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NON-BAMBUSOID GRASSES (GRAMINEAE) FROM RAJA AMPAT ARCHIPELAGO, PAPUA BARAT PROVINCE, INDONESIA

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ABSTRACT

SUMADIJAYA, A. & VELDKAMP, J. F. 2012. Non Bambusoid grasses (*Gramineae*) from Raja Ampat Archipelago, Papua Barat Province, Indonesia. *Reinwardtia* 13(3): 241–253. — Thirty two species of non-bambusoid grasses from 28 genera were recorded for the Raja Ampat Archipelago, Papua Barat Province, Indonesia, mostly from secondary forest. The result was compiled from *Widya Nusantara* Expedition (EWIN), Takeuchi (2003), and Van Royen (1960). This is a first attempt to record non-bambusoid grasses for a remote archipelago in Indonesia.

Keywords: *Gramineae*, Grass, Indonesia, Raja Ampat Archipelago, Widya Nusantara Expedition.

ABSTRAK

SUMADIJAYA, A. & VELDKAMP, J. F. 2012. Rerumputan Non-Bambusoid (*Gramineae*) dari Kepulauan Raja Ampat, Provinsi Papua Barat, Indonesia. *Reinwardtia* 13(3): 241–253. — Tiga puluh dua jenis rerumputan non bambu dari 28 marga terdapat di Kepulauan Raja Ampat, Propinsi Papua Barat, Indonesia, yang sebagian besar berada di hutan sekunder. Hasil ini merupakan penggabungan dari Ekspedisi Widya Nusantara (EWIN), Takeuchi (2003), serta van Royen (1960), yang merupakan upaya perdana untuk melakukan pendataan rerumputan non bambu di kepulauan terpencil Indonesia.

Kata kunci: *Gramineae*, Rumput, Indonesia, Kepulauan Raja Ampat, Ekspedisi Widya Nusantara.

INTRODUCTION

Raja Ampat Archipelago

The Raja Ampat Archipelago located at 2°25'–4°25' S and 130°–132°55' E, in the western (Indonesian) part of New Guinea. Its stretch covering 4.6 million hectares with surrounding sea under 200 m in depth. Known as the heart of the Coral Triangle, it harbours the richest marine diversity on earth. Several different tectonic plates with diverse composition (of Australian, Caroline, Eurasian, Indian, and Philippine origin) have shaped the archipelago (Hall, 2002).

The 4 major islands are: (1) Waigeo in the North, the twins (2) Batanta and (3) Salawati which are close to mainland, and (4) Misool (Map 1). The landscape consist of hilly country with uplifted coral reefs (Anonymous, 2006).

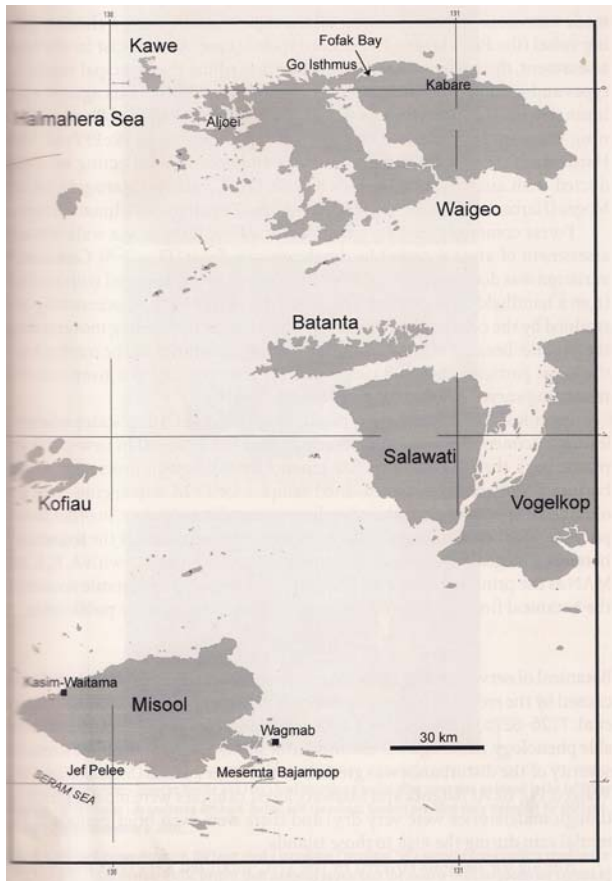
After Indonesia's independence, the archipelago was part of the Irian Jaya Province, which is the whole Indonesian part of New Guinea. Nowadays, administratively Raja Ampat is one of the regencies located at Papua Barat Province since its establish-

ment in 2007, a significant change after Irian Jaya Barat, which was established in 1999 (<http://pauabaratprov.go.id>).

The EWIN (Ekspedisi Widya Nusantara) expedition had the objective to explore the biodiversity, describing the habitat, and listing the species of the outer and remote islands of Indonesia. One of the aims was to increase the number of representative herbarium specimens from eastern part of Indonesia, especially from an isolated archipelago such as Raja Ampat. This was a good opportunity to collect data on grasses, a neglected component of vegetation, but with great effect on ecosystems. Previous publication by Takeuchi (2003) and Van Royen (1960) only gave a brief inventory.

A brief history of early exploration of Waigeo

Van Steenis-Kruseman (1950) summarised the botanical explorations in the Raja Ampat Archipelago, especially in Waigeo. The acronyms for the herbaria mentioned below have been taken from the Index Herbariorum.



Map. 1. The archipelago of Raja Ampat. Taken from Sida 20, 1095, Fig.2 (2003).

Before 1900

Between February 26th and March 2nd, 1775, Forrest of the English East Indian Company came looking for spices: cinnamon, clove, pepper, nutmeg and mace. The whereabouts of botanical specimens collected by him, if any, are not known. Then, French scientific expedition was made in search for the lost ship *La Pérouse* with the botanists De la Billardiére and De la Haye on board. They collected between August 29th and September 11th, 1793. Their specimens are in major European herbaria, *e.g.* FI, G, and P. Another French team, with Gaudichaud-Beaupré as scientist briefly visited around Christmas time in 1819. Most of the collections were lost due to the stranding of the ship *L'Uranie*, the remainder is now in G and in a number of other European institutes. The third expedition of the *La Coquille* with Dumont D'Urville on board landed around August 1823. Specimens are kept especially in G and P. The Dutchman Teijsmann is reported to have been in Waigeo (probably in 1871). His specimens are in BO. The German Von Rosenberg collected mainly zoologically between July and August 1860, and again in June 1869. A few plants are present in L and possibly in BO. Wallace, the famous Welshman spent some time in Waigeo in September 1860. He

was mainly interested in animals. Plants may be present in K or other British institutes. Bernstein, a German, also a zoologist, explored in January 1863. Plants might be present in WRSL. He came back to the area after July 1864, and died in Batanta in April 1865. Ten years later, the Italian Beccari visited Waigeo between March 5th—14th, 1875, and was in Batanta and Kofiau in 23rd—29th July. The main set of his collections is in FI. Before entered 20th century, on between 12th—15th August 1899 the Dutch Ms. Weber-Van Bosse studied mainly the algae. Her first set is in L.

