PROS SEM NAS MASY BIODIV INDON
Volume 1, Nomor 5, Agustus 2015 ISSN: 2407-8050
Halaman: 987-992 DOI: 10.13057/psnmbi/m010505

Diversity and distribution of *Selaginella* in the Province of Yogyakarta Special Region

Keanekaragaman jenis dan sebaran *Selaginella* di Provinsi Daerah Istimewa Yogyakarta

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Manuscript received: 28 April 2014. Revision accepted: 22 Juni 2015.

Abstrak. *Setyawan AD, Sugiyarto, Susilowati A, Widodo. 2015. Keanekaragaman jenis dan sebaran* Selaginella *di Provinsi Daerah Istimewa Yogyakarta. Pros Sem Nas Masy Biodiv Indon 1: 987-992*. Daerah Istimewa Yogyakarta memiliki topografi yang cukup beragam dengan ketinggian mulai dari tepian pantai hingga puncak Gunung Merapi (2930 m dpl). Sebagian besar wilayah Yogyakarta didominasi oleh kawasan perbukitan atau pegunungan yang relatif kering, yaitu: Pegunungan Kars Sewu, Pegunungan Menoreh dan Gunung Merapi. Daerah bertopografi datar ditemukan di antara ketiga pegunungan tersebut. *Selaginella* merupakan jenis tumbuhan herba yang memerlukan banyak air untuk pertumbuhan dan perkembangbiakan. Sehingga, keberadaan *Selaginella* di kawasan yang relatif kering ini menarik untuk diteliti. Dalam penelitian ini ditemukan sembilan spesies *Selaginella. S. ornata* ditemukan pada dataran menengah hingga tinggi. *S. opaca* dan *S. remotifolia* hanya ditemukan di dataran tinggi pada lereng Gunung Merapi, demikian pula *S. singalanensis*. *S. plana* ditemukan di dataran rendah hingga ketinggian 1200 m dpl, di Gunung Merapi, batas tertinggi pertumbuhan jenis ini di Pulau Jawa. *S. aristata* dan *S. ciliaris* tumbuh di dataran rendah hingga menengah, seperti Pegunungan Menoreh, namun umumnya hanya dijumpai di musim hujan. *S. repanda* banyak dijumpai di kawasan karst Pegunungan Sewu, terutama pada celah-celah bebatuan yang lembab. Sementara itu, *S. involvens* dapat ditemukan baik di lereng Gunung Merapi maupun di dekat kawasan karst Pegunungan Sewu.

Kata kunci: Gunung Merapi, daerah kering, Pegunungan Sewu, Pegunungan Menoreh, *Selaginella*, Yogyakarta

Abstract. *Setyawan AD, Sugiyarto, Susilowati A, Widodo. 2015. Diversity and distribution of* Selaginella *in the Province of Yogyakarta Special Region. Pros Sem Nas Masy Biodiv Indon 1: 987-992.* Special Region of Yogyakarta has fairly diverse topography with altitude starting from the seashore to the peak of Mount Merapi (2930 m asl.). Most of the area of Yogyakarta is dominated by hills or mountainous regions that is relatively dry, such as Sewu Karst, Menoreh and Merapi mountains. The flat topographic area being observed is between the three mountains. *Selaginella* is a herbaceous plant species that requires a lot of water for growth and fertilization. Therefore, the existence of *Selaginella* in a relatively dry region is an interesting matter of study. In this study, nine species of *Selaginella* were found in Yogyakarta. *S. ornata* was found at medium to high plain land. *S. opaca* and *S. remotifolia* were found only in highlands on the slopes of Mount Merapi as well as *S. singalanensis*. *S. plana* was found from the lowland up to an altitude of 1200 m of Mount Merapi, the highest growing limit of this species in the island of Java. *S. aristata* and *S. ciliaris* grew ranging from the lowland to medium altitudes, such as Menoreh mountain. However, it was generally grown only in the rainy season. *S. repanda* was often found in the karst region of Sewu Mountain, especially in the crevices of the rocks which were moist. Meanwhile, *S. involvens* was found on the slopes of Mount Merapi as well as near the karst region of Sewu Mountain.

