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**Short Communication**

# Seed and Germination Study of a New Guinea Endemic Plant Species *Grevillea papuana* Diels.

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**ABSTRACT**
*Grevillea papuana* is a culturally important endemic plant species of New Guinea highland. Although *G. papuana* conservation and propagation attempts were already conducted, this species seed and germination characters information were still very limited. This study aimed to provide information regarding *G. papuana* seed and germination biology. Seed characteristic and germination trials were conducted in this study. Data analysis was conducted descriptively, while germination parameters were also calculated. *G. papuana* has a light, elliptic, and winged seed. The species germination was low and ununiform with *phanerocotylar epigeal foliaceous* (PEF) seedling functional type.

**Keywords:** epigeal, phanerocotylar, germination, proteaceae

*Grevillea papuana* is a New Guinea endemic plant species that belong to the Proteaceae family (Makinson 2000; POWO 2019). This species is culturally essential for traditional construction, firewood, traditional medicine, and birth controller (Wiriadinata 1995; Priyono et al. 2002; Sukamto 2003; Arobaya & Pattiselanno 2007; Williams 2011; Jorim et al. 2012; Kuswantoro & Solihah 2017). *G. papuana* is also crucial for soil fertility as soil samples from the plant species dominated area produce a high *Rhizobium* population value (Purwaningsih 2005).

Ongoing harvesting for firewood and medical properties, low natural germination rate, and the absence of local community propagation attempt treat *G. papuana* wild population (Priyono et al. 2002; Sukamto 2003). Therefore, the plant species ex-situ conservation attempt is conducted in Bali and Cibodas Botanic Garden (Kuswantoro & Solihah, 2016). These two botanic gardens were chosen as they were situated in highland regions similar to *G. papuana* native distribution range in New Guinea highland. For example, Bali Botanic Garden is geographically situated in the Bedugul, a highland basin at an altitude of about 1200-1500 meters above sea level. However, this conservation attempt is still needed to be supported by propagation research (Priyono et al. 2002). *G. papuana* in-vitro and shoot cutting vegetative propagation research was already conducted by Sukamto (2003) and Kuswantoro and Solihah (2016), respectively. Generative

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propagation research of the species was also reported by Priyono et al. (2002) and Kuswantoro and Solihah (2016).

Despite all these researches, research on *G. papuana* seed and germination characteristics is still needed to be done as to the best of our knowledge, little report on *G. papuana* seed characteristic is present, while no record regarding this species seeding functional type was reported. This condition is unfortunate as seed and germination characteristics can provide information regarding plant species adaptation strategies that is valuable for the plant conservation effort (Kuswantoro & Oktavia 2019; Handayani 2019). Due to its importance, germination biology and seedling functional type of several plant species such as *Euchresta horsfieldii*, *Pinanga arinasae*, *Areca vestiaria, Artabotrys hexapetalus,* and some Annonaceae species were already studied in Bali and Bogor Botanic Garden (Lestari & Asih 2015; Handayani 2017; Kuswantoro & Oktavia 2019; Handayani 2019). Thus, this study aimed to describe seed morphology, germination type, and seedling functional type of *G. papuana*. We hope that this study will contribute to the plant species conservation effort by enhancing our understanding of its seed and germination biology.

The study was carried out in November 2019-March 2020 at Bali Botanic Garden Seed Bank Laboratory. Seeds were harvested from the only *G. papuana* plant cultivated in the garden. Of all thirty-six seeds collected during the harvesting period, twenty-five seeds were randomly selected for morphometric and weight measurement. Seed measurement parameters used in this study are the seed length (SL) and seed wide (SW), which defined as the measurement of the seed length and wide, as well as total seed length (TL) and total seed wide (TW), which defined as the measurement of the total seed area, including the seed wing. Measurement of *G. papuana* seed conducted in this study is illustrated in Figure 1.

