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Diversity of *Selaginella* in the Bromo Tengger Semeru National Park, East Java

Keanekaragaman jenis *Selaginella* di Taman Nasional Bromo Tengger Semeru, Jawa Timur

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Abstrak. *Setyawan AD, Sugiyarto. 2015. Keanekaragaman jenis* Selaginella *di Taman Nasional Bromo Tengger Semeru, Jawa Timur. Pros Sem Nas Masy Biodiv Indon 1: 1312-1317*. Jawa bagian timur memiliki iklim yang relatif lebih kering daripada daerah lain di Pulau Jawa, namun memiliki cukup banyak kumpulan gunung-gunung yang sejuk dan menyediakan cukup air, misalnya kompleks Pegunungan Bromo, Tengger dan Semeru. *Selaginella* adalah jenis tumbuhan herba yang memerlukan air untuk reproduksi, sehingga sangat menarik untuk mengetahui keberadaannya di kawasan yang beriklim relatif kering mengingat adanya perubahan iklim global. Penelitian ini bertujuan untuk mengetahui keanekaragaman jenis *Selaginella* di kawasan Taman Nasional Bromo, Tengger dan Semeru (TNBTS), Jawa Timur. Penelitian lapangan dilakukan pada bulan Agustus 2007 dan Mei 2015, dan dilengkapi dengan pengamatan koleksi spesimen dari "Herbarium Bogoriense" Pusat Penelitian Biologi LIPI Cibinong, Bogor. Dari penelitian lapangan telah dikoleksi lima spesimen herbarium, sementara dari koleksi BO diamati 49 spesimen herbarium. Hasil penelitian menujukkan di kawasan taman nasional ini dan daerah perbatasannya ditemukan delapan spesies *Selaginella*, yaitu: *S. ciliaris, S. intermedia, S. involvens, S. opaca, S. ornata, S. plana, S. remotifolia* dan *S. singalanensis.* Namun, sifat morfologi *S. intermedia* dan *S. singalanensis* perlu dikonfirmasi lebih lanjut karena masing-masing hanya teramati dari satu lembar herbarium, yaitu *O Posthumus 1615* dan *Kobus Tosari 147*. Di Jawa, sebaran *S. intermedia* terkonsentrasi di Jawa bagian barat. Sementara, perjumpaan *S. singalanensis* di Jawa relatif jarang.

Kata kunci: Keanekaragaman, *Selaginella*, Taman Nasional Bromo Tengger Semeru

Abstract. *Setyawan AD, Sugiyarto. 2015. Diversity of* Selaginella *in the Bromo Tengger Semeru National Park, East Java. Pros Sem Nas Masy Biodiv Indon 1: 1312-1317*. Eastern Java has a relatively drier climate than other parts of Java, but it still has quite a lot of cool mountain areas and provide enough water, for example, Bromo Tengger and Semeru Mountains complex. *Selaginella* is a herbaceous plant that need water for reproduction, thus it is important to know its existence in the dry climates region due to global climate change. This aims of this study was to determine the species diversity of *Selaginella* in the National Park of Bromo Tengger and Semeru (BTSNP), East Java. Field study was conducted in August 2007 and May 2015, and followed by observation of specimen collection of Herbarium Bogoriense, Research Center for Biology, Indonesian Institute of Sciences Cibinong, Bogor. From the field research, there were collected five herbarium specimens, while the herbaria collections observed were 49 sheets of specimens. The results showed that in this park and its border areas, there were found eight species of *Selaginella*, namely: *S. ciliaris, S. intermedia, S. involvens, S. opaca, S. ornata, S. plana, S. remotifolia* and *S. singalanensis*. However, the morphological characteristic of *S. intermedia* and *S. singalanensis* needs to be further confirmed since each of them was only observed from a single sheet herbarium, namely *O Posthumus 1615* and *Kobus Tosari 147*, respectively. In Java, *S. intermedia* was mainly distributed in the western part of Java. Meanwhile, the presence of *S. singalanensis* in Java was relatively rare.