Keywords: Mount Merapi, dry region, Sewu Mountains, Menoreh Mountains, *Selaginella*, Yogyakarta

INTRODUCTION

The Province of Yogyakarta Special Region is located between 7º30'-8º15' S and 110º04'-110º 52' E. Yogyakarta is an area of 3185.80 km², the second smallest Indonesian province after Jakarta. In 2010, it has a population of 3.5 million with a population density of 1,084 people per km^2. Yogyakarta has fairly diverse topography with altitude starting from the seashore to the peak of Mt. Merapi (2930 m asl.). Based on the physiographic units, this province is dominated by hilly areas, consists of Sewu Mountains (52%; altitude 150-700 m asl.), Menoreh Mountains (22%; 0-572 m), Mount Merapi (18%; 80-2911 m), as well as lowland areas between the three mountains (8%; 0-80 m). Most area of Yogyakarta is located at an altitude of 100-500 m asl. (65.65%), followed by an altitude of less than 100 m (28.84%), an altitude of 500-1000 m (5.04%) and an altitude above of 1000 m (0.47%). Yogyakarta has a C-type climate (Schmidt and Ferguson 1951) with an average rainfall of 2,070 mm per year and 99 days of rain. The average temperature is 26.7ºC and the average humidity is 83.4%. Soil types can be divided into lithosol, regosol,

lathosol, grumusol, mediterranean, alluvial, and rensina (BPS D.I. Yogyakarta 2014). Modified from Steenis (1972), lowlands, medium and highlands have a height of <500 m, 500-1000 m and > 1000 m respectively.

Differences in physiographic conditions lead to differences in the pattern of land use which have an impact on the diversity of wildlife. More than half of Yogyakarta is dry land. The land use is divided into dry land (agroforestry plantation, dry fields, and bare land), wet rice fields, settlements and a small part of forest area. Forest areas consist of natural reserves and natural conservation land (910.34 ha), protected forests (2067.90 ha), and production forest (13851.28 ha). The Sewu mountains that make up more than half of the province have barren soil conditions and prone to drought during the dry season (BPS D.I. Yogyakarta 2014).

Selaginella is a herbaceous plant that needs a lot of water to grow, then often found growing in moist and rather wet places, such as around water spring, small ditches, small tributaries, as well as moist cliffs of roadside and riverside, and hilly areas. In the tropics, its distribution is influenced by altitude, because higher regions generally have higher moisture and rainfall. The hilly areas are suitable for growth, as they provide moist slopes to grow. Each species of *Selaginella* have preferred area to grow; some species grow in the lowlands, others grow in the highlands, and there are also species that grows between the two areas. Some species have a wide distribution range, while the others are narrow. Some species are present throughout the year while others only abundant in the rainy season, although still limited growth in the dry season. *Selaginella* could be affected by global climate change, for growth and breeding, it is dependent on the availability of water. It is important to know the diversity of *Selaginella* in Yogyakarta, which has a relatively dry climate since this plant requires a lot of water to grow.

The aims of this study were to determine the diversity and distribution of *Selaginella* in the Province of Yogyakarta Special Region, middle Java, Indonesia.

MATERIALS AND METHODS

Study areas

The area of this study follows the administrative boundaries instead of geographical borders, i.e. the Province of Yogyakarta Special Region, Middle Java, Indonesia (Figure 1.A). It is uncommon but is important to register genetic resources in the province. Several surveys on distribution and diversity of *Selaginella* had been conducted, with an altitude between 0 and 2000s m asl.

Procedures

The field study was carried out several times in August 2007, May and November 2010, November 2011 and August 2013. All selaginellas were recorded and collected as herbarium specimens as well as living plants for the experimental garden in Wonosobo, Central Java (768 m asl.). Data passport collected along with the specimens were used as a standard for herbarium specimens. Each specimen was distinguished by time of collection and location. Both herbarium specimens and living plants were observed. Specimens of field collection were deposited at the Herbarium Soloense (SO), Sebelas Maret University, Surakarta, Indonesia and selected specimens will be sent to the Herbarium Bogoriense (BO), Research Center for Biology, Indonesian Institute of Sciences (LIPI), Cibinong-Bogor, Indonesia. Some field studies were also conducted, but only to take photographs, without collecting specimens.

From field work, a total of six species was obtained from 16 herbarium specimens collected from eight sites. Observations were also conducted on the collection of Herbarium Bogoriense, which had 600s herbarium sheets of Javan selaginellas, but only five specimens collected from Yogyakarta, that adding one species. Besides, there were also two species whose existence recorded through photographs taken in salak plantation of Turi subdistrict, Sleman (600-800 m asl.), in March 2010, but without collecting herbarium. Therefore, Setyawan et al. (2012, 2013) were used for description.

