

FLOWERING PLANTS OF BANGKA ISLAND: NATIVE AND INTRODUCED

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(Received: 29 December 2024; Accepted: 30 April 2025)

A study of seven different habitats was carried out to update the flowering plant diversity in Bangka Island, Indonesia, over 150 years. Data on native, introduced, and endemic species and their uses is an important database for conservation management and bioprospecting facing the post-tin-mining era. Voucher-based data were collected from transects and plots in 139 villages in the last nineteen years and enriched with secondary publications. The island supports 1,524 taxa from 32 families, 184 genera, 353 species, and 5 infraspecific taxa of Liliopsida plants, and 124 families, 524 genera, 1,114 species, and 52 infraspecific taxa of Magnoliopsida plants of terrestrial, aquatic, mangrove, coastal, and tin spoils in the island. As many as 594 species (39%) grow in lowland habitats and are mostly native, and 14 species are critically endangered. A quarter of the flora is naturalised species for their timber, fruit, flower, and revegetating tin spoils. A total of 366 native and naturalised taxa from 91 families are reported for their uses as ornamental plants, medicine, staple food, edible fruits, vegetables, spices, furniture, construction, etc., for which leaves are mostly used. While not all of Kurz's 1864 list was recorded, this study documented an increase of 637 species (71%) to that list. The intensive and extensive exploration and re-identification of the unidentified specimens might reveal more species to add to the current list. Evaluating exotic species in the wild and bioprospecting become two of the main priorities for future conservation management and economics especially in the post-tin mining era.

Key words: Bangka, conservation, endemic, Magnoliophyta, native, naturalised, tropical rain forest, uses

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INTRODUCTION

Bangka Island, with a land area of 11,700 square kilometres, is found off the eastern coast of southern Sumatra Island, lying between 1° 20'–3° 7' S and 105°–107° E, and is the largest island in the Indonesian Province of Bangka Belitung Islands. The highest point on the island is Mount Boei (710 m a.s.l.) and Mount Maras National Park (692 m a.s.l.), but the island is mainly low-land below 50 m, with some hills between 400 and 700 m. Often called tin island, Bangka Island is in the Sundaland region (Ko 1986) and is located in the SE Asia tin belt and has an Af-type Köppen Geiger climate classification (PT Timah Tbk. 1997), with an average daily temperature of 23–32 °C, average humidity of 62%, and an average annual rainfall of approximately 2,400 mm. The climate is influenced by monsoon activity. The highest rainfall of *ca* 400–500 mm takes place in December and January, and the lowest is *ca* 100–150 mm during the peak of the dry season in August and September (Nurhuda *et al.* 2016). The soils consist of several soil types (Soil Survey Staff 2014), and Hapludox type is the dominant one. The island is in one of three Indonesia's bioregions together with Sumatra, Indonesian Borneo, and Java (Trethowan *et al.* 2024).

The Bangka and Belitung islands are reported as the only places where extensive areas of heath forest and padang vegetation can be found in western Indonesia (Sumatra and Bangka) (Whitten *et al.* 2000). The islands, which are called tin islands (Barber *et al.* 2005), are in the Riau Pocket, one of the four phytogeographical provinces in Peninsular Malaysia (Kiew and Saw 2019) and have a specific flora (Corner 1958, Laumonier 1997). The most common species of the Riau Pocket flora are: (a) in the canopy: *Dipterocarpus lowii* Hook. f., *Dryobalanops oblongifolia* Dyer, *Richetia gibbosa* (Brandis) P. S. Ashton et J. Heck., *Richetia peltata* (Symington) P. S. Ashton et J. Heck., *Shorea lumutensis* Symington (Dipterocarpaceae), *Castanopsis johorensis* Soepadmo, *Lithocarpus bancanus* (Scheff.) Rehder (Fagaceae), (b) in lower stories: *Drepananthus ramuliflorus* Maingay ex Hook. f. et Thomson, *Goniothalamus malayanus* Hook. f. et Thomson (Annonaceae), *Dacryodes macrocarpa* (King) H. J. Lam (Burseraceae), *Calophyllum flavoramulum* M. R. Hend. et Wyatt-Sm. (Calophyllaceae), *Lophopetalum pachyphyllum* King (Celastraceae), *Ctenolophon parvifolius* Oliv. (Ctenolophonaceae), *Dillenia albiflos* (Ridl.) Hoogland (Dilleniaceae) (Laumonier 1997).

Botanical surveys were conducted by several botanists. Teijsmann was one of the first Dutch botanists to explore Bangka Island (Teijsmann 1859). During his stay on the island in 1857, he collected at least 284 species from 190 genera and 70 families (Kurz 1864, Scheffer 1870, 1873). Teijsmann started his expedition from Muntok in the northwest and went down to Toboali in the south and crossed Lepar Island in the south. His collections were written

up and cited in Kurz (1864) and Scheffer (1870, 1873). Berkhout also explored some sites in Bangka during his visit in August 1886 (Steenis-Kruseman 1950). The work of Kostermans with his colleague Anta in 1949–1950 was mostly undertaken on Mount Maras, Mount Mangkol (398 m a.s.l.), and on the east coast of central Bangka. There are several scientists who contributed to herbarium collections from Bangka, notably Horsfield in the 1800s, Buddingh in the 1850s, Akkeringa in the 1850s, and Grashoff in 1914.