Keywords: Diversity, *Selaginella*, Bromo Tengger Semeru National Park

INTRODUCTION

The Bromo Tengger Semeru National Park (BTSNP) is located in East Java Province of Indonesia, including the districts of Lumajang, Malang, Pasuruan, and Probolinggo, and the geographical position is 7°51' to 8°11' S and 112°47' to 113°10' E. This park consists of the Bromo-Semeru volcanic massif plateau averaging 40 km north-south and 20-30 km east-west, covering an area of 50,276.3 ha, an altitudinal range of 750-3676 m asl., a temperature range of 18-20°C (day-time) to 3-4°C (night-time), and an average annual rainfall of 6600 mm/year. Frosts are very common in the highest village of Ranu Pani (2300 m). The air humidity around the sand sea is high, between 42-45% and 90-97%, with the air pressure of 1007 to 1015.7 mm Hg. Based on the climate classification of of Schmidt and Ferguson, the climate types of the park is A in the south and B in the north. During periods of heavy rain in January and February, many parts of the park are inaccessible due to flooding and landslides (Menteri Kehutanan, SK No. 278/Kpts-VI/97).

The park was officially gazetted in 1982 (Menteri Pertanian, SK No.736/Mentan/X/1982), ratified in 1997 (Menteri Kehutanan, SK No. 278/Kpts-VI/97), and effectively

managed as national park in 2009 (Berita Acara Serah Terima No. 04/SJ/Dir/2009 dan No. BA.3/IV-Set/2009). Most of its area is comprised of land which had protected status as nature reservation, protection forest or other protected area before the national park was declared. This park was designed for watershed protection, as a buffer zone for volcanic eruptions, for recreational and tourism purposes, as well as for species conservation (Menteri Kehutanan, SK No. 278/Kpts-VI/97). The name of this park comes from two mountains, i.e. Mt. Semeru (the highest mountain in Java, 3,676 m), Mt. Bromo (the most popular mountain tourist destination, 2,329 m) and the Tenggerese people who inhabit the area.

The main landscapes of Bromo Tengger Semeru National Park are Mt. Semeru, in the southern part of the park, which one of the most active volcanoes; and the vast Tengger caldera (5250 ha) of dessert sand sea in the north, which is Mt. Bromo in the center. The caldera boundary of sand sea is steep walls with the height between 200-700 m, at altitide 2.100 m asl. Ecotourism is the main reason for establishment of Bromo Tengger Semeru National Park because of the spectacular scenery (Cochrane 1997; Radecki 2006).

Vegetation type of Bromo Tengger Semeru National Park covers sub-montane (750-1500 m), montane (1500-2400 m) and sub-alpine (> 2400 m). The middle slopes of the park are covered with tropical mountain forests in good condition, with sub-alpine bushes above 2,400 m. *Casuarina junghuhniana* forests is commonly found around the populated areas, due to the vegetation burning in the past (Department of Forestry 1992-1993). Another large trees scattered throughout the forest is jamuju (*Dacrycarpus imbricatus*), a pioneer endemic plant species, but its existence pressured by illegal logging (Rahadiantoro et al. 2013). Grasslands cover the floor of Tengger caldera and hillsides in the south of Bromo crater, that is found Javan eidelweis (*Anaphalis javanica*), an endemic grass (*Styphelia pungieus*), etc. The park contains nine species of plants that are not recorded elsewhere in Java, including one endemic (FAO 1977, 1980; Department of Forestry 1992-1993). In this area there are several species of pioneer plants that can be used for land rehabilitation, namely *Astronia spectabilis, Casuarina junghuhniana, Engelhardtia spicata, Omalanthus giganteus,* and *Trema orientalis* (Hakim and Miyakawa 2013). There is also an aphrodisiac plants endemic to Java, *Pimpinella pruatjan* (*Pimpinella alpina* var. *pruatjan*)(Hidayat and Risna 2007).