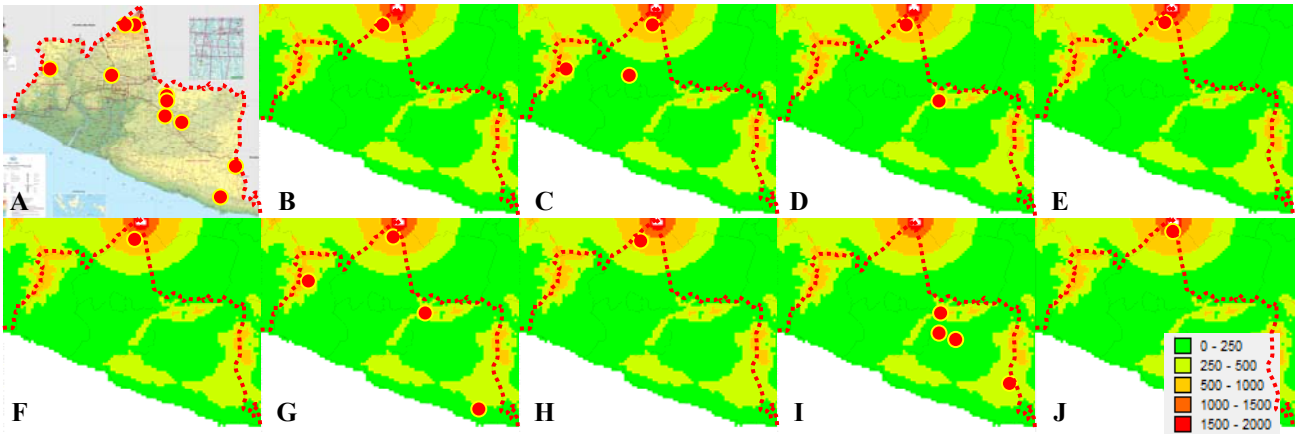

Figure 1. Selaginellas distribution in the Province of Yogyakarta Special District, Indonesia. A. All selaginellas species, B. *S. aristata,* C. *S. ciliaris,* D. *S. involvens,* E. *S. opaca*, F. *S. ornata*, G. *S. plana,* H. *S. remotifolia,* I. *S. repanda,* J. *S. singalanensis*. Note: ·····• = Yogyakarta provincial boundary, ● = *Selaginella* presence.

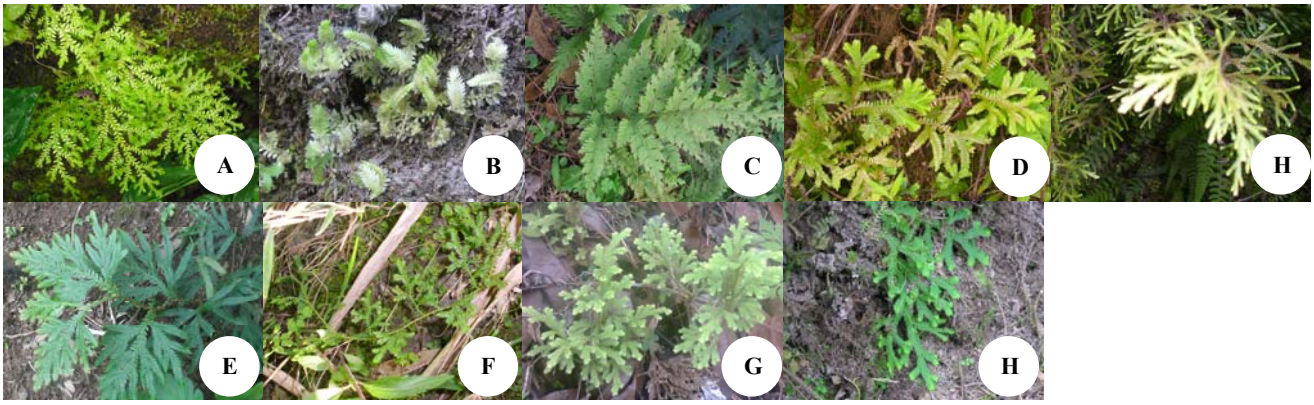

Figure 2. Selaginellas diversity in the Province of Yogyakarta Special District, Indonesia. A. *S. aristata,* B. *ciliaris,* C. *S. involvens,* D. *S. opaca*, E. *S. ornata*, F. *S. plana,* G. *S. remotifolia,* H. *S. repanda,* I. *S. singalanensis*.