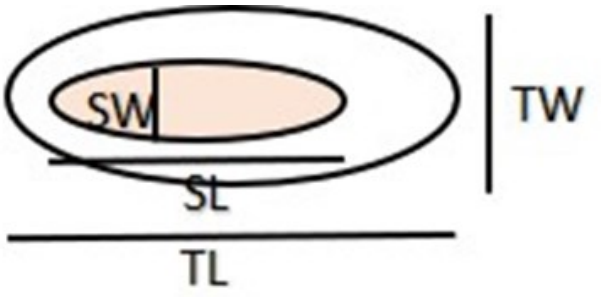


**Figure 1.** *Grevillea papuana* Seed Measurement

All thirty-six *G. papuana* seeds were then sown in a clear, closed plastic container with straw paper as the germination media. Before the sowing process, *t*he seeds, container, and straw papers were sterilized by dipping them into boiling water for about one and a half minutes. The seeds were then incubated at room temperature within the seed bank laboratory. The germination observation was carried out every day and terminated after 120 days after sowing.

Descriptive data analysis was conducted to describe *G. papuana* seed morphology, germination process, and seedling functional type. Moreover, calculation of the seed final germination percentage (FGP), the first day of germination (FDG), last day of germination (LDG), and time spread germination (TSG) values are also conducted. The calculation of germination parameters value is following Kader (2005) as follows:

$$FGP = \frac{\text{Total Number of Germinated Seed}}{\text{Total number of Sowed Seed}} \times 100\%$$

FDG = First day when germination occurred

LDG = Last day when germination occurred

TSG = time between first and last day of germination

Meanwhile, the seed germination type is defined following Tjitrosoepomo (2009), while the seedling functional type is defined according to Ibarra-Manríquez et al. (2001) and Pérez-Harguindeguy et al. (2016).

*Grevillea papuana* seeds are light, elliptic, and winged. *G. papuana* seed elliptic shape is based on its morphometric measurement result, which indicated that the seed averages total length value is about 1.87 times of the seed average total wide value (Table 1.). Meanwhile, the average seed weight value of *G. papuana* measured in this study which lighter than the seed weight of six *Grevillea* species studied by Auld and Denham (1999) highlight the seed lightness. *G. papuana* light seed is probably due to its small embryo and endosperm, reported by Priyono et al. (2002).

**Table 1**. *Grevillea papuana* Seed Characteristic Parameters Value

| Seed Character Parameters | Average Value |
|---|---|
| Total Length (TL) | 14.08 mm |
| Total Wide (TW) | 7.52 mm |
| Seed Length (SL) | 5.29 mm |
| Seed Wide (SW) | 3.39 mm |
| Seed Weight | 11.15 mg |

*Grevillea papuana* seed is surrounded by a thin wing (Figure 2). This discovery corresponds with Priyono et al. (2002), who also reports wing in *G. papuana* seed. As *G. papuana* native range is in New Guinea highland, the species light and winged seed are in correspondence with Makinson (2000), who stated that a light, flat and winged seed is a strong trend in tropical and South Western Australia *Grevillea* species. The presence of wing in *G. papuana* seeds suggests that the seed is wind-dispersed. Our suggestion that *G. papuana* seeds are wind-dispersed is also based on our observation during this study seed collection period, which found that *G. papuana* mature seed pods were open to allow wind mediated dispersal (Figure 2).