Changes in land use, such as settlement, plantations, tin mining, and other anthropogenic activities, and also human population growth, affect the landscape and biodiversity. The population of Bangka Island was 24,628 people in 1829, became 168,217 in 1920 (Sujitno 2007a), and is 1,177,800 in 2022 (BPS Kepulauan Bangka Belitung 2023). Tree cover loss of Bangka Island during the years 2000–2020 is 817,684 ha (68.8%) (<https://gfw.global/3E0Awff>). Some native species are in danger, but introduced species, including some ornamental species, are intentionally brought in. What is the updated status of the native, introduced, and endemic species, particularly the seed plants now? The current study is important as a database for conservation management and also for bioprospecting in the post-tin-mining era. Voucher-based data enriched with secondary publications in the last nineteen years is then compared with Kurz's 1864 list to update the flowering plants in a 150-year gap. This research aims to update the flowering plant diversity of Bangka Island, Indonesia, in over 150 years. It provides important data for conservation management and bioprospecting, focusing on native, introduced, and endemic species.

MATERIAL AND METHODS

Study sites

Bangka Island has seven major habitats: lowland forest, swamp, mangrove, coastal, heath forest, padang vegetation, and ex-tin-mined land (Figs 1–7).

Each habitat has key families (Table 1): in lowland forest, the dominant trees are Clusiaceae; heath forest (kerangas) and padang vegetation are dominated by Myrtaceae; mangrove is characterised by members of Rhizophoraceae; coastal vegetation comprises Convolvulaceae, Lamiaceae, and Pandanaceae. Swamp vegetation is easily recognised by the dominant taxon *Melaleuca leucadendra* (L.) L. (Myrtaceae), and natural regeneration on ex-tin-mined land is dominated by sedges and grasses, Theaceae as shrubs, and the absence of local trees. Contrary to Laumonier (1997), thickets of *Baeckea frutescens* (sapi-sapu) (Myrtaceae) are not observed at altitudes of 450–800 m a.s.l., but in a nearly coastal area, and most are found in the eastern part of the island.

A quantitative and qualitative ecological study of seven different habitats (i.e., lowland forest, swamp forest, coastal forest, mangrove forest, padang vegetation, heath forest, and ex-tin-mined land) was carried out in 139 villages in four regencies, Main Bangka, Central Bangka, South Bangka, West Bangka, and the municipality Pangkalpinang (Table 2). The study includes Bangka mainland, as well as two small inhabited islands, Lepar and Pongok, and four islets, i.e., Nangka (inhabited), Mengkubung (uninhabited), Semumbung (uninhabited), and Panjang (uninhabited). Most of the vouchers (99.2%) were collected in Bangka Island, where Bangka (main) regency is the highest (40.6%) (Table 2). The voucher-based sites are overlaid in the WWF ecoregion map and are shown in Figure 8. There are 77 sites in the heath forest area (white colour background) and 58 sites in the lowland rainforest area (red colour background).

Data collection and identification

A total of 17 species-area curves of 8 m × 8 m to 128 m × 192 m with an area varying from 0.0064–1.2 ha each, 45 line transects (80–39, 175 m) of approximately 99.6 km with the width of 10 m to the left and 10 m to the right, and 1,477 quadrat plots (1–900 m²) with a total area of 48.5 ha were the area vouchered specimens at all growth stadia collected. Data from 97 non-vouchered resources, i.e., 17 journal articles, 1 book, 53 undergraduate theses, 4 master theses, and 22 field reports, were added (for further details see the Digital Supplement).

A total of 1,890 voucher specimens deposited in Herbarium Bangka Belitungense (HBB) in Universitas Bangka Belitung was gathered during the last nineteen years from various sites across the island at undisturbed forests, cultivated areas, padang vegetation, ex-tin-mined sites, and some offshore sites. Most of the specimens were identified at Herbarium Bogoriense (BO), BRIN, Indonesia, and a few with Universitas Andalas, Indonesia (ANDA). Scientific names were then checked with Plants of The World Online (<https://powo.science.kew.org/>). As many as 552 specimens (21.7%) remained unidentified at the species level. Additionally, the Global Biodiversity Information Facility–GBIF (<https://doi.org/10.15468/dl.ag9awm>) species occurrences for Bangka were added to the dataset. Unfortunately, another 428 voucher specimens, some collections from 2004, 2007–2011, went missing during the transfer from the old campus in Sungailiat to the current campus in Balunijuk, Merawang, in 2011.

Present-day species and infra-species are compared with those of Kurz (1864) to see the differences in the seed plant in a 150-year gap. Names of species and families in Kurz's list are then checked with Plants of The World Online. Plant uses by people of Bangka Island were based on research of the authors and secondary data from 26 publications, which consist of 10 journal

articles, 12 undergraduate theses, and 4 books on herbal medicine (for further details see the Digital Supplement).

RESULTS

Species richness

Bangka Island supports 1,524 taxa belonging to 156 families and 706 genera (Digital Supplement) from 32 families, 184 genera, 353 species, and 5 infraspecific taxa of Liliopsida plants (Table 3), and from 124 families, 524 genera, 1,113 species, and 53 infraspecific taxa of dicotyledonous plants (Table 4) from terrestrial, aquatic, mangrove, coastal, and ex-tin-mined areas. Most of the species recorded fall into the lowland rain habitat, with 1,265 taxa (83.0%), mangrove and marine with 26 taxa (1.7%), peat swamp forests with 23 taxa (1.5%), heat forests with 1 (0.1%), freshwater forests with 6 taxa (0.4%), coastal with 10 taxa (0.7%), and 193 taxa (12.7%) are found in two or three habitats. As many as 594 species (39%) are in the IUCN Red List (<https://www.iucnredlist.org/>), of which 0.9% are critically endangered (CR), 1.2% endangered (EN), 1.3% vulnerable (VU), 2% near threatened (NT), 32.2% the least concern (LC), and 1.4% data deficient (DD). Of those species, almost 47% are trees, 12% are shrubs, 21% are herbs, and 11.5% are climbers; grass and sedge are *ca* 7%, and palm and aquatic are *ca* 1% each; *ca* 95% are found in the lowland, and almost 75% are native. Over a quarter of the flora, 387 taxa (25.4%), can be considered as introduced or naturalised species. There are six endemic species recorded in this study: *Dehaasia teijsmannii* Kosterm. (Lauraceae), *Dendrobium subpan-difolium* J. J. Sm. (Orchidaceae), *Syzygium robustum* Miq., *Syzygium variifolium* Miq. (Myrtaceae), *Pandanus lais* Kurz (Pandanaceae), and *Podochilus bancanus* J. J. Sm. (Orchidaceae).

