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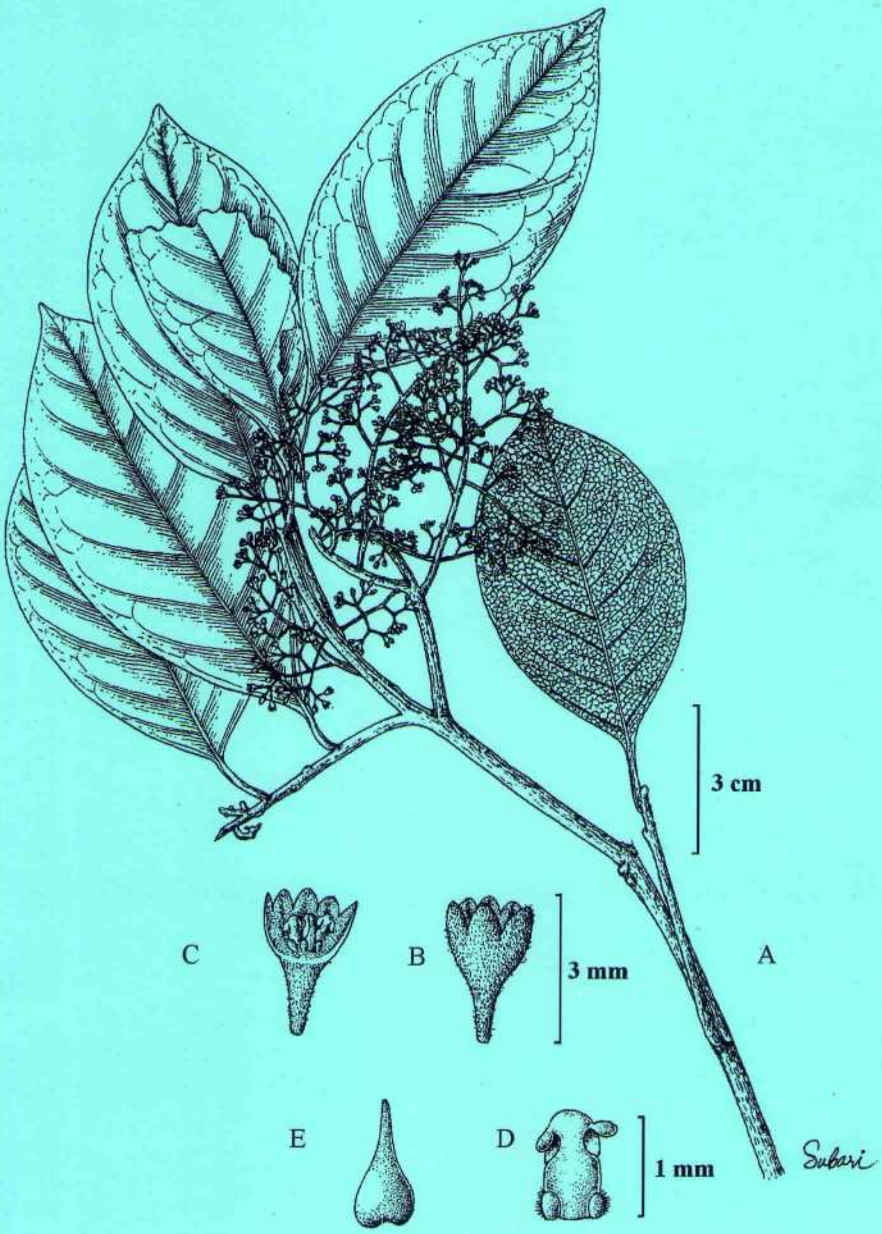

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SIX YEARS EXPERIENCE ON PLANT IDENTIFICATION SERVICES: A CASE STUDY IN HERBARIUM BOGORIENSE

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ABSTRACT
SUMADIJAYA, A. Six years experience on plant identification services: a case study in Herbarium Bogoriense. *Reinwardtia* 13(4): 347-356. — The Herbarium Bogoriense (BO), an integrated part of the Botanical Division, Research Center for Biology, Indonesian Institute of Sciences, receives plant specimens to be identified on a daily basis. In a six year period from 2005 to 2010, data were extracted from thousand of identification requests by hundreds of clients. Patterns were observed based on variables such as time, plant groups, client expertises, and taxonomic level. Outputs from these analysis are being expected to become one of the pillar to build a unifying scheme for botanical research at the Herbarium Bogoriense by focusing on human resources development to deal with biodiversity issues about frequently encountered taxa.

Keywords: Biodiversity, Herbarium Bogoriense, ID service, names, specimen.

ABSTRAK
SUMADIJAYA, A. Pengalaman enam tahun dalam pelayanan identifikasi tumbuhan: sebuah studi kasus di Herbarium Bogoriense. *Reinwardtia* 13(4): 347-356. — Herbarium Bogoriense (BO), sebagai bagian dari Bidang Botani, Pusat Penelitian Biologi - LIPI, menerima jasa identifikasi tumbuhan sebagai kegiatan rutin. Data selama enam tahun sejak 2005 sampai 2010, dikumpulkan dari ribuan hasil identifikasi yang diajukan oleh ratusan pengguna. Pencarian pola pelayanan berdasarkan beberapa faktor antara lain waktu, kelompok tumbuhan, keahlian pengguna serta hirarki taksonomi. Luaran dari analisis ini diharapkan dapat menjadi dasar untuk membangun sebuah skema yang menyatukan skema penelitian botani di Herbarium Bogoriense dengan memfokuskan pada pengembangan sumber daya manusia yang berkaitan dengan keanekaragaman taksa yang sering dijumpai sehari-hari.

Kata kunci: Keanekaragaman hayati, Herbarium Bogoriense, jasa identifikasi, nama, spesimen.

INTRODUCTION

Plant Identification Service

Every year, the Herbarium Bogoriense (BO) receives hundred of requests for plant identification (ID) service. Supported by the best qualified technicians (parataxonomists) for identification, as well as plant taxonomists for validation of the plant names, the institution maintains the status as the national scientific authority for plant biodiversity in Indonesia. It has numerous plant specimens as reference collections (dried, spirit, and carpology) and become one of the oldest herbaria in the tropics, which is established in 1817 (Holmgren *et al*, 1990).

