ini adalah untuk menguji karakteristik serbuk sari dan hubungannya dengan sistem penyerbukan pada empat spesies rotan darah naga dari Sumatra, yaitu *Daemonorops* aff. *propinqua* Becc., *D. propinqua* Becc., *D. draconcella* Becc. dan *D. didymophylla* Becc. Serbuk sari rotan darah naga dikumpulkan dari hutan sekunder Jambi dan Taman Nasional Bukit Duabelas, kemudian disimpan dalam larutan FAA, diikuti dengan pengamatan menggunakan SEM (Scanning Electron Microscope). Serbuk sari *Daemonorops* aff. *propinqua* dan *D. propinqua* memiliki tipe apertura dan ex-ornamentasi yang tidak beraturan, sedangkan *D. draconcella* tipenya monocolpus dan *D. didymophylla* memiliki tipe tricolpus. Pollen dari *Daemonorops* aff. *propinqua* dan *D. propinqua* menunjukkan eksin yang tidak rata sedangkan *Daemonorops* lainnya memiliki eksin yang rata. Karakter permukaan serbuk sari yang halus pada *D. draconcella* dan *D. didymophylla* menunjukkan bahwa penyerbukan spesies berhubungan dengan angin, sedangkan butiran serbuk sari yang berlekuk-lekuk pada *Daemonorops* aff. *propinqua* dan *D. propinqua* berhubungan dengan penyerbukan oleh serangga.

Kata kunci: *Daemonorops*, penyerbukan, rotan darah naga, serbuk sari.

Revis Asra, UpikYelianti & Joko Ridho Witono. 2019. The Pollen Morphology of Dragon's Blood Rattans (*Daemonorops* spp.) from Sumatra. *Floribunda* 6(2): 35–40. — Dragon's blood rattans (*Daemonorops* spp.) or locally known as jernang, is one of the well anticipated and economically valuable non timber forest products from Sumatra. The species group produces a red resin on the fruit scale and is one of the main resources of some medicines and colouring. The characteristic of pollen morphology was one of important role in determining the pollination system of dioecious species such as dragon's blood rattans. The purpose of this study was to examine the pollen characteristic and its relation to the pollination system of four species of dragon's blood rattans from Sumatra, i.e. *Daemonorops* aff. *propinqua* Becc., *D. propinqua* Becc., *D. draconcella* Becc. and *D. didymophylla* Becc. Pollen of dragon's blood rattans were collected from the secondary forest of Jambi and Bukit Duabelas National Park, then stored in FAA solution, followed by observation using SEM (Scanning Electron Microscope). The pollen of *Daemonorops* aff. *propinqua* and *D. propinqua* have aperture and irregular ex-ornamentation type, while *D. draconcella* is monocolpus and *D. didymophylla* is tricolpus. The pollen of *Daemonorops* aff. *propinqua* and *D. propinqua* show uneven exines while the others *Daemonorops* have even exines. Characters of smooth pollen grainsin *D. draconcella* and *D. didymophylla* are indicated that those species associated with wind pollination, whereas sculptured pollen grains in *Daemonorops* aff. *propinqua* and *D. propinqua* are associated with insect pollination.

Keywords: *Daemonorops*, dragon's blood rattans, pollen, pollination.

Dragon's blood rattansis non timber forest products from Sumatra. All dragon's blood rattans are included in the genus *Daemonorops* section *Piptospatha*. People harvest the rattans for its stem, but the other uses are for producing the red resin on its fruit scale. The red resin from dragon's blood rattans is a famous traditional Chinese medicine (Shi *et al*. 2009). In Sumatra, red resin is well-known as the sap of *jernang* which could be used as natural dying (Cavallo *et al*. 2008; Rustiami *et al*. 2004) and medicines, such as diarrhea, anti-tumor, anti-virus, anti-microbial, dental medication and to stop bleeding (Purwanto *et al*. 2005; Gupta *et al.* 2008; Thomson 2007; Yetty *et al*. 2013; Waluyo & Pasaribu 2015).