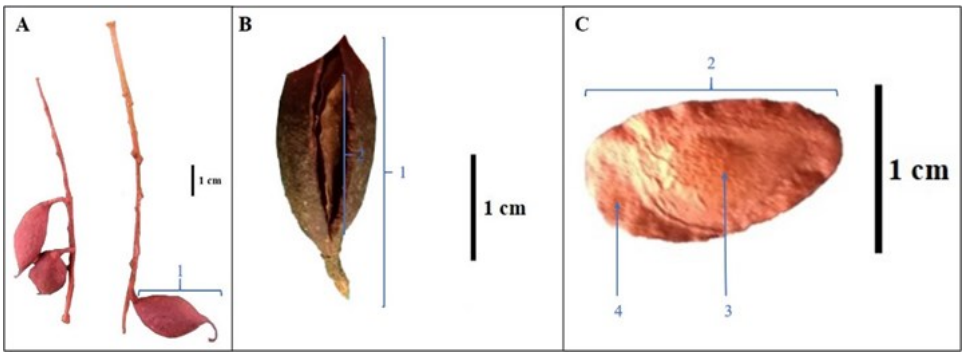


**Figure 2.** (A) *Grevillea papuana* Pods; (B) *Grevillea papuana* Open Pod Showing Seeds Ready to Disperse; (C) *Grevillea papuana* Seed. Remarks 1=Pod; 2= Whole Seed; 3=Seed; 4=Wing.

The result showed that *G. papuana* FGP value is 25%. Meanwhile, its FDG, LDG, and TSG values were 20, 117, and 97 days respectively (Table 2). FGP value indicates the seed germination rate, FDG, and LDG value indicates germination initiation and termination speed, while TSG value

indicates the time difference between fast and slow germination seed within the seed population (Kader 2005).

**Table 2**. *Grevillea papuana* Germination Parameter Value

| Parameter | Value |
|---|---|
| Final germination percentage (FGP) | 25% |
| First day of germination (FDG) | 20 days after sowing |
| Last day of germination (LDG) | 117 days after sowing |
| Time spread germination (TSG) | 97 days |

Several factors might cause *G. papuana* low FGP value acquired from this study. The presence of hard seed coat induced dormancy can be considered as one of the factors as Briggs et al. (2005) recorded that three types of seed coat induced dormancy potentially occurred in three *Grevillea* species. As seed anatomical study was not conducted in this study, we can not suggest that a hard seed coat is present in *G. papuana.* However, Priyono et al. (2002) reported that a hard seed coat does present in *G. papuana* seed. The presence of hard seed coats probably caused the low germination of *G. papuana* seed as research by Morris (2000), Morris et al. (2000), Baker et al. (2005), Guo et al. (2012), and Ma et al. (2015) stated that seed coat removal was able to increase *Grevillea* spp. germination rate.

Although a study by von Richter et al. (2001) suggested that fire-related cues were not required to produce a high germination rate in *G. kennedyana.* Studies by Morris (2000), Kenny (2000), Briggs and Morris (2008), and Guo et al. (2012), reported that fire-related cues such as smoke, temperature, and heat could improve the germination rate of some *Grevillea* species. Heat and smoke may also alleviate seed coat-induced dormancy in *G. juniperina* (Briggs et al. 2016). Thus, as there seems to be a various factor contributing to *Grevillea* low germination rate, further research needs to be conducted to understand the factor that contributes to the low FGP value of *G. papuana.*

*Grevillea papuana* FDG value acquired from this study is lower than *G. papuana* FDG value previously reported by Priyono et al. (2002) and Kuswantoro and Solihah (2016). *G. papuana* FDG value acquired from this study is comparable with the FDG value of another New Guinea highland plant species, *Pittosporum spicessens,* which was 19-21 days (Satyanti et al. 2015). Following the Annonaceae germination standard mentioned in Handayani (2019), based on its FDG value acquired from this study, *G. papuana* was grouped into fast germinated plant species. However, this study also reported a high TSG value in *G. papuana* germination, indicating low germination uniformity in its seed population. The low germination uniformity indicated low seed population quality, as Egli et al. (2010) suggested that germination uniformity is related to the seed population vigor.