The annual report of the Research Center for Biology, Indonesian Institute of Sciences (the parent institution) inconsistently mentioned the cumulative number of specimen which has been determined and number of client during each calendar year (January 1st to December 31st). Annually, the number of client and specimen were varies, with the following records: 1484 specimens in 2002 (Anonymous, 2003); 2272 specimens in 2003 (Prasetyo, 2004); 311 clients and 2567 specimens in 2008 (Anonymous, 2009); 332 clients and 2650 specimens in 2009 (Anonymous, 2010).

The basic function of the service is to provide clients with the scientific name(s) of their plant specimens. The ID service starts when a client request for plant identification being received by BO (delivered by client, courier or sent by mail). The specimen was then identified by parataxonomist to determine the species name. The next step was validation of the name by plant taxonomists or often the curator(s) of the particular taxa. The result is a written certificate, given to the client, with the scientific name(s) of the specimen(s) under family, genus and species names. Most of the requests can be resolved into the species level, or even the infraspecies level, although some remain unresolved only to genera or family level, or were unidentified.

During 6 years, dynamic of the ID services were unrecorded with respect to the feature such as taxonomic level, time of certificate issue, and field of expertise of the client. These data change with time, but the pattern, if any, remains unknown. Resuit of data mining and pattern seeking can be used to focus limited human resources on particular priority taxa that were frequently accessed.

The clear objectives for the study was to digitize the data, as well as establish a baseline for quantitative information of the ID services, and improve the result. Any defect, mainly dealing with standarisation *(e.g.* for names), can be revised for BO's future improvement of ID services. In addition, a more advanced utilization of the data could be used for the development of policy issues at local, national, or international levels. For example, the data can be used to identify (potentially) valuable species for national programs, or for supporting assessments in biodiversity.

BO's human resources and plants collection

To identify the specimens, parataxonomists rely on the reference of BO's dried collection. BO has dried collections which comprises 306 families of Spermatophytes, and more than 30 families and groups in Pteridophytes. Most collections were collected from the Malesia phytogeography region, with a smaller number of plant collections from other region, as a result of voucher deposits from other herbaria. Considering variable number of the families in flowering plants as mentioned in Heywood (1993) and realizing differences in major plant classification systems (Brummit, 1992), the taxon names being used for identification is based on a system which has been exclusively developed by the Herbarium Bogoriense. Over time, the system had been influenced by prominent botanists such as F. W. Junghuhn (1809-1864), C. A. Backer (1874 - 1963), and C. G .G. J. van Steenis (1901-1986).

Today, plant taxonomists expertise in BO are distributed unequally, most focus on taxa with important ecological functions or economic uses. Several large families have more than one expert (number in parentheses) *e.g. Orchidaceae* (2), *Arecaceae* (2), *Araceae* (2), *Zingiberaceae* (2), *Begoniaceae* (2), and *Poaceae* (2). On the contrary, the large collection of Pteridophytes have only 3 experts. The remaining taxonomists focus on *Euphorbiaceae, Myrtaceae, Rutaceae, Sapotaceae, Pandanaceae, Musaceae, Araceae, Lauraceae, Rafflesiaceae, Balsaminaceae, Bryophytes,* and *Basidiomycetes.* These staff come from various education levels, ranging from Bachelors to Doctoral degree, and Professorship. Name validation also conducted by accessing authorized websites (www.ipni.org, www.tropicos.org, and www.theplantlist.org) regularly.

MATERIAL AND METHOD

Digital available data extracted from the year of 2005 to 2010. The data were arranged annually, and each year comprised of hundred of request from clients.

The procedure for the data analysis was divided into 2 phases. Phase one consisted of copying the data from the certificates (.doc or .docx), then arranging it into columns (scientific names, families, client, and time factor) on a spreadsheet (.xls). The next step was standardizing the format (e.g. look at nomenclature issues in discussion) for easier sorting. Data were checked based on client name to remove any duplicate entries.

Phase 2 involved searching for annual pattern(s) in the data. Data were sorted into alphabetical order to extract for scientific names, clients, and time period. In each year, data were filtered for the most frequently identified taxa, by ordering from the highest rank into the lowest one. The final step was comparing these data annually to spot any pattern(s) over the years.

RESULT AND ANALYSIS

The study covered 15,779 specimens from 4,158 client requests six years (72 months) period. In total, there were 3,783 specimens being determined (including synonyms), within 1,377 genera and 314 families. Taxon determination with *cf.* status and infra-specific level were treated as being part of the appointed species.

Nomenclature Issues

Standardization of names is very important, since many taxa have synonyms or alternative names. Different names treated to the same taxon could be the result of whether different human resources (with varying taxonomic backgrounds and expertise during the validation process) or purely changes in classification. Several widely known families of *Compositae, Cruciferae, Gramineae, Guttiferae, Labiatae, Leguminosae, Palmae,* and *Umbelliferae* were treated each under nomen alternativum (McNeill *et al.,* 2006), as *Asteraceae, Apiaceae, Poaceae, Clusiaceae, Lamiaceae, Fabaceae, Arecaceae* and *Brassicaceae* consecutively. These alternative names were found occasionally contaminating the certificates, sometimes written as *e.g.* "*Labiatae= Lamiaceae*". These inconsistencies are the priority for future improvement. There were also cases such as *Papilionaceae, Caesalpiniaceae,* and *Mimosaceae* which regarded as three different families. It was decided to unify these taxa under single family in accordance with specimen management storage at BO. Typing errors also found, with different character(s) *(e.g. Allophilus* of *Allophyllus)* and character inconsistency (e.g. *Axonophus compressus* of *Axonopus compressus).*

Synonyms problem were haunting in the analysis, since a name easily becomes synonym under particular taxa. Here, from 3,783 names given, each might not represent a unique taxa. Some of these were discussed in Species section below.

Number of specimens and clients

Specimen and client number were slowly increasing in six years, as shown by linear regression analysis in Figure 1. This analysis has goal to forecast and anticipate the bulk of specimen in the future. It will become a strong justification to improve the management system for ID services.

The year of 2006 marked the lowest client number, with 604 clients, a slight decrease from 621 clients in 2005. Then, the client number increased steadily to 645 in 2007, 676 in 2008, expanding to 792 in 2009, and reached 819 in 2010.

Contrary to client numbers, the year of 2006 with 2,810 specimens served as the peak point after the increase from 2,032 in the previous year. In the following years of 2007 and 2008, specimen number dropped to 2,609 and 2,537 in a row, before reaching up to 2,843 in 2009, and 2,948 in 2010. These dynamic figures might correspond to dynamic number of people who have involved general biodiversity issues or focusing on species in their research project, such as forestry and mining.