The specimens were identified by using several bibliographies on *Selaginella* of the Nusantara (Malay Archipelago) and adjacent area, i.e. Alston (1934, 1935a,b, 1937, 1940); as well as Wong (1982, 2010), Tsai and Shieh (1994), Li and Tan (2005), Chang et al. (2012), Zhang et al. (2013), and Setyawan et al. (2012, 2013, 2015). In addition to direct observations, the kinds of literature were used to guide the preparation of description. Meanwhile, the global distributions are mainly referred to Hassler and Swale (2002) and Chang et al. (2012). The locality was according to the administrative division of sub-district level. Data were analyzed with DIVA-GIS program.

RESULTS AND DISCUSSION

In this study, nine species of *Selaginella* were found. Eight species were directly obtained in the field work. Six species were collected along with herbarium namely *S. ciliaris, S. involvens, S. opaca, S. ornata, S. plana,* and *S. repanda*, while two species were only recorded through photographs, namely *S. aristata* and *S. remotifolia*. Both are believed to be still found in nature because there were no significant environmental changes since the photographs were taken. Meanwhile, one species was only found from the Herbarium Bogoriense collections, i.e. *S. singalanensis*.

Selaginella aristata is a species of medium to highland plains. In this study, it is found at an altitude of 600-800 m (Figure 1.B), the highest altitude where it is found is 1220 m in Java (Setyawan et al. 2013). This plant has a fleshy stem (herb), generally abundant in the rainy season and grows in moist cliffs around the springs, creeks, ponds, etc. At a relatively dry habitat, the stems are less fleshy; and in the dry season, it is difficult to find.

Selaginella ciliaris is a species of lowland to highland plains (Figure 1.C). In Java, it grows from the coastal area to highlands (0-1250 m asl.) (Setyawan 2012). It is found on the cliff wall or directly growing on the ground, in a slightly open shaded but moist habitat, such as on the edge of road, channel, trail, under the trees, etc. This species can grow in a variety of habitats for allegedly having high genetic diversity. According to Setyawan (2012), the availability of water causes the growth is very abundant in the rainy season but rare in the dry season. This plant uses a r-strategy in adapting to the environments.

Selaginella involvens commonly grows on the cliffs of highland areas, but in this study, it was found also in the middle mountains (Figure 1.D). This species is found on the slopes of Nglanggeran, Mts. Baturagung (502 m) and Mt. Merapi (1008 m), but not present in the area between the two. The anthropogenic process is probably the cause. This plant is adapted to dry conditions by rolling the leaves in dry conditions and reopening them under humid conditions.

Selaginella opaca and *S. remotifolia* generally grow in the same habitat in the highlands, found growing on cliffs or flat places (Figure 1.E and 1.H). They can be distinguished easily since *S. opaca* have larger and fleshier stems, while *S. remotifolia* have a much smaller stem. *S. remotifolia* can grow in an open area, for example, grows like weeds in fields and gardens. Another species that grows in highlands only is *S. singalanensis* (Figure 1.J). The stem grows deep-creeping on the soil surface of moist cliffs and can form an extensive set but more fragile stem, as well as rarer than the other two selaginellas. In this study, the existence of *S. singalanensis* is only originated from a collection of Herbarium Bogoriense, but Setyawan et al. (2012) found the same species, not far from the site collection of this herbarium sheet but it is located in the Province of Central Java.

Selaginella ornata is a species of medium to highland plains, but in this study, it is only found in the highlands (Figure 1.F). *S. ornata* has a very high genetic diversity, even in the past, there are more than 25 scientific names for this species (Hassler and Swale 2002). However, it is only growing at a fairly moist habitat. Climate type of Yogyakarta is a dry climate, and then the species is found only in the humid highlands. According to Setyawan (2012), this species can grow at 200-1350 m asl.

Selaginella plana is a typical lowland species but can grow up on the mountains (Figure 1.G). In this study, it was found growing at an altitude of 267-1216 m. This species has a very broad distribution such as *S. ciliaris*, but has a fairly large stem and have a K-strategy in adapting to the environmental conditions; then it can be found throughout the year. This species can be found in relatively

dry areas like the karst area of Mt. Sewu, Gunungkidul, to the more humid areas such as the slopes of Mt. Merapi, Sleman.

Selaginella repanda is a species adapted to dry areas, it often found in Mts. Sewu and the surrounding area of Gunungkidul (Figure 1.I). It attached to the rocks and used the leaf litters as nutrients source, and mainly grows in slightly shaded and moist places. The leaves tend to be strong, tapered or pointed, as a form of adaptation to dry areas.