1900 to present

The Danish zoologist Waterstredt visited in 1902. He seems to have collected living orchids for Sander & Sons, a British nursery firm, and for the Botanical Garden of Singapore. Then, the Dutch mining engineer Brouwer sent living orchids from Waigeo to the Kebun Raya Bogor, in 1915. More than 10 years apart, the American zoologist Herre was also interested in lichens. He collected 7 botanical numbers in Waigeo on June 7, 1929. They are stored in F, NY, US (formerly in GMS). Three years later, the German teacher Stein made some botanical collections around January, and again between May 6th and 16th June, 1931. His efforts were destroyed in the bombing of B. The British entomologist Ms. Cheesman in March 1938 collected mainly cryptogams which are preserved in BM, K, and some in A. The Dutchman Van Royen explored between January 12th and February 18th, 1955. First set in L (Van Royen, 1960). Finally, Takeuchi, Neville, Mogeia, and Liuw visited between October 30th and November 22nd, 2002. The first set is in BO, duplicates are in A, K, L, MAN.

A brief history of early exploration of Batanta

Exclusively for Batanta, a few visits have been recorded, *e.g.* by the British buccaneer Dampier who passed by through the Strait that was later named after him on February 4th, 1700. He might have collected some floating algae, which then might be in the Sloane collection at BM. Micholitz from Germany collected living orchids for Sander & Sons around 1890. Specimens might be in K. In 1954, Van Royen visited from March 30 to April 3rd, first set in L.

Biodiversity

It will be clear that the information about the biodiversity of the Raja Ampat archipelago is more or less casually mentioned in publications by or about the explorers of many nations and scattered over numerous botanical and zoological publications and taxonomic revisions. These are often unavailable in Indonesia and, also in many languages (Dutch, English, French, German, Italian,

Latin). The vouchers are usually stored in American and European institutes, which makes it not easy to study them for researchers in Asia, particularly Indonesia.

Van Royen (1960) explained the general vegetation on several locations at Waigeo and he summarized vegetation types as lowland rainforest, mangroves, riverine forest, coastal forest, xerophytic vegetation, and submountain vegetation. Takeuchi (2003) conducted his research for The Nature Conservancy, and was the first to describe the principal vegetation components of the Archipelago comprehensively. Webb (2005) renewed the information and made additions in mapping the vegetation. Anonymous (2006) gave descriptions of all major aspects such as the conservation, ecology, economy, environment, wildlife, and other aspects in *Atlas Sumberdaya Pesisir Kabupaten Raja Ampat Provinsi Irian Jaya Barat*, also known as Coastal Resource Atlas of the Raja Ampat District, West Irian Jaya Province.

The organisms in these islands are often unique as a result of long-term isolation from the nearest areas of the Moluccas and New Guinea, and provide many challenges to scientific research. Humans, by colonizing new areas have had tremendous effects in changing their biological composition. This applies especially on grasses, many of which have turned into noxious invasive aliens, and often occur scattered or, worse, come to dominate newly opened areas. They have mostly remained neglected by the botanists of the area, who often were foresters.

The basic reference to grasses for this area is the manual by Henty (1969). He enumerated with keys and brief descriptions and some illustrations of 130 non-bambusoid genera for New Guinea. A survey of the woody bamboos was given by Holttum (1967).

LOCATION

The first author conducted a two-year survey areas in Waigeo (villages of Kalitoko and Warsamdin with extra spot on Warmakrak) as well as Batanta (village of Way lebet). The research location can be seen in Map. 1. Notes were taken recording life-form, habitat condition, and the presence of any special feature. Vouchers were made by the Schweinfurth method: using alcohol 70 %, then dried by oven on 60°C at BO.

The nomenclature was extracted from published accounts, e.g. by C. Monod de Froideville (1968), and unpublished manuscripts by the second author, including those by the late P. Jansen, and from the Tropicos database (<http://www.tropicos.org/>).

RESULTS

Overall, 32 species from 28 genera were recorded from the area. Most species are adapted to human disturbances. The greatest diversity was found in open situations which comprises of riverine areas, roadsides, water ways, abandoned fields and gardens, as well as urban areas. Only one species, *Scrotochloa urceolata* (Roxb.) Judz. was found as a forest inhabitant (Fig. 1), and habituated under partially open to closed canopies.

Several major vegetation types have been encountered in Waigeo and Batanta, including lowland, limestone, alluvium, and secondary forest, with several areas with swamps, beaches, mangroves, and ultrabasic ecosystems. Takeuchi (2003) mentioned only 4 grasses from Raja Ampat. Van Royen (1960) observed 14 grasses from 13 genera (including 1 bamboo *Dinochloa*, which is excluded from Table 1) in Waigeo. Among these were *Chrysopogon aciculatus* (Retz.) Trin., *Coix lacryma-jobi* L., *Digitaria mollicoma* (Kunth) Henrard (previously as *Digitaria* sp.), *Imperata conferta* (J. Presl) Ohwi, *Ischaemum barbatum* Retz., *Ischaemum muticum* L., *Mnesithea glandulosa* (Trin.) De Koning & Sosef, *Ophiuros exaltatus* (L.) Kuntze (previously as *Ophiuros* sp.), *Paspalum longifolium* Roxb., *Saccharum spontaneum* L., *Thuarea involuta* R. Br., which were not observed in field work. One taxon remains unsolved to species level, perhaps a species of *Oplismenus* (Van Royen 5156), where the presumed inflorescences are leafy galls.

The survey was made mainly in pristine forest, in Waigeo between 0–300 m, and 0–650 m in Batanta. Those areas are relatively flat, but fenced by steep hill forests as well as limestone walls, forming homogenous habitats for grass species.

In relatively short time, only 9 species in Batanta and 19 species in Waigeo were collected. The cultivated species, *Saccharum officinarum* L. and *Zea mays* L. were disregarded. Henty (1982) reported savannahs for various other places in New Guinea, and Takeuchi (2003) mentioned for Misool, formed by *Imperata conferta*, *Ischaemum barbatum*, and scattered *Saccharum spontaneum*, while *Imperata conferta* and *Ischaemum muticum* occurred on Jef Pelee, an island near Misool. Webb (2005) mostly followed Takeuchi in explaining grass species, and gave brief descriptions of savannah and grassland for non-ultrabasic soil.

