



Systematics and Ethnobiology of Spineless Leaf Common Pandanus (*Pandanus tectorius* Parkinson Ex Du Roi; Pandanaceae) from Kelapan Island, Bangka and Belitung, Indonesia

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ABSTRACT

Pandanus tectorius Parkinson ex Du Roi forma *integifolius* S. Agustika, S. Santiago and A.P. Keim is a new forma described from Kelapan Island in the Bangka and Belitung Province, Indonesia. This new forma is identified through the distinctive morphological character of spineless leaf margin. These facts are important to be explained related to the unique morphological phenomenon recently discovered in a small population of *P. tectorius* found in one of the small islands around Bangka Island. The result showed that the phenomenon of spineless leaves in *P. tectorius* found in Kelapan Island is related with the absence of predator, especially frugivore that consume the fruit of the species. In other words, the complete absence of bats in Kelapan Island apparently triggers the individuals of *P. tectorius* in the island to stop developing the spines in the leaf margin in order to protect the fruits from predators. The people of Kelapan Island harvest the leaves of *P. tectorius* for making mats.

Keywords: Belitung, Kelapan, Pandanaceae, spineless leaf, Sumatera

INTRODUCTION

Pandanus tectorius is a species from the genus *Pandanus* (Pandanaceae) commonly found inhabit vast coastal areas from East Coast of Africa through India and the Flora Malesiana region (including Indonesia) to the Pacific and northern Australia (Stone, 1967a, 1982, 1993, 2008; Gallaher, 2013). The species can also be found naturally in the coastal areas of Taiwan, Ryukyu Archipelago, and as far north as Hong Kong (Stone, 1970, 1973; Kun and De Filips 1994). Those facts make *P. tectorius* as the widest spread species in the genus, even in Pandanaceae.

Pandanus tectorius is only absent in New Zealand (Moore and Edgar, 1970). The reason for this absence is still unclear to this day. The absence of the bats from the genus *Pterocarpus* in New Zealand has long been assumed as the cause of the absence. Bats from the genus *Pterocarpus* have been observed to pollinate the flowers and consume the phalanges of *P. tectorius* in some islands in the South Pacific, thus can also be treated as the pollinators and dispersal agents of *P. tectorius* (Cox, 1990; Cox et al., 1991). In Samoa, *Pterocarpus samoensis* has been observed consuming the phalange of *Pandanus tectorius*, whereas in the Marianas is *Pterocarpus mariannus* (Stinson et al., 1992; Wiles and Brooke, 2009). These facts are important to be mentioned here as they are apparently related to the unique morphological phenomenon recently discovered in a small population of *Pandanus tectorius* found in one of the small islands surrounding Bangka Island discussed later in this current paper.

The presence of *P. tectorius* in the Bangka Island was firstly reported and collected by Teysmann in 1857 from the vicinity of Muntok in the Northwestern part of the island (Teysmann, 1859a, 1859b, 1864a, 1864b). Followed by Kurz, who together with Teysmann visited Bangka in 1857, but Kurz remained in the island until the following year (1858), where he collected his specimen of *P. tectorius* in the village of Batu Rusa in the present day Merawang Sub-District in the north-eastern part of the island (Kurz, 1864, 1865a, 1865b; Warburg, 1900; Van Steenis, 1950).

Despite the fact that Teysmann had landed and explored the Kelapan Island (one of several small islands surrounding Bangka Island) during his short visit from 26th of November to 4th of December 1869 (Van Steenis, 1950), there has been no specimen of *pandan* collected. In other word, until recently the *pandan* flora of the adjacent islands of Bangka Island was completely unknown adding to the fact that the *pandan* flora of Bangka Island itself then was still generally unknown.

The most recent study of the *pandan* flora of Bangka Island is provided by one of us (S) in whom the presence of the genus *Freycinetia* has been firstly acknowledged, the occurrence of *Benstoneae piphytica* has been firstly recognized, and the enigma of the existence of *P. furcatus* in Bangka Island has been finally confirmed (Santiago, 2018).

The pandans of the small islands offshore of Bangka Island, including Kelapan Island have finally been observed and collected by one of us (Sela Agustika, SA) during her exploration to the island (Agustika, 2018). Sela Agustika noted a population of *P. tectorius* in Kelapan Island with spines is completely absent throughout the leaf margins. In other word, population of *P. tectorius* that possess integer leaves. Furthermore, we observed that this spineless *P. tectorius* is in cohabitant with the ordinary spine possessing leaf margin individuals of *P. tectorius*, although not in the same clusters, but very close enough to be treated as the same large population.