The annual report of the Research Center for Biology (2009) showed different number, with lower client number (332), which might be caused by unfiltered multiple clients, and higher specimen number (2,576), which caused by the duplication of specimen input.

Time component

Twelve months period in each year were divided into 4 quarters, each with three months interval as seen in Figure 2. In the first quarter (January - March), specimen number were relatively stable, except for 2009, which increased to 562 in February. The most productive time was during the last quarter (October - December) with *ca.* 400 specimens identified (600 in 2009), except for 2005 and 2006, when the number dropped dramatically to less than 200 specimens in November and December respectively.

Each year, the period of minimum specimen (less than 100 specimens) was generally 1 month. In the case of 2007, March to May had a low number in ID service because of the institution relocation from Bogor to the new location at Cibinong Science Center. On the following year, the low specimen number might be the result of no extra ordinary activity in the beginning of the year, which was associated with budget allocation in most institutions.

Caution should be noted in the time factor recorded on the certificate. It was represent the month of the ID service was approved by the institution, not the time of specimen arrival at BO. Most clients with single specimen received the result as the same month as the sample arrived. However, some clients had hundred of specimens. It resulted in the work of ID services that would be extended up to 2

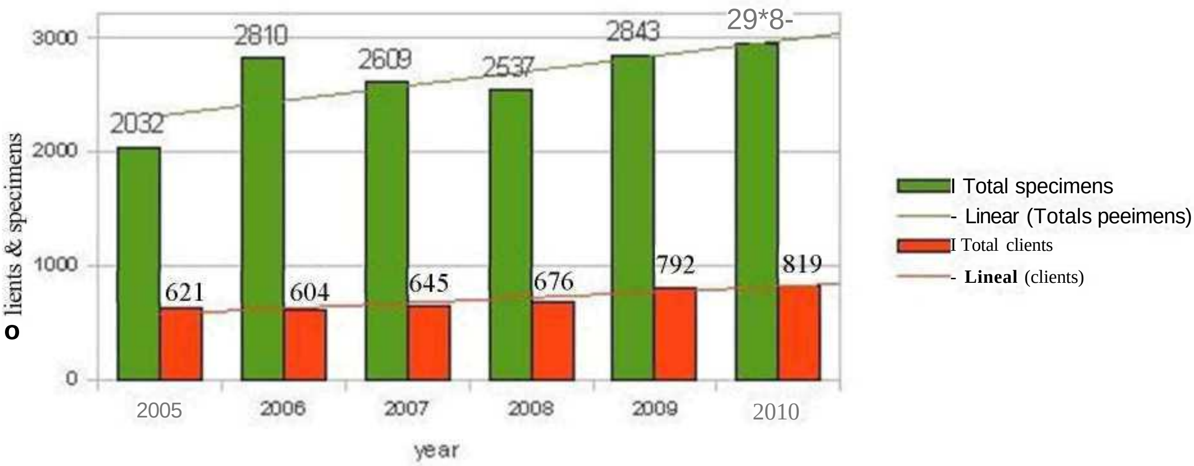

Fig 1. Number of clients and specimens varies annually, trends show steady increase with linear regression.

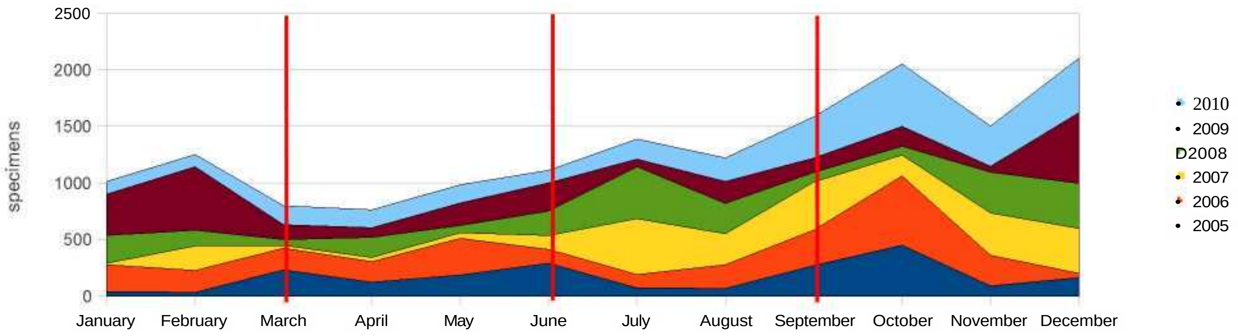

Fig. 2. Client requests within the 6 year period studied. Note the light period (March-April), in contrast to significant increase in the last quarter (October - December).

- 3 months before the certificate issued.

Client expertises

Unfortunately the expertises of the client were not properly recorded, as the data were inconsistently noted. On average, 67.37 % of the total client (ranging from 59.0% in 2008 to 76.7% in 2009) did not mention their expertise explicitly. Field of expertises were extracted from the remaining 32.63% client who mentioned their domain explicitly. Some clients did mention their expertise generally as Natural Sciences. Natural sciences is a broad domain which can be categorised into pharmacy, biology, chemistry, mathematics, geography, and physics. The first three is often to use ID services, rather than the last three. This case makes natural sciences as a domain lacks of details and produces bias information. Therefore it was not included in the analysis.

The dominant clients were pharmacy, followed by biology and chemistry which almost equal in number. Medical field increased slowly after appeared in 2005, whereas forestry was up and down sporadically from year to year. Other minor fields were oceanography, anthropology, and geology.

Focusing on the institutions, most of the users came from various educational institutions such as Universities (public and private) and Academies of pharmacy, whether as undergraduate or graduate students, from either Indonesia or overseas. Others were from public sector, mainly various Research Centers in Biotechnology, Chemistry, and Geotechnology, all are parts of Indonesian Institute of Sciences, Veterinary Services, Government Departments (Forestry, Agriculture), Botanical Gardens, National Parks, as well as private companies (Food, Pharmaceutical, Foundry, Plantation and Agribusiness, and Forest Concessions). Minority came from International Groups, International Companies, Non -Governmental Organizations, and Hospitals.

Interesting sporadic requests were made by BPOM (Badan Pengawas Obat dan Makanan, the National Agency of Drug and Food Control). The institution requested identification of many specimens at once, with each specimen was given a single certificate apart from another, which resulted in large number of certificates.