In this national park, it was found at least 137 species of birds, 22 species of mammals and 4 species of reptiles (Cochrane 1997). Referring to Azrianingsih et al. (2011), there are 176 plant species and 84 animal species used by the Tenggerese. The small number of wildlife found was very surprising, this is due to high levels of hunting in the past (FAO 1977, 1980). Hunting, land burning and illegal logging still occurs untill now (Radecki 2006). Some typical Javan mammals found are muntjac deer (*Cervus timorensis*), wild boar (*Sus scrova*), leopard (*Panthera pardus*), marbled cat (*Pardofelis marmorata*), macaque (*Macaca fascicularis*), and wild dog (*Cuon alpinus*). Several forest birds found are junglefowl (*Gallus gallus*), besra sparrow hawk (*Accipiter virgatus*), rhinoceros hornbill (*Buceros rhinoceros silvestris*), bido serpent eagle (*Spilornis cheela bido*), black drongo (*Dicrurus macrocercus*), and brahminy kite (*Haliastur indus*) (FAO 1977, 1980).

Selaginella requires lots of water to grow and to carry out reproduction, so it is often found growing in moist and humid places, such as around the water spring, small ditches, small tributaries, as well as moist cliffs of roadside and riverside, and hilly areas. Its distribution is influenced by altitude, because the higher regions generally have higher moisture and rainfall. The hilly areas are suitable for growth, as it provides moist slopes to grow. Bromo Plateau has been inhabited for hundreds of years uninterruptedly, with high population numbers. The biodiversity is severely affected, which is relatively low for a very large area in tropical Java, due to deforestation, land clearing and hunting in the past. *Selaginella* is a wild herb with no significant use, but it is important to know its presence in the disturbed highlands, which has been declared a conservation area.

The aims of this study are to determine the diversity of *Selaginella* in the Bromo Tengger Semeru National Park (BTSNP), East Java Province, Indonesia.

MATERIALS AND METHODS

Study areas

This research was conducted in the Bromo Tengger Semeru National Park and surrounding areas of the districts of Lumajang, Malang, Pasuruan, and Probolinggo, East Java Province, Indonesia. The geographical position is 7°51' to 8°11' S and 112°47' to 113°10' E (Figure 1). Field surveys of *Selaginella* had been carried out, with an altitude between 400s m and 2000s m asl.

Procedures

The field study was carried out twice in August 2007 and May 2015. Some field works were also conducted, but only photographs taking, with no specimens collecting. The presence of *Selaginella* was recorded and collected as herbarium specimens and living plants for the experimental garden in Wonosobo, Central Java (768 m asl.). Data passport collected along with the specimens were used as standard for herbarium specimens. Each specimen was unique, distinguished by location and time of collection. 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 some selected specimens will be sent to the Herbarium Bogoriense (BO), Research Center for Biology, Indonesian Institute of Sciences (LIPI), Cibinong-Bogor, Indonesia. From field study, a total of two species were obtained from five herbarium specimens collected from three sites. Observations were also conducted on the collection of Herbarium Bogoriense, which had 600s herbarium sheets of Javan selaginellas, 49 specimens collected from this area, consist of eight species, including two species of field survey.