Observation of *G. papuana* germination in this study revealed that the species seed germination is epigeal. At the same time, the species seedling functional type is *Phanerocotylar Epigeal Foliaceus* (PEF). According to Tjitrosoepomo (2009), epigeal germination is a type of germination in which, during the germination period, the cotyledon is elevated from the germination media. *Phanerocotylar* is defined by Ibarra-Manriquez et al. (2001) and Rifai (2004) as a condition in which the cotyledon is exposed during the germination period. Meanwhile, Ibarra-Manriquez et al. (2001) and Pérez-Harguindeguy et al. (2016) defined foliaceus as a condition in which the cotyledon shape and primary function are reassembling the shape and function of a leaf as a photosynthesis organ. The illustration of the *G. papuana* germination process observed during this study is presented in

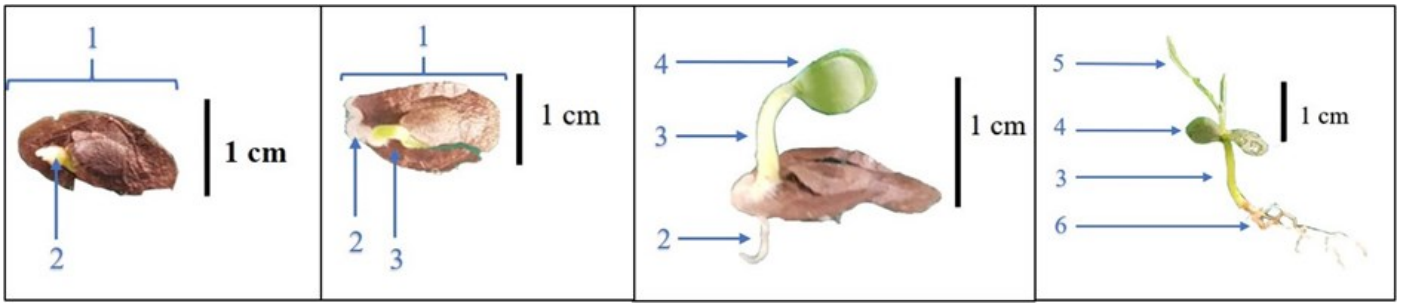


**Figure 3**. *Grevillea papuana* Germination Process. Remarks 1= Whole seed; 2= Radicle; 3= Hypocotyl; 4= Cotyledon; 5= Eophyll; 6= Roots.

Figure 3.

During this study, *G. papuana* cotyledon is observed as a pair of thin, leaf-like organs with green color. The thin and green cotyledon suggests that its primary function is as a photosynthetic organ. Satyanti et al. (2009) also supported this statement, suggested that *phanerocotylar* cotyledon is a photosynthetic cotyledon. These conditions supported our suggestion that *G. papuana* exhibit PEF seedling functional type.

Ibarra-Manriquez et al. (2001) report that PEF is the dominant seedling functional type in non-animal mediated seed dispersal plant species. The statement corresponded with this study result, which indicated that *G. papuana* has a wind-dispersed seed. *G. leucopteris* is another *Grevillea* species with a wind-dispersed seed (Lamont 1982). Ibarra-Manriquez et al. (2001) and Ressel et al. (2004) also stated that PEF is the dominant seedling functional type in pioneer species. PEF seedling functional type observed in this study suggests that *G. papuana* might also be a pioneer species. A study by Purwanto (2003) supports this suggestion, as they report *G. papuana* as one of the species that dominated secondary forest in Baliem Valley, Jayawijaya. This study finding further highlighted the seed biology study potency to provide information regarding plant species adaptation strategies, which important for the plant species conservation effort. In conclusion, this study record *G. papuana* light, elliptic and winged seed exhibited low and ununiform germination with epigeal germination type and *Phanerocotylar Epigeal Foliaceus* (PEF) seedling functional type.

## AUTHORS CONTRIBUTION

F.K. contributes to seed collection, conducting trials, data collection and analysis, and manuscript writing.

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## CONFLICT OF INTEREST

The author state that there is no conflict of interest regarding the research and the research funding.

## REFERENCES

Arobaya, A.Y.S & Pattiselanno, F., 2007. Jenis Tanaman Berguna Bagi Suku Dani di Lembah Baliem, Papua, *Biota: Jurnal Ilmiah Ilmu-Ilmu Hayati*, 12 (3), pp.192-195.