Data Dilemma

Based on various client backgrounds, the samples given for ID services were in variable state. Some were severely damaged by fungi, due to improper method of preservation, or lacked of vital parts like flower and inflorescence, which is difficult to be identified. This resulted in unidentified specimens, or identified only to family or genera level.

To date, the information still leaves several unresolved questions. One was the lack of information about which plant parts were used for identification (the plant parts could be twigs, leaves, stems, tubers, flowers, fruits, or the whole plant). Answering this question could help anticipate future obstacles to successful identification. Second, the exact locations (island, mountain, beach, forest, or other geographical details), and habitat or sites (plantation, roadside, garden, mine, conversion area, or other landscape information) of specimens was not recorded, resulting in difficulties to determine the origin of specimens.

Future potential

The **ID** services potentially inform the existence of new species. It can serve as the hunting ground for new species candidate if we focus on unidentified specimens at families or, and genera level, with appropriate generative structure and field notes.

New record regarding expansion of distribution area of certain taxa can be resulted from this activity. In order to do so, a specific task force should be assembled. For temporary, the comparison can be treated only for the island of Java, which has detailed inventory of Spermatophytes in Flora of Java. The three volume books of Flora of Java serve as basic list to monitor the plants in this island.

Plant group

The division of plants were based on practical reason. Among these groups are: Spermatophytes (Seeded plant), Pteridophytes (Fern), Bryophytes (Mosses), Lichens and Fungi. Most specimens were Spermatophytes with 14,540 specimens (92.1%). The Spermatophytes itself divided into subgroups of Angiosperm which had significant portion with 14,495 specimens (91.8%) and Gymnosperms with 45 specimens (0.3%). Angiosperms consist of Dicotyledoneae with 12,162 specimens (77%) and Monocotyledoneae with 2,333 specimens (14.8%), as seen in Figure 3. Annual dynamic of plant groups were visualised in Figure 4.

The Dicotyledoneae within Spermatophytes noted as the largest proportion of identified plant group. The result was matched with the prediction, since the majority of flowering plants are within these groups, which have most frequent interaction with people's daily life.

Pteridophytes (612 specimens, 3.9%) ranging from 55 specimens in 2007 to 149 specimens in 2009. From 2008, there were more than 100 specimens annually. The group only had a small proportion of the total specimens, but has stable presence in each passing year.

Gymnosperms comprised fewer than 10 specimens annually, except for 2008 when there were 16 specimens.

The rest of the groups had percentages around 1% of the total specimens. Lichens were a tiny fraction (101 specimens, 0.6 %), ranging from 1 in 2005 up to 67 in 2006, with less than 15 specimens for the next 4 years. Bryophytes (185 specimens, 1.1%) and Fungi (136 specimens, 0.9%) only occur sporadically. The former was absent in 2006 and 2007, whereas the latter was absent in 2007 and 2010. *Sargassum granuliforum* C. Agardh. *(Sargassaceae)* represented Thalophytes, had only single occurrence within the 6 years period, which was in 2009. For oceanic species, it was assumed that most of the specimen being given to the Research Center for Oceanography which focus on marine species.

Families

The top 10 families based on identified specimen were marked by *Euphorbiaceae* as the most specimen (943), followed by *Fabaceae* (797), *Moraceae* (combined with *Cecropiaceae,* 736), *Rubiaceae* (593), *Zingiberaceae* (combined with *Costaceae,* 588), *Myrtaceae* (521), *Poaceae* (502), *Asteraceae* (491), *Dipterocarpaceae* (359), and *Lauraceae* (358) as seen in Figure 5.

To visualize some taxa dynamics, criteria were subjectively defined (more than 50 specimens annually from 6 consecutive years). As consequences, only several of the top ten families being represented here. Families with 50 specimens, but without consecutive presence within these years or vice versa, were rejected from Figure 6.

As the largest family identified with 943 specimens, Euphorbiaceae consisted of various species within 58 genera. *Macaranga* was the largest genus with 100 specimens (10.6%), followed by *Glochidion* with 86 specimens (9.12%), *Mallotus* with 67 specimens (7.1%), *Phyllanthus* with 60 specimens (6.36%), *Antidesma* with 57 specimens (6.04%), *Acalypha* with 55 specimens (5.83%), *Baccaurea* with 53 specimens (5.62%), and *Aporusa* with 49 specimens (5.19%). The rest of the genera each contributed less than 5 %.

Fabaceae had 797 specimens, and had the largest number of genera (78) compared to all identified

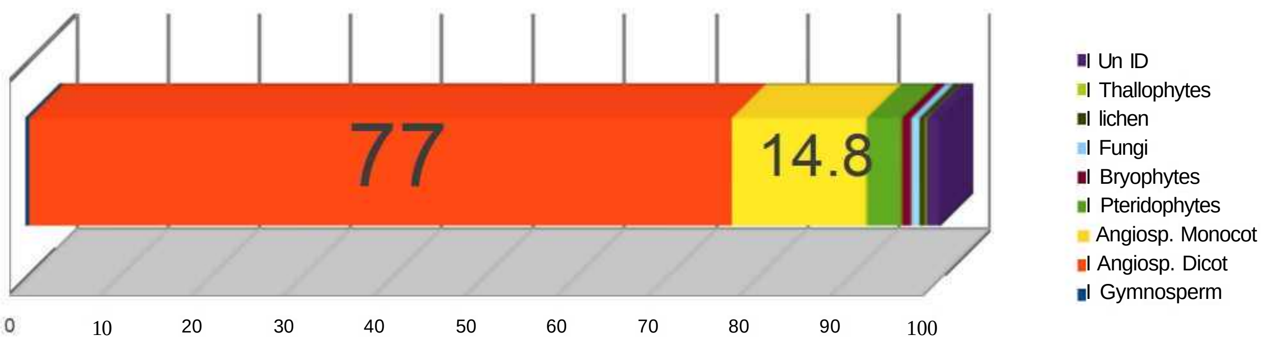

Fig. 3. Percentage of total plant group identified. Percentages only correspond with Dicotyledoneae and Monocotyledoneae as the largest components. Fern, Lichens, Thallophytes, Fungi and Gymnosperms have very small proportion shown here.