Table 1
Key flowering plant families of Bangka island

Habitat	Key families		
	seedling / ground vegetation	sapling / shrub	pole / tree
Lowland forest	Rubiaceae	Melastomataceae	Clusiaceae
Kerangas	Cyperaceae	Nepenthaceae	Myrtaceae
Padang vegetation	Myrtaceae	Myrtaceae	Myrtaceae
Beach	Convolvulaceae	Pandanaceae	Lamiaceae
Mangrove	Rhizophoraceae		Rhizophoraceae
Swamp	Cyperaceae	Myrtaceae	Myrtaceae
Ex-tin-mined (natural regeneration)	Poaceae, Cyperaceae	Theaceae	–

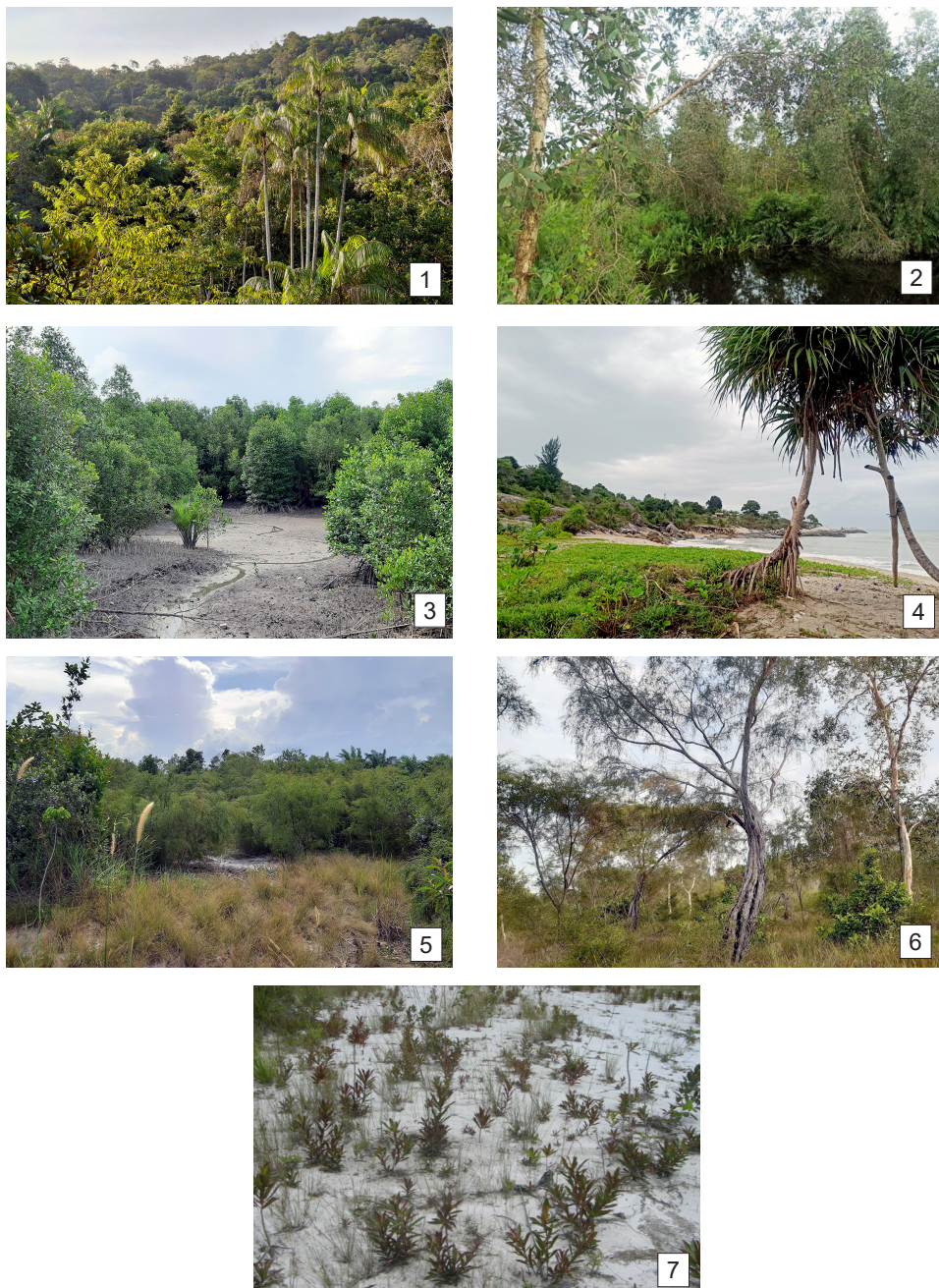


Fig. 1–7. Bangka island habitats: 1 = lowland forest, 2 = swamp forest, 3 = mangrove forest, 4 = beach forest, 5 = heath forest, 6 = padang vegetation, 7 = ex tin-mined land. Photo credits: 1, 3, 5, 7 – E. Nurtjahya; 2, 4 – Y. Lestari; 6 – H. Hermiati