Auld, T.D. & Denham, A.J., 1999. The role of ants and mammals in dispersal and post-dispersal seed predation of the shrubs *Grevillea* (Proteaceae), *Plant Ecology*, 144(2), pp.201-213.

Baker, K.S. et al., 2005. Seed dormancy and germination responses of nine Australian fire ephemerals, *Plant and Soil*, 277(1-2), pp.345.

Briggs, C.L. & Morris, E.C., 2008. Seed-coat dormancy in *Grevillea linearifolia*: little change in permeability to an apoplastic tracer after treatment with smoke and heat, *Annals of Botany*, 101(5), pp.623-632.

Briggs, C.L. et al., 2005. Investigations into seed dormancy in *Grevillea linearifolia, G. buxifolia* and *G. sericea*: anatomy and histochemistry of the seed coat, *Annals of Botany*, 96(6), pp.965-980.

Briggs, C.L. et al., 2016. Micropylar seed coat restraint and embryonic response to heat shock and smoke control seed dormancy in *Grevillea juniperina, Seed Science Research*, 26(2), pp.111-123.

Egli, D.B. et al., 2010. Seed vigor and uniformity of seedling emergence in soybean, *Seed Technology*, pp.87-95.

Guo, J. et al., 2012. Seed Coat Removal Greatly Enhances *Grevillea* (Proteaceae) Seed Germination, *Acta Hortic.*, 937, pp.763-768

Handayani, T., 2017. Seed germination and seedling morphology of *Artabotrys hexapetalus, Nusantara Bioscience,* 9(1), pp.23-30.

Handayani, T., 2019. Perkecambahan Biji dan Tipe-Tipe Fungsional Semai Pada Jenis-Jenis Suku Annonaceae, *Buletin Kebun Raya*, 22(1), pp.1-12.

Ibarra-Manríquez, G. et al., 2001. Seedling Functional Types in a Lowland Rain Forest in Mexico, *American Journal of Botany*, 88(10), pp.1801−1812.

Jorim, R.Y. et al., 2012. An ethnobotanical survey of medicinal plants used in the eastern highlands of Papua New Guinea, *Journal of Ethnobiology and Ethnomedicine,* 8(1), pp.47.

Kader, M.A., 2005. A comparison of seed germination calculation formulae and the associated interpretation of resulting data, *Journal and Proceeding of the Royal Society of New South Wales*, 138, pp.65-75.

Kenny, B.J., 2000. Influence of multiple fire-related germination cues on three Sydney *Grevillea* (Proteaceae) species, *Austral Ecology*, 25(6), pp.664-669.

Kuswantoro, F. & Oktavia, G.A.E., 2019. Studi Tipe Perkecambahan Dan Pertumbuhan Anakan *Pinanga arinasae* Witono dan *Euchresta horsfieldii* (Lesch.) Benn. Untuk Mendukung Upaya Konservasinya, *Buletin Kebun Raya*, 22(2), pp.105-116.

Kuswantoro, F. & Solihah, S.M., 2016. Wiep (*Grevillea papuana* Diels): Tumbuhan Endemik New Guinea dan Upaya Konservasi Ex Situ di Kebun Raya Indonesia, *Warta Kebun Raya*, 14(1), pp.55-62

Kuswantoro, F. & Solihah, S.M., 2017. Jenis-Jenis Tumbuhan Bermanfaat Di Sekitar Lokasi Tapak Kebun Raya "Biologi" Wamena, Papua, *Warta Kebun Raya*, 15(2), pp.3-12.

Lamont, B., 1982. The reproductive biology of *Grevillea leucopteris* (Proteaceae), including reference to its glandular hairs and colonizing potential, *Flora*, 172(1), pp.1-20.

Lestari, D. & Asih, N.P.S., 2015. Perkecambahan Pinang Yaki (*Areca Vestiaria* Giseke) Di Kebun Raya Eka Karya Bali, *Prosiding Semnas Biodiversitas*, pp.87-90

Ma, X. et al., 2015. *Grevillea* (Proteaceae) seed coats contain inhibitors for seed germination, *Australian Journal of Botany*, 63(7), pp.566-571.