Although Henty (1982), Takeuchi (2003) and Webb (2005) reported savannahs at Misool and Jef Pelee, but no savannah was seen on surveyed areas. I assume the climate is too wet for its presence. On the other hand, it seems too dry to sustain the cultivation of rice.



Fig. 1. *Scrotachloa urceolata* (Roxb.) Judz., the only grass species inside pristine forest. Photo: A. Sumadijaya



Fig. 3. *Imperata cylindrica* (L.) Raeusch., on riverbank, grow steadily nearby protective boulders. Photo: A. Sumadijaya



Fig. 4. Forest enclave, fulfilled by corn, *Zea mays* L. Photo: A. Sumadijaya



Fig. 2. a. *Leptochloa virgata* (L.) P. Beauv. on sandy riverbank, b. *Leptochloa virgata* on death tree stump. Photo: A. Sumadijaya

Riverine open area

In Waigeo, a riverine path (00° 18' 09.4" S; 130° 55' 47.8" E) was used along the Orobai (pronounced as We-ra-bi-ai) River as our track to reach the inner forest. Near the estuary, a large area of sedimentation consisting of small stones and soil was encountered. Several figs (*Ficus spp.*) were present and fertilized the soil around them by the accumulation of litter fall. The river varies in width from 10 to 25 m, consisting of gravel stones ranging from around 3 to 50 cm which form a transition zone to traditional gardens. At several places the area widened with stony islands in the middle of the runoff as result of many years of sedimentation. At certain periods after heavy downpour, upstream flash floods occur, draining the islands and wiping out most of the vegetation. No detailed observation for rheophytes was made.

Table 1. Distribution of grasses at Raja Ampat Archipelago (only Waigeo and Batanta visited), with addition of Takeuchi (2003) and van Royen (1960).

No	Species	Waigeo	Batanta	Takeuchi (2003)	Van Royen (1960)
1	<i>Bothriochloa bladhii</i> (Retz.) S.T. Blake	+	-	-	-
2	<i>Cenchrus brownii</i> Roem. & Schult.	+	+	-	-
3	<i>Cenotheca lappacea</i> (L.) Desv.	+	-	-	+ (W)
4	<i>Chionachne macrophylla</i> (Benth.) Clayton	+	-	-	-
5	<i>Chloris barbata</i> Sw.	-	+	-	-
6	<i>Chrysopogon aciculatus</i> (Retz.) Trin.	-	-	-	+ (W)
7	<i>Coix lacryma-jobi</i> L.	-	-	-	+ (W)
8	<i>Cyrtococcum oxyphyllum</i> (Hochst. ex Steud.) Stapf	+	-	-	-
9	<i>Digitaria mollicoma</i> (Kunth) Henr.	-	-	-	+ (W)
10	<i>Eleusine indica</i> (L.) Gaertn.	+	+	-	-
11	<i>Eragrostis amabilis</i> (L.) Kuntze	+	-	-	-
12	<i>Imperata conferta</i> (Presl) Ohwi	-	-	+ (M, K)	-
13	<i>Imperata cylindrica</i> (L.) Raeusch.	+	+	-	-
14	<i>Ischaemum barbatum</i> Retz.	-	-	+ (M)	-
15	<i>Ischaemum muticum</i> L.	-	-	+ (K)	+ (W)
16	<i>Leptochloa virgata</i> (L.) P. Beauv.	+	+	-	-
17	<i>Mnesithea glandulosa</i> (Trin.) de Koning & Sosef.	-	-	-	+ (W)
18	<i>Ophiuros exaltatus</i> (L.) Kuntze	-	-	-	+ (R)
19	<i>Oplismenus compositus</i> (L.) P. Beauv.	+	-	-	-
20	<i>Oplismenus hirtellus</i> (L.) P. Beauv.	-	-	-	+ (W)
21	<i>Paspalum conjugatum</i> P.J. Berg.	+	+	-	-
22	<i>Paspalum longifolium</i> Roxb.	-	-	-	+ (W)
23	<i>Phragmites karka</i> (Retz.) Steud.	+	-	-	-
24	<i>Pogonatherum crinitum</i> (Thunb.) Kunth	+	-	-	-
25	<i>Saccharum spontaneum</i> L.	-	-	+ (M)	+ (W)
26	<i>Scrotochloa urceolata</i> (Roxb.) Judz.	+	-	-	-
27	<i>Setaria flavida</i> (Retz.) Veldk.	+	-	-	-
28	<i>Sorghum propinquum</i> (Kunth) Hitchc.	+	+	-	-
29	<i>Spinifex littoreus</i> (Burm. f.) Merr.	+	+	-	-
30	<i>Sporobolus indicus</i> var. <i>major</i> (Buse) Baaijens	+	+	-	-
31	<i>Thuarea involuta</i> R. Br.	-	-	-	+ (R)
32	<i>Zoysia matrella</i> (L.) Merr.	+	-	-	-

Note: + for present ; - for absent; K for Kofiau; M for Misool; R for Rauki, (small island north of Waigeo); W for Waigeo

The most distinctive grass species was *Leptochloa virgata* (L.) P. Beauv., forming scattered stands up to 1.5 m high at the riverbank (Fig. 2a), as well as on the stony islands, even on a dead tree stump (Fig. 2b), with some soil to grown with *Cyrtococcum oxyphyllum* (Hochst. ex Steud.) Stapf and *Paspalum conjugatum* P.J. Berg. formed

mats near the forest margins. The difference was the former occurred in shaded places and the latter in fully exposed open areas.

Remarkably, *Imperata cylindrica* (L.) Raeusch was found far upstream near the forest, protected by boulders (Fig. 3). *Phragmites karka*, which is easy to recognise, stood on top of a limestone cliff, with

Pogonatherum crinitum hanging down at the wall.

Along the way in the forest, gradual changes in grass components were noticed. After entering denser forest, herbaceous grasses were replaced by the woody type of bamboo. A temporary base camp (00° 17' 22.1" S; 130° 55' 36.8" E) was built here, therefore was called Bamboo Camp.