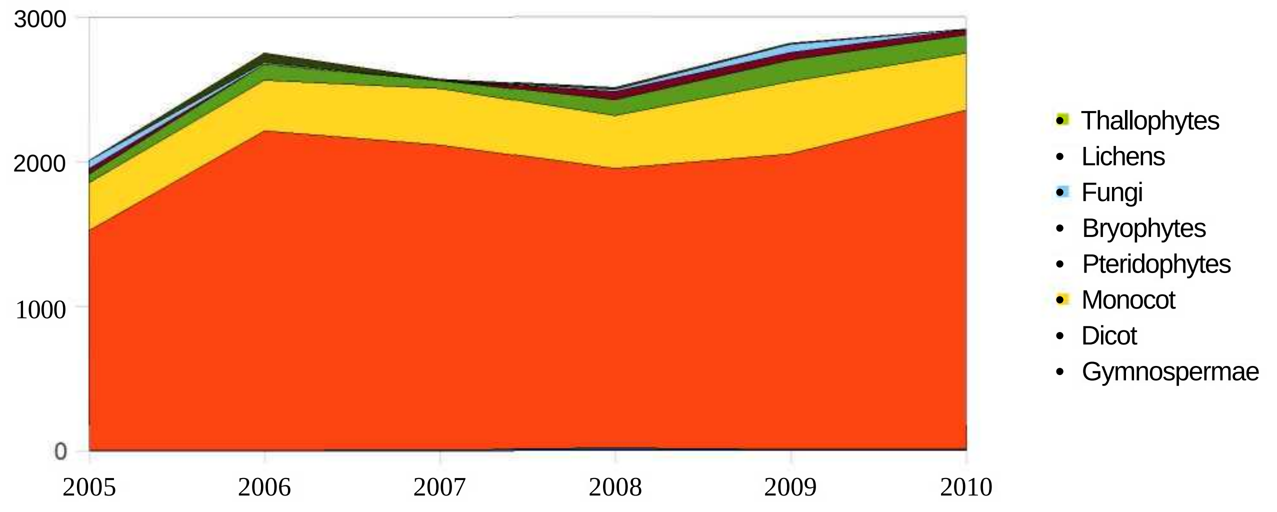

Fig. 4. Dynamics of plant groups identified. Thallophytes have very small proportion that is not shown here.

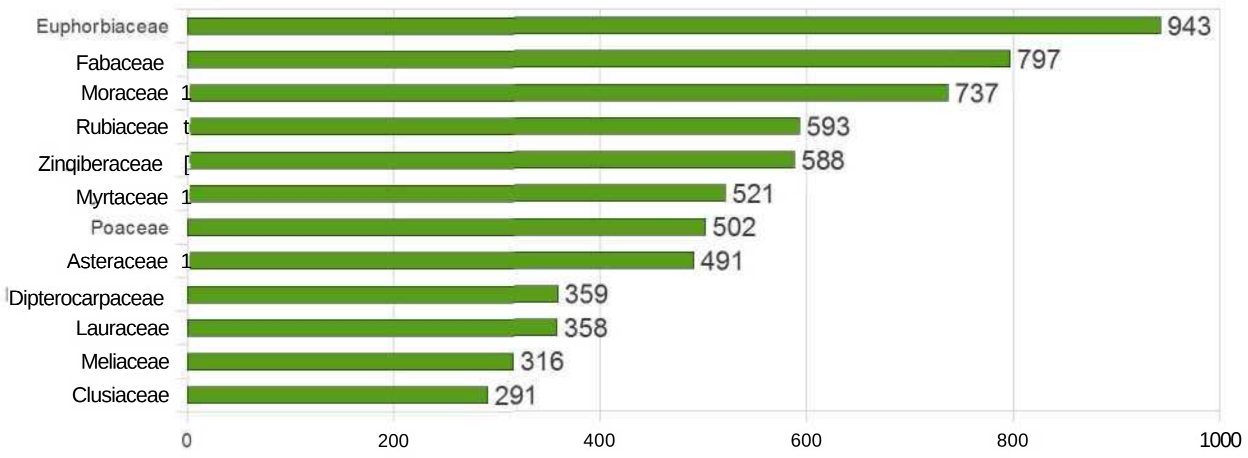

Fig. 5. Ten dominant families from 2005 to 2010.

Fig. 6. Identification at family level. Only 6 families top dominant are shown. Dipterocarpaceae has a significant increase at the end of the period. Specimen only showed at *Dipterocarpaceae, Euphorbiaceae* & *Fabaceae.*

family. The largest genus was *Cassia* with 56 specimens (7.02%), comprised of 13 species (some were ornamental plants such as *C. fistula* L., *C. hirsuta* L., *C. multijuga* Rich., and *C. siamea* Lam.). There was no dominant genus with more than 10% proportion. It happened due to almost equal distribution of the genera. Some were pulses such as *Arachis hypogaea* L., *Cajanus cajan* **(L.) Huth,** *Glycine max* (L.) Merr., *Parkia speciosa* Hassk., *P. timoriana* (DC.) Merr., *Phaseolus radiatus* L., *P. lunatus* L., *P. vulgaris* L., *Pithecellobium jiringa* **(Jack) Prain** ex King, *Tamarindus indica* L., and *Vigna unguiculata* (L.) Walp. *Fabaceae* also contains forages such as *Calopogonium mucunoides* Desv., *Desmodium* spp., and *Leucaena leucocephala* (Lam.) De Wit, as well as wayside trees *(Dalbergia, Pterocarpus indicus* Willd.), and even weeds *(Mimosapudica* L.).

Moraceae, with 737 specimens, was dominated by the giant genus of *Ficus* (516 specimens, 70.1%), which was discussed further in the genera section. Meanwhile *Artocarpus,* known as either a vegetable or fruit in daily life, with *A. altilis* (Park.) Fosberg, *A. heterophyllus* Lam. and *A. Integra* Merr., consisted of only 143 specimens (19.4%). These 2 genera were making for almost 90% of the specimens of the family. The remaining *c.* 10% was occupied by *Morus* (34 specimens, 4.6%), with contribution of some minor genera such as *Antiaris, Broussonetia, Cecropia, Cudrania, Fatoua, Parartocarpus, Poikilospermum, Sloetia, Streblus,* and *Taxotrophis.*

Zingiberaceae, with 588 specimens *(Costus,* with 29 specimens also included here). Two genera of *Curcuma* and *Zingiber* occupied more than half (59.9%) of the family. Further discussion is in the section on genera trends.