Makinson, R.O., 2000. *Introduction to Grevillea*. In Wilson, A.J.G. (ed.) *Flora of Australia* 17A, Proteaceae 2, *Grevillea*. Melbourne: ABRS/CSIRO Australia. ISBN 0 643 05969, pp.1-19.

Morris, E.C., 2000. Germination response of seven east Australian *Grevillea* species (Proteaceae) to smoke, heat exposure and scarification, *Australian Journal of Botany*, 48(2), pp.179-189.

Morris, E.C. et al., 2000. Seed coat dormancy in two species of *Grevillea* (Proteaceae), *Annals of Botany*, 86(4), pp.771-775.

Pérez-Harguindeguy, N. et al., 2016. Corrigendum to: New handbook for standardised measurement of plant functional traits worldwide, *Australian Journal of Botany*, 64, pp.715–716.

POWO 2019, 'Plants of the World Online', in Plants of the World online, viewed 28 October 2020, from http:// www.plantsoftheworldonline.org/.

Priyono, S-H. et al., 2002. Pengaruh Perendaman Air Kelapa Hijau Pada Pertumbuhan Biji *Grevillea papuana* Diels, *Prosiding Simposium Nasional II Tumbuhan obat dan Aromatik*. Kehati, LIPI. Apinmap, Unesco dan JICA, Bogor, 8-10 August 2001, pp.289-293.

Purwaningsih, S., 2005. The isolation, enumeration, and characterization of *Rhizobium* bacteria of the soil in Wamena Biological Garden, *Biodiversitas Journal of Biological Diversity*, 6(2), pp.82-84.

Purwanto, Y., 2003. Studi Etnoekologi Masyarakat Dani-Baliem dan Perubahan Lingkungan di Lembah Baliem, Jayawijaya, Irian Jaya, *Berita Biologi*, 6(5), pp.661-678.

Ressel, K. et al., 2004. Ecologia morfofuncional de plântulas de espécies arbóreas da Estação Ecológica do Panga, Uberlândia, Minas Gerais, *Brazilian Journal of Botany* 27(2), pp.311-323.

Rifai, M.A., 2004, Kamus Biologi, Cetakan ke-4, Balai Pustaka, Jakarta.

Satyanti, A. et al., 2009. Morphological Investigation on Cotyledons: Revealing Tribes Within Bignoniaceae, *Buletin Kebun Raya* 12(2), pp.55-60.

Satyanti, A. et al., 2015. Highland Species and Temperature Requirement for Germination: A Case from Two Endemic Papuan *Pittosporum* (Pittosporaceae) Species, *Buletin Kebun Raya*, 18(1), pp.15-22.

Sukamto, L.A., 2003. Perbanyakan Tanaman Wiep (*Grevillea Papuana*) Secara Kultur Jaringan, *Berita Biologi*, 6(5), pp.685-689.

Tjitrosoepomo, G., 2009. Morfologi Tumbuhan Cetakan ke-17. *Gadjah Mada University Press*, Yogyakarta, pp.247-250.

Von Richter, L. et al., 2001. Seed germination in the rare shrub *Grevillea kennedyana* (Proteaceae), *Cunninghamia*, 7(2), pp.205-212.

Williams, C.J., 2011, Medicinal Plants in Australia Vol. 2: Gums, Resins, Tannin and essential oils. 1 ed. *Rosenberg Publishing.* Australia, p.95

Wiriadinata, H., 1995. Ethnobotany of Economic Plants in The Baliem Valley, Jayawijaya, Irian Jaya, In Schneider, J. (ed.), *Indigenous Knowledge in Conservation of Crop Genetic Resources Proceeding of an International Workshop Held in Cisarua Bogor Indonesia. 30 January -3 February,* pp.87-97