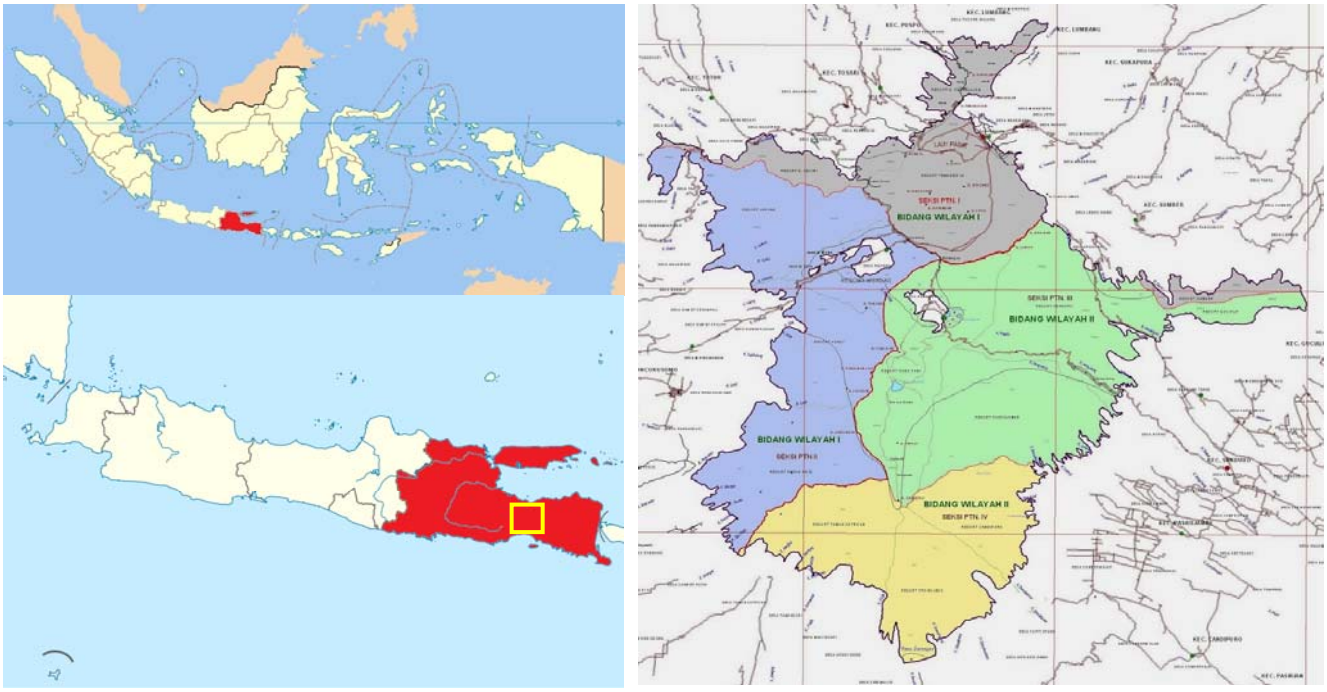

Figure 1. Bromo Tengger Semeru National Park in the Province of East Java, Indonesia

Figure 2. Selaginellas diversity in the Bromo Tengger Semeru National Park in the Province of East Java, Indonesia. A. *ciliaris,* B. *S. intermedia,* C. *S. involvens,* D. *S. opaca*, E. *S. ornata*, F. *S. plana,* G. *S. remotifolia,* H. *S. singalanensis.*

Several early bibliographies on *Selaginella* of the Nusantara (Malay Archipelago) and adjacent area were used for identification, i.e. Alston (1934, 1935a,b, 1937, 1940); as well as the newest literatures such 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). The literatures were also used to guide the preparation of description. Meanwhile, the global distributions mainly refer to Hassler and Swale (2002) and Chang et al. (2012).

RESULTS AND DISCUSSION

Eight species of *Selaginella* had been found in the Bromo Tengger Semeru National Park, East Java and the surrounding areas, namely: *S. ciliaris, S. intermedia, S. involvens, S. opaca, S. ornata, S. plana, S. remotifolia* and *S. singalanensis*. The morphological characteristics of *S. intermedia* and *S. singalanensis* need to be further confirmed since each of them was only observed from a single sheet herbarium.