Table 2
Location studied

Islands / islets	Inhabitancy	Area (km ²)	Regency and municipality	Number of village	Identified vouchers (%)
Bangka	+	(11,623.54)		(135)	(99.2)
		2,950.68	Bangka (main)	38	40.6
		2,155.77	Central Bangka	29	12.4
		3,607.08	South Bangka	40	21.5
		2,820.61	West Bangka	26	23.7
		89.40	Pangkalpinang	2	0.9
Nangka	+	3.07	Central Bangka	1	0.3
Panjang		1.16	Central Bangka	0	0.1
Lepar	+	169,313.00	South Bangka	2	0.1
Pongok	+	48.14	South Bangka	1	0.1
Mengkubung		0.098	West Bangka	0	0.2
Semumbung		0.055	West Bangka	0	0.2

+ denotes inhabited

Kurz's work

Kurz's paper (1864), Short sketch of vegetation of Bangka Island, consists of his own observation during his stay on the island in 1857 and 1858, the work of F. A. W. Miquel, J. E. Teijsmann, Th. Horsfield, and J. J. Lindgreen. It presented 732 species of 124 families of Dicotyledons, 6 species of 3 families of Gymnospermae, and 221 species of 32 families of Monocotyledons. By comparing families, genera, species, and infraspecific taxa of the seed plants recorded in this study to those by Kurz, 403 taxa of monocotyledonous and dicotyledonous plants (from 104 families and 302 genera) are shared between Kurz and this study (Table 5). An additional 1,121 taxa from this study are recorded, which consist of 833 native taxa and 288 non-native taxa (52 families and 404 genera). By contrast, there are 484 taxa of monocotyledonous and dicotyledonous plants (40 families, 262 genera, 232 native and infra-species, and 252 non-native and infra-species) reported by Kurz in 1864 but are not recorded in this study.

Plant uses

The uses of 366 taxa of 91 families of 1,524 taxa are recorded. As many as 194 taxa are used as medicine; 61% of the leaves are used for this purpose. 105

taxa have edible parts, and fruit outnumbers the other parts of the plants, like shoots (stem, wood, or cane), root, bark, sap, flowers, and bulbs. The uses are various; there are ornamental plants, plants for medicine, staple food, edible (wild) fruits, vegetables, ingredients for cooking, ropes, wrapping material, handicrafts, furniture, latex, dyes, and housing construction. Medicines are composed of a single plant part or species, or they can be combinations of some plant parts/species.

Almost all the reported taxa (96%) grow in the lowland area; 46% are trees and 17% shrubs. Of the 366 plant taxa reported used in Bangka Island and the small islands surrounding it, 241 (65%) taxa are native, and from the 366 taxa, as many as 209 taxa are recorded in the IUCN red list: 12 are data deficient (DD), 115 are the least concern (LC), 11 are near threatened (NT), 7 are vulnerable (VU), 7 are endangered (EN), and 5 are critically endangered (CE). Of the 444 native plant taxa in Bangka Island and the small islands surrounding it recorded in the IUCN red list the majority grow in the lowland habitat: 7 taxa data deficient (DD), 373 taxa the least concern (LC), 26 taxa are near threatened (NT), 16 are vulnerable (VU), 9 are endangered (EN), and 13 are critically endangered (CE).

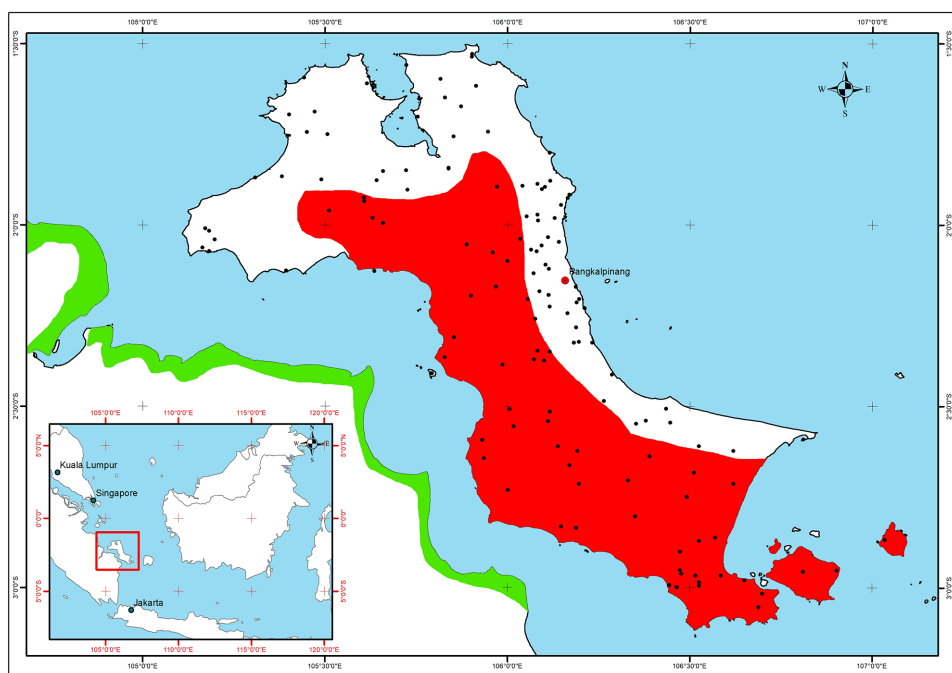


Fig. 8. Location studied showing Bangka Island and two small islands: Lepar Island (east) and Pongok Island (far-east) overlaid with the WWF ecoregion map; the white colour denotes heat forest area, and the red colour denotes lowland rainforest area (photo by A. Suwedi)

