

การทบทวนอนุกรมวิธานของกล้วยไม้สกุล DENDROBIUM SW.
หมู่ FORMOSAE (BENTH. & HOOK.F.) HOOK.F. (ORCHIDACEAE)
ในประเทศไทยและพื้นที่ใกล้เคียง



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ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย

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TAXONOMIC REVISION OF ORCHIDS IN THE GENUS DENDROBIUM
SW. SECTION FORMOSAE (BENTH. & HOOK.F.) HOOK.F.
(ORCHIDACEAE) IN THAILAND AND ADJACENT AREAS



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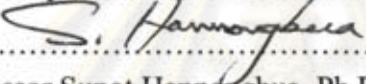
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Thesis Title	TAXONOMIC REVISION OF ORCHIDS IN THE GENUS <u>DENDROBIUM</u> SW. SECTION <u>FORMOSAE</u> (BENTH. & HOOK.F.) HOOK.F. (ORCHIDACEAE) IN THAILAND AND ADJACENT AREAS
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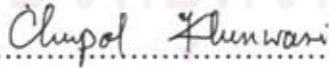

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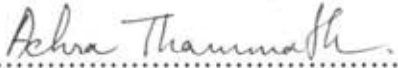

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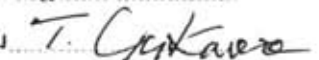
อภิรดา สถาปิตยานนท์ : การทบทวนอนุกรมวิธานของกล้วยไม้สกุล DENDROBIUM SW. หมู่ FORMOSAE (BENTH. & HOOK.F.) HOOK.F. (ORCHIDACEAE) ในประเทศไทยและพื้นที่ใกล้เคียง. (TAXONOMIC REVISION OF ORCHIDS IN THE GENUS DENDROBIUM SW. SECTION FORMOSAE (BENTH. & HOOK.F.) HOOK.F. (ORCHIDACEAE) IN THAILAND AND ADJACENT AREAS) อ. ที่ปริกษาวิทยานิพนธ์หลัก : ผศ.ดร. ต่อศักดิ์ สีลานนท์, อ. ที่ปริกษาวิทยานิพนธ์ร่วม : ศ. ดร. โดโมฮิสะ ซูกาวา, 319 หน้า.

กล้วยไม้สกุล *Dendrobium* หมู่ *Formosae* ถูกจัดจำแนกออกจากหมู่อื่นในสกุลด้วยลักษณะการมีขนสีน้ำตาลคลุมบนแผ่นใบและกาบใบ อย่างไรก็ตาม กล้ามมีกล้วยไม้หลายชนิดในสกุล *Dendrobium* ที่ถูกจัดให้อยู่ในหมู่นี้ไม่ว่าจะมีขนสีน้ำตาลปกคลุมบนแผ่นใบและกาบใบหรือไม่ก็ตาม ดังนั้นจึงได้มีการศึกษาทบทวนอนุกรมวิธานของกล้วยไม้สกุล *Dendrobium* หมู่ *Formosae* ในประเทศไทยและพื้นที่ใกล้เคียง ผลการศึกษาทบทวนครั้งนี้ทำให้กล้วยไม้ในหมู่ *Formosae* มีสมาชิกทั้งสิ้น 39 ชนิด โดยได้แยกกล้วยไม้ที่เคยจัดอยู่ในหมู่นี้จำนวน 4 ชนิด 4 พันธุ์ ออกจากหมู่ *Formosae* นอกจากนี้ยังค้นพบกล้วยไม้ชนิดใหม่ของโลก คือ *D. roseiodorum* A. Sathapattayanon, T. Yukawa and T. Seclanan พบกล้วยไม้ที่รายงานครั้งแรกในประเทศไทย 1 ชนิด คือ *D. hirsutum* Griff. รวมถึงได้จัดทำคำบรรยายภาษาละตินและกำหนดตัวอย่างต้นแบบให้แก่ *D. sanderse* 2 พันธุ์ ได้แก่ พันธุ์ *luzonicum* และพันธุ์ *major* นอกจากนี้ยังได้เลือกตัวอย่างต้นแบบ (lectotype) ให้แก่ *D. ignoniveum* J.J. Sm.

การศึกษาลักษณะผิวใบของกล้วยไม้สกุล *Dendrobium* 63 ตัวอย่าง ซึ่งเป็นกล้วยไม้ 42 ชนิด จากหมู่ *Formosae* หมู่ *Conostalix* หมู่ *Dendrobium* และ หมู่ *Distichophyllum* พบว่า สามารถนำรูปร่างและชนิดของปากใบ รวมถึงลักษณะของขน มาใช้ในการจัดหมวดหมู่ให้แก่กล้วยไม้สกุล *Dendrobium* ได้ในระดับหมู่ ส่วนลักษณะของผิวเคลือบคิวทินสามารถนำมาใช้แยกชนิดได้บ้างสำหรับกล้วยไม้หมู่ *Formosae* บางชนิด

การวิเคราะห์สายสัมพันธ์ทางวิวัฒนาการของกล้วยไม้สกุล *Dendrobium* หมู่ *Formosae* โดยใช้ลำดับนิวคลีโอไทด์ในไรโบโซมดีเอ็นเอบริเวณ ITS และคลอโรพลาสต์ดีเอ็นเอบริเวณ *matK* โดยวิเคราะห์แยกและวิเคราะห์ร่วมกัน พบว่า กล้วยไม้สกุล *Dendrobium* หมู่ *Formosae* ไม่เป็นชาติพันธุ์เดียว (non-monophyletic) โดยสมาชิกแยกออกเป็น 2 กลุ่ม คือ กลุ่ม A ประกอบด้วยกล้วยไม้หมู่ *Formosae* ที่มีขนสีน้ำตาลบนแผ่นใบและกาบใบในทางกลับกัน กลุ่ม B ประกอบด้วยกล้วยไม้หมู่ *Formosae* ที่ไม่ปรากฏขนสีน้ำตาลอวัยวะใดๆ ดังนั้น จึงควรแยกกลุ่ม B ออกจากหมู่ *Formosae* และจำกัดหมู่ *Formosae* ไว้ในกลุ่ม A โดยใช้ลักษณะการมีขนสีน้ำตาลบนแผ่นใบและกาบใบ ร่วมกับลักษณะการเรียงตัวของใบแบบสลับกันห่างๆและการมีเนื้อเยื่อเจริญบนกลีบปาก (ยกเว้น *D. kontumense* เท่านั้นที่ไม่มีเนื้อเยื่อเจริญบนกลีบปาก) นอกจากนี้ยังพบว่า *D. jerdonianum* และ *D. trigonopus* ไม่รวมกลุ่มกับกล้วยไม้สกุล *Dendrobium* หมู่ *Formosae* รวมทั้งหมู่อื่นๆ จึงควรทำการศึกษาค่าต่อไปในอนาคต

สาขาวิชา วิทยาศาสตร์ชีวภาพ
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ลายมือชื่อผู้พิมพ์ อภิรดา สถาปิตยานนท์
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APIRADA SATHAPATTAYANON: TAXONOMIC REVISION OF ORCHIDS IN THE GENUS DENDROBIUM SW. SECTION FORMOSAE (BENTH. & HOOK.F.) HOOK.F. (ORCHIDACEAE) IN THAILAND AND ADJACENT AREAS. ADVISOR : ASST. PROF. TOSAK SEELANAN, Ph.D., CO-ADVISOR : PROF. TOMOHISA YUKAWA, Ph.D., 319 pp.

Dendrobium section *Formosae* is diagnosed by the presence of blackish hairs on leaf blades and leaf sheaths. However, several *Dendrobium* species were included or excluded from this section regardless of the presence of blackish hairs on plant parts. Therefore, a taxonomic revision of section *Formosae* in Thailand and adjacent areas was carried out. In total, 39 species were described. In addition, eight taxa in 6 species and 2 varieties, formerly included in section *Formosae*, were removed from the section. A new species, *D. roseiodorum* A. Sathapattayanon, T. Yukawa and T. Seelanan is described, and two varieties of *D. sanderae*, var. *luzonicum* and var. *major*, were validated by giving the Latin descriptions and assigning the type specimens. *D. hirsutum* Griff. was first discovered in Thailand. Moreover, *D. ignoniveum* J.J. Sm. was also lectotypified.