Poaceae had 502 specimens. Bamboos as a distinct group consisted of 58 specimens (11.55%). *Oryza sativa* L., a staple food in Indonesia, had 32 specimens, with 4 specimens identified to the infraspecific level *i.e. O. sativa* f. *glutinosa* Blanco (recognized as sticky rice). *Zea mays* L. had 13 specimens. The sugar cane, *Saccharum,* occured with 3 species *(S. edule* Hassk, S. *officinarum* L., and *S. spontaneum* L.) of 7 specimens. *Axonopus compressus* (Sw.) Beauv., an exotic species from South America now commonly used as lawn grass, had 23 specimens. It has polymorphic appearance, contributed to different vernacular names such as jukut pait, suket pait, papaitan, or rumput gajah mini. The essential oil producer *Cymbopogon* was recorded with 2 species of 26 specimens. The dominant weeds genera encountered were *Imperata, Panicum, Paspalum,* and *Pennisetum.*

Weedy *Asteraceae* consisted of 491 specimens. Similarly to *Fabaceae,* 49 genera were distributed almost equally and resulted on no dominant genus with more than 10% proportion of each genera within family. The largest contributions were *Gynura* (48 specimens, 9.77%), *Eupatorium* combined with *Chromolaena* (35 specimens, 7.12%), *Blumea* (41 specimens, 8.35%), and *Pluchea* with single species of P, *indica* (L.) Lees. (30 specimens, 6.1%). The other genera were less than 5% and included of *Ageratum, Bidens, Clibadium, Cosmos, Elephantopus, Erigeron, Lactuca, Mikania, Sonchus, Synedrella, Tagetes, Tridax,* and *Wedelia.*

The rest of the families with more than 100 specimens annually were economic importance such as *Rubiaceae* (593; medicine, ornamental, and weeds), *Myrtaceae* (521; fruit and spices), *Lauraceae* (358 specimens, fruit and spices), *Dipterocarpaceae* (359 specimens, timber trees), *Meliaceae* (316 specimens, fruit, medicine, and timber) and *Clusiaceae* (291 specimens, fruit and medicine).

Largest unidentified specimens belonged to the families of *Rubiaceae* (23), *Dipterocarpaceae* (17), *Fabaceae* (15), *Arecaceae* (11), and *Apocynaceae* (10). Meanwhile, 196 specimens remained unidentified to the family level because specimens were incomplete, broken, fragmented, or experienced colour change.

Number of ornamental plants such as *Araceae (Homalomena, Aglaonema)* were less than expected. This might be caused by easier access to popular information from TRUBUS, an agricultural and hobbyist magazine, which provides informations for ornamental, medicinal, and other economic prospective plants.

An interesting fact was observed in the banana family. *Musaceae* had 53 specimens, but only 10 specimens were identified by using scientific names (M *acuminata* Colla, *M. balbisiana* Colla, or *M. paradisiaca* L.). The rest were identified as either *Musa* "ABB" (followed by local names, mainly *kepok,* with other variants such as *nangka, uli, lampung, raja sereh, tanduk),* or *Musa* "AAA" (followed by local names, mainly *ambon,* and with other variants such as *mas, barangan, ambon lumut,* and *giant cavendish).* It was illustrating the use of two systems which were 1.) a botanical binomial nomenclature of species name for wild type, and 2.) a standardized genotype based with local names on recognized cultivated variants.

Most of the specimens that have been identified were banana cultivars and some of them were not using the current system. Classification and nomenclature of banana cultivars have been a long complicated issue. Today, the three tiers system using species, genome group, and cultivar are being adopted. The edible diploid and triploid which were derivatived from *Musa acuminata* Colla and *Musa balbisiana* Colla uses the scientific name of their respective wild parents. Whereas the hybrids will be classified under *Musa* x *paradisiaca* L. as recognized by International Code of Nomenclature for Cultivated Plants.

Genera

Ten largest genera were identified as *Ficus* (514 specimens), *Syzygium* (341 specimens), *Shorea* (264 specimens), *Piper* (261 specimens), *Curcuma* (199 specimens), *Garcinia* (172 specimens), *Zingiber* (148 specimens), *Artocarpus* (143 specimens), *Litsea* (130 specimens), and *Aglaia* (110 specimens) as shown in Figure 7.

With similar rules as for the families, criteria were subjectively being customised to identify genera dynamic. The criteria was the number which must exceed 15 specimens annually within 6 consecutive years (Figure 8).

Ficus had the highest number with 514 specimens. Two dominant taxa, each with significant portions of the total were *F. sinuata* Thunb. (31 specimens) and *F. fistulosa* Reinw. ex Blume (27 specimens). Fifty two specimens (10.11%) remained unidentified and was the highest unidentified genus in ID services. It might be caused by polymorphic species appearance and sterile specimens which made difficulties in ID service.

Next genus was *Syzygium* with 20 specimens in 2005, increasing to more than 50 specimens in the following year. It showed steady progress through the rest of the period and included a variety of species. *Syzygium* had variable species with 341 specimens (65.45%) from the rest of Myrtaceae. *Psidium*, an exotic plant in Indonesia with only a single species (*Psidium guajava* L.) followed it with 57 specimens (10.94%).

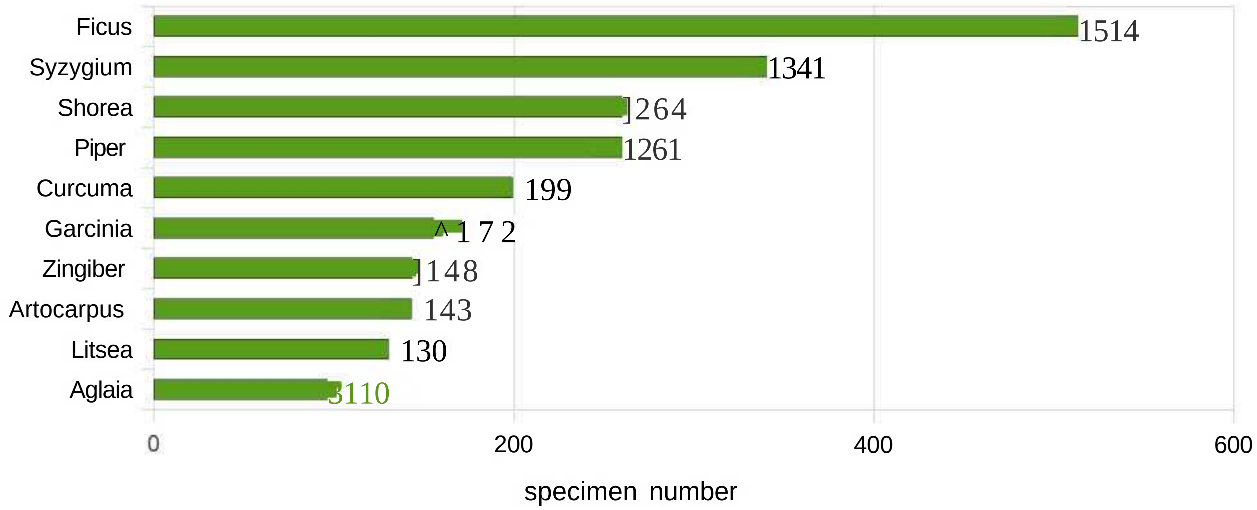

Fig. 7. Ten dominant genera from 2005 to 2010.