The existence of spineless *P. tectorius* had been firstly reported in West Java by Miquel (1885) and then published as *P. spurius* "Putat". Miquel added a note that this species can only been seen in cultivation. Warburg (1900) placed this species as a synonym of *P.*

tectorius and gave the infra-specific rank of variety, thus *P. tectorius* var. *laevis*. As Miquel, Warburg also mentioned that this spineless *P. tectorius* could only be seen in cultivation in Java. Thus, the variety had never been seen in the wild.

Hofstede (1925) supported both Miquel and Warburg with further notes that this taxon can only be seen in cultivation and the Sundanese and Javanese prefer harvesting the leaves from this variety; thus, the plantation of *P. tectorius* var. *laevis* did exist in the vicinity of Banten, especially near Ujung Kulon. Unfortunately, Rahayu *et al.* (2008) reported that in Ujung Kulon, Banten (Banten Province) the variety cannot be found anymore and the pandan leaves industry described by Hofstede (1925) in West Java was apparently closed prior to the Indonesian independence. Thus, at present the people are only harvesting the leaves from the spiny wild form of *P. tectorius*.

Stone (1967b) reported the existence of *Pandanus tectorius* var. *laevis* in Niue Island in the Pacific. This is the first report of the existence of the spineless *P. tectorius* from outside Java. Nevertheless, as in Java Stone also stated that this variety could be found only as a cultivar. Stone also mentioned *P. veitchii* and *P. verus* as the other cultivars found in the island. *Pandanus veitchii* itself is simply just a variegated form of *P. tectorius*; whereas, *P. verus* is a species described by Linnaeus (1743) and has been regarded as a synonym of *P. tectorius*.

In the same publication Stone (1967b) also mentioned the presence of formerly Tahitian endemic, *P. tahitensis* (Martelli, 1907) to be existed as well in Fiji and Tonga, with a new variety in Niue, *P. tahitensis* var. *niueana*. These two taxa and other varieties of *P. tahitensis* have now been placed as synonyms of *P. tectorius* (Welsh, 1998).

Several years later Stone (1975) reported that the spineless variety of *P. tectorius* can be found occasionally in Sri Lanka in cultivation. Stone did not mention about the existence of the variety in the wild. Then, Stone still placed *P. tectorius* var. *laevis* as the synonym of *P. tectorius*; thus, the infra-specific rank was sunken.

St. John (1979) reported the existence of sterile cultivated plants he described as *P. spurius* 'Putat' in Tahiti with spineless leaves (or unarmed in St. John's own note) in Tahiti Island. Apparently, St. John was unaware of the taxonomic state of *P. spurius* 'Putat', which had been previously placed into synonym of *P. tectorius* var. *laevis* by Warburg (1900). Dassanayake (1981), and Welsh (1998) have placed it as a synonym of *P. tectorius*; thus, the presence of a spineless form of *P. tectorius* in Tahiti Island has been confirmed.

Stone (1982) mentioned *P. tectorius* var. *laevis* again as a distinct taxon with spineless leaves found in islands adjacent to mainland New Guinea (Stone, 1982). Nevertheless, as in Java and Sri Lanka, the islanders also prefer this variety than the wild form. In other word, the statement can be interpreted that the taxon identified by Stone as *P. tectorius* var. *laevis* above is also a cultivar.

The spineless or nearly spineless variety in many Pacific islands such as Fiji, Hawaii, Niue, Samoa, Tonga, and Vanuatu with a string of cultivar names have been reported with notes that all of these taxa are found only in cultivations (Stone, 1967b; Thomson *et al.*, 2006; Rauch and Weissich, 2009). None of them bears any clear infra-specific ranks.

The existence of spineless *P. tectorius* in the wild have been confirmed in several places in coastal of mainland India, especially Odisha and Tropical East Africa (Panda *et al.*, 2007; Panda *et al.*, 2012). Due to their wild nature, they are best treated as mutants. Furthermore, those authors agreed on the difficulties in distinguishing the mutant with the cultivated *P. tectorius* var. *laevis*, thus suggested that the two taxa might have been the same taxon.

The same conclusion is shown in Sarille and Menguito (2007) that carried out molecular analysis on several selected "Pandanus" (i.e. *Pandanus tectorius*) taxa found in the

Philippines, including the spineless *P. tectorius*. The result of the analysis shows that Bootstrap analysis demonstrated that subgroups consisting of *P. tectorius*, *P. sanderi*, *P. amaryllifolius* ‘variegatus’, *P. tectorius* ‘veitchii’ and *P. tectorius* var. ‘laevis’ cv, *P. tectorius* var. ‘laevis’ were robust (100% confidence estimate). Results also demonstrated that *P. sanderi* and *P. amaryllifolius* ‘variegatus’ appeared to have identical RAPD DNA profiles in 22 primers.