DISCUSSION

Species richness

Dalil, Namang, Dendang, Sempan, Kundi (Menduyung), Pangkalpinang, and Air Abik are 7 of 139 sites studied, with more than 36 families and 80 species at each site. Each of the seven sites contributes more than 5% of the 1,524 taxa of this study. According to WWF ecoregion, in the lowland rainforest area: Dendang 5.8%, Sempan 6.7%, and in the heath forest area: Dalil contributes 5.2%, Namang 5.7%, TWA Jering Menduyung 7.5%, Pangkalpinang records 7.7%, and Air Abik 9.0% of the species. Besides habitat differences, the intensity of research and the variety of research purposes may influence the study result, e.g., general floral inventory and specific studies for orchids, pandans, wild edible fruits, and the ethnobotany of plants. The growing number of ornamental plants recorded is shown in Pangkalpinang municipality, which is also the capital of the province, which has much less forest but has the second-largest species records.

The majority of the species of this study are in the lowland forests below 150 m, and a small number are in the mangrove, peat swamp, heat forests, pandang vegetation, coastal, and freshwater swamp forests. The high plant species diversity in Bangka Island's lowland forests is primarily influenced by stable climatic conditions, nutrient-rich soils, complex ecological interactions, high primary productivity, and long-term environmental stability. These factors collectively create an environment conducive to the establishment and persistence of a broad range of plant species. The highest species richness in lowland forest cannot be ruled out from the focus of research in that habitat and little exploration in mangrove, peat swamp, heat forests, grassland vegetation, coastal, and freshwater swamp forests. This means that extensive exploration into other habitats opens up opportunities for increasing the number of species. The hilly sites studied were Mount Maras, Mount Pading (654 m a.s.l.), and Mount Permisan (457 m a.s.l.). We did not study the plant at the different elevations. These study areas are fit to Laumonier's division of vegetation and forest types in Sumatra and its surrounding islands (including Bangka and Belitung islands), i.e., into lowland swamp areas (alt. < 15 m) where brackish environments, freshwater swamp, and peat swamp are, drained soils at low elevation < 150 m, and low elevation, non-karst hill plant formation (alt. 150–450 m) (Laumonier 1997). In the field, it is found that some species live in more than one WWF subecoregion. Mangroves, for instance, grow in the habitat in WWF lowland rain forests area (red colour background in Figure 8), such as Tukak, Tanjung Labu Lepar Island, Pongok Island, and Kelapan Island, and in the WWF heath forest area (white colour background in Figure 8), such as Kurau, Kundi, Mangkalok, Mapur, and Perimping River. *Spondias dulcis*, *Hoya coronaria*, *Calophyllum*

Table 3
Summary of Liliopsida

Family	Genera	Species	Infraspecific taxa	Total taxa
Acoraceae	1	1		1
Alismataceae	1	1		1
Amaryllidaceae	3	4		4
Araceae	16	17		17
Arecaceae	21	53	1	54
Asparagaceae	2	4		4
Asphodelaceae	2	2		2
Bromeliaceae	1	1		1
Burmanniaceae	1	2		2
Cannaceae	1	1		1
Colchicaceae	1	1		1
Commelinaceae	3	3		3
Costaceae	1	1		1
Cymodoceaceae	1	1		1
Cyperaceae	17	54		54
Dioscoreaceae	2	5		5
Eriocaulaceae	1	2		2
Flagellariaceae	1	1		1
Hanguanaceae	1	1		1
Hydrocharitaceae	4	5		5
Hypoxidaceae	1	2		2
Marantaceae	3	3		3
Musaceae	1	2		2
Orchidaceae	50	101	3	104
Pandanaceae	3	13		13
Philydraceae	1	1		1
Poaceae	31	48		48
Pontederiaceae	1	2		2
Smilacaceae	1	3		3
Stemonaceae	1	1		1
Xyridaceae	1	2		2
Zingiberaceae	9	15	1	16
Total	184	353	5	358

Table 4
Summary of Magnoliopsida

Family	Genera	Species	Infraspecific taxa	Total taxa
Acanthaceae	8	12		12
Achariaceae	1	1		1
Actinidiaceae	1	1		1
Aizoaceae	1	1		1
Amaranthaceae	2	4		4
Anacardiaceae	8	19		19
Ancistrocladaceae	1	1		1
Anisophylleaceae	2	2		2
Annonaceae	24	46	2	48
Apiaceae	2	2		2
Apocynaceae	16	43		43
Aquifoliaceae	1	1		1
Araliaceae	2	6		6
Asteraceae	27	28		28
Balsaminaceae	1	1		1
Basellaceae	1	1		1
Begoniaceae	1	1		1
Bignoniaceae	4	4		4
Bonnetiaceae	1	1		1
Boraginaceae	1	1		1
Brassicaceae	2	2	1	3
Burseraceae	4	10		10
Cactaceae	1	2		2
Callophyllaceae	1	11	1	12
Cannabaceae	2	5	1	6
Capparaceae	1	1		1
Caricaceae	1	1		1
Casuarinaceae	1	1		1
Celastraceae	5	9		9
Centroplacaceae	1	2		2
Chloranthaceae	1	1		1
Chrysobalanaceae	5	4	2	6
Cleomaceae	1	2		2

Table 4 (continued)