Harvesting the red resin of dragon's blood rattans is one of the occupations by Suku Anak-Dalam, an indigenous people who live in Bukit Duabelas National Park, Jambi and also other indigenous ethnics, who live in the Bukit Tigapuluh National Park (BTNP) of Jambi and Riau such as Melayu Tua and Talang Mamak. In addition, local people around these areas are also harvesting young fruit in the peak seasons as part of their living (Asra *et al.* 2014a).

Rustiami *et al*. (2004) reported that the distribution of dragon's blood rattans is limited in Malaysia, Thailand, and western part of Indonesia (Sumatra, Borneo and West Java). Since their limited natural distribution, some species are endemic to certain regions. About six species of *Daemonorops* produce red resin in Sumatra, such as: *D. siberutensis*, *D. acehensis*, *D. brachystachys*, *D. draconcella*, *D. dransfieldii* and *D. draco*. Four species (*D. draco*, *D. maculata*, *D. propinqua*, and *D. draconcella*) were found in Jambi (Asra 2013).

Dragon's blood rattans are a dioecious plant, which male and female flower are found in separate individuals. Pollination in dioecious plants has likely failed since both plants flowering at different times. As a result, the plants produce less fruit compare to monoecious plant. Asra (2013) mentioned that there is a species of dragon's blood rattans that produce more fruits, i.e. *Daemonorops draco* and three species (*D. maculata*, *D. propinqua*, and *D. draconcella*) produce fewer fruits but able to produce more resin on its fruits scale. This condition creates chances to have inter-species outcrossing.

Several studies have been conducted to analyze the relationship between pollination system and ornamentation of pollen. To reach female organs, pollen requires either biotic or abiotic factors. The role of pollen surface is in the efficiency of interaction with pollination agent. (Lumaga *et al*. 2006; Osborn *et al*. 2001). According to Dransfield *et al*. (2008), Arecoid palm can be separated based on pollen shape, aperture type, and exine ornamentation.

No detailed information on the pollen morphology of dragon's blood rattans of Sumatra is available. Therefore, pollen grains of 4 species from Sumatran dragon's blood rattans were studied using Scanning Electron Microscope (SEM).

METHODS

Plant materials

The pollen of four species of dragon's blood rattans obtained from Bukit Duabelas National Park and secondary forest in Lamban Sigatal, Jambi (Figure 1 and Table 1).

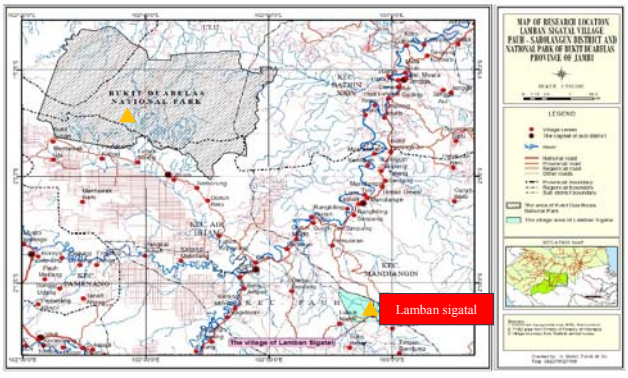


Figure 1: Map of study site

Table 1. Material used for pollen grains observation

No	Species	Sample (inflorescences)	Source
1	*Daemonorops* aff. *propinqua* Becc.	3	Secondary forest
2	*Daemonorops propinqua* Becc.	3	Secondary forest
3	*Daemonorops draconcella* Becc.	3	Secondary forest
4	*Daemonorops didymophylla* Becc.	3	Bukit Duabelas National Park

Methods

Pollen of dragon's blood rattans were collected, then stored in FAA solution, followed by observation using SEM (Scanning Electron Microscope) in SEM Laboratory, Department of Zoology, Indonesian Institute of Sciences, Cibinong.

Character of pollen morphology observed were pollen shape, pollen size, existence of aperture, number of apertures, presence of laesura, laesura shape, and ornamentation form. Determination of pollen form and size based on the ratio of Length of Equatorial Axis (LEA) and Length of Polar Axis (LPA). The characteristic of pollen morphology is determined by Erdtman (1963).