Villages, traditional gardens, abandoned fields, and roadsides

Whether the traditional gardens are relatively distant from the villages or not, they all share the same features near the riverine forest. Local people plant various kinds of commercial species such as banana (*Musa cf. paradisiaca* L.), maize (*Zea mays*, Fig. 4), manioc (*Manihot esculenta* Crantz). Other species also often encountered are the sweet potato [*Ipomoea batatas* (L.) Poir.], red pepper (*Capsicum annum* L.), water melon [*Citrullus lanatus* (Thunb.) Matsum. & Nakai], *Theobroma cacao* L., and also the genera of *Canna*, *Ocimum*, *Piper*, *Sesbania*, *Coffea*, and *Tectona*. Abandoned gardens (00° 17' 37.9" S; 130° 56' 40.2" E) often are blanketed by *mangkapararan* [*Merremia peltata* (L.) Merr.], with other herbs such as: *Amaranthus*, *Cras-socephalum crepidioides* (Benth.) S. Moore, *Ipomoea aquatica* Forssk., and *Passiflora edulis* Sims.

A particular area of the Trans Waigeo road (00° 19' 22.3" S; 130° 55' 13.8" E) with full sunlight has abundant grass species. Stands of *Sorghum propinquum* (Kunth) Hitchc. reach 2 m, *Leptochloa virgata* up to 1.5 m high, with sporadic patches of *Sporobolus indicus* var. *major* (Buse) Baaijens, *Setaria flavida* (Retz.) Veldk., and *Eleusine indica* (L.) Gaertn. *Cenchrus brownii* Roem. & Schult. and *Eragrostis tenella* (L.) Gaertn. were scattered along the sides of a road.

Bothriochloa bladhii (Retz.) S.T. Blake, *Imperata cylindrica*, and *Paspalum conjugatum* inhabit an abandoned field. Occasionally, local people use this field for activities such as a sports event, after which it remains abandoned and soon is colonized by grasses. *Zoysia matrella* (L.) Merr. was only found at a traditional harbour where it grew close to a medium-sized coral fragment (ca. 50 cm in diameter). It might be the result of accidental human transportation.

Damaged Forest

Occasionally, people go into the forests to hunt animals, such as wild boar or birds, or to log high quality trees such as merbau [*Intsia bijuga* (Colebr.) Kuntze] for building houses. They make a simple track, with both sides colonized by herbs (Acanthaceae, Asteraceae, Zingiberaceae), ferns, and grasses. In shaded places *Cyrtococcum*

oxyphyllum and *Oplismenus compositus* (L.) P. Beauv. often form gregarious mats and soon dominate a particular area. *Cenotheca lappacea* (L.) Desv. occurs in humid, shaded places or close to water puddles.

Expected, but unencountered grasses

Large genera such as *Digitaria* Haller (ca. 250 spp, 22 species in New Guinea), *Panicum* L. (a paraphyletic assemblage of at present ca. 450 spp, 14 species in New Guinea), and *Urochloa* P. Beauv., (with 120 spp worldwide, 13 species in New Guinea) were not encountered. They were expected but not found, possibly because of the lack of time to collect and limited locations during the survey or not finding fertile material.

Key to the species

Adapted from Duistermaat (2005), Gilliland (1971), Henty (1969), and Monod de Froideville (1968):

- 1. a. Occurs only in pristine forest, blades with a distinct pseudo-petiole, obovate-oblong, pinnately nerved, spikelet urceolate, stigmas 3 *Scrotochloa urceolata*
- 1. b. Occurs in open areas, or under shaded forest track, blades without a pseudo-petiole or at least less than 1 cm long, narrow-linear, curvined or rectined, spikelet not urceolate, stigmas 2 2
- 2. a. Spikelet terete or subterete..... 3
- 2. b. Spikelet dorsoventrally or laterally-compressed.... 8
- 3. a. Spikelet with 1 floret..... 4
- 3. b. Spikelet with 2 florets..... 6
- 4. a. Spikelet in a spike-like raceme, not gaping, the caryopsis enclosed..... *Zoysia matrella*
- 4. b. Spikelet in a panicle 5
- 5. a. Tall reed-like grass, up to 3 m high. Panicle expanded, silky-hairy..... *Saccharum spontaneum*
- 5. b. Small to medium size grass up to 50 cm high. Panicle contracted, not hairy *Sporobolus indicus* var. *major*
- 6. a. Leaves stiff, pungent. Inflorescences in a capitate fascicle, with accessories of spathaceous leaves, and prophylls, grows on sandy beaches.....*Spinifex littoreus*
- 6. b. Leaves herbaceous. Inflorescence otherwise..... 7
- 7. a. Inflorescence a panicle, spikelets in groups of three, sometimes with additional lower ones in pairs, callus awned, needle-shaped *Chrysopogon aciculatus*
- 7. b. Inflorescence a spike-like raceme, spikelets upaired, with sessile burs..... *Cenchrus brownii*
- 8. a. Spikelet laterally-compressed.....8
- 8. b. Spikelet dorsoventrally-compressed.....17
- 9. a. Inflorescence spike-like.....*Thuarea involuta*
- 9. b. Inflorescence in panicle or digitate..... 10
- 10.a. Inflorescence (sub)digitate..... 11
- 10.b. Inflorescence with a central axis..... 12
- 11. a. Spikelet awned, brown.....*Chloris barbata*
- 11. b. Spikelet not awned, green.....*Eleusine indica*