Selaginella aristata Spring; Bull. Acad. Brux. 10: 232, no. 152 (1843) (Figure 2.A)

This plant is a small, fleshy, annual herb. *Stems* are decumbent to ascending, multiple branched, dendritic, fan-shaped, ca. 4-20 cm long, 3-6 mm wide (incl. leaves). *Rhizophores* are present at basal stem, from the ventral side of branching stem, ca. 1 mm in diam. *Leaves* (trophophylls) are dimorphic, arranged in 4 lanes (2 lateral, 2 median), sparsely at the main stem but closely arranged at the branches, single vein; *lateral leaves* are lanceolate to oblong-ovate at main stem, lanceolate to falcate at branches, 1.8-3 mm long, 1-2 mm wide, subcordate or rounded base, asymmetrical, acute apex, serrulate to subentire margin; *median leaves* are lanceolate to ovate, nearly symmetrical, 1.2-2 mm long, 0.5-1 mm wide, obtuse base, caudate to long tail-like apex, apices are upward, serrulate margin, single vein reaching the apex; *axillary leaves* are lanceolate to ovate, 1.5-3 mm long, 0.5-1.5 mm wide, single vein nearly reaching the apex, rounded base, obtuse apex, serrulate margin. *Strobili* are solitary, terminal, loosely, bisymmetrical; upper-plane sporophylls longer than lower-plane, ovate, complanate, acute apex, pointing outwards, up to 1 cm long (Setyawan et al. 2013).

Locality: Turi (Sleman)

Habitat and ecology: It was found on steep cliffs, at the edge of salak plantation, near irrigation canal, only abundant in the rainy season; at an altitude of 600-800 m asl.

Distribution: Indonesia (Java, Sulawesi, Ternate); Myanmar, Philippines.

Specimen examined: -.

Selaginella ciliaris (Retz.) Spring; Bull. Acad. Brux. 10: 23 (1843) (Figure 2.B)

This plant is a small, annual herb. *Stems* are recumbent, creeping or ascending, sometimes fan-shaped, without a significant main stem, 2-15 cm long, 4-5 mm wide (incl. leaves). *Rhizophores* are present at intervals but mostly near the base, from the lateral side of branching stem, ca. 0.2-0.3 mm in diam. *Leaves* are dimorphic, arranged in 4 lanes, single vein; *lateral leaves* are ovate, nearly symmetrical, 1.5-2 mm long, 0.5-1 mm wide, base rounded or subcordate, acute or acuminate apex, ciliate or serrulate margin, single vein reaching the apex, keeled, pointing outwards; *median leaves* are ovate to falcate, asymmetrical, 2-3 mm long, 0.5-1.5 mm wide, base rounded, acute apex, attenuate or cuspidate, serrulate margin with basal laciniate, pointing upwards, minutely toothed, ciliate, midrib prominent, single vein reaching or nearly reaching the apex; *axillary leaves* are ovate to lanceolate, bisymmetrically, 1.5-2.5 mm long, 1-1.5 mm wide, single vein nearly reaching the apex, base rounded to subcordate, ciliate, apex acute, toothed margin, with basal laciniate and apical serrulate. *Strobilus* are solitary or (rarely) twin, terminal, flattened, complanate, up to ca. 1-2 cm long; sporophylls are dimorphic.

Locality: Cangkringan, Mlati (Sleman), Girimulyo (Kulonprogo).

Habitat and ecology: It was found on the pine forests, small-river banks, natural forest of Mt. Merapi National Park, and community teak forest of Mt. Menoreh, embankment of rice field; at an altitude of 149-904 m.

Distribution: Indonesia (Java, Sulawesi, Ternate, New Guinea); India, Sri Lanka, Myanmar, S-China, Taiwan, Thailand, Vietnam, Solomons, Philippines, Northern Australia, Marianas, Palau Isl., Micronesia

Specimen examined: ADS 16, ADS 407, W. Meijer 2747.

Selaginella involvens (Sw.) Spring; Bull. Acad. Brux. 10: 136, no. 6 (1843) (Figure 2.C)