The leaf surfaces of 63 taxa were investigated, representing 42 species of *Dendrobium* section *Formosae*, *Conostalix*, *Dendrobium* and *Distichophyllum*. It was found that leaf surface are taxonomic useful for classifying taxa at sectional level. The most important and informative characters are stomatal shape, stomatal type and epidermal hairs, while the cuticular sculpture can be partially used to segregate some species.

Molecular phylogenetic analyses of *Dendrobium* section *Formosae* sensu lato based on the ITS region of 18S-26S nuclear DNA gene and the maturase (*matK*) gene of plastid DNA were performed separately and in combined datasets. The results did not support the monophyly of *Dendrobium* section *Formosae*. The section *Formosae* as currently circumscribed fell into 2 separated, well-supported clades and anomalous placements of two taxa, namely *D. jerdonianum* and *D. trigonopus*. CladeA represented the taxa with diagnostic character. In contrast, CladeB included taxa with the absence of blackish hairs on any part of plants. Accordingly, section *Formosae* sensu stricto should be included only taxa in CladeA and more characters, such as stem with far distichous leaves and labellum with more or less callus (excepting for *D. kontumense*) should be add to the diagnose. The new section established for CladesB is suggested. *D. jerdonianm* and *D. trigonopus* should be removed from section *Formosae* and further investigation of their affinity to the other sections is needed.

Field of Study : Biological Sciences

Academic Year : 2008

Student's Signature : Apirada Sathapattayanon

Advisor's Signature : Tosak Seelanan

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CHAPTER I

GENERAL INTRODUCTION

Orchidaceae are one of the largest families of flowering plants, with reasonable estimates ranging from 17,000-35,000 species observed so far (Dressler, 1993). Each year, as many as 300 new species are added to the list. Some botanist estimated that more than 5,000 species remain undiscovered. More than 100,000 hybrids have been cultivated by the horticulturalists. The orchid family can distribute throughout the world, with their major concentration in the tropical rainforest in Asia. However, orchids can even be found in very arid areas and in sub-Arctic areas such as Alaska.

This family has attracted widespread attention in man by its elaborate and intriguing flowers therefore the orchids have had an enormous appeal in horticulture for ornamental propose. Orchid grower, dealers and collectors spent millions every year on the exotic species. The worldwide retail business is estimated to be worth in excess of 2.5 billion United Kingdom Pounds. The World Conservation Monitoring Centre (WCMC) conducted the report of the five years of orchids trade, based on 1995-1999 data and revealed that most of the trade involved 40 orchid genera, which are traded in the thousands. Import and export data indicate that 20 to 25 millions or more orchid plants are traded each year worldwide. The entire orchid family has been included in the CITES Appendices since the treaty entered into force in 1975. Several species were included in Appendix I because they were over-collected from the wild for horticulture.

The ancient Chinese were the one of the first people to use orchids as medicine, and some of the earliest paintings of orchids can be found on the oldest of Chinese vases. In India in the 1800's, a nutritious drink made from the roots of *Orchis morio* was produced and known by the name of "Salep" or "Saloop" (Bose and Bhattacharjee, 1980). Nowadays, several orchid species are used as the mendacious plants. For examples, the orchid product called

“Shihu” is currently for sale and made from several *Dendrobium* species. It is recommended for indigestion, rehydration, as an anti-pyretic, to increase white blood cells (Bulpitt, 2005). Interestingly, the Chinese use *Dendrobium loddigesii* for stomach and lung cancer. The species has anti-cancer activity for stomach and lung cancer cell lines (Ho and Chen, 2003). It is also an anti-platelet agent (Chen *et al.*, 1994). *Gastrodia elata* is grown commercially. It is used to treat allergies and relieve headache and fatigue. Interestingly, the plant contains gastrodin, which has anticonvulsant effects, at least in gerbils (An *et al.*, 2003).

Vanilla is an example of orchid used for food. The most important vanilla species is *Vanilla planifolia*. Aromatic oil, derived from the seedpods of the orchid, is widely used as flavoring and perfume in making ice cream, beverage and cosmetics (Kalimuthu *et al.*, 2006).

In some areas, the local orchid species are used as the material for decorate artifacts, including domestic implement, clothing, body ornaments, ceremonial articles and funerary relics. For example, in Sulawesi and Kalimantan, the stems of *Diplocaulobium utile* are split and dried to yellow strips, which mainly used for decorative edging on small items such baskets or cigar cases. The young women of Manipore wear the flowers of *Dendrobium densiflorum* behind their ears while the dried plants of *D. clavatum* are used in scent (Lavarack *et al.*, 2002). In Thailand in the early 1900's, Mae Hong Son was a province tributary to Chiang Mai. At that time flowering plants of *D. scabrilingue* were one of the prescribed articles of tribute that inhabitants of Mae Hong Son had to pay annually to the ruling chief of Chiang Mai (Wanandon, 1968). Nowadays, the flowering shoots of *D. scabrilingue* are still being collected and used for hair decoration and for paying respect to the images and shrines of Buddha (Watthana and Pedersen, 2008).

Several orchids exhibit large variation in life forms, habitats, distributions and trophic pattern within family. Taxonomically, Orchidaceae is recently

classified into 5 subfamilies, viz. Apostasioideae, Cyripedioideae, Vanilloideae, Orchidoideae and Epidendroideae (Pridgeon *et al.* 1999).

1.1 General morphology (adapted from Dressler, 1993; Zomlefer, 1994 and Cribb, 1999)

1.1.1 General morphological characters of the Orchidaceae

Orchidaceae is distinguished from the other monocotyledonous plant families by its unique characteristics. Orchid morphology has formed the basis of all orchid classifications set forth by Swartz (1800), Richard (1818), and Lindley (1826; 1830). These early classification concentrated on floral structure to delimit genera and higher taxa. Not until the work of Pfitzer (1888) were vegetative characters considered significant in the construction of classifications. Dressler (1993) used both macro and micro morphology together in his classification.

Plant habitat

Orchids can be terrestrial, epiphytic or lithophytic. In the tropics, the majority of orchids are epiphytic on forest trees, or lithophytic on the rocks and cliffs, but a significant minority is terrestrial, growing on the forest ground. The epiphytes can be lithophyte where the rainfall is sufficient. It is common to find the same species growing on trees and rocks in the same locality. In such cases orchids that are usually epiphytic can grow terrestrially. In temperate regions the terrestrial habit predominates, especially in woodland and grassland. Some of them are achlorophyllous, bearing scale leaves or lacking leaves altogether and reliant on their mycorrhizal fungi for nutrients throughout their life. These orchids are known as mycoheterotrophs. Most appear above ground only at flowering time for pollination and seed dispersal.

Roots

Orchid roots may have one or more functions: attachment to the substrate, anchorage in a substrate, absorption of water and nutrients, photosynthesis, litter gathering and as a link between orchid and mycorrhizal fungus. They can be diverse in their morphology depending on which functions they perform. Although, most terrestrial orchids have a simple rhizodermis, some terrestrials and virtually all epiphytes have a velamen, epidermal tissue comprising one to eighteen layers of cells, which die as the root matures. They form a spongy, whitish sheath around the root, separate from the cortex by the exodermis of long empty cells and shorter, living passage cells. The structure and physiology of the velamen and underlying exodermis are adapted for at least two functions: (1) attachment to the substrate; (2) water and nutrient uptake in a periodically dry environment (Pridgeon, 1987).

In many terrestrial orchids the roots are storage organs and consequently are swollen and often tuberous while roots of some mycoheterotrophic orchids can be abbreviated and vestigial. Such *Neottia* and *Corallorhiza* have coralloid roots, in which the main absorptive function is assumed by the mycorrhizal fungi. In the leafless orchids of such genera as *Taeniophyllum*, the roots have entirely taken over the photosynthetic function.