Pollen Morphological Observation

Sample preparation and photographic method of JEOL JSM 5310 LV Scanning Electron Microscope (SEM) based on Wang *et al*.(2004) method. Results of the best SEM images were taken and identified.

RESULTS AND DISCUSSION

Based on phylogenetic tree of subtribe *Calaminae* (*Daemonorops, Ceratolobus, Calamus, Pogonotium*, and *Retispatha*) (Dransfield *et al*. 2005), pollen morphology of those subtribe were: ellipsoidal or circular, apertura equator disulcate, exine tectate, reticulate verrucate, sometimes round excrescences (Dowe 2010). SEM results of *Daemonorops* shows ellipsoidal or circular pollen form.

Dioecious plants require conspecific and synchronized contribution of each event to achieve sexual reproduction. Successful pollination might happen when both male and female individuals flowering in the same time, with some quality of pollen, effective pollen transport and planting mechanism in the female organ. There are diverse pollen characteristic across Arecoideae such as in size, shape, aperture, and the form of exine. The main type of aperture is monosulcate (7 of 8 species monosulcate) but *Elaeisguineensis* has trichotomosulcate pollen (Harley & Dransfield 2003). The average length of pollen is 13–36 μm and the pollen width is 20–65 μm. The shapes of the pollen grains on elliptical polar appearances are not only symmetrical or asymmetrical but also round to triangular. Types of the exines are reticulate, perforate-rugulate, punctate, vermiculate and spinulose. However, the most common form is reticulate. Generally, most species have mottled or perforate or granulate ornamentation, and average thickness is 1.0–3.0 μm (Rasheed *et al*. 2016). The pollen morphology of subfamily Arecoideae corresponds to the observed type of *Daemonorops* pollen, both mostly in monosulcate and trichotomosulcate.

According to Halbritter *et al.* (2008), an oblate pollen grain has polar axis shorter than the equatorial, a prolate grain has polar axis longer than the equatorial and spheroidal axes, while apolar type has polar axis equal to the equatorial axis. The aperture type of the pollen can be classified on Sulcus (s), Colpus (c), Rugus (ru), and Porus (po) (Fahn 1982). The amount of aperture is expressed as mono, di, tri, tetra, penta, hexa and the remainder are called poly. These terms are used to describe pollen morphology of the four species of *Daemonorops* as shown in Table 2.

Table 2. Pollen morphology of four species of Dragon's Blood Rattans

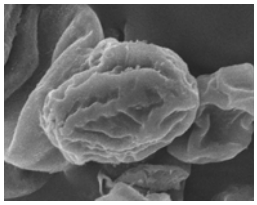
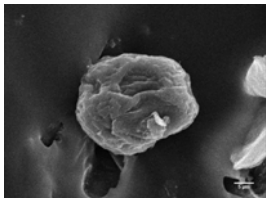
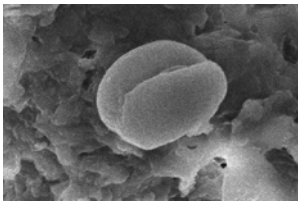
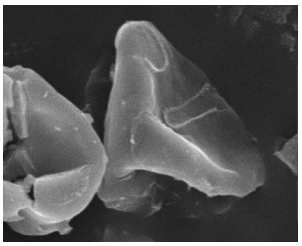
No	Pollen morphology	Pollen description
1.	 *Daemonorops* aff. *propinqua*	Pollen unit: single, sculptured, prolate. Pollen has aperture, uneven and irregular ex-ornamentation type.
2.	 *D. propinqua* Becc.	Pollen unit: single,prolat, sculptured. Pollen has aperture, uneven and irregular ex-ornamentation type.

Table 2. Pollen morphology of four species of Dragon's Blood Rattans (continued)

No	Pollen morphology	Pollen description
3.	 *D. draconcella* Becc.	Pollen unit: single, smoothprolat. Pollen has aperture, monocolpate, sulcus, long aperture on the distal surface, exin ornamentation type is even.
4.	 *D. didymophylla* Becc.	Pollen unit: single, smooth prolat. Pollen has aperture, trichotomocolpate, exine ornamentationtype is even, triangular shape in the polar parts, tectum is reticulate to vermiculate.