- 12. a. Spikelet with 3 or more florets.....13
- 12. b. Spikelet with 1 or 2 florets.....14
- 13. a. Plants less than 70 cm tall. Spikelet with long pedicel (more than 1 mm). Palea as long as the lemma, margins setose.....*Eragrostis amabilis*
- 13. b. Plants 0.5--2 m tall. Spikelet with short-pedicel (ca. 1 mm). Palea shorter than the lemma, margin smooth to serrulate.....*Leptochloa virgata*
- 14. a. Reed-like grass, 2--4 m tall. Rachilla with fine spreading hairs.....*Phragmites karka*
- 14. b. Not reed-like, less than 1.5 m tall. Rachilla Glabrous.....15
- 15. a. Inflorescence a simple raceme, pedicel hairy, spikelets with an awn 8--22 mm long.....*Pogonatherum crinitum*
- 15. b. Inflorescence a panicle, pedicel glabrous or with minute hairs, spikelets not awned.....16
- 16. a. Spikelet oblong. Lemma with eflexed tubercle-based bristles.....*Centotheca lappacea*
- 16. b. Spikelet triquetrous. Lemma unarmed.....*Cyrtococcum oxyphyllum*
- 17. a. Involucre indurated forming a bead-like structure, with female and sterile spikelets, upper part with male spikelets.....*Coix lacryma-jobi*
- 17. b. Involucre absent, or not indurated.....18
- 18. a. Spikelet plano-convex, arranged in 2--4 rows along Rachis.....19
- 18. b. Spikelet ovate-lanceolate, arranged differently.. 20
- 19. a. Stoloniferous, spikelet strictly 2-seriate, upper glume margin ciliate, rachis width 0.7 mm.....*Paspalum conjugatum*
- 19. b. Not stoloniferous, spikelet up to 4-seriate, upper glume margin not ciliate, rachis width 4 mm.....*Paspalum longifolium*
- 20. a. Inflorescence composed of strictly 1 raceme.....*Chionachne macrophylla*
- 20. b. Inflorescence composed of more than racemes, or panicle with a central rachis.....21
- 21. a. Rachis thickened, and spikelet inserted inside of axis..... 22
- 21. b. Rachis not thickened, spikelet attached freely, as a different structure from rachis.....23
- 22. a. Internodes longer than spikelet length.....*Ophiuros exaltatus*
- 22. b. Internodes shorter than spikelet length.....*Mnesithea glandulosa*
- 23. a. Central axis present, racemes distributed along main axis, longer than 2 cm.....24
- 23. b. Central axis absent, or up most to 1 cm long, racemes (sub)digitate derived from (more or less) 1 point of peduncle..... 30
- 24. a. Raceme alternate on central axis.....25
- 24. b. At least basal racemes whorled, or more than 1 raceme attached to nodes of central axis.....27
- 25. a. Spikelet in 2 rows, rachis without setae, ending in a point, glumes unawned.....*Setaria flavida*
- 25. b. Spikelet in group or not, but not in row, and distantly each other, rachis with setae, ending in a spikelet, glumes awned.....26
- 26. a. Spikelet subsessile in fascicled cluster at intervals on the inflorescence axis.....*Oplismenus undulatifolius*
- 26. b. Spikelet in racemes, spaced along common axis.....*Oplismenus compositus*
- 27. a. Spikelet awned.....*Bothriochloa bladonii*
- 27. b. Spikelet unawned.....28
- 28. a. Inflorescence an open panicle, branched at most short hairy. Spikelet paired or in threes. Sessile spikelet ellipsoid, pedicelled spikelet shorter and narrower.....*Sorghum propinquum*
- 28. b. Inflorescence densely contracted, white hairy. Spikelet paired, all subequal.....29
- 29. a. Panicle 30 to 50 cm, lax.....*Imperata conferta*
- 29. b. Panicle 18 to 30 cm, constricted.....*Imperata cylindrica*
- 30. a. Spikelet awned.....31
- 30. b. Spikelet not awned.....*Digitaria mollicoma*
- 31. a. Lower glume of sessile spikelet transversely rugose or wrinkled.....*Ischaemum barbatum*
- 31. b. Lower glume of sessile spikelet not transversely rugose or wrinkled.....*Ischaemum muticum*

Synopsis of the Species

1. BOTHRIOCHLOA BLADHII (Retz.) S.T. Blake, Proceedings of the Royal Society of Queensland 80: 62. 1969.

Distribution. Waigeo, Raja Ampat Archipelago. Tropical Africa and Asia, introduced to America, widespread in Malesia (Lazarides, 1980).

Ecology. Sunny or slightly sheltered grasslands, Imperata fields, limestone, roadsides, teak forests, dry riverbeds, 0--900 m.

Notes. This taxon is polymorphic species. It has many names as synonyms, such as *Bothriochloa glabra* (Roxb.) A. Camus, and *Bothriochloa intermedia* (R. Br) A. Camus (Blake 1969). The latter name is derived from the fact that it easily hybridize with the other species, from the genera of *Bothriochloa*, *Capillipedium* and *Dichanthium*.

2. CENCHRUS BROWNII Roem. & Schult. Systema Vegetabilium, 2: 258. 1817.

Distribution. Batanta, Waigeo, Raja Ampat Archipelago. Originally from Central and South America, introduced to Africa and tropical (Austral) Asia (Duistermaat 2005), widespread, but local in Malesia.

Ecology. Sandy beaches, abandoned places, roadsides, railroads, rice fields, 0--600(=1800) m.

Notes. Annual, up to 70 cm tall. Easily confused with *C. echinatus* L., distinguished by its rachis

internodes and ratio of outer main bristles to inner spines of the burr.

3. *CENTOTHECA LAPPACEA* (L.) Desv., *Nouveau Bulletin des Sciences* 2: 189. 1810.

Distribution. Waigeo, Raja Ampat Archipelago. Lazarides (1980) mentioned in India to China, Polynesia, and Australia (Queensland). Widespread in Malesia.

Ecology. Swamps, open places in rain forest, under thickets, sometimes dominant along shaded roads, fields, up to 1500 m. The deflexed spines of the lemmas easily cling to clothing or furs (Gilliland, 1971).

4. *CHIONACHNE MACROPHYLLA* (Benth.) Clayton, *Kew Bulletin* 35(4): 814. 1981.

Distribution. Waigeo, Raja Ampat Archipelago. Moluccas (Ternate), Kai Island, Irian Jaya (Fakfak, Jayapura, Manokwari, Yapen Waropen), Papua New Guinea (East & West Sepik, Madang, Morobe, West & East Highlands, Western, Gulf, Central, Northern, Milne Bay, New Britain, New Ireland), Solomon Islands (Bougainville, Santa Isabel, Guadalcanal, Malaita, San Cristobal).

Ecology. Savanna, near water, disturbed areas, coconut plantations, *Imperata* fields, roadsides, fire-resistant, soil with rock and gravel, peaty clay, limestone, locally common, forming dense thickets, 0–1450 m.

Notes. It is a robust grass, with a maize-like appearance. It was found near a local plantation, as a big clump, up to 2 m across and 1.5 m high, and growing together with herbs.

5. *CHLORIS BARBATA* Sw., *Flora Indiae Occidentalis* 1: 200. 1797.

Distribution. Batanta, Raja Ampat Archipelago. Originally from tropical America, introduced to Africa, Asia and Australia (Duistermaat, 2005), widespread in Malesia.

Ecology. Weed in disturbed, dry, sandy sites. Along roads, swampy land, dunes, and grassland. Resistant to trampling and drought, thrives on saline or alkaline soil. Common along the coast, rare inland, 0–900 m. At Batanta, it found near the beach with other species such as *Imperata cylindrica* (L.) Rausch.

6. *CHRYSOPOGON ACICULATUS* (Retz.) Trin. *Fundamenta Agrostographiae*. 188. 1820.

Distribution. Waigeo, Raja Ampat Archipelago. Southeast Asia to Australia (Duistermaat, 2005; Lazarides, 1980).

Ecology. Common on open place, lawn, roadsides (Duistermaat, 2005), from sea level –1600 m.

Notes. Troublesome weed, spikelet with needle-like callus, easily attached to animal hairs and clothings (Henty, 1969).

7. *COIX LACRYMA-JOBI* L. *Species Plantarum* 2: 972. 1753.

Distribution. Waigeo, Raja Ampat Archipelago. Tropical Asia, now worldwide (Duistermaat, 2005).