Stems

Orchids can have one of two growth patterns, either sympodial or monopodial. In sympodial growth the apex of each shoot terminates in a flowering axis. The subsequent vegetative shoot emerges from a node below the apex of the new shoot. Usually the new growth is produced annually or seasonally. Monopodial growth, the derived condition, is the result when the stem apex is of indeterminate growth and the inflorescences are borne laterally. Monopodial growth is found in vanilloids and vandoids.

Rhizomes are horizontal or ascending stem of sympodial orchids, either below or on the substrate surface. On the other hand, pseudobulbs are

swollen or thickened stems, essentially water storage organs of sympodial orchids. Pseudobulbs are common in tropical epiphytic orchids but are also found in tropical terrestrials, growing either above the ground as in *Calanthe* or underground as in *Eulophia*.

In many orchids, the pseudobulbs are green and photosynthetic. In *Bulbophyllum minutissimum*, the leaf is very small that the pseudobulbs functions as the main photosynthetic organ.

Leaves

The orchid leaves perform the main photosynthetic function in most species. In most orchids the leaves are arranged distichously. However, in some they can be spirally arranged on the stem or reduced to a single terminal leaf. Distichous leaves are derived from spirally arranged one (Dressler, 1993).

The leaves of orchids are typical monocotyledon leaves with parallel longitudinal venation, usually linked by obscure commissural veins. Leaf venation can be systematically informative. In some terrestrial such as *Nervilia*, the venation appears fan-shaped because of the leaf-shape.

Dorsiventrally flattened leaves are common. The leaves of species found in the drier places are often more or less succulent or leathery. Genera such as *Luisia* and *Papilionanthe* are characterized by terete leaves. Laterally flattened leaves are characteristic of some genera such as *Podangis* and *Bolusiella*.

Leaf shape is relatively uniform for many genera. Most orchids have simple, linear, lanceolate, oblanceolate, ovate, or elliptic leaves. However, fan-shaped leaves are found in some *Cypripedium* and *Nervilia* species.

In many orchids, the leaves have a sheathing base, which closely clasps the stem. Leaf articulation is found only in the Epidendroideae orchids. The abscission layer is usually between the leaf blade and leaf sheath.

Flowers

The development of most orchid flowers, forming the suitable platform for pollinators, is resupination. Normally, labellum lies uppermost in the flower and column lowermost. However, the pedicel or ovary twists through 180°, therefore the labellum becomes lowermost in the flower when it opens. Nonresupinate species cause by its pedicel or ovary does not twist during development or else twist though 360°, so that the labellum is uppermost. There are many examples of nonresupinate flowers in Orchidoideae and Epidendroideae.

The floral parts of orchids are situated at the apex of the ovary, which is inferior and usually born on a pedicel. The outermost whorl of the orchid flower is calyx, which consists of three sepals. The two lateral sepals differ slightly from the third, called dorsal or median sepal. In some orchids such as *Dendrobium* and *Bulbophyllum*, the lateral sepals are united at base forming the mentum. In Cyripedioideae the lateral sepal are united to the apex, forming a synsepal.

The corolla comprises three petals. The two lateral petals differ markedly from the third petal, which lies at the lowermost of the flower. The lateral petals are often showy and coloured. The third petal, called labellum or lip, is highly modified. It is the important adaptation to facilitate cross-pollination. The labellum, including visual cues and fragrance glands, acts as an attractant and/or landing platform. Lip shape and its features can be diagnostic in orchid classification.

The central part of the orchid flower shows the greatest modifications. Its male and female organs fused into a single structure, called column.

In Apostasioideae, *Neuwiedia* has three functional anther but the median stamen in *Apostasia* is sterile or absent. Similarly, only two lateral anthers in Cyripedioideae are fertile. In most other orchids, a single median anther lies at the apex of the column with the other two either sterile or absent. The anther of most orchids does not contain powdery pollen but discrete waxy masses called pollinia. The pollinia are attached to a sticky

organ, called viscidium, by a stalk. The stalks can have various origins. Those that originate in the anther are called caudicles. Most vandoid have the stripe, derived from rostellar tissue instead of anther tissue. The pollinia, stalk and viscidium together comprise a pollination unit termed pollinarium, normally covered by the anther cap or called operculum.

Stigma of orchid is positioned on the ventral surface of the column. The stigma is a sticky lobed situated below the anther, but in some terrestrial genera such as *Habenaria* the stigma is bilobed with the receptive surface at the apex of each lobe. In many species, the pollen masses are transferred to the stigmatic surface by a modified lobe of the stigma called the rostellum, which acts as the projecting flap that catches the pollen masses and directs them into the stigmatic cavity.

Fruits

Orchid fruits, termed capsule, dehiscent by 3 or 6 longitudinal slits, while remaining closed at both ends. The ripening of a capsule can take 2 to 18 months. Mature capsules of terrestrial orchids are generally erect, thin-walled, rather dry and papery, whereas those of epiphytes are usually pendent, thicker-walled, and often fleshy.

Seeds

The orchid seeds are generally almost microscopic and very numerous, in some species over a million per capsule. After ripening they blow off like dust particles or spores. Most orchids have a loose, rather thin seed coat around the embryo. The seed range from 0.15 mm to 6 mm in length and vary a great deal in width and in structural details (Dressler, 1993). Because of lacking endosperm, the seeds have to enter symbiotic relationship with various mycorrhizal fungi that provide them the necessary nutrients to germinate.

1.1.2 General morphological characters of orchid subtribe

Dendrobiinae

Tribe Dendrobieae are characterized by naked pollinia, without caudicle or other appendages. The Dendrobiinae is one of the most distinctive subtribes. Dressler (1993) described the characteristics of the orchids in this subtribe that they are the epiphytes or occasionally terrestrials. Stems are slender or forming pseudobulbs, usually have several internodes, sometimes of a single internode. Leaves distichous, duplicate, and articulate. Inflorescences are lateral or terminal, usually upper axillary, simple or branched with few to many spiral flowers. Flowers are small to large, resupinate, and usually with a spur. Labellum often joint basally. Column has a prominent foot. The anther is terminal with two cells and four naked pollinia in two pairs.

1.2 Literature reviews

1.2.1 Taxonomic History of Orchidaceae

The taxonomy of the orchid family has evolved slowly during the last 150 years ago, starting with Carolus Linnaeus (1753) who first recognized 69 species in 8 genera, namely *Orchis*, *Satyrium*, *Ophrys*, *Serapias*, *Limodorum*, *Arethusa*, *Cypripedium* and *Epidendrum*, in "Species Plantarum". He assigned all epiphytes to *Epidendrum*. However, there is no family designation.

Antoine Laurent de Jussieu (1789) recognized the Orchidaceae as a separate family, published in "Genera Plantarum".

The first orchid specialist is Olaf Swartz (1800) who recognized 25 genera of orchids in "Afhandling om Orkidernes slægter och deras systemmatiska indelning". Moreover, he is the first who separated orchids to 2 groups, monandrous and diandrous orchids.

John Lindley took the next step in 1826-1840. He is generally known as the father of modern orchid classification. Lindley (1826) published 4 tribes of orchids (*Neottieae*, *Orchideae*, *Epidendreae* and *Cypripedieae*) in "Orchidearum Sceletos". He also published "Genera and Species of

Orchidaceous Plants” (Lindley, 1830). He described 1,980 orchid species and classified into 7 tribes, viz. Malaxaeae, Epidendreae, Vandaeae, Ophreae, Arethuseae, Neottiaeae and Cypripediaeae.

The next important step was taken by George Bentham and Joseph Dalton Hooker (1883). Their influential system of orchid classification, modified based on Lindley’s system, published in “Genera Plantarum, volume 3”. They classified 5 tribes of Orchidaceae, i.e. Epidendreae, Vandaeae, Neottiaeae, Ophrydeae and Cypripediaeae.

Friedrich Richard Rudolf Schlechter (1926) recognized 2 subfamilies, Cypripedioideae and Orchidoideae. He separated Apostasiaceae as a family in “Das System der Orchidaceen”.