Pollen of *D. propinqua* has ornamentation type similar to pollen *D. melanochaetes.* Pollen looks triangular in the polar part as in *D. didymophylla* pollen. The morphology pollen of *D. draconcella*, almost the same with pollen of *D. draco*, where pollen shape is prolat with monocolpate aperture (Asra *et al*. 2014b). Pollen of *D. didymophylla* is trichotomocolpate, similar with *Elaeisguineensis* subfamily Arecoideae (Rasheed *et al*. 2016). Trichotomosulcate pollen is also found in some others Arecoid, such as *Pinanga*, *Bactris*, *Astrocaryum*, and *Acrocomia* (Thanikaimoni 1970; Sowunmi 1972; Ferguson 1986).

Sulcus structure of *D. draconcella* similar to *Chamaedoreamicrospadix* (*Arecaceae*), *Vrieseaneoglutinosa* (*Bromeliaceae*), and *Doryanthespalmeri* (*Agavaceae*) (Halbritter *et al*. 2008). In plants, there are wide variation of pollen morphology even within genus level. Rasheed *et al*. (2016) stated that at the species level, pollen data is not helpful because species representing the genus has mixed pollen.

Based on this study, the pollen of four species of dragon's blood rattans are in the form of single pollen. This result supported by Knox (1985), that almost all Angiospermae pollen are solitary and free, develop from a single microspore.

The pollen of *Daemonorops* aff. *propinqua* and *D. propinqua* (Table 2) show an unclear form of pollen. It was difficult to determine the size and type of pollen, due to different pollen maturity stages, environmental factors, or optical focus of the observation. According to Erdtman (1963), the shape, size or type of pollen can also vary according to stage maturity. According to Faegri & Iversen (1989), the existence of variations in size usually is based on geographical location. However, attempts to link the varying pollen sizes in determining the presence of environmental factors have not produced satisfactory results.

The relationships of pollen morphology and pollination

The ornamentation shape of Angiosperms pollen is related to the diversity of pollination system. This idea arises since the pollen grains require abiotic or biotic factor to arrive at the female flower. Pollen surface morphology plays important role in determining the interaction between the pollination agents or receiving region of female organ. Some research linking flat pollen ornamentation with abiotic (wind and water) pollination agents (Sannier *et al*. 2009). The number of pollen is also related to pollination agent. The pollen is greatly assisted by wind (Gojmerac 1983). Pollen log ratio is an indicator of plant pollination system. Based on the pollen ovule ratio, xenogami has been shown in *D. didymophylla* (Asra & Yelianti 2016), *Daemonorops* aff. *propinqua, D. propinqua*, and *D. draconcella* (Asra 2017). Successful pollination rate in xenogamy is greater than autogamy (Cruden 1977).

Many flowering plants and insects are interconnected in the reproductive cycle (Adnan 2016). About 30–80% of plant pollination is assisted by insects (bees) (Braga *et al*. 2012). In *D. draco*, the inflorescence visitor insects are species of the ge-

nus *Trigona*, such as *Trigona* (*Geniotrigona*) *thoracica*, *Trigona* (*Tetragonula*) *fuscobalteata*, and *Trigona* (*Tetragonula*) *drescheri* (Asra 2015). The colour of flowers strongly correlated with pollinator type. Pollinator insects attracted to yellow colour of anther and crown of *Daemonorops*. This fact indicates that some pollination in *Daemonorops* is also facilitate by insects. According to Singh (1990), the bright colour and beautiful flowers is one of the attractions for insects to visit.

Conclusions

The smooth pollen grains in *Daemonorops draconcella* and *D. didymophylla*are associated with abiotic pollination (wind), while sculptured pollen grains of *D.* aff. *propinqua* and *D. propinqua*are associated with biotic pollination (insects). The pollen morphology of *Daemonorops* aff. *propinqua* and *D. propinqua* have aperture and irregular ex-ornamentation type, while *D. draconcella* is monocolpus and of *D. didymophylla* is tricolpus.