This plant is a perennial herb, terrestrial or epiphytic. *Stems* are robust, ascending or erect, without branches on the lower half, with a subterranean rhizome; 20-50 cm long, 3-4 cm wide (incl. leaves), 1-1.5 mm in diam. *Rhizophores* are at intervals of rhizomes. *Leaves* on the rhizome are monomorphic, scale-like, ovate, ciliate, sessile, apex acute, recurved or appressed, pale yellow or brown, ca. 1 mm long, 0.5-1 mm wide; *Leaves* on the main stem are monomorphic, ovate, sessile, nearly asymmetrical, well-spaced, appressed, 1-2 mm long, 1-1.5 mm wide, acute apex, truncate base, serrate to serrulate margin. *Leaves* on the branches are dimorphic, arranged in 4 lanes, single vein, reaching the apex, green to yellowish green, rolling up when dry, fan-shaped; *lateral leaves* are ovate, contiguous or imbricating, asymmetrical, 1-2.5 mm long, 0.2-1.5 mm wide, attenuate or acuminate apex, cuneate or oblique base, curved vein with 2 grooves; *median leaves* are ovate, asymmetrical, 1.5-2.5 mm long, 1-2.5 mm wide, acute apex, rounded to subcordate base, single vein, entire margin; *axillary leaves* are ovate, cordate or lanceolate, nearly symmetrical, 1-1.3 mm long, 0.5-1.5 mm wide, acute apex, cordate base, exauriculate, serrate margin. *Strobili* are solitary, terminal, tetragonal, compact, up to 2 cm long; sporophylls are monomorphic.

Locality: Cangkringan, Pakem (Sleman), Patuk (Gunungkidul).

Habitat and ecology: It was found in the primary forest of Mt. Merapi National Park, shielded from the lava flow, pine forest, small-river banks, pond edges, and on the crevices of the rocks of Nglanggeran, Mts. Baturagung; at an altitude of 502-1008 m asl.

Distribution: Indonesia (Java, Kalimantan, Sulawesi, Flores); India, Bhutan, Nepal, Sri Lanka, Myanmar, China, Japan, Korea, Vietnam, Laos, Cambodia, Thailand, Palau Isl.

Specimen examined: ADS 17, ADS 423, ADS 488, M.A. Donk 9280.

Selaginella opaca Warb.; Monsunia 1: 108, 122, no. 112 (1900) (Figure 2.D)

This plant is a fleshy perennial herb. *Stems* are creeping to ascending, usually fertile branches alternate on main stem, up to 60 cm long, 3-6 cm wide (incl. leaves).

Rhizophores are at the branching stem, mostly near the base, from the dorsal side of branching stem, ca. 1-1.5 mm in diam. *Leaves* on the main stem are monomorphic, oblong, asymmetrical, well spaced, midrib present. Leaves on the branches are dimorphic, arranged in 4 lanes, loosely arranged at long creeping stem but closely arranged at top of branches; *lateral leaves* are ovate to oblong, asymmetrical, 2-4 mm long, 1.5-3 mm wide, rounded base, acute apex, single vein, not reaching the apex, serrulate to entire margin, pointing outwards, imbricating at the top of branches; *median leaves* are ovate to oblong, asymmetrical, 1.5-2.5 mm long, 1-2 mm wide, caudate apex, cordate base, pointing upwards, imbricating at the top of branches, single vein not reaching the apex, serrate margin, but entire at basal part; *axillary leaves* are ovate, entire, rounded or obtuse, symmetrical, 2-3 mm long, 1-2 mm wide, cordate base, acute apex, entire or serrulate at apical part margin. *Strobili* are solitary, terminal or lateral, tetragonal, up to 3 cm long.

Locality: Pakem (Sleman)

Habitat and ecology: It was found in the primary forest of the Mt. Merapi National Park, shielded from the lava flow; at an altitude of 999 m asl.

Distribution: Indonesia (Sumatra, Java, Lombok, Ceram, New Guinea), Philippines.

Specimen examined: ADS 424.

Selaginella ornata (Hook & Grev.) Spring; Bull. Acad. Brux. 10: 232 (1843) (Figure 2.E)

This plant is a fragile perennial herb, in general appearance. *Stems* are suberect fragile, easily broken, 20-30 cm long, 1-3 cm wide (incl. leaves). *Rhizophores* are at the lower part and sometimes at branching stem, originated from the dorsal side of stem at the branch site, ca. 0.5-1.5 mm in diam. *Leaves* are dimorphic, arranged in 4 lanes, densely arranged throughout the stem and imbricating at top of branches, green or brownish green; *lateral leaves* are oblong to falcate, denticulate to dentate, exauriculate, asymmetrical, 1.5-2.5 mm long, 1-1.5 mm wide, acuminate to acute apex, and prickly tip, single vein not reaching the apex, rounded to truncate base, entire margin; *median leaves* are denticulate to dentate, with arista often more than half the lamina length, asymmetrical, 1-1.5 mm long, 0.5-1 mm wide, acute apex, prickly tip, rounded base, single vein not reaching the apex, entire margin; *axillary leaves* are ovate to subcordate, exauriculate, imbricating, asymmetrical, 1-1.5 mm long, 0.5-1 mm wide, acute apex, rounded base, entire margin. *Strobili* are solitary, terminal, bisymmetrical, upper-plane, up to more than 1 cm long.