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

Annual herb, small. *Stems* are creeping, recumbent, without a significant main stem, 2-13 cm in 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. 0.3 mm in diam. *Leaves* are dimorphic, arranged in 4 lanes (2 lateral, 2 median), single vein; *lateral leaves* are ovate-lanceolate, nearly symmetrical, 1.5-2 mm long, 0.5-1 mm wide, acute or acuminate apex, rounded or subcordate base, ciliate or serrulate margin, single vein reaching the apex, keeled, pointing outwards; *median leaves* are ovate to falcate, asymmetrical, 2-2.5 mm long, 0.5-1.5 mm wide, acute apex, attenuate or cuspidate, rounded base, serrulate margin with basal laciniate, pointing upwards, minutely toothed, ciliate, midrib prominent, single vein nearly reaching the apex; *axillary leaves* are ovate to lanceolate, bisymmetrically, 1.7-2.5 mm long, 1-1.5 mm wide, single vein nearly reaching the apex, acute apex, rounded to subcordate base, ciliate, toothed margin, with basal laciniate and apical serrulate. *Strobili* are solitary, terminal, flattened, complanate, up to ca. 1.5-2 cm long; sporophylls are dimorphic.

Locality: Malang (West Tengger), Probolinggo (Sukapura).

Habitat and ecology: at altitude of 1077-1337 m asl.

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

Specimen examined: CA Backer ? (1), CA Backer ? (2).

Selaginella intermedia (Blume) Spring, Bull. Acad. Brux. 10: 144 (1843)(Figure 2.B)

Perennial herb, suberect to ascending, glabrous, membranous, multiple branched at main stem, up to ca 70 cm long, pale green leaves. *Stems* suberect to ascending, cylindrical, glabrous, multiple branched toward apex, 3-5 mm wide (including leaves). *Rhizophores* present at basal stem, thick, cylindrical, originated from the ventral side of branching stem, ca. 1-1.5 mm in diam. *Leaves* dimorphic, arranged in 4 lanes (2 lateral, 2 median), sparsely arranged at main stem but closely arranged at the branches, single vein; *lateral leaves* oblong or ovate at main stem, lanceolate at branches, 4-4.5 mm long, 1.5-2.5 mm wide, acute or acuminate apex, asymmetrical, rounded base, dentate margin; *median leaves* smaller than the lateral ones, obovate, oblique at base, more or less symmetrically, 3-3.5 mm long, 1-2 mm wide, aristate apex, rounded or cordate base, dentate margin; *axillary leaves* lanceolate or ovate, 2-3 mm long, 1.5-2 mm wide, acute or obtuse apex, rounded base, dentate–denticulate margin, single vein nearly reaching the apex. *Strobili* solitary, terminal, loosely, quadrangular, up to 5 cm long; sporophylls monomorphic.

Locality: Lumajang (Pucungsari-Tempursari).

Habitat and ecology: at altitude of 409 m asl.

Distribution: India, Indonesia, Malaysia, Myanmar, Sri Lanka, Thailand, Vietnam,. In Indonesia: Java, Sumatra, Sulawesi.

Specimen examined: O Posthumus 1615.

Note: This species is typical of the western Java highlands, and it is very rare in Central Java. In this study, it was only found one specimens in the southern slopes of Bromo Tengger Semeru National Park, East Java. In Dieng Plateau of Central Java, this speciment can be found at three sites namely Doro and Paninggaran of Pekalongan as well as Mojotengah of Wonosobo (Setyawan et al. 2015).

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

Perennial herb, terrestrial or epiphythic. *Stems* are robust, ascending or erect, with a creeping rhizome, main stems pinnately branched from half upward, 18-50 cm long, 3-4 cm wide (incl. leaves), 1-1.5 mm in diam. *Rhizophores* present at intervals of rhizomes. *Leaves* on the rhizome are scale-like, monomorphic, ovate, ciliate, sessile, acute apex, colorless to brown, about 1 mm long, 0.4-1 mm wide; Leaves on the main stem are monomorphic, ovate, sessile, nearly asymmetrical, 1-2 mm long, 1-1.8 mm wide, acute apex, truncate base, serrate margin. Leaves on the branches are dimorphic, arranged in 4 lanes (2 lateral, 2 median), single vein, reaching the apex, dendritic, fan-shaped, green to yellowish green, rolling up when dry; *lateral leaves* are lanceolate, contiguous or overlapping, asymmetrical, 1-2.5 mm long, 0.2-1.5 mm wide, attenuate apex, cuneate base, vein curved with 2 grooves; *median leaves* are ovate, asymmetrical, 1.5-2,8 mm long, 1-2.5 mm wide, acute apex, rounded base, single vein with 1-2 groove(s) at the adaxial side and 2-3 grooves at the abaxial side on the top branch, entire margin; *axillary leaves* are ovate, nearly symmetrical, 1-2.5 mm long, 0.5-1.5 mm wide, acute apex, subcordate base, serrate margin. *Strobili* are solitary, terminal, tetragonal, compact, up to 2 cm long; sporophylls are monomorphic.