ACKNOWLEDGEMENTS

The authors thank to the Ministry of Research, Technology and Higher Education who funded this research through the Fundamental Scheme. Appreciation also goes to the community in the village of Pematang Kabau and Lamban Sigatal, Sarolangun Jambi for their assistance as field guide and obtaining research samples.

REFERENCES

Adnan ME. 2016. Pollen Atlas for Some Saharian Species. Universite Kas di Merbah Ouargla. Algeria.

Asra R. 2013. Diversitas dragon's blood palms (*Daemonorops* spp.) di hutan sekunder. Prosiding Seminar Nasional Biodiversitas dan Ekologi Tropika Indonesia (BioETI). Universitas Andalas. Padang.

Asra R, Syamsuardi, Mansyurdin & JR Witono. 2014a. Genetic diversity of *Daemonorops draco* (Palmae) using ISSR markers. *Biodiversitas* 15(2): 109–114.

Asra R, Syamsuardi, Mansyurdin & JR Witono. 2014b. Karakteristik morfologi polen *Daemonorops draco* (Willd.) Blume. Prosiding Seminar Nasional Biodiversitas dan Ekologi Tropika Indonesia (BioETI). Universitas Andalas. Padang.

Asra R. 2015. Serangga pengunjung pada perbungaan jernang rambai (*Daemonorops draco* (Willd.) Blume). *Jurnal Penelitian Universitas Jambi Seri Sains* 17(2): 40–43.

Asra R & U Yelianti. 2016. Sistem Polinasi *Dragon's Blood Palms* berdasarkan morfologi perbungaan dan rasio polenovul. Prosiding Semirata 2016 Bidang MIPA BKS-PTN Wilayah Barat. Fakultas Matematika dan Ilmu Pengetahuan Alam. Universitas Sriwijaya. hal. 2447–2451.

Asra R. 2017. Study of the pollination system some species rattans jernang (*Daemonorops* spp.). Makalah Seminar Nasional Biologi – Biodiversitas dan Ekologi Tropika Indonesia ke-4 dan Konggres Penggalang Taksonomi-Tumbuhan Indonesia ke-12 (BioETI 4 dan PPTI XII). Departemen Biologi. Universitas Andalas. Padang.

Braga JA, ÉO Sales, JS Neto, MM Conde, OM Barth & MC Lorenzon. 2012. Floral sources to *Tetragonisca angustula* (Hymenoptera: Apidae) and their pollen morphology in a Southeastern Brazilian Atlantic Forest. *Revista de Biologia Tropical* 60(4): 1491–1501.

Cavallo P, MC Proto, C Patruno, A Del Sorbo & M Bifulco. 2008. Review Article: The first cosmetic treatise of history. A female point of view. *International Journal of Cosmetic Science* 30: 79–86.

Cruden RW. 1977. Pollen ovule ratios: a conservative indicator of breeding system in flowering plants. *Evolution* 31: 32–46.

Dowe JL. 2010. *Australian Palms Biogeography, Ecology and Systematics*. CSIRO Publishing. Australia.

Dransfield J, NW Uhl, CB Asmussen, WJ Baker, MM Harley & CE Lewis. 2005. A new phylogenetic classification of the palm family *Arecaceae*. *Kew Bulletin* 60: 559–569.

Dransfield J, NW Uhl, CB Asmussen, WJ Baker, MM Harley & CE Lewis. 2008. *Genera Palmarum: The Evolution and Classification of Palms*. Royal Botanic Gardens. Richmond, Kew.

Erdtman G. 1963. Palynology. *In*: RD Preston (ed.) *Advances in Botanical Research* 1:149–208.

Faegri K & J Iversen. 1989. *Text Book of Pollen Analysys 4th Ed. U*SA: John Wiley & Sons, Inc.

Fahn A. 1982. *Plant Anatomy. 3th Ed*. London: Pergamon Press Ltd.

Ferguson IK. 1986. Observations on the variation in pollen morphology of Palmae and its significance. *Canadian Journal of Botany* 64

(12): 3079–3090.