Classification system of Robert Louis Dressler (1981), published in “The Orchids: Nature History and Classification”, is widely accepted by botanists and growers. The scheme has been modified in “Phylogeny and Classification of Orchid Family” (Dressler, 1993). Dressler considered in evolution and interrelationships of the subfamilies. This is the most comprehensive classification at the moment. There are 5 subfamilies (Apostasiodeae, Cypripedioideae, Spiranthoideae, Orchidoideae and Epidendroideae), 22 tribes, 70 subtribes, 850 genera and about 30,000 species.

Nowadays, Alec M. Pridgeon, Phillip J. Cribb, Mark W. Chase and Finn N. Rasmussen have published the “Genera Orchidacearum” since 1999, organized as 6 volumes. These books have the completed orchid classification. Orchidaceae are divided into 5 subfamilies, namely Apostasiodeae, Cypripedioideae, Orchidoideae, Vanilloideae and Epidendroideae, based on morphological characters, molecular data, phylogeny and evolution. All of 6 volumes will be completed in the near future.

1.2.2 Taxonomic History of *Dendrobium Sw.*

Swartz (1799) established the genus *Dendrobium* in “Nova Acta Regiae Societatis Scientiarum Upsaliensis”. The species included by him were described as parasitic (actually epiphytic) orchids on trees. He named

Dendrobium in allusion to this growth habit. The 14 species included in the genus by Swartz have lateral sepal converging with or fused to the lip and often imitating a muntum. Only 3 of these are now retained in *Dendrobium*. One is a type species of the genus, *D. moniliforme* (L.) Sw., which was originally described by Linnaeus in 1753 as *Epidendrum moniliforme* and transferred to *Dendrobium*.

Many subsequent botanists classified *Dendrobium* into several subgroups as following: Blume (1825), divided *Dendrobium* into 7 sections, based on his study of the orchids of Java. He provided details descriptions of the sections but did not refer any species to them. Lindley (1844) recognized 4 sections of genus *Dendrobium*: *Eudendrobium*, *Stachyobium*, *Ceratobium* and *Padilonum*. Lindley and Paxton (1850) published a sectional arrangement of *Dendrobium* consisting of 10 sections. Other revisions of *Dendrobium* were preceded by later workers such as Reichenbach (1861), Benthum and Hooker (1883) and Pfitzer (1888). The next classification followed by Kraenzlin (1910), his revision of *Dendrobium* has been much criticized and has not been widely adopted. He divided the genus into 10 genera and recognized 32 sections.

The significant classification of *Dendrobium* is that of Schlechter (1912). He divided *Dendrobium* into 4 subgenera based on vegetative characters. The first considered character was on the basis of the presence or absence of leaf sheaths. Subgenus *Athecebiium* contains the species in which the leaves lack sheaths. The remaining species, in which the leaves have distinct sheaths, are divided into 3 subgenera on the basis of the degree of fleshiness of the stem. Subgenus *Eu-Dendrobium* has pseudobulbs or stem fleshly throughout. In subgenus *Rhopalobium*, the pseudobulbs are thickend for the basal 1-3 internodes only and wiry above. The last subgenus, *Xerobium*, has wiry dry and very slender pseudobulbs. Among these, Schlechter also recognized 41 sections. A few of his sections came to be accepted as genera over the years. For examples, *Desmotrichum* (now *Flickingeria*), *Diplocaulobium*, *Sarcopodium* (now *Epigeneium*) and *Goniobulbon*. Subsequently, Brieger (1981) revised Schlechter's (1912) classification. He subdivided *Dendrobium* into 23 genera by

re-establishing old generic concepts and adopting new genera based on formerly recognized sections. However, many botanists have not accepted Brieger's classification.

1.2.3 Taxonomic History the section *Formosae*

The term *Nigrohirsutae*, or now section *Formosae*, originated by Lindley (1859), in his "Contributions to the Orchidology of India volume 2" as a name for subsection in section *Eu-dendrobium* of the genus *Dendrobium*. The subsection distinguished by the presence of short black hairs on the young stems. Five species were listed in this subsection; *D. formosum*, *D. infundibulum*, *D. longicornu*, *D. xanthophlebium* and *D. attenuatum* (not *Formosae*).

The description of the subsection *Formosae* appeared in "Genera Plantarum, volume 3" by Bentham and Hooker (1883). They divided *Dendrobium* into 7 sections. In *Eu-dendrobium*, the section was subdivided into 6 subsections. Subsection *Formosae* was described in Latin and was referred to the protologues of *D. formosum*, *D. hirsutum*, *D. longicornu* and *D. lowii*.

Hooker (1890) published "Flora of British India 5" and revised his previous work (Bentham and Hooker, 1883). He divided *Dendrobium* into 12 sections. He followed the same description of *Formosae* by Bentham and Hooker (1883) but in this work Hooker used the sectional name *Formosae* for the group. He recorded 10 taxa to the section, *D. longicornu*, *D. cariniferum*, *D. watii*, *D. infundibulum*, *D. formosum*, *D. williamsonii*, *D. albo-sanguineum* (not *Formosae*), *D. draconis*, *D. lubbersianum* (this name is a synonym of *D. williamsonii*) and *D. virgineum*.

Kraenzlin (1910) raised the subsection *Nigrohirsutae* Lindl. to subgenus level, namely *Nigrohirsuta*, and placed here some 26 taxa. He provided the Latin description and also the key to species of this subgenus.

In 1912, Schlechter revised the genus *Dendrobium* by dividing it into 4 subgenera and subdivided subgenus *Eudendrobium* to 17 sections. He named the new section, *Oxygenianthe*, by broadening the descriptive characteristics

from *Nigrohirsutae*. However, Schlechter did not list any species for his section.

Brieger (1981) revised Schlechter's revision. He recognized 2 subgenera of *Dendrobium*, subgenus *Dendrobium* and subgenus *Stachyobium*. The first subgenus was divided into 5 sections. Brieger accepted Lindley's epithet, *Nigrohirsutae*, therefore he named his revised section as *Nigrohirsuta*, which comprised 7 species. Brieger described the section and each species in German and typified *D. formosum* for the section.

It seems that many botanists have applied various names and taxonomic ranks to this orchid group but used the same diagnostic characterization of hairiness.

Seidenfaden (1985) placed *Formosae*, prior to *Nigrohirsutae* or *Nigrohirsuta* or *Oxygenianthe*, as the correct section name. He based his rename on the description of the section, first established by Hooker (1890). Lindley (1859) first recognized the circumscription of this orchid group but he used subsectional level, *Nigrohirsutae*, for the group as well as Bentham and Hooker (1883) who also used subsection *Formosae*. Under current rules of nomenclature, Hooker's (1890) name is later, but properly published in sectional level then becomes the first validly publication. Therefore, this *Dendrobium*'s section should be named *Formosae* (Benth. & Hook.f.) Hook.f. This name is widely accepted in recent floristic works and the other publications

1.2.4 History of taxonomic works relevant to section *Formosae* in Thailand and adjacent areas.

Dendrobium disperses from India and Sri Lanka in the west to Tahiti in the east and from Japan and Korea in the north to New Zealand in the south (Lavarack *et al.*, 2002). No members are recorded from America or Africa. The distribution of section *Formosae* has more limits. The section occurs from India and the Himalaya to the Philippines and Sulawesi in the west. It seems likely that the section has its center of distribution in Indochina. The numbers of

species are still varied due to the discoveries of new plants, especially from Borneo, Sumatra and Sulawesi Islands.

Accordingly, the taxonomic works, which involved *Dendrobium* section *Formosae*, usually reported from distributed areas in the part of orchid's explorations or plant Floras. For example, India (Lindley, 1858; Hooker, 1890), Buthan (Pearce and Cribb, 2002), Myanmar (Grant, 1895; Tanaka, 2003; 2004), Thailand (Seidenfaden and Smitinand 1959-1965; Seidenfaden, 1985), Indochina (Gagnepain and Guillaumin, 1932; Seidenfaden, 1992), Vietnam (Averyanov and Averyanova, 2005; Averyanov, 2006), Peninsular Malaysia (Holtum, 1953; 1957; Seidenfaden and Wood, 1992), Indonesia (Latif, 1953), Sumatra (Smith, 1933; Comber, 2001), Borneo (Chan et al., 1994; Wood and Cribb, 1994; Wood, 1997; 2003) and the Philippines (Valmayor, 1984; Cootes, 2001). Furthermore, there are 2 recent publications as *Dendrobium* (Lavarack et al. 2002; Wood, 2006), demonstrated several species of *Dendrobium* of each section, including some of section *Formosae* (Table 1.1). However, those publications still used some names that are outdated or uncorrected nomenclature because there are no taxonomists who emphatically study only section *Formosae*. Most of *Formosae* species have the attractive large and long-lasting flowers. They became the cultivated plants and were included in some publications. These lead to the confusion on the distribution and the native of the species.