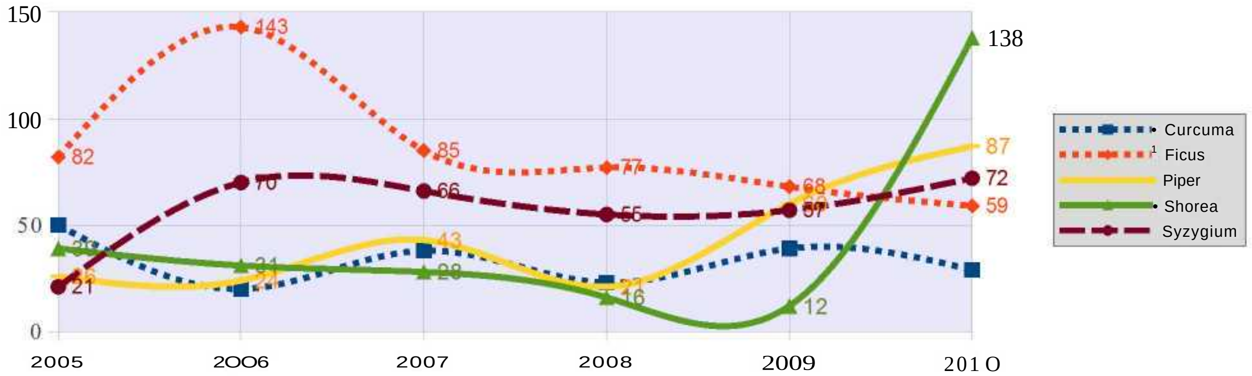

Fig. 8. Identifications at Genera level. The graphic is shown the largest 5 families dominant with specimen number, except for *Curcuma*.

Shorea showed a significant increase in 2010, with more than 100 specimens. The genus was dominant family of *Dipterocarpaceae* (264 of 359 specimens, 73.53%). Two of the most frequent species, *S. selanica* Blume (66 specimens, 25%) and *S. assamica* Dyer (31 specimens, 11.7%) resulted in more than one third of the family. High demand of identification for this taxa were due to its high economic value. The remaining genera with less than 25 specimens were *Dipterocarpus* (24), *Hopea* (20), *Vatica* (18), *Cotylelobium* (13), *Parashorea* (6) and *Anisoptera* (3).

Piper with 261 specimens was a significant component of Piperaceae (93.21%). More than half of *Piper* was *P. betle* L. (132 specimens, 47.14%). Three other genera, *Heckeria, Pilea,* and *Peperomia,* which only represented minor proportion.

Specimens of *Curcuma* (199 specimens, 33.8%) was consisted of *C. zanthorrhiza* Roxb., *C. zedoaria* Roscoe, *C. longa* L., and *C. mangga* Valeton & Zipp. *Zingiber* (148 specimens, 25.2%) was consisted of Z *officinale* Roscoe, Z *zerumbet* (L.) Smith, and Z *montanum* (J. Konig) A. Dietr. Both genera dominated in *Zingiberaceae* were the next significant genera within 6 years. The detail is discussed under species section.

Garcinia was the largest genus (172 specimens, 59.1%) in Clusiaceae, with a total of 291 specimens. The next giant genus was *Calophyllum* (105 specimens, 36.1%) with the remaining (5.8%) distributed in 4 genera *(Clusia, Cratoxylon, Mammea,* and *Mesua).*

Some genera with significant number of species remained unidentified to the species level were *Syzygium* (65 specimens), *Ficus* (51 specimens), *Calamus* (34 specimens), and *Dendrobium* (21 specimens).

Species

Top ten species were *Piper betle* (132 specimens), *Zingiber officinale* (84 specimens), *Phaleria macrocarpa* (74 specimens), *Alpinia galanga* (L.) Willd. (72 specimens), *Curcuma zanthorrhiza* (69 specimens, with *C. xanthorrhiza* treated as synonym (Newman, *et al.* 2004)), *Shorea selanica* (66 specimens), *Aloe barbadensis* Mill. (65 specimens), *Psidium guajava* (57 specimens), *Hibiscus sabdariffa* L. (54 specimens), and *Syzygium polyanthum*