This result can be interpreted that those taxa mentioned above are just morphological forms of *P. tectorius*. Indeed, based on their description, that *P. amaryllifolius* ‘variegatus’ is actually the variegated form of *P. tectorius* or previously known as *P. veitchii*. This explains the identical of *P. sanderi* and *P. amaryllifolius* ‘variegatus’ as they are both simply just synonyms of *P. tectorius*.

The previous researches show that apart from the possession of spineless leaves, there is no distinctive morphological character that can be implemented to distinguish the spineless cultivated *P. tectorius* var. *laevis* and the wild spiny *P. tectorius*. This current study is in accordance with those previous researches and noted that the spineless phenomenon is merely showing the morphological plasticity in *P. tectorius*. Nevertheless, none of the previous studies gave any formal taxonomical rank for the mutant.

During her study one of us (SA) found a small population of the spineless *P. tectorius* in Kelapan Island, one of several small islands adjacent to the southern part of Bangka Island. Although the presence of the spineless mutants of *P. tectorius* have been confirmed elsewhere previously, they have never been found cohabitant with the “ordinary” spine-possessing leaves *P. tectorius*. This study records for the first time the two taxa are found coexisting in relatively wild continuous populations, thus becomes the novelty of this study.

Furthermore, traditional fishermen that rarely harvested the leaves of *P. tectorius* mostly inhabit Kelapan Island. This can be interpreted that the spineless phenomenon in the mutant certainly is not somehow triggered by human interventions. In fact, it is proven that continuous harvesting of leaves never causes *P. tectorius* to lose its thorns as at least observed by Hofstede (1925), Stone (1976), and Rahayu *et al.*, (2020).

It is suggested here that it might have related to the absence of the predators that consume the cephalium of *P. tectorius*, especially bats from the genus *Pterocarpus*. In Samoa Island the species of bats that are proven to eat the phalanges of *P. tectorius* is *Pterocarpus samoensis*, while in the Marianna Islands are *Pterocarpus mariannus* (Stinson *et al.*, 1992; Wiles and Brooke, 2009). The absence of a bat, especially from the genus *Pterocarpus* on the Kelapan Island is considered here as a factor that triggers *P. tectorius* to drop the spines as apparently it is not necessary to defend itself with sharp thorns along the edges of the leaves, thus, the thorns are rudimentary. This is a very interesting hypothesis to test in the field further study is needed. As no formal taxonomical rank has ever been given for the mutant, it is proposed here as a new forma, *P. tectorius* Parkinson ex Du Roi forma *integifolius* S. Agustika, S. Santiago and A.P. Keim.

ENUMERATION OF THE NEW FORMA

Key to *Pandanus tectorius* in Kelapan Island

Leaf with spines throughout the margin *Pandanus tectorius* forma *tectorius*

Leaf without spines throughout the margin,

integer leaf *Pandanus tectorius* forma
integrifolius

Pandanus tectorius Parkinson ex Du Roi forma ***integrifolius*** S. Agustika, S. Santiago and A.P. Keim forma nov. — Figures 1 and 2.

Moderate to large solitary tree pandan; all morphological characters similar to *P. tectorius* forma *tectorius* except that individuals belong to this new forma possess leaves without spines on their margins. In other words, this new forma has integer leaves. — Type: Indonesia, Sumatera, Bangka Islands, Kelapan Island, 23 Mar. 2018, S. Agustika 6 (Herbarium of the Bangka Belitung University).



Figure 1. *Pandanus tectorius* Parkinson ex Du Roi forma *integrifolius* S. Agustika, S. Santiago and A.P. Keim found in Kelapan Island showing the habit with spineless leaves (left) and light whitish brown trunk with nodules (right) [Agustika, 2018]

Distribution: Endemic.

Habitat: Coastal area with fairly sandy beach.

Etymology: The epithet refers to the spineless leaf margin.

Vernacular name: Pandan (Malay).

Uses: Leaves are used for mats. In Kelapan Island the leaves are rarely harvested.

Notes: It is regarded interesting here to study the DNA of the other previously known spineless mutants dispersed from East Africa to Pacific. There is a possibility that the result of the analysis might resurrect to the former rank of variety, thus *P. tectorius* var. *laevis* but this time with more solid supporting evidence that the variety do exist naturally in the wild. Until the result of that DNA analysis becomes available, the taxon from Kelapan Island discussed here is proposed as a new forma, *P. tectorius* forma *integrifolius*.