Family	Genera	Species	Infraspecific taxa	Total taxa
Clusiaceae	1	12		12
Combretaceae	3	6		6
Connaraceae	3	6		6
Convolvulaceae	6	7	3	10
Crassulaceae	1	1		1
Ctenolophonaceae	1	1		1
Cucurbitaceae	7	8		8
Daphniphyllaceae	1	1		1
Dilleniaceae	2	9		9
Dipterocarpaceae	5	27	3	30
Droseraceae	1	1		1
Ebenaceae	1	7	1	8
Elaeocarpaceae	1	10	1	11
Ericaceae	4	7	2	9
Erythroxylaceae	1	1		1
Euphorbiaceae	28	62	1	63
Fabaceae	48	71	4	75
Fagaceae	3	17		17
Flacourtiaceae	1	1		2
Gelsemiaceae	1	1		1
Gentianaceae	2	2		2
Gesneriaceae	2	2		2
Goodeniaceae	1	1		1
Hypericaceae	1	4	1	5
Icacinaceae	1	1		1
Ixonanthaceae	1	2		2
Juglandaceae	1	1		1
Lamiaceae	16	27		27
Lauraceae	16	55		55
Lecythidaceae	1	5		5
Lentibulariaceae	1	1		1
Linderniaceae	1	1		1
Loranthaceae	4	6		6
Lythraceae	5	7		7

Table 4 (continued)

Family	Genera	Species	Infraspecific taxa	Total taxa
Magnoliaceae	1	2		2
Malvaceae	16	25		25
Melastomataceae	7	16	1	17
Meliaceae	11	28		28
Menispermaceae	9	10		10
Molluginaceae	1	1		1
Moraceae	4	51	2	53
Moringaceae	1	1		1
Muntingiaceae	1	1		1
Myricaceae	1		1	1
Myristicaceae	4	13	3	16
Myrtaceae	10	56	3	59
Nelumbonaceae	1	1		1
Nepenthaceae	1	6		6
Nyctaginaceae	2	2		2
Nymphaeaceae	1	2		2
Nyssaceae	1	2	1	3
Ochnaceae	3	3		3
Olacaceae	1	1		1
Oleaceae	4	5	1	6
Onagraceae	1	2		2
Oxalidaceae	2	4		4
Passifloraceae	3	4		4
Pentaphragmaceae	3	8		8
Peraceae	1	1		1
Phyllanthaceae	8	51	2	53
Phytolaccaceae	1	1		1
Picrodendraceae	1	1		1
Piperaceae	2	7		7
Pittosporaceae	1	1		1
Plantaginaceae	3	4		4
Polygalaceae	4	7		7
Primulaceae	4	12	1	13
Proteaceae	1	2	1	3

Table 4 (continued)

Family	Genera	Species	Intraspecific taxa	Total taxa
Putranjivaceae	1	2		2
Rhamnaceae	2	2		2
Rhizophoraceae	5	11		11
Rosaceae	2	2	3	5
Rubiaceae	31	57	5	62
Rutaceae	7	13		13
Sabiaceae	1	1	1	2
Salicaceae	5	6		5
Santalaceae	2	2	1	3
Sapindaceae	12	19	2	21
Sapotaceae	8	16	1	17
Schisandraceae	1	1		1
Simaroubaceae	3	3		3
Solanaceae	5	10		10
Staphyleaceae	1	1		1
Stemonuraceae	2	2		2
Styracaceae	1	2		2
Symplocaceae	1	7	1	8
Theaceae	3	6		6
Thymelaeaceae	4	6		6
Verbenaceae	2	2		2
Violaceae	2	2		2
Vitaceae	5	11		11
Total	524	1113	53	1166

lanigerum, and *Cyperus rotundus* are found in heath forests and lowland forests, while *Trema orientale*, *Vitex pinnata*, and *Rhodomyrtus tomentosa* are found in lowland forests, heath forests, and ex-tin mined land. *Baeckea frutescens*, *Syzygium buxifolium*, and *Syzygium urceolatum* subsp. *palembanicum* are found in lowland forests, heath forests, and padang vegetation. They may grow in more than one sub-ecoregion because of the similarity of the habitat to some degree, and therefore they can adapt better to more or less similar biotic and abiotic properties. In this study, subcategories are made to present more details of

Table 5
Statistical sum of the flora (sp = species, isp = infraspecific taxa)

Source	Groups	Families	Genera	Native			Non-native			Total taxa
				sp	isp	subtotal	sp.	isp	subtotal	
This study	Liliopsida	32	181	275	5	280	78	0	78	358
	Magnoliopsida	124	525	809	48	857	304	5	309	1166
	Total	156	706	1084	53	1137	382	5	387	1524
Kurz 1864 ^{*)}	Liliopsida	27	128	125	9	134	77	3	80	214
	Magnoliopsida	117	436	394	8	402	263	8	271	673
	Total	144	564	519	17	536	340	11	351	887
Similarity of this study and Kurz 1864	Liliopsida	22	69	67	1	68	20	0	20	88
	Magnoliopsida	82	233	234	2	236	79	0	79	315
	Total	104	302	301	3	304	99	0	99	403

^{*)}Data were checked with Plant On the World Online website, where some entries were changed their species and family names, or deleted. Some taxon genera are excluded.

the habitat; therefore, there are additional habitats, i.e., coastal, padang vegetation, ex-tin mining, marine, and freshwater.