From the last two decades, 12 new species of the section *Formosae* were reported; namely *Dendrobium lueckelianum* Fessel and M. Wolff (Fessel and Wolff, 1990), *D. ayubii* J.B. Comber and J.J.Wood (Comber and Wood, 1999), *D. vogelsangii* P. O'Byrne (O'Byrne, 2000), *D. suzukii* T. Yukawa (Yukawa, 2002), *D. schildhaueri* Ormerod and H.A. Pedersen (Ormerod and Pedersen, 2003), *D. trankimianum* T. Yukawa (Yukawa, 2004), *D. ochraceum* var. *albiflorum* H. Schildhauer and W. Schraut (Schildhauer, 2005; 2006), *D. schrautii* H. Schildhauer (Schildhauer, 2006), *D. chapaense* Aver. (Averyanov, 2006), *D. meghalayense* C. Deori, S.K. Sarma, T.M. Hynniewta and S.J. Phukan (Deori et al., 2006), *D. jaintianum* C.M. Sabapathy (Sabapathy, 2007), *D. toppii* A. Lamb

and J.J. Wood (Lamb, Wood and Miadin, 2008), *D. sisuronense* J.J. Wood (Wood *et al.*, ined.) and *D. roseiodorum* A. Sathapattayanon, T. Yukawa and T. Seelanan (Sathapattayanon *et al.*, ined.), mostly from Vietnam and Borneo. However, some of them were reduced to the synonymous names after this revisionary study (see next chapter).

The first taxonomic account of the orchid family in Thailand was carried out by J. Schmidt during 1899-1900. He collected orchids from Koh Chang and nearby islands. These orchids were studied by Kraenzlin who enumerated 31 species in 21 genera of orchids (Kraenzlin, 1900).

In the early of 1900s, A. F. G. Kerr collected orchids from Doi Sutep, Chiang Mai Province and sent the specimens to the Royal Botanical Gardens, Kew for identification (Wolters-Noordhoff and Jacobs, 1962).

Prince Nakhon Sawan published the Orchids of Thailand in 1916. He described the orchid species in Thai but also provided the scientific names. Most of his orchids are the cultivated species. He reported several *Dendrobium* species, among these 9 species of section *Formosae* were included.

The most important taxonomic studies of Thai orchids were arranged by G. Seidenfaden, former Danish ambassador to Thailand. During 1959-1965, he collaborated with T. Smitinand, from the Royal Forest Department of Thailand. They explored the orchid family throughout Thailand and published the list of 858 Thai orchid species (Seidenfaden and Smitinand, 1959a; 1959b; 1960; 1961; 1963 and 1965). The most important of Seidenfaden's numerous works on Asiatic orchids are the series of "Orchid Genera in Thailand", which are still the most usable framework for identification. The first volume was published in 1975 and the last one (volume fourteenth) was the impressive "59 Vandoid Genera" in 1988. The genus *Dendrobium* was published in volume seventh (Seidenfaden, 1985). He recognized 14 sections of *Dendrobium*, included section *Formosae*. The other Seidenfaden's works on orchids of Thailand are the series of "Contributions to the Orchid Flora of Thailand" volume 1-13, during 1969-1997 (Larsen, 2001).

Not only a number of taxonomic and floristic notes on Thai orchids but he also published the accounts on orchids from the other parts of southeast Asia, for examples, Northwestern Himalaya (Seidenfaden and Arora, 1982), Peninsular Malaysia and Singapore (Seidenfaden and Wood, 1992) and Indochina (Seidenfaden, 1992).

During February 1962 to August 1963, Cumberlege and Cumberlege spent 75 days for the preliminary orchids expedition in Khao Yai National Park. One hundred and twenty-one species in 54 genera were found. There are 12 species of *Dendrobium* and the two of these were section *Formosae* species (Cumberlege and Cumberlege, 1963).

The later taxonomic works on Thai orchids were usually reported by the botanists who worked in some specific areas. The examples for some accounts relevant to *Dendrobium* section *Formosae* are following.

Phengklai (1996) surveyed plants diversity at Doi Inthanon National Park, Chiang Mai Province. He reported 221 species in 62 genera of Orchidaceae. Thirty-two species of *Dendrobium* were found, among these 7 species were members of the section *Formosae*.

Thaithong (1999) listed the orchid species of Thailand together with their localities based on Seidenfaden's works (1959-1997). In 2000, she published her own orchid collections from throughout Thailand and provided the species descriptions. Both of her publications included *Dendrobium* section *Formosae*.

In 2003, Boonkerd et al. carried out vascular plant exploration at Khun Korn Waterfall Park, Chiang Rai Province. There were 77 species in 40 genera of Orchidaceae. Thirteen species were included in the *Dendrobium* and 2 species were members of the section *Formosae*. In the same year, Sudee reported his taxonomic study on Orchidaceae at Pa Hin Ngam National Park, Chai yaphum Province. He found 37 species of 22 genera. *D. draconis* members of the section *Formosae* was also found (Suddee, 2003).

Buakhlai (2005) worked on diversity of orchids at Khao Khiao area in Kao Yai National Park. One hundred and six species were identified. Ten species of *Dendrobium* were found, one of them was *D. scabrilingue*.

So far, the orchids Flora of Thailand is rather in a slow process. Only the small group of Apostasioids has been included in Flora of Thailand. Larsen and De Vogel (1972) treated it as a separate family. Recently, the Orchidaceae Project for Flora of Thailand was initiated in 2002, as a joint venture between the Forest Herbarium, Bangkok and the botanical Museum, Copenhagen, by the coordination of Henrik Pedersen. The project has been prepared to include the remaining part of the Thai orchids (ca. 1,200 species) in a volume composed of six installments. The first installment will provide an entrance key to the family and deal with the genera of Cyripedioideae, Vanilloideae, and Orchidoideae. The five others will each cover one or more larger groups of Epidendroideae. This taxonomic revision of *Dendrobium* section *Formosae* also the part of this project.

1.3 Objectives

1.3.1 To provide a complete account of *Dendrobium* section *Formosae* in Thailand and the adjacent area.

1.3.2 To re-evaluate circumscription of section *Formosae* by using morphological, anatomical and molecular study.

1.3.3 To clarify the phylogeny of the section *Formosae* based on molecular characters.

1.4 Scopes of study

The study included taxa of *Dendrobium* section *Formosae* found in Thailand and adjacent area using anatomical and morphological characters with some ecological and distribution data. Also, molecular systematics of the section *Formosae* will be conducted using both a nuclear gene and cpDNA gene.

1.5 Anticipated benefits

The results of this research will be a part of the taxonomic revision of Orchidaceae for the Flora of Thailand and accommodate the model for future taxonomic revision in the Orchidaceae.



ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย

Table 1.1 List of species (including synonyms) in section *Formosae* sensu lato.