Locality: Cangkringan, Pakem (Sleman)

Habitat and ecology: It was found in the primary forest of the Mt. Merapi National Park that shielded from the lava flow, pine forest, small-river banks, pond edges; at an altitude of 904-999 m asl.

Distribution: Indonesia (Sumatra, Java, Kalimantan, Bali, Lombok, Flores); Cambodia, India, Malaysia (Peninsular), Thailand, Vietnam, Philippines

Specimen examined: ADS 18, ADS 425, MA Donk P276.

Selaginella plana (Desv. ex Poir.) Hieron.; Nat. Pflanzenfam. 1 (4): 703 (1901) (Figure 2.F)

This plant is a stout perennial herb. *Stems* are sub-erect with a subterranean stoloniferous rhizome, without branches on the lower part, up to 65-80 cm long, 3-8 cm wide (incl. leaves). *Rhizophores* are sometimes at the branching stem, from the dorsal side of branch, ca. 1-1.5 mm in diam. *Leaves* on the rhizome are scale-like, monomorphic, ovate, ciliate, sessile, acute apex, appressed, yellow or red, ca. 0.8 mm long, 0.5 mm wide. *Leaves* on the main stem are monomorphic, well-spaced, appressed, ovate, 1.5-2.5 mm long, 1-2 mm wide, acute or acuminate apex, asymmetrical, entire margin. Leaves on the branches are dimorphic, arranged in 4 lanes, loosely arranged at lower stem but closely arranged at branches; *lateral leaves* are oblong to ovate, asymmetrical, 2-4 mm long, 2-3 mm wide, acute to acuminate apex, sessile, single vein, not reaching the apex, truncate and rounded base, upper base with a spur-like lobe which overlaps the stem, transparent, entire margin; *median leaves* are ovate to oblong, asymmetrical, 1.5-3 mm long, 1-2 mm wide, apex acute to acuminate, sessile, single vein, not reaching the apex, truncate and rounded base, entire margin; *axillary leaves* are ovate, asymmetrical, 2.5-3.5 mm long, 1.5-2.5 mm wide, acute apex, rounded base, entire margin. *Strobili* are solitary, terminal, tetragonal, up to 3 cm long.

Locality: Cangkringan, Pakem (Sleman), Girimulyo (Kulonprogo), Patuk (Gunungkidul)

Habitat and ecology: It was found in the pine forests, small-river banks, natural forest of Mt. Merapi National Park that shielded from the lava flow, community teak forest of Mt. Sewu and Mt. Menoreh, and in the rock crevices of Nglanggeran, Mts. Baturagung; altitude 267-1216 m asl.

Distribution: Indonesia (Sumatra, Java, Bali, Timor, Flores, Sumbawa, Solor, Sulawesi, Ambon, Banda, Ceram, Kei Isl., Ternate, Buru), Malaysia (Peninsular). Introduced to: India, Taiwan, Philippines, Florida, Puerto Rico, Honduras, Costa Rica, Panama, Colombia, Brazil, Jamaica, Trinidad, St. Kitts, Barbados, Ecuador, British Guyana, St. Thomas, Dominica, Martinique, Tanzania.

Specimen examined: ADS 19, ADS 406, ADS 422, ADS 489, CA Backer 2750.

Selaginella remotifolia Spring; Miq. Pl. Jungh. 3: 276, no. 5 (1854) (Figure 2.G)

This plant is a wiry, perennial herb. *Stems* are creeping, usually several fertile branches alternate on long main stem, up to 60 cm long, 0.5-1 cm wide (incl. leaves). *Rhizophores* are at the branching stem, from the dorsal side of branch, ca. 0.5 mm in diam. *Leaves* on the main stem are monomorphic, lanceolate, acuminate, asymmetrical, well spaced, midrib present. Leaves on the branches are dimorphic, arranged in 4 lanes, loosely arranged at the long creeping main stem but closely arranged at branches; *lateral leaves* are contiguous, lanceolate to ovate, asymmetrical, 1.5-3 mm long, 1-2 mm wide, acute to acuminate apex, single vein, obscure not reaching the apex, rounded base, serrulate margin but usually entire or minutely ciliate margin, pointing outwards; . *median leaves* are lanceolate to ovate, asymmetrical, 1.5-2.5 mm long,

0.5-1 mm wide, cordate or cuneate base, attenuate or caudate apex, leaves at top of branches imbricating, single vein not reaching the apex, serrulate or serrate margin, but entire at abaxial medium and basal part; *axillary leaves* are ovate, entire, rounded or obtuse, symmetrical, 2-2.5 mm long, 1-1.5 mm wide, acute apex, entire margin or loosely serrulate at apical part. *Strobili* are solitary, terminal or lateral, tetragonal, up to 2 cm long (Setyawan et al. 2013).