Locality: Malang (Pusungsajimah, Bendo), Lumajang (Pucungsari-Tempursari, Ranu Darungan, G. Semeru), Pasuruan (Nongkojajar, Tengger), Probolinggo (Sukapura).

Habitat and ecology: at altitude of 409-2009 m asl.

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

Specimen examined: ? [BO!], APG Bijhouwer 209, CA Backer ?, CA Backer 34148, CA Backer 34148, CA Wisse 626, E de Vries ?, J Viets 30, JD Dangelo 97, Jeswiet ?, Mousset 488, O Posthumus ?, P. Groenhart 122, T Ottolander ?

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

Perennial herb, fleshy. *Stems* are creeping to ascending, usually fertile branches alternate on long fleshy main stem, up to 70 cm long, 3-6 cm wide (incl. leaves). *Rhizophores* are at the branching stem, mostly near the base, originated 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 (2 lateral, 2 median), closely arranged at branches; *lateral leaves* are ovate to oblong, asymmetrical, 2-5 mm long, 2-3 mm wide,

acute apex, rounded base, single vein, not reaching the apex, serrulate margin, pointing outwards, overlapping at the ends of branches; *median leaves* are ovate to oblong, asymmetrical, 1.5-3 mm long, 1-2 mm wide, caudate apex, cordate base, pointing upwards, overlapping at the ends of branches, single vein not reaching the apex, serrulate or serrate margin; *axillary leaves* are ovate, entire, rounded or obtuse, symmetrical, 2.5-3.5 mm long, 1.5-2.5 mm wide, acute apex, entire margin. *Strobili* are solitary, terminal or lateral, tetragonal, up to more than 3.5 cm long.

Locality: Malang (Ngepuh, Pusungsajimah, Tengger (barat), Ampelgading, Nongkojajar, Poncokusumo), Pasuruan (Tengger utara, Tosari, Tutur), Probolinggo (Sukapura).

Habitat and ecology: On the vegetable fields, cliff of the roadsides and river banks, dirty road near waterfall; at altitude of 655-1799 m asl.

Distribution: Indonesia, Philippines. In indonesia: Sumatra, Java, Lombok, Ceram, New Guinea.

Specimen examined: ADS 57, ADS 59, ADS 61, ?, Buysman 93, CA Backer ?, CA Backer-O.Posthumus ?, E de Vries ?, Harreveld 41, J van Karvoeld 41, J Viets 2, JD Dongelo 184, Kobus ? (1), Kubus ? (2), P. Groenhart 20, P. Groenhart 124.

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

Perennial herb, fragile. *Stems* are suberect, 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 branching stem, ca. 0.5-1 mm in diam. *Leaves* are dimorphic, arranged in 4 lanes (2 lateral, 2 median), densely arranged throughout the stem and overlapping at top of branches, greenish or brownish; *lateral leaves* are oblong to falcate, denticulate to dentate, exauriculate, asymmetrical, 1.5-3 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, overlapping, 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: Malang (G. Semeru SW, G. Semeru S, Kali Glidik-Ampel Gading, Kalimocing, Dampit-Sumberrowo, Tangkil, Turen), Lumajang (Pucungsari-Tempursari, Ranu Darungan).

Habitat and ecology: at altitude of 409-1830 m asl.

Distribution: Cambodia, India, Indonesia, Malaysia, Thailand, Vietnam, Philippines. In Indonesia: Sumatra, Java, Kalimantan, Bali, Lombok, Flores.