No.	Species	Publication																									
		Averyanov, 2006	Averyanov et Averyanova, 2005	Chan <i>et al.</i> , 1994	Comber, 2001	Gagnepain et Guillaumin, 1932	Grant, 1895	Holtum, 1957	Hooker, 1890	Latif, 1953	Lavarack <i>et al.</i> , 2002	Lindley, 1858	Nakhawn Sawan, 1916	Pearce et Cribb, 2002	Phengkhai, 1996	Seidenfaden, 1985	Seidenfaden, 1992	Seidenfaden, 1995	Seidenfaden et Smitinand, 1959	Tanaka, <i>et al.</i> , 2003	Tanaka, <i>et al.</i> , 2004	Thaithong, 2000	Valmayor, 1984	Wood, 1997	Wood, 2003	Wood, 2006	
1.	<i>D. andersonii</i> J.Scott					✓																					
2.	<i>D. ayubii</i> J.B.Comber et J.J.Wood				✓																						✓
3.	<i>D. bellatulum</i> Rolfe					✓				✓				✓	✓	✓			✓	✓		✓					✓
4.	<i>D. cariniferum</i> Rchb.f.		✓			✓		✓		✓					✓	✓			✓		✓						✓
5.	<i>D. christyanum</i> Rchb.f.					✓				✓					✓	✓			✓	✓		✓					✓
6.	<i>D. cruentum</i> Rchb.f.					✓	✓	✓		✓		✓			✓	✓			✓			✓					✓
7.	<i>D. dearei</i> Rchb.f.						✓	✓	✓			✓											✓		✓		✓
8.	<i>D. draconis</i> Rchb.f.					✓	✓	✓	✓			✓		✓	✓	✓			✓	✓		✓					✓
9.	<i>D. evrardii</i> Gagnep.					✓																					
10.	<i>D. formosum</i> Roxb. ex Lindl.					✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓			✓					
11.	<i>D. fuerstenbergianum</i> Schltr.					✓										✓			✓								✓
12.	<i>D. galactanthum</i> Schltr.					✓													✓								
13.	<i>D. hallieri</i> J.J.Sm.																								✓		
14.	<i>D. igneoniveum</i> J.J.Sm.				✓																						
15.	<i>D. infundibulum</i> Lindl.					✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓			✓					✓
16.	<i>D. infundibulum</i> var. <i>jamesianum</i> (Rchb.f.) Veitch					✓																					✓

No.	Species	Publication																									
		Averyanov, 2006	Averyanov et Averyanova, 2005	Chan <i>et al.</i> , 1994	Comber, 2001	Gagnepain et Guillaumin, 1932	Grant, 1895	Holtum, 1957	Hooker, 1890	Latif, 1953	Lavarack <i>et al.</i> , 2002	Lindley, 1858	Nakhawn Sawan, 1916	Pearce et Cribb, 2002	Phengkhai, 1996	Seidenfaden, 1985	Seidenfaden, 1992	Seidenfaden, 1995	Seidenfaden et Smitinand, 1959	Tanaka, <i>et al.</i> , 2003	Tanaka, <i>et al.</i> , 2004	Thaithong, 2000	Valmayor, 1984	Wood, 1997	Wood, 2003	Wood, 2006	
17.	<i>D. infundibulum</i> var. <i>ornatissimum</i> Rchb.f.					✓																					
18.	<i>D. jamesianum</i> Rchb.f.											✓															
19.	<i>D. jerdonianum</i> Wight							✓																			
20.	<i>D. kontumense</i> Gagnep.		✓			✓																					
21.	<i>D. longicornu</i> Lindl.		✓			✓		✓			✓	✓	✓			✓					✓					✓	
22.	<i>D. lowii</i> Lindl.							✓				✓											✓			✓	
23.	<i>D. lubbersianum</i> Rchb.f.						✓		✓																		
24.	<i>D. lueckelianum</i> Fessel et M.Wolff																	✓									✓
25.	<i>D. margaritaceum</i> Finet					✓													✓								
26.	<i>D. multilineatum</i> Kerr														✓	✓											
27.	<i>D. nutans</i> Lindl.								✓																		
28.	<i>D. nutantiflorum</i> A.D.Hawkes et A.H.Heller																										✓
29.	<i>D. ochraceum</i> De Wild.	✓													✓	✓											✓
30.	<i>D. ovipostoriferum</i> J.J.Sm.							✓																			✓
31.	<i>D. parthenium</i> Rchb.f.																										✓
32.	<i>D. phi</i> E.Christensen	✓																									
33.	<i>D. radians</i> Rchb.f.																									✓	
34.	<i>D. sanderae</i> Rolfe							✓		✓													✓				✓
35.	<i>D. sanderae</i> var. <i>luzonicum</i> Tiu																										✓

No.	Species	Publication																														
		Averyanov, 2006	Averyanov et Averyanova, 2005	Chan <i>et al.</i> , 1994	Comber, 2001	Gagnepain et Guillaumin, 1932	Grant, 1895	Holtttum, 1957	Hooker, 1890	Latif, 1953	Lavarack <i>et al.</i> , 2002	Lindley, 1858	Nakhawn Sawan, 1916	Pearce et Cribb, 2002	Phengkklai, 1996	Seidenfaden, 1985	Seidenfaden, 1992	Seidenfaden, 1995	Seidenfaden et Smitinand, 1959	Tanaka, <i>et al.</i> , 2003	Tanaka, <i>et al.</i> , 2004	Thaithong, 2000	Valmayor, 1984	Wood, 1997	Wood, 2003	Wood, 2006						
36.	<i>D. sanderae</i> var. <i>major</i> Hort.																										✓				✓	
37.	<i>D. sanderae</i> var. <i>milleri</i> Quisumb.																												✓			✓
38.	<i>D. sanderae</i> var. <i>parviflorum</i> Anschuetz ex Quisumb.																												✓			✓
39.	<i>D. sanderae</i> var. <i>surigaense</i> Quisumb.																												✓			✓
40.	<i>D. scabrilingue</i> Lindl.						✓			✓		✓	✓		✓	✓	✓		✓				✓								✓	
41.	<i>D. schildhaueri</i> Ormerod & H.A.Pedersen																														✓	
42.	<i>D. schuetzei</i> Rolfe								✓		✓																✓				✓	
43.	<i>D. sculptum</i> Rchb.f.			✓																												
44.	<i>D. sinense</i> T.Tang et F.T.Wang																														✓	
45.	<i>D. singkawangense</i> J.J.Sm.																														✓	
46.	<i>D. sisuronense</i> J.J.Wood																														✓	
47.	<i>D. spectatissimum</i> Rchb.f.			✓							✓																				✓	
48.	<i>D. surigaense</i> (Quisumb.) H.P.Wood																														✓	
49.	<i>D. sutepense</i> Rolfe ex Downie														✓	✓							✓								✓	
50.	<i>D. suzukii</i> T.Yukawa		✓																												✓	

No.	Species	Publication																									
		Averyanov, 2006	Averyanov et Averyanova, 2005	Chan <i>et al.</i> , 1994	Comber, 2001	Gagnepain et Guillaumin, 1932	Grant, 1895	Holttum, 1957	Hooker, 1890	Latif, 1953	Lavarack <i>et al.</i> , 2002	Lindley, 1858	Nakhawn Sawan, 1916	Pearce et Cribb, 2002	Phengkhai, 1996	Seidenfaden, 1985	Seidenfaden, 1992	Seidenfaden, 1995	Seidenfaden et Smitinand, 1959	Tanaka, <i>et al.</i> , 2003	Tanaka, <i>et al.</i> , 2004	Thaithong, 2000	Valmayor, 1984	Wood, 1997	Wood, 2003	Wood, 2006	
51.	<i>D. tobaense</i> J.J.Wood et J.B.Comber				✓					✓																	✓
52.	<i>D. trigonopus</i> Rchb.f.		✓			✓	✓		✓							✓	✓		✓			✓					✓
53.	<i>D. virgineum</i> Rchb.f.	✓					✓		✓							✓	✓				✓						
54.	<i>D. wattii</i> (Hook.f.) Rchb.f.	✓				✓			✓					✓	✓	✓		✓	✓								✓
55.	<i>D. williamsonii</i> J.Day et Rchb.f.					✓			✓						✓	✓			✓			✓					✓
56.	<i>D. xanthophlebium</i> Lindl.						✓		✓		✓				✓	✓					✓						✓

CHAPTER II

MORPHOLOGY OF SECTION FORMOSAE

2.1 Introduction

Morphological data is the basic evidence for plant taxonomy and often used as the important data for classification. Most of the taxonomic studies usually include the part of morphological data because the external structures can be easily investigated with the naked eyes or hand lens or dissecting microscope. In Orchidaceae, the informative morphological characters for classification of genera are the numbers and shapes of pollinarium. In the genus *Dendrobium*, there are a large number with rather high variations. Therefore, the earlier taxonomists have classified *Dendrobium* into infrageneric rank, such as subgenus, section and subsection in various ways mainly based on the vegetative morphological characters. Five of forty sections have been revised previously: *Microphytanthe* Schltr. (Reeve, 1983), *Latouria* (Blume) Miq. (Cribb, 1983), *Spatulata* Lindl. (Cribb, 1986), *Oxyglossum* Schltr. (Reeve and Wood, 1989) and *Pedilonum* Blume (Dauncey, 2003).