Locality: Turi (Sleman).

Habitat and ecology: It was found on steep cliffs, at the edge of salak plantation, near irrigation canal; at an altitude of 600-800 m asl.

Distribution: Indonesia (Sumatra, Java, New Guinea); Myanmar, S-China, Taiwan, Japan, Korea, Philippines

Specimen examined: -.

Selaginella repanda (Desv. ex Poir.) Spring, Gaud. Voy. Bonite Bot. 1: 329 (1846) (Figure 1H)

This plant is a perennial herb, terrestrial or epiphytic. *Stems* are oval or terete, consists of creeping (vegetative), multiple branched, ca. 30 cm long, 3-4 mm wide (incl. leaves) and decumbent to ascending (generative), dendritic, fan-shaped, ca. 10-25 cm long, 3.5-5 mm wide (incl. leaves). *Rhizophores* are at creeping stem, and sometimes on base of ascending ones, from ventral side of branching stem, ca. 1 mm in diam. *Leaves* are dimorphic, those on main stem larger than on branches, arranged in 4 lanes, sparsely at main stem but imbricating at the branches, single vein, brownish or reddish green, scabrous; *lateral leaves* are oblong-falcate, asymmetrical, approximate, 2-2.5 mm long, 1-1.5 mm wide, acute apex, rounded base, ciliolate margin, single vein; *median leaves* are asymmetrical, approximate, obliquely ovate at branches, 1-2 mm long, 0.5-1 mm wide, acuminate apex, obliquely subcordate base, ciliate margin; *axillary leaves* are ovate, nearly symmetrical 2-3 mm long, 1-1.5 mm wide, acute apex, rounded base, ciliolate margin, single vein. *Strobili* are solitary, terminal, compact, subtetragonal or subcomplanate, 2-5.5 mm long; sporophylls are submonomorphic, spores orange-brown to bright yellow.

Locality: Patuk, Playen, Rongkop (Gunungkidul).

Habitat and ecology: It was found in the secondary forest of Wanagama and production forest of Banaran, around a small rivers, springs and pools of the karst region, and in the rock crevices of Nglanggeran, Mts. Baturagung; at altitudes of 129-502 m asl.

Distribution: Indonesia (Java, Sumbawa, Timor, Sumatra); Bhutan, Cambodia, China, India, Laos, Malaysia (Peninsular), Myanmar, Nepal, Philippines, Taiwan, Thailand, Vietnam.

Specimen examined: ADS 49, ADS 485, ADS 486, ADS 487.

Selaginella singalanensis Hieron.; Hedwigia 50: 18, no. 12 (1910) (Figure 2.I)

This plant is a tender, perennial herb. *Stems* are deep-creeping, appressed to the ground, 20-25 cm long, 1-3 cm wide (incl. leaves). *Rhizophores* are at branching stem, originated from the dorsal side of stem at the branch site, ca. 0.5 mm in diam. *Leaves* are dimorphic, very soft, arranged in 4 lanes, densely arranged at through stem and imbricating at top of branches, green to yellowish green; *lateral leaves* are oblong, imbricating, asymmetrical, 1.5-2.5 mm long, 0.5-1.5 mm wide, acute apex, single vein not reaching the apex, rounded base, entire margin; *median leaves* are dentate, exauriculate, asymmetrical, 0.5-1.5 mm long, 0.5 mm wide, acute apex, single vein not reaching the apex, rounded base, entire margin; *axillary leaves* are ovate, imbricating, asymmetrical, 0.5-1.5 mm long, 0.5 mm wide, acute apex, rounded base, entire margin. *Strobili are* solitary, terminal, loosely, bisymmetrical, upper-plane, up to more than 1 cm long (Setyawan et al. 2013).

Locality: Pakem (Sleman),

Habitat and ecology: It was found on the steep cliffs and small river bank; at an altitude of 1133 m asl.

Distribution: Sumatra, Java

Specimen examined: Junghuhn 255.

ACKNOWLEDGEMENTS

The authors thank the head and staff of Herbarium Bogoriense (BO), RCB-IIS, Cibinong-Bogor, Indonesia for facilitating the herbarium materials.

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