There are 6 endemic species of 4 families: *Dehaasia teijsmannii* (Lauraceae), *Syzygium robustum* (Myrtaceae), *Syzygium variifolium* (Myrtaceae), *Dendrobium subpandifolium* (Orchidaceae), *Podochilus bancanus* (Orchidaceae), and *Pandanus lais* (Pandanaceae) (Table 6). There are other 5 endemic species from 3 families that are in Kurz's but are not found in this study: *Adenosma nelsonioides* (Acanthaceae), *Garcinia klabang* (Clusiaceae), *Canthium leave* (Rubiaceae), *Ixora akkeringae* (Rubiaceae), and *Oldenlandia accedens* (Rubiaceae). *G. klabang* and *D. teijsmannii* are critically endangered (CR) on the IUCN Red List. A study in Jamaica tropical montane rainforests shows that diversity and richness of endemic tree species are imperilled by invasive trees (Bellingham *et al.* 2018). It needs to consider Brewer's (2013) population survey for threatened tree species in high-potential habitats and do the survey in especially reported locations by Kurz (1864).

Table 6
Endemic species (Ts = this study, RL = red list)

Family	Species	Ts	Kurz 1864	IUCN RL
Acanthaceae	<i>Adenosma nelsonioides</i> (Miq.) Hallier f. ex Bremek.		v	NE
Clusiaceae	<i>Garcinia klabang</i> Miq.		v	CR
Lauraceae	<i>Dehaasia teijsmannii</i> Kosterm.	v		CR
Myrtaceae	<i>Syzygium robustum</i> Miq.	v	v	NE
Myrtaceae	<i>Syzygium variifolium</i> Miq.	v	v	NE
Orchidaceae	<i>Dendrobium subpandifolium</i> J. J. Sm.	v		NE
Orchidaceae	<i>Podochilus bancanus</i> J. J. Sm.	v		NE
Pandanaceae	<i>Pandanus lais</i> Kurz	v	v	NE
Rubiaceae	<i>Canthium laeve</i> Teijsm. et Binn.		v	NE
Rubiaceae	<i>Ixora akkeringae</i> (Teijsm. et Binn.) Valetton ex Bremek.		v	NE
Rubiaceae	<i>Oldenlandia accedens</i> (Miq.) Kuntze		v	NE

Kurz and this study

The differences in the number of species and families compiled by Kurz (1864) and this study have documented an increase in the species richness of the island by 637 species, or 71% over 150 years, with notes that 1,121 taxa are not in Kurz's list, and on the other hand, there are 484 taxa from Kurz that are not recorded in this study. There are many factors that may explain these differences. One of them, which is more likely the most important factor, is the degree of exploration and the extensive exploration in the last two decades. There is a gap between the last exploration and this study. Compared to this study, the annual increase of vascular plant species in the three major tropical areas in the world was reported, e.g., an average of 364 newly described species for the past 12 years being added annually in Tropical Asia (Raven *et al.* 2020). That data validate the huge diversity of tropical forests, where robust estimates of the number are insufficient (Slik *et al.* 2015). Another possible cause is the introduction of species brought from the Java and/or Sumatra mainland as agricultural and ornamental species, which can be negligible. This increase may also be due to demographic and economic aspects of the cultivation of some plant species. The population of Bangka Island in 1829 was 24,628; 168,217 in 1920 (Sujitno 2007b); and it is now 1,177,800 in 2022 (BPS Kepulauan Bangka Belitung 2023).

The main agricultural sectors on the island for many decades have been pepper, rubber, and cocoa. Palm oil plantation was introduced on the island in the early 1990s. In 1992, when revegetation on ex-tin-mined land was man-

datory, *Acacia auriculiformis* was the only species introduced for restoration. Later, *Acacia mangium* replaced *A. auriculiformis*, and just in the last 15 years or so, more tree species are planted on the ex-tin-mined soils, including fruit trees such as *Mangifera indica* and *Syzygium* species. Other fast-growing species that have been introduced are *Falcataria falcata* (Fabaceae) and *Neolamarckia macrophylla* (Rubiaceae). Considering the different composition of the two studies, recent exploration accounts for the higher number of plant taxa recorded, and it is therefore likely that more taxa can be added to the list if more exploration of priority areas is conducted.

The majority of Kurz's site falls in the heath forest area, from the northwest of the island, the upper north, and the east area of the island from north to the southeast. The research was mostly from 20 sites across the island, and 63% concentrated in three sites: Mount Menumbing (9.1%), Batu Rusa (23.3%), and Muntok (30.6%). These areas fall in the WWF heath forest zone. One of the many reasons why that area got attention from the scientists and Kurz at that time is because Muntok, located on the northwest coast of Bangka Island, was the capital of Residency Bangka during the colonial era and the centre of tin mining activity by the colonial government until 1913, when the administration office was moved to Pangkalpinang. Muntok was the gate to enter Sumatra Island by ship. It is likely that those sites were supported by the accessible routes, which were the main tin transportation on the island at that time around the year 1800.

The area of Bangka Island that was less explored by Kurz and other scientists at that time is the central west coast and west south coast. In this area, plant species grown on peat soil of histosols have the potential to have more intensive exploration. *Gonystylus bancanus* and *Koompassia malaccensis* were recorded on the central west coast at the centre of the island.

Plant uses

Over a quarter of the flora, 387 taxa (25.4%), are introduced or non-native species. The increasing number of exotic species is partly because of the agricultural, ornamental value, and herbal. Some species have been cultivated for more than 200 years since the colonial era, such as *Piper nigrum*, whereas others are recent arrivals within the last one or two decades, such as *Arachis pintoii*, which was non-native as an ornamental plant for gardens but is now common in roadsides and gardens. Others, like *Tabebuia aurea*, are non-native, planted as ornamental trees for sidewalks and parks in very recent years, while other tree species, e.g., *Acacia auriculiformis* and *Acacia mangium*, are non-native for revegetating ex-tin-mined spoil since 1992, as revegetation on ex-tin-mined soils is mandatory (Nurtjahya 2001). In the future, it might be

necessary to evaluate the status of some exotic species, and will some of the plant species become invasive or not?