John Lindley (1859) described subsection *Nigrohirsutae* of the section *Eudendrobium* based on the presence of blackish hairs on leaf blades and leaf sheaths. He listed 5 species that “are all distinguished by the presence of short black hairs on the young stem, a peculiarity which separates them from everything else except *D. furcatum*”. Later workers such as Bentham and Hooker (1883), Hooker (1890), Kraenzlin (1910), Schlechter (1912) and Brieger (1981) have applied various names and taxonomic ranks to this orchid group but used the same diagnostic characterization of hairiness. The sectional rank of *Formosae* (Benth. & Hook. f.) Hook. f. is widely accepted in recent floristic works and other publications (e.g. Seidenfaden 1985, 1992; Pearce and Cribb 2002).

The section *Formosae* (Benth. & Hook.f.) Hook.f. comprises about 49 species and occurs from the Himalaya eastwards to the Philippines and

Sulawesi. The numbers of species are still inconstant due to the discoveries of new plant, especially from Borneo, Sumatra and Sulawesi Islands. As mention above, the hairy character has been using for circumscribing the section *Formosae*, however several species were included though no blackish hairs were present on their leaves. For instances, especially most species from Philippines Islands and few species from northeastern part of Borneo Island were classified into section *Formosae* because they resemble to the other members in having the hard-textured flowers with white, greenish or yellow perianth lobes (Yukawa, 2004) and long mentum. On the other hand, some species of the other sections (section *Dendrobium* Sw., section *Distichophyllum* Hook.f. and *Conostalix* Kraenzl.) also have hairs on their leaf blades and leaf sheaths but they differ from *Formosae* in the floral characters.

2.2 Characters of *Dendrobium* section *Formosae*

2.2.1 Habitat

All species of the section *Formosae* are generally epiphytic. However, some species can grow on the rock, lithophytes, or also on ground, terrestrials. For example, *Dendrobium infundibulum* can be found in all 3 habitats (Pl. 1: A-C). They occur in diverse habitats with the distinct dry season as well as with a uniform climate, such as evergreen forest, deciduous forest, monsoon forest and montane forest. However, the section is restricted to exposed areas.

The growth habit of the *Formosae* is a monopodial orchid as in all *Dendrobium* species. The plant is perennial, which produces the new shoot every year.

2.2.2 Pseudobulbs

Plants are usually with long, and rather robust pseudobulbs bearing leaves along or upper half of their length and covering along with the leaf sheaths. Pseudobulbs of the *Formosae* is cane-like, erect with several internodes, usually constricted at nodes. Some species have the fractiflex

pseudobulbs, e.g. *Dendrobium lowii*, *D. spectatissimum* and *D. vogelsangii* (Pl. 2: A-C), while some plants have fusiform pseudobulbs, e.g. *D. bellatulum* (Pl. 2: D).

2.2.3 Leaves

Leaves arrangement of the *Formosae* is distichous. Most species have rather far distichous leaves, e.g. *Dendrobium lowii*, *D. spectatissimum*, *D. vogelsangii* and *D. draconis*, (Pl. 2: A-C and E). However, some species such as *D. dearei* have close distichous leaves (Pl. 2: F).

The leaf is consisting of two parts: leaf blade and leaf sheath. Dark brown or black hairs are presented on both parts, especially when immature (Pl. 2: G) and often fall off when ageing. Sometimes hairs are also present on the bract of the inflorescence (Pl. 2: H).

As mention in previous chapter that the character of having hairs on the leaves has been used for circumscribing the section *Formosae*, however several species were included though no hairs are found on their leaves. For examples *D. sanderae* var. *luzonicum* (Pl. 2: I), which originate from Philippines Islands.

2.2.4 Inflorescence

The inflorescences are borne at the uppermost node or along the upper portion of the pseudobulbs. It is usually short inflorescence with short peduncle and rachis, bearing 1 to 4 flowers, up to 6 flowers. Only few species have much more flowers, up to 26 flowers on an inflorescence such as *D. dearei* from Borneo Island (Pl. 7: E).

2.2.5 Flowers

The *Formosae*'s flowers are often showy, waxy and usually long lasting. Most are predominantly white or less often yellow, with red or orange or yellow or yellowish-green markings on the labellum.

Sepals

Both of the dorsal and lateral sepals are often dorsally keeled on the abaxial surface. These keels are hardly visible in some species, e.g. *Dendrobium sutepense* (Pl. 3: A), while some have the obvious keels, e.g. *D. williamsonii* (Pl. 3: B). Keels of some species are very distinct as the wing-like keels. Moreover, these keels continue downwards to the pedicellate ovary, e.g. *D. cariniferum* (Pl. 3: C).

Mentum

There are 4 types of mentum in the section *Formosae* species:

- 1) Broadly conical or saccate mentum, e.g. *Dendrobium bellatulum* (Pl. 3: D).
- 2) Shortly conical mentum, e.g. *D. sutepense* (Pl. 3: E).
- 3) Narrowly conical mentum, e.g. *D. cariniferum* (Pl. 3: F).
- 4) Very narrowly conical, ovipositor-shaped mentum, e.g. *D. ochraceum* (Pl. 3: G).

Petals

The petals are more or less the same size with the dorsal sepal in most species of the *Formosae* such as *Dendrobium draconis*, *D. lowii*, *D. cariniferum* and *D. sisuroense*. However, some species have broader petals than dorsal sepal such as *D. infundibulum* and *D. formosum*. Few species such *D. ayubii* and *D. cruentum* have narrower petals than dorsal sepal. Shapes of petals are varied from lanceolate through very widely obovate (Fig. 2.1).

Labellum

All of the *Formosae* species have distinctly three-lobed labellum but they are different in its side lobes and mid-lobe shape (Fig. 2.2). The detail of decoration on the labellum of each species is also different, for examples, *Dendrobium roseiodorum* has dense verrucose callus on its labellum (Pl. 3: H), *D. tobaense* has 3-5 rough keels (Pl. 3: I), *D. williamsonii* has many hair-like

callus (Pl. 3: J) while *D. sanderae* var. *luzonicum* has no callus (Pl. 3: K). These characters are taxonomic significant for identification.

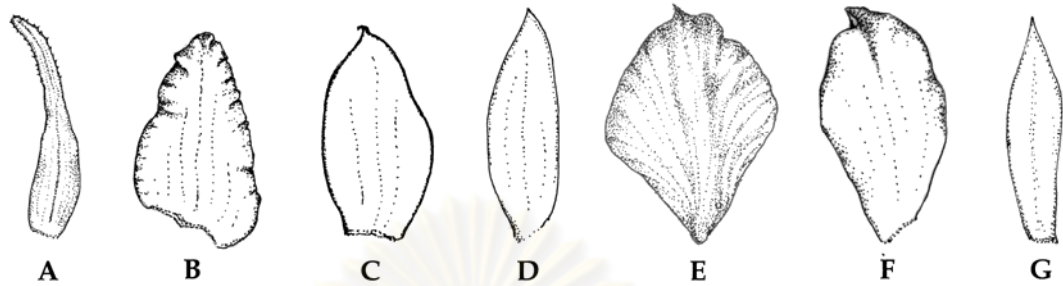


Figure 2.1 Variation of lateral petals: A. *Dendrobium ayubii*; B. *D. bostrychodes*; C. *D. cariniferum*; D. *D. draconis*; E. *D. jamesianum*; F. *D. roseiodorum* and G. *D. schrautii* (Drawn by T. Boonjarus)

Column and column foot

The columns of the *Formosae* species are mostly the same but some plants have different shape of stelidia. In generally, the stelidia are triangular in shape, except in a few species such as *Dendrobium schrautii*, which have the irregular shape. The stelidia of this species is varied in shape, for example deltoid with erose margin, 2-triangular lobed, or 2-serrated lobed (Pl. 3: L&M).