Specimen examined: ? [BO!], CA Backer 3780, CA Backer 5780, CA Backer-O Posthumus 533, Koorders 23724, O Posthumus ?, O Posthumus 1505.

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

Perennial herb, stout. *Stems* are sub-erect with stoloniferous rhizome, without branches on the lower part, up to 80 cm long, 3-10 cm wide (incl. leaves); rhizome shallowly radiating. *Rhizophores* are sometimes at the branching stem, originated from the dorsal side of branching stem, ca. 1-1.5 mm in diam. *Leaves* on the main stem are monomorphic, well-spaced, appressed, 1.5-3 mm long, 1-2 mm wide, ovate, acuminate apex, asymmetrical, translucent, entire margin. Leaves on the branches are dimorphic, arranged in 4 lanes (2 lateral, 2 median), closely arranged at branches; *lateral leaves* are oblong, asymmetrical, 2-4 mm long, 2-3 mm wide, acuminate apex, sessile, single vein, not reaching the apex, truncate base, upper base with a spur-like lobe which overlaps the stem, transparent, entire margin; *median leaves* are ovate, asymmetrical, 1.5-3 mm long, 1-2 mm wide, acuminate apex, sessile, single vein, not reaching the apex, truncate and rounded base, transparent, 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 more than 3 cm long.

Locality: Malang (Bendo), Pasuruan (Tengger-north slope)

Habitat and ecology: altitude 665-1109 m asl.

Distribution: Peninsular Malaysia, Sumatra, Java, Bali, Timor, Flores, Sumbawa, Solor, Sulawesi, Moluccas (Ambon, Banda, Ceram, Kei Isl., Ternate, Buru). Introduced: 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: Mousset 878, T Ottolander ?.

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

Perennial herb, wiry. *Stems* are creeping, usually several fertile branches alternate on long main stem, up to 85 cm long, 0.5-1 cm wide (incl. leaves). *Rhizophores* are at the branching stem, originated from the dorsal side of branching stem, 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 (2 lateral, 2 median), closely arranged at branches; *lateral leaves* are lanceolate to ovate, asymmetrical, 1.5-3 mm long, 1-2 mm wide, acute apex, single vein, not reaching the apex, rounded base, serrulate margin, pointing outwards; *median leaves* are lanceolate, asymmetrical, 1.5-2.5 mm long, 0.5-1 mm wide, cordate base, attenuate apex, leaves at ends of branches overlapping, single vein not reaching the apex, serrulate margin; *axillary leaves* are ovate, symmetrical, 2-2.5 mm long, 1-1.5 mm wide, acute apex, entire margin. *Strobili* are solitary, terminal or lateral, tetragonal, up to more than 2 cm long.

Locality: Lumajang (Ranu Peni-Ranu Kumbolo), Malang (Cemarakandang, Tengger (west slope), Pasuruan (Nongkojajar, Tosari, Tutur).

Habitat and ecology: On the vegetable fields, cliff at the edge of the river and road; at altitude of 1415-2607 m asl.

Distribution: S-China, Indonesia, Japan, Korea, Myanmar, Taiwan, Philippines. In Indonesia: Sumatra, Java, New Guinea.

Specimen examined: ADS 58, ADS 60, ? [BO!], CA Backer-O Posthumus 485(a), CA Backer-O Posthumus 485(b), JD Dongelo N 146, MA Donk P275, MA Donk P276, O Posthumus 3998, Verdoorn 25.

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

Perennial herb. *Stems* are creeping, tender, attached to the ground, very soft and very thin, 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 (2 lateral, 2 median), densely arranged at thorough stem and overlapping at top of branches, yellowish green; *lateral leaves* are oblong, overlapping, 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, overlapping, 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.

Locality: Pasuruan (Tosari).

Habitat and ecology: at altitude of 1772 m asl.

Distribution: Sumatra, Java

Specimen examined: Kobus Tosari 147.

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