Although 366 taxa of 91 families have been identified for their uses, there are many more plant species that may be uncovered for their uses in more intensive research in the future. A list of 67 food plant species used by people in a conservation forest in South Bangka Regency was reported (Pujinisa *et al.* 2023). Regarding the use of plants in medicine, the dominant part of the plant used in medicine is leaves, and this is also reported by other scientists (Afriyansyah *et al.* 2013, Anjelia 2016, Hafizoh 2016, Henri *et al.* 2020, Jumila 2019). In medication preparation, a single plant part or its extract is used, or a combination of some plant parts is also reported by other scientists (Afriyansyah *et al.* 2013, Analisa 2018, Hafizoh 2016). The ingredient(s) is prepared mostly by boiling or decoction, compared to powder, infusion, juice, etc. (Henri *et al.* 2020, 2022, Jumila 2019). The most frequently used plants are trees, and this is also reported in other studies (Analisa 2018, Anjelia 2016, Hafizoh 2016, Henri *et al.* 2022, Jumila 2019). Phytochemical screening in a few species is reported: phenolic content of *Baeckea frutescens* leaf extracts (Ningsih *et al.* 2020). It is also challenging to study the bioprospecting of the potential economic species for ingredients in medicine, food, and cosmetic industries.

CONCLUSIONS

The island supports 1,524 taxa from 32 families, 184 genera, 353 species, and 5 infraspecific taxa of monocotyledonous plants, and 124 families, 524 genera, 1,114 species, and 52 infraspecific taxa of dicotyledonous plants of terrestrial, aquatic, mangrove, coastal, and tin spoils in Bangka Island. There are 594 species (39%) that are grown in lowland habitats and are mostly native, of which 14 species are critically endangered. A quarter of the flora is introduced species for their timber, fruit, flower, and revegetating tin spoils. A total of 366 native and introduced taxa from 91 families are reported for their uses as ornamental plants, medicine, staple food, edible fruits, vegetables, spices, furniture, construction, etc., for which leaves are mostly used. While not all of Kurz's 1864 list was recorded, the current research documented an increase of 637 species (71%) to that list.

Seven potential areas are still less unexplored: the lowland forest area in Jerieng Menduyung Natural Recreation Park in West Bangka Regency, Rimbe Mambang forest in Dalil, Mount Boei, and a mangrove in the Perimping river area in Bangka Regency, Mount Permisan in South Bangka Regency, and Mount Pading, and the peat swamp in Tanjung Pura (was Tanjung Tedung) in Central Bangka Regency. Re-identification of 552 voucher specimens stored in Herbarium Bangka Belitungense to species level would be another impor-

tant agenda to increase the number of species in future revisions of the current list. Locating endemic species, evaluating some exotic species in the wild, and finding the potential economic species for medical, food, and cosmetic industries would be challenging for future conservation management and economic for the people, especially in the post-tin mining era.

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Acknowledgements – The first author gratefully acknowledges the Directorate of Human Resources, Ministry of Education, Culture, and Research and Higher Education for funding the opportunity to enrich the draft of the manuscript by facilitating collaboration with experts in Royal Botanic Gardens, Kew, United Kingdom, through the SAME – Scheme of Academic Mobility and Exchange program 2021 [Grant Number: 2434/E4/KK.04.03/2021]. The authors thank the Royal Botanic Gardens, Kew, for giving permission into the herbarium collections and library and facilitating the collaboration. The first author also acknowledges part of the funding of this research by the Directorate General of Higher Education, Ministry of Education, Republic of Indonesia [Grant Numbers: 092/SPPP/PP/DP3M/IV/2005, 092/SP2H/PP/DP2M/III/2007, 086/SP2H/PP/DP2M/III/2008], and to the government of Bangka Belitung Province for partially funding the field research. The first author thanks Dr Ian M. Turner, Dr André Schuiteman, Ms Alison Moore, Dr Laura V. S. Jennings, Ms Sally Dawson, Dr Gemma L. C. Bramley, Mr Martin Xanthos, Ms Marrie Briggs, and Dr Carmen Puglisi of the Royal Botanic Gardens, Kew, who helped in finding the specimen in some families and discussing some families, International Tropical Timber Organisation (ITTO) funded a PhD research [Grant Number: 039/03A] for the first author. We would like to thank Herbarium Bogoriense (BO) and Herbarium Bangka Belitungense (HBB) for helpfully providing facilities to work in their herbaria. The following people are thanked for providing inventory data: the late Ms Idha Susanti, the late Mr Munawar, Ms Sudariah, Ms Siti Aminah, Mr Angga Saputra, Ms Ina Miranti, Ms Nursah Putri, Ms Vera Natasya, Mr Syahril, Ms Nurul Abiad, Mr Aldan, Ms Arinda Unigraha Utama, Mr Husaini, Mr Mardian, Ms Meri Wilanda, Ms Salmah, Ms Yuniar Safitri, Ms Dahlia, Ms Sri Murtini and Ms Melia Panca Rani. The first author also thanks the late Dr Yadi Setiadi, the late Prof. Edi Guhardja, the late Dr Utut Widyastuti, the late Dr Agustinus Joko Nugroho, and the late Dr Ratna Santi, Prof. Ani Mardiasuti, Ms Diah Sulistiani, Dr Nuril Hidayati, Ms Rossy Hertati, Prof. Dede Setiadi, and Dr Ignatius Muhadiono for their help in supervising the students research and identifying specimens, and thanks Mr Aripin Suwedi, who prepared the map. Special appreciation goes out to anonymous reviewers for their valuable comments on the manuscript.

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