Figure 2. The type of *Pandanus tectorius* Parkinson ex Du Roi forma *integrifolius* S. Agustika, S. Santiago and A.P. Keim. (S. Agustika 6 kept at the Herbarium of Bangka Belitung University) showing the habit and the distinctive spineless leaves [Agustika 2018]

Ethnobiology

Prior to this current study, there has been very little information on the ethnobiology of pandans from Belitung Island and they are usually in relation with the studies proceeded in the neighboring island, Bangka (Nuraini, 2015; Gustria, 2017). The studies by Agustika (2018) and Santiago (2018) are the most recent studies on the *pandan* flora specifically conducted in Belitung and its adjacent small islands, where commonly harvested species are *Freycinetia sumatrana*, *Benstonea atrocarpa*, *Pandanus amaryllifolius*, and *P. lais* (Agustika, 2018; Santiago, 2018).

The surprising result is that *P. tectorius* is less harvested and used by the people in Belitung Island despite the widely usages of the species throughout the Indian and Pacific Oceans. The people in Belitung prefer the leaves of *B. atrocarpa* and *P. lais* as the source materials for many kinds of their daily usages, from mats up to hats. The reason for this less frequent usage of the species by the people in Belitung Island is apparently due to the texture and durability of the leaves and the fact that the two species are relatively easier to harvest and prepare. On the contrary, *P. tectorius* particularly, this spineless leaf forma is harvested more by the people of the Kelapan Island as this species is the only species occurs in the island (Agustika, 2018).



Figure 3. Samoan bat (*Pterocarpus samoensis*) is eating the phalange of *Pandanus tectorius* [Stinson et al., 1992, used here with permission]

The result of this current study suggests that the phenomenon of spineless leaves in *P. tectorius* found in Kelapan Island is related with the absence of predator, especially frugivore that consume the fruit (i.e. phalange) of the species. Bats are reported as one of the frugivores of *P. tectorius* (Cox, 1990). Some species, especially from the genus *Pterocarpus* are known to consume the fruit (i.e. phalanges) of *P. tectorius* such as *Pterocarpus samoensis* (Figure 3) in Samoa Island and *Pterocarpus mariannus* in Marianna Islands (Stinson et al., 1992; Wiles and Brooke, 2009).

In other words, the complete absence of bats in Kelapan Island apparently triggers the individuals of *P. tectorius* in the island to stop developing the spines in the leaf margin in order to protect the fruits (i.e. cephalia) from predators. This is in accordance with the report by the people of Kalapan Island that bats are not found in the island.

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Journal of Tropical Ethnobiology

VOLUME III

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CONTENTS

Consumption and Trade of Asian Water Monitor, *Varanus salvator* as Reliance on Wildlife for Livelihoods among Rural Communities in North Sumatra, Indonesia

Evy ARIDA, Arief HIDAYAT, MULYADI, Noor L. MAIREDA, Dadang R. SUBASLI, and MUMPUNI 81-92

Etnobiologi, Etnoekologi, dan Etnoarkeologi Karawang: Sebuah Kajian Komprehensif

Ary P. KEIM, Sahat M. PANGGABEAN, Tukul R. ADI, Nurul ISTIQOMAH, Fauzi AKBAR, Lady H. RAHMA, Cellica NURRACHADIANA, I N. LUGRAYASA, Nissa ARIFA, and Wawan SUJARWO 93-123

Systematics and Ethnobiology of Spineless Leaf Common Pandanus (*Pandanus tectorius* Parkinson Ex Du Roi; Pandanaceae) from Kelapan Island, Bangka and Belitung, Indonesia

Sela AGUSTIKA, SANTIAGO, Eddy NURTJAHYA, Ary P. KEIM, Nissa ARIFA, Muhamad NIKMATULLAH, Ida F. HASANAH, and Wawan SUJARWO 124-132

Dorsal Colour Patterns of Asian Water Monitor, *Varanus salvator* Collected for Trade in Cirebon, Indonesia

Elika BOSCHA, Evy ARIDA, and Donan S. YUDHA 133-138

Kajian Etnobotani Pakundalang (*Blumea balsamifera* (L.) DC.) sebagai Solusi Alternatif untuk Kemandirian Kesehatan Masyarakat Banggai Kepulauan, Sulawesi Tengah

WARDAH, and Emma S. KUNCARI 139-148

Cultural Significance Analysis to Support the Valuation of Non Timber Forest Products of the Malay Community in Tanjung Jabung, Jambi, Sumatra

Esti MUNAWAROH, Yupi ISNAINI, Purity S. AJININGRUM, Siti SUSIARTI, and Y. PURWANTO 149-174