Ecology. Roadsides, waste places, secondary vegetations (Duistermaat, 2005).

Notes. Cultivated as cereal and escaping. False fruit used for beads (Henty, 1969).

8. *CYRTOCOCCUM OXYPHYLLUM* (Hochst. ex Steud.) Stapf in Hooker, *Icones Plantarum*: t. 3096. 1922.

Distribution. Waigeo, Raja Ampat Archipelago. Seychelles, Sri Lanka, Bhutan, India to South China (Guangdong), Pacific (widespread), Australia (Queensland), in Malesia: widely spread, less common in the East (not yet in Timor island): Moluccas (Ambon, Buru), Papua New Guinea (Madang, Morobe, Milne Bay, New Britain, Central, Bougainville Province).

Ecology. Forests, light shade, edges of woods, clearings, road sides, not too dry, with some preference for a sandy substrate, locally common, (0–) 300–1500 m.

Notes. Apparently a new record for Irian Jaya. Mat of *C. oxyphyllum* forming shade-loving perennial, erect parts up to 50 cm tall, leaf blades flat, with small spikelet in an open panicle. Often coexisting with *Oplismenus compositus* (L.) P. Beauv.

9. *DIGITARIA MOLLICOMA* (Kunth) Henr. *Blumea* 1(1): 97. 1934.

Distribution. Waigeo, Raja Ampat Archipelago. Taiwan, Malay Peninsula to New Guinea (Duistermaat, 2005).

Ecology. open area, damp, sandy to rocky soil (shaded) roadsides (Duistermaat, 2005).

10. *ELEUSINE INDICA* (L.) Gaertn., *De Fructibus et Seminibus Plantarum* 1: 8. 1788.

Distribution. Batanta, Waigeo, Raja Ampat Archipelago. Originally from the Old World (sub) tropics, throughout Southeast Asia (Lazarides, 1980; Duistermaat, 2005), now widely introduced and naturalized. Widely spread and common on Malesia.

Ecology. Waste places, road-sides, fields. Drought resistant, often as the first and dominant colonist, and might become a serious weed; up to 1600 (–2000) m.

Notes. Easily recognized tufted species, up to 85 cm tall.

11. ERAGROSTIS AMABILIS (L.) Kuntze, *Revisio Generum Plantarum* 2: 773, 774. 1891

Distribution. Waigeo, Raja Ampat Archipelago. Tropics of the Old World (Lazarides, 1980), widely introduced in the New World. Throughout Malesia.

Ecology. Open waste places, roadsides (Duistermaat, 2005), between stones, near beaches, locally abundant, 0–550(–1400) m.

Notes. Found randomly dispersed as small patches at Kalitoko village in Waigeo island, common at roadsides.

12. IMPERATA CONFERTA (Presl) Ohwi, *Botanical Magazine* 55: 549. 1941.

Distribution. Misool, Kofiau, Raja Ampat Archipelago. Southeast Asia (Duistermaat, 2005).

Ecology. Open sandy place, unshaded to partly shaded, roadsides (Duistermaat, 2005).

Notes. See *I. cylindrica*.

13. IMPERATA CYLINDRICA (L.) Raeusch. *Nomenclator botanicus* 3: 10. 1797.

Distribution. Batanta, Waigeo, Raja Ampat Archipelago. Originally native in the Old World with a number of local forms, now widely introduced in the (sub)tropics (up to 45° on Northern and Southern hemisphere) with temperatures between 20–40 °C.

Ecology. Sunny to moderately shaded fields, land slides, sand and gravel banks, cultivated fields, gardens, plantations; 0–2700 m.

Notes. One of the worst weeds in world. The rhizomes form a dense mat with allelopathic, could

prevents other plants to grows. Flowering period is before the dry season, the fluffy spikelet widely dispersed by turbulent winds. The rhizomes are fire-resistant and new growth starts immediately after fire. The seeds have no dormancy. Very similar, if not identical, is *I. conferta* (J. Presl) Ohwi, mentioned by Takeuchi (2003) for Misool growing together with other grasses in a periodically fired savannah. Ms. D. Co (L) has not found any correlating character to distinguish between the two. Curiously, she found that anthers may be Y-shaped, while the species would be distinct by the number of anthers in the floret: 1 in *I. conferta* or 2 in *I. cylindrica*.

14. ISCHAEMUM BARBATUM Retz. *Observationes Botanicae* 6: 35. 1791.

Distribution. Misool, Raja Ampat Archipelago. Southeast Asia to New Guinea (Henty, 1969).

Ecology. Widespread and common, in grassland from sea level to 1750 m. (Henty, 1969).

Notes. use as pasture, withstand moderate grazing.

15. ISCHAEMUM MUTICUM L. *Species Plantarum* 2: 1049. 1753.

Distribution. Kofiau, Raja Ampat Archipelago. India to East Asia and Polynesia (Duistermaat, 2005).

Ecology. Common in lawns, open place, scrub, near sea with mangrove or beaches above high tide (Duistermaat, 2005).

Notes. Economically used as good fodder, and ecologically as sand binder (Lazarides, 1980).

16. LEPTOCHLOA VIRGATA (L.) P. Beauv. *Essai d'Nouvelle Agrostographie* 71, 161, 166, t. 15, f. 1. 1812.

Distribution. Batanta, Waigeo, Raja Ampat Archipelago. Originally from (sub)tropical Americas, introduced elsewhere, e.g. in Malesia: Java (Junghuhn, without locality, between 1835–1860, lectotype of *L. chinensis* Nees var. *aristata* Buse), New Guinea (before 1954): Irian Jaya (Raja Ampat, Sentani Lake), Papua New Guinea [West Sepik, Western (Daru Island), Madang, Morobe, New Britain, Gulf, Central, Northern, Milne Bay Province (Goodenough Island, Fergusson Island)].

Ecology. On open rocky (basaltic) or gravelly grounds, roadsides, exhausted fields; also in

savannas, on river banks, inundated grass land and swampy areas, tolerant to waterlogged and compacted soil, sometimes forming dense mats. 0–1000 m.

Notes. The specimens were initially misidentified as *L. chinensis* Nees by (Sumadijaya, 2007, unpublished). It forms scattered clumps, up to 1.5 m high, sprouts in between the stones, and grows successfully among other species.

17. MNESITHEA GLANDULOSA (Trin.) de Koning & Sosef, Blumea 31(2): 290. 1986

Distribution. Waigeo, Raja Ampat Archipelago. Malesia (Duistermaat, 2005).

Ecology. Dry-moist soil, from lowland to 1500 m, roadsides, streambanks (Lazarides, 1980).

Notes. In association with mixed forest and scrub (Lazarides, 1980).

18. OPHIUROS EXALTATUS (L.) Kuntze, Revisio Generum Plantarum 2: 780. 1891.

Distribution. Rauki, Raja Ampat Archipelago. China, India, Southeast Asia, Australia (Lazarides 1980).

Ecology. Ranging from sea level to 1540 m, in scattered clump, on wet soil, open savannah and evergreen forest (Lazarides, 1980).

19. OPLISMENUS COMPOSITUS (L.) P. Beauv., Essai d'une Nouvelle Agrostographie 54, 168-169. 1812.

Distribution. Waigeo, Raja Ampat Archipelago. Malesia, especially the Philippines, widespread in New Guinea, Micronesia, Fiji, Samoa, apparently introduced elsewhere (Scholz, 1981).

Ecology. Shaded areas, forested steps and ridges, along stream banks and roadsides from sea level to 1200 m (Henty, 1969).

Notes. Often sterile, but easily recognised by the relatively broad and slightly wavy leaf blades. *Van Royen 5156* from Waigeo only identified to genus level, the presumed inflorescences are leafy galls (personal observation by second author).

20. OPLISMENUS HIRTELLUS (L.) P. Beauv., Essai d'une Nouvelle Agrostographie 54, 168-170. 1812.

Distribution. Waigeo, Raja Ampat Archipelago. Throughout the tropical area of the world (Clayton *et al.* 2002 onwards).

Ecology. Shady places, on forested slopes and ridges, below 2400 m (Lazarides, 1980).

Notes. Van Royen 5308 from Waigeo is *O. hirtellus* of which *O. undulatifolius* is a variety.

21. PASPALUM CONJUGATUM P. J. Berg., Acta Helvetica 7: 129, t. 8. 1772.

Distribution. Batanta, Waigeo, Raja Ampat Archipelago. A noxious and aggressive weed of American origin, introduced in Malesia on the last half of the 19th century (not collected by *e.g.* Cuming, Junghuhn), now common throughout the area.

Ecology. Not restricted to particular situations, but with a preference of poor, open to moderately shaded, humid habitats. Often vegetation forming and out-competing crops and shade trees. Present on a variety of soils, up to 1700 m. The spikelet have a hairy fringe by which they easily attach themselves to fur and clothing. According to Henty (1969), the local names on Papua New Guinea meaning “mission grass”, suggesting a relatively recent introduction. The first Papua collection on BO was (*Peekel 21*) in 1905, collected by a German missionary, who since 1904 was in the Bismarck archipelago. This is an early collection, as it was believed that he started collecting in 1908 (Van Steenis-Kruseman, 1950; Sleumer, 1960; Stafleu & Cowan, 1983).

Notes. This is a perennial, rhizomatous, mat-forming, opportunist species, which is easily recognized by the “hunch-T” appearance of inflorescence. The spikelet has small hairs attach easily to anything that passes, and result as widely dispersed species.

22. PASPALUM LONGIFOLIUM Roxb., Flora Indical: 283-284. 1820.

Distribution. Waigeo, Raja Ampat Archipelago. Southeast Asia and North Australia (Duistermaat, 2005).

Ecology. Wet places, sometime floating on open water (Duistermaat, 2005).

Notes. Rare, weeds on rubber plantations, rice fields, and fruit gardens (Lazarides, 1980).

23. PHRAGMITES KARKA (Retz.) Steud. Nomenclator Botanicus. Editio secunda 1: 144. 1840.

Distribution. Waigeo, Raja Ampat Archipelago. Tropical West Africa to Japan, Polynesia, Australia (West Australia to Queensland) (Lazarides, 1980; Duistermaat, 2005), wide-spread on Malesia.

Ecology. Humid soils, along water, forming vegetation, 0–2000 m.

Notes. Young plant palatable for buffaloes. The whole plant is used against rheumatic complaints. Rhizomes and roots are edible, used as cure for diabetes. Roots used in healing broken bones. Culms used for flutes, pipes, being split for weaving baskets, chairs, fences, fish-traps, roofing, thatching, mats, walls. Used for making paper pulp. Inflorescences for brooms and cordage.

24. POGONATHERUM CRINITUM (Thunb.) Kunth, Enumeratio Plantarum Omnium Hucusque Cognitarum 1: 478. 1833.

Distribution. Waigeo, Raja Ampat Archipelago. Widespread from Sikkim, Bhutan, India, Sri Lanka to China, North West Pacific, Australia (Queensland). (Gilliland, 1971; Lazarides, 1980; Duistermaat, 2005).

Ecology. Growing abundantly from sea level to 2600 m in moist, or periodically flooded, shady, steep, rocky, open sites, crevices in rocky cliff and ravines, disturbed places (Gilliland, 1971). Facultative rheophyte.

Notes. Mat-forming grass, culms up to 20 cm. Receiving full sunlight.

25. SACCHARUM SPONTANEUM L., Mantissa Plantarum 2: 183.1771.

Distribution. Misool, Raja Ampat Archipelago. Paleo (sub) tropic (Duistermaat, 2005).

Ecology. Sandy soil, near water, occurs in lowland, up to at least 1500 m (Lazarides, 1980).

Notes. Robust perennial with extensive rooting system, often colonizing land exposed by retreating flood. Suitable for thatching and high quality material for paper pulp (Lazarides, 1980).

26. SCROTOCHLOA URCEOLATA (Roxb.) Judz. Phytologia 56 (4): 300. 1984.

Distribution. Waigeo, Raja Ampat Archipelago. Widespread from South India, Sri Lanka to Vietnam, throughout Malesia, Solomon islands and Queensland (Henty, 1969; Gilliland, 1971; Lazarides, 1980; Duistermaat, 2005).

Ecology. Generally rare, but locally common, distributed from low to medium altitudes. Inhabitant of primary alluvial forest with closed to partially closed canopy. Culms tufted, height reaching 50 cm, with easily detaching spikelet.

Notes. In the pristine forest under more or less closed canopy, it was the only grass found. The presence of species is often regarded as an indicator of good-quality forest. Known as rumput babi (pig's grass) in Singapore (Duistermaat 2005), because the inflorescence easily attaches to the fur of large mammals and clothing. The leaf blades are relatively broad, to maximize photosynthesis under the canopy. As a consequence, it is often misidentified as the seedling of a palm, a terrestrial orchid, or even a gingers.