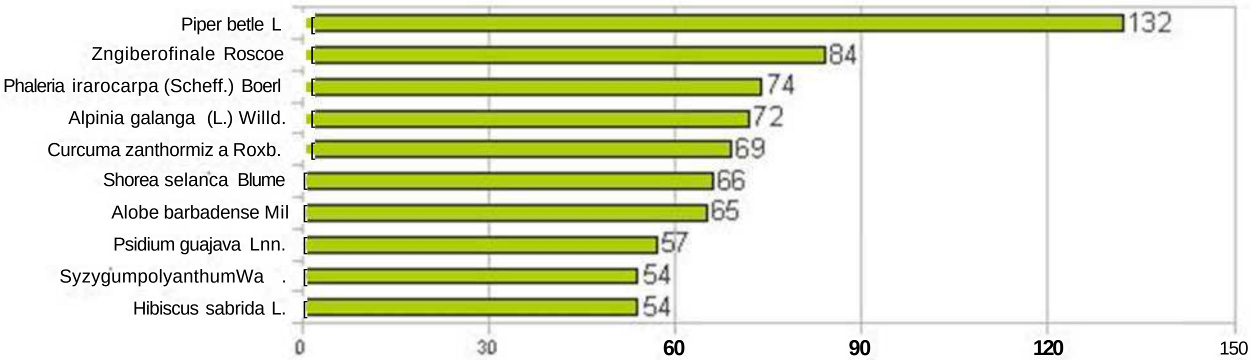

Fig. 9. Ten dominant species from 2005 to 2010

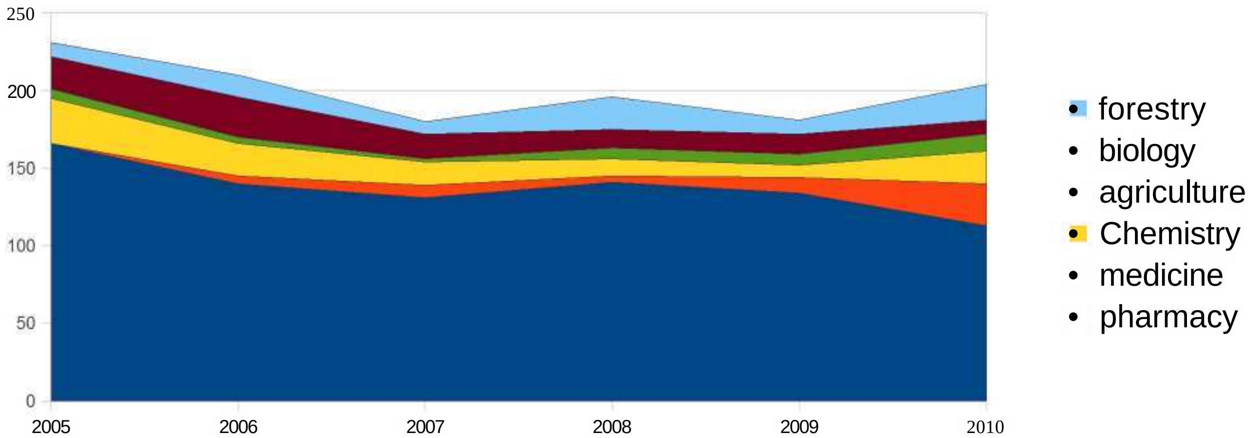

Fig. 10. Expertise from 32.63% of total clients. The majority were from the Pharmacy sector.

(Wight) Masam (54 specimens), as shown in Figure 9.

Real obstacles were faced in efforts to generate species patterns using customizable criteria. There was no single species with a cumulative number equal to, or greater than 8 specimens annually for 6 consecutive years. Species names tend to occur randomly. For example, *P. betle* presence was recorded in each year except in 2008. *C. zedoaria, Z. officinale, A. barbadensis* (with synonym *A. vera* (L.) Burm.f) occurs randomly for 4 years. *Ageratum conyzoides* L., *Andrographis paniculata* Nees, *Carica papaya* L., *Camelia chinensis* Kuntze, *Centella asiatica* (L.) Urb., *Phaleria macrocarpa* Boerl., *P. guajava*, and *S. polyanthum* occured in non-consecutive three years within six years period.

No pattern was revealed on species level. There were 2 factors contributed to this result: relatively short time and the abundance of species name. Too many species names resulted in too few accumulation on each taxa. I assume longer periods combined with other customizable criteria, will reveals patterns at the species level.

CONCLUSION

Specimen pattern had not detected for short period of time and too many species. However, for genera and families level, the data showed dynamic appearance in six year. It was assumed the data will reveal something more robust if collected comprehensively for at least one decade. With more data, the dynamics will show the information with better resolution. Ten years data can be treated as first baseline for the next decade.

The family *Euphorbiaceae*, the genus *Ficus*, and the species *P. betle* had shown up as the highest hit on three different levels. These temporary results can be explained by great diversity as well as significant utilization in some species in *Euphorbiaceae*, many different species of *Ficus*, and intensive projects in uncovering the savor *of P. betle.*

Furthermore, the ID services can be used as one of the effort to add BO's the new plant collection since the materials originated from elsewhere in Indonesia. It is a smart way to save time, budget, and energy of BO's staffs, which only collect them during limited field work.

Capacity building of human resources in BO should be directed to overcome challenges in particular taxa. Along with time, the regeneration of identification skill become the main issue, since the senior parataxonomists will retire. To train young technicians to be professional parataxonomist, on the other hand, will take considerable time and energy to expand their expertise in plant identification.

Focusing in the right facet, priorities should be directed toward families with significant proportions in ID services since they represented more frequent utilized taxa contact within society. On the other side, it will serve as general map to see the blank spot of the families expertise in the institution.

In the future, collaboration with other taxonomists worldwide on relevant taxa is required to solve numerous problems. With cooperation, various analysis can reveal new pattern to discover something new.

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REFERENCES

ANONYMOUS. 2003. Laporan tahunan Pusat Penelitian Biologi Tahun Anggaran 2002. Pusat Penelitian Biologi-LIPI, Bogor.

ANONYMOUS. 2009. Laporan tahunan Pusat Penelitian Biologi Tahun Anggaran 2008. Pusat Penelitian Biologi-LIPI, Bogor.

ANONYMOUS. 2010. Laporan tahunan Pusat Penelitian Biologi Tahun Anggaran 2009. Pusat Penelitian Biologi-LIPI, Bogor.

BRUMMITT, R. K. 1992. *Vascular Plant Families and Genera.* Royal Botanic Garden, Kew.

HEYWOOD, V. H. 1993. *Flowering Plants of the world.* B.T. Batsford Ltd, London.

HOLMGREN, P. K, HOLMGREN, N. H. & BARNETT, L. C. 1990. *Index Herbariorum, Part I: The Herbaria of the World, 8th ed.* New York Botanical Garden, New York.

KENG, H. 1978. *Orders and families of Malayan Seed plants.* Singapore University Press. Singapore.

MCNEILL, I, BARRIE, F. R., BURDET, H. M., DESMOULIN, V., HAWKSWORTH, D. L., MARHOLD, K., NICHOLSON, D. H., PRADO, I, SILVAP, C, SKOG, J. E., WIERSEMAJ. H. & TURLAND, N. J. 2006. *International Code of Botanical Nomenclature (Vienna Code). Regnum Vegetabile 146.* A.R.G. Gantner Verlag KG, Vienna.

NEWMAN, M., LHUILLIER, A. & POULSEN, A. D. 2004. Blumea supplement 16. *Checklist of Zingiberaceae of Malesia.* Nationaal Herbarium Netherlands- Universiteit Leiden Branch, Leiden.

PRASETYO, E. B. 2004. Laporan tahunan Pusat Penelitian Biologi Tahun Anggaran 2003. Pusat Penelitian Biologi-LIPI. Bogor.

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