The shape of column foot is also taxonomic significant for classification. It was found that the relative species usually have the similar column shape although their perianths are different. For example, the group of *Dendrobium draconis* allies: *D. draconis*, *D. kontumense*, *D. ochraceum*, *D. roseiodorum* and *D. trankimianum*, which share the character of truncate column foot and the foot abruptly reduce to the slender mentum.

The surface of column and column foot can be divided into 2 types: smooth surface (e.g. *D. infundibulum*, *D. cruentum*, *D. formosum* and *D. sinense*)

and papillose surface (e.g. *Dendrobium draconis*, *D. ovipositoriferum* and *D. trankimianum*).

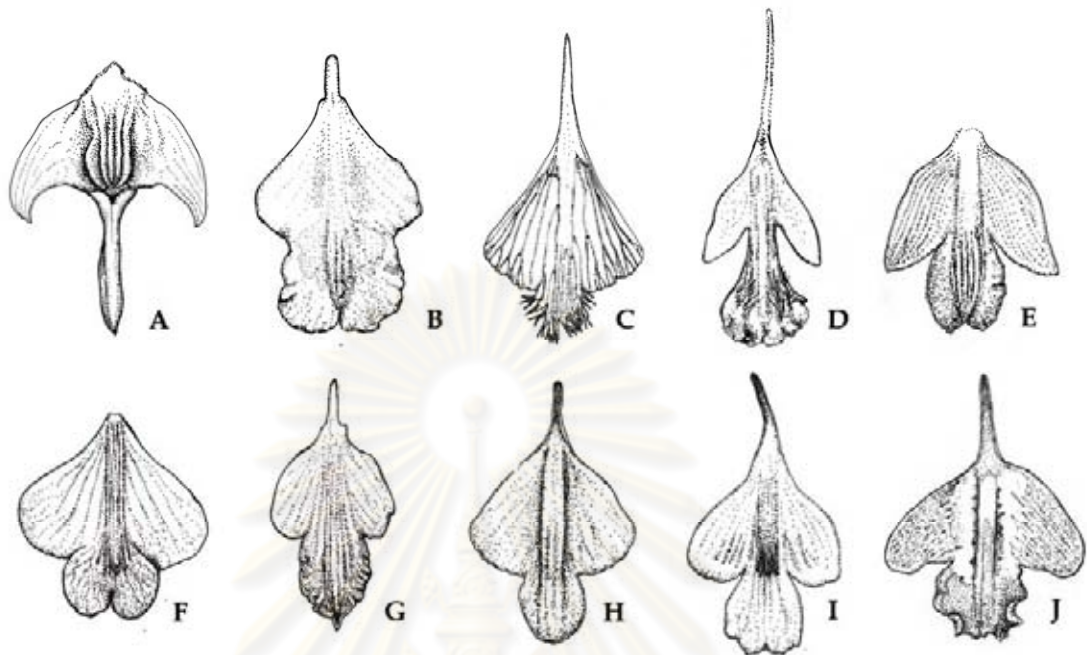


Figure 2.2 Variation of labellums: A. *Dendrobium ayubii*; B. *D. formosum*; C. *D. longicornu*; D. *D. lowii* E. *D. scabrilingue*; F. *D. sinense*; G. *D. singkawangense*; H. *D. trankimianum*; I. *D. wattii* and J. *D. xanthophlebium* (Drawn by T. Boonjarus)

Pedicellate Ovary

The pedicellate ovary is narrowly clavate, frequently with 3 obtuse keels. Only few species of the *Formosae* have wing-like keels on pedicellate ovary instead of the normal keels, e.g. *Dendrobium trigonopus* (Pl. 3: N) and *D. cariniferum* (Pl. 3: O). The keels of those species connect with the keels on the reverse of sepals. In *D. trigonopus*, the keels lead to easily notice the twist of the pedicellate ovary.

2.2.6 Fruits

The fruit of *Formosae* species is the same as typical fruit of the family Orchidaceae: capsule, always dry and dehiscent at maturity. The apex of fruit is usually with persistent dried perianths.

2.3 Conclusion

The diagnostic character of blackish hairs on leaves and leaf sheathes of the *Dendrobium* section *Formosae* is not the informative taxonomic character due to the absence of this character in some species from the Philippines and Borneo Islands. The section should be narrower by adding more characters for the sectional circumscription. The floral characters such as the inflorescences and the details of labellum are the most two important characters that should be used for sectional identification.

In addition, other floral characters, i.e. dorsally keels at abaxial surface shape of sepals, type of mentum, callus on the labellum, the shape of column foot and the keels on the pedicellate ovary can be useful for species identification.



CHAPTER III

ANATOMICAL STUDY

3.1 Introduction

Anatomy is another classical source of data used in plant taxonomy. Anatomical data are often extremely useful in solving problems of relationships because they can often suggest with greater confidence the homological character state. Therefore, it was used in classification of both major and minor categories (Stuessy, 1990).

The vegetative anatomical characters have been used with more regularity than floral anatomical characters. This is due to the viewpoint that if additional data are believed desirable to solve a taxonomic problem. The examination of leaves, stems and root anatomy could potentially yield different information than that from reproductive organs. The data from floral anatomy usually correlate with observed reproductive morphological characters and hence serve to refine the relationships already documented instead of offering totally new insights (Jones and Luchsinger, 1987).

3.2 Literature reviews

3.2.1 General leaf anatomy of *Dendrobium*

Leaves provide many anatomical characters. Most leaf features, which provide taxonomic significant data, derive from the blade. Morris *et al.* (1996) investigated the vegetative anatomy and systematic of subtribe Dendrobiinae. Anatomy of leaves, stems and roots of more than 100 species in this subtribe was studied with the light microscope. They described the leaf's transverse section anatomical characters of *Dendrobium* as following:

Cuticle: thin to thick, smooth to irregular. **Epidermis:** cell square, rectangular to hexagonal with round angles; adaxial cells larger than abaxial; cell thin- to thick-walled, outer walls frequently thickest. **Stomata:** superficial, substomatal chambers small, outer ledges large, inner ledges minute.

Hypodermis: present or absent, subtending adaxial or abaxial or both surfaces, comprising one or more layers of polygonal to rounded, thin-walled parenchyma cells or parenchyma cells alternating with fibre bundle. *Fibre bundle*: present or absent, with or without stegmata all of which contain rough-surface spherical silica bodies. *Chlorenchyma*: homogeneous or heterogeneous, cell living, columnar, polygonal, oval, or round, thin-walled, intercellular spaces more conspicuous abaxially; water-storage cells usually lacking. *Vascular bundle*: collateral, in one row, sclerenchyma well-developed associated with both xylem and phloem poles. Bundle sheath cells thin-walled, forming discontinuous sheaths around most bundles, continuous around smaller bundles. Stegmata all with rough-surfaced, spherical silica bodies along outer margin of sclerenchyma of larger bundles at either xylem or phloem poles or both absent around smaller bundles, and generally only at the phloic side of midvein bundles. *Crystals*: raphide bundles in thin-walled mesophyll idioblasts elongated parallel to the midvein.

3.2.2 Anatomical works on Orchidaceae

Orchidaceae is one of the largest and most complicated family of the vascular plants mainly due to the variation of gross morphology (Pridgeon, 1999). An attempt has been made to elucidate classification and relationships to other taxa in the family by locating the other diagnostic character other than gross morphology. From the last four decades several studies have been carried out using chromosome characters, alkaloid content and anatomy (Hashimoto, 1987; Tanaka and Kamemoto, 1984; Yukawa *et al.*, 1991, 1992). The anatomical study has been applied widely in taxonomy as well as the phylogeny (Stace, 1984), especially Orchidaceae (Rasmussen, 1987).