27. SETARIA FLAVIDA (Retz.) Veldk., Blumea 39 (1-2): 376. 1994

Distribution. Waigeo, Raja Ampat Archipelago. Mauritius, Réunion, Sri Lanka to Sikkim, Bhutan, to South China (Guangdong, Hainan, Hong Kong, Yunnan), Australia (Queensland), Solomons, in Malesia: Malay Peninsula (Selangor), Sumatra (Lampung), Java, Madura, Kangean, Lesser Sunda Island (Lombok, Sumba, Sumbawa, Flores, Timor, Kisar), Philippines (Bohol, Cagayan Sulu Island, Cebu, Jolo, Leyte, Luzon, Mindanao, Mindoro, Palawan, Sulu), Celebes (Tala), Moluccas (Buru), Papua New Guinea (West Sepik), Solomon Island (Honiara) (Veldkamp, 1994).

Ecology. Areas with a moderate to strong dry season, lightly shaded grass fields, along roads, open teak forest, waste places, locally common, 0–500 m (Veldkamp, 1994).

Notes. This species is very rare in New Guinea, and only known from the present collection in Waigeo, one from Vanimo (West Sepik: *Waterhouse 2623*), one from Wewak (*Croat 52777*: <http://www.tropicos.org/Specimen/2370855>, accessed 17 December 2008), and a locality given offshore the North coast depicted in a map on the internet by CANB (http://www.anbg.gov.au/cgi-bin/map/winmap?taxon_id=47329, accessed 9 June 2009). In Waigeo, it was only spotted along roadsides (as part of ongoing project of the Trans Waigeo road).

28. *SORGHUM PROPINQUUM* (Kunth) Hitchc., Lingnan Science Journal 7: 249. 1931.

Distribution. Batanta, Waigeo, Raja Ampat Archipelago. South India, Sri Lanka to South China and Palau Island. Wide-spread in Malesia, introduced in New Guinea, e.g. Sorong.

Ecology. Sunny to lightly shaded, barren localities in grass jungles, river banks, thickets, teak forests, 0–500 m.

Notes. Robust, cane-like, rhizomatous grass, up to 2 m high (Lazarides, 1980).

29. *SPINIFEX LITTOREUS* (Burm. f.) Merr., Philippine Journal of Science 7(4): 229. 1912.

Distribution. Batanta, Waigeo, Raja Ampat Archipelago. Sri Lanka, India to South East China, Japan, Ryukyu Island, Ashmore Island (Northern Territory, Australia). Throughout Malesia in suitable places.

Ecology. Halophyte of sandy sea shores, locally vegetation-forming in *pes-caprae* formation, just above the high water line. Tussock forming, stoloniferous, dioecious.

Notes. Diaspores dispersed by wind and water. Roots bind unstable sand, forming dunes, and thus have a vital role in enlarging the coastal area as sand accumulator. We found it in the coastal area at Warmakrak as a small sized grass. It might be corresponded to a less light condition. In the sterile state, it can be recognized by the blades which are curved back, relatively short and rigid, and with apex pungent. It can be distinguished from *S. longifolius* R. Br with blades more or less erecto-patent, usually flattish to concave above, relatively long and flaccid, 20–50 cm long, upper surface nerved along the margins, distally slightly scaberulous, apex not pungent.

30. *SPOROBOLUS INDICUS* (L.) R. Br. var. MAJOR (Buse) Baaijens in Baaijens & Veldk., Blumea 35: 437.

Distribution. Batanta, Waigeo, Raja Ampat Archipelago. Sri Lanka, India to the Pacific, possibly introduced elsewhere (Baaijens & Veldkamp, 1991).

Ecology. Sunny to lightly shaded, not too dry or soggy, preferably hard or stony areas, especially along roads and paths, withstanding trampling, locally abundant and forming a narrow fringe along

paths, 0–2075(–2700) m.

Notes. Tufted grass up to 50 cm high.

31. *THUAREA INVOLUTA* R. Br., The Cyclopaedia 35, 2(70).

Distribution. Rauki, Indo-Pacific (Duistermaat, 2005).

Ecology. Sandy beaches (Duistermaat, 2005).

Notes. Nut-like structure of spikelet is adapted for dispersal by water with watertight and bouyant feature. Long creeping, mat forming, perennial, excellent sand binder and good fodder.

32. *ZOYSIA MATRELLA* (L.) Merr., Philippine Journal of Science 7(4): 20, 230. 1912.

Distribution. Waigeo, Raja Ampat Archipelago. Coasts of the Indian Ocean and Chinese Sea to the Ryukyu Island, Malesia: New Guinea: Aru Island, Irian Jaya, possibly introduced in New Guinea, e.g. Jefman Island, Waigeo, Morobe Province.

Ecology. Sandy beaches on the landward part of the *pes-caprae* formation, dry salt-marsh pastures, under coconut, locally dominant. Cultivated inland from 0–400 m. Often cultivated as a lawn grass because of its mat-forming habit, and used to control erosion (Gilliland, 1971; Lazarides, 1980; Duistermaat, 2005). Once established it may be difficult to be eradicated.

Notes. Small grass, found sterile at traditional pier, vegetatively slightly similar to *Cynodon dactylon* (L.) Pers., which has close-set leaves in groups of three and auricles with a tuft of hairs.

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W.J.J.O. DE WILDE & BRIGITTA E.E. DUYFJES. <i>Trichosanthes (Cucurbitaceae)</i> in Malesia: additions and corrections, including a new species and a new variety.....	221
DEDEN GIRMANSYAH. Two new species of <i>Begonia (Begoniaceae)</i> from Bukit Tiga-puluh National Park, Riau, Sumatra.....	229
PUDJI WIDODO. New nomenclature in <i>Syzygium (Myrtaceae)</i> from Indonesia and its vicinities.....	235
ALEX SUMADIJAYA & JAN FRITS VELDKAMP. Non-Bambusoid <i>Grasses (Gramineae)</i> from Raja Ampat Archipelago, Papua Barat Province, Indonesia.....	241
ARY PRIHARDYANTO KEIM. New variety, records & discoveries of some species of <i>Pandanus (Pandanaceae)</i> in Sumatra and Kalimantan, Indonesia.....	255
HARRY WIRIADINATA. A new species of <i>Begonia (Begoniaceae)</i> from Sagea Lagoon, Weda Bay, Halmahera Island, North Moluccas, Indonesia.....	263
ARY PRIHARDYANTO KEIM. The Pandan flora of Foja-Mamberamo Game Reserve and Baliem Valley, Papua-Indonesia.....	271
JAN FRITS VELDKAMP. <i>Koordersiochloa</i> Merr. (<i>Gramineae</i>), the correct name for <i>Streblochaete</i> Hochst. ex Pilg.....	299
SRI ENDARTI RAHAYU, KUSWATA KARTAWINATA, TATIEK CHIKMAWATI & ALEX HARTANA. Leaf anatomy of <i>Pandanus</i> species (<i>Pandanaceae</i>) from Java.....	305

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