Gojmerac WL. 1983. *Bees, Beekeping, Honey and Pollination.* The Avi Publishing Company, Inc. Connecticut.

Gupta D, B Bleakley & RK Gupta. 2008. Dragons's blood: Botany, chemistry and therapeutic uses. *Journal of Ethnopharmacology* 115: 361–380.

Halbritter H, M Weber, R Zetter, AFrosch-Radivo, R Buchner & M Hesse. 2008. *PalDat-Illustrated Handbook on Pollen Terminology*. University of Vienna. Vienna.

Harley MM & J Dransfield. 2003. *Triporate pollen in The Arecaceae.* The Herbarium, Royal Botanic Gardens, Kew. Richmond.

Knox RB & SC Ducker. 1985. Pollen and pollination: A historical review. *Taxon* 34(2): 401–409.

Lumaga MR, S Cozzolino & A Kocyan. 2006. Exine micromorphology of Orchidinae (*Orchidoideae, Orchidaceae*): Phylogenetic constrainsts or ecological influences? *Annals of Botany* 98: 237–244.

Osborn JM, G El-Ghazaly & RL Cooper. 2001. Development of the exineless pollen wall in Callitrichetruncate (*Callitrichaceae*) and the evolution of underwater pollination. *Plant Systematics and Evolution* 228: 81–87.

Purwanto Y, R Polosokan, S Susiarti & BE Wahyu. 2005. Ekstraktivis mejernang (*Daemonorops* sp.) dan kemungkinan pengembangan: Studi kasus di Jambi, Sumatra, Indonesia. Valuasi Ekonomi Produksi Hutan Non Kayu (NTFPs): Laporan Teknik Bidang Botani, Pusat Penelitian Biologi-LIPI. hal. 401–415.

Rasheed AA, A Perveen, R Abid & M Qaiser. 2016. Pollen morphology of the subfamily Arecoideae Griff. (family *Arecaceae*) from Pakistan and Kashmir. *Pakistan Journal of Botany* 48(3): 1051–1060.

Rustiami H, FM Setyowati & K Kartawinata. 2004. Taxonomy and uses of *Daemonorops draco* (Willd.) Blume. *Journal of Tropical Ethnobiology* 1(2): 65–75.

Sannier J, WJ Baker, M-C Anstett & S Nadot. 2009. A comparative analysis of pollinator type and pollen ornamentation in the *Araceae* and the *Arecaeae*, two unrelated families of the monocots. *BMC Research Notes* 145: 1–11.

Shi J, R Hu, Y Lu, C Sun & T Wu. 2009. Single-step purification of dracohordin from dragon's blood resin of *Daemonorops draco* using high-speed counter-current chromatography combined with pH modulation. *Journal of Separation Science* 32: 4040–4047.

Singh S. 1990. *Beekeeping in India*. India Council of Agriculture Research. New Delhi.

Sowunmi MA. 1972. Pollen morphology in the Palmae with special reference to trends in aperture development. *Review Palaebotany Palynology* 7: 45–53.

Thanikaimoni G. 1970. Pollen morphology, classification and phylogeny of Palmae. *Adansonia II* 9: 347–365.

Thomson GE. 2007. *The Health Benefits of Traditional Chinese Plant Medicines: Weighing the Scientific Evidence*. Rural Industries Research and Development Corporation. Australian Government. Australia.

Waluyo TK & G Pasaribu. 2015. Aktivitas antijamur, anti bakteri dan penyembuhan luka ekstrak resin jenang. *Jurnal Penelitian Hasil Hutan* 33(4): 377–385.

Wang YQ, DX Zhang & ZY Chen. 2004. Pollen histo chemistry and pollen-ovule ratios in *Zingiberaceae*. *Annals of Botany* 94: 583–591.

Yetty, B Hariyadi & P Murni. 2013. Studi etnobotani jernang (*Daemonorops* spp.) pada masyarakat Desa Lamban Sigatal dan Sepintun Kecamatan Pauh Kabupaten Sarolangun Jambi. *Biospecies* 6(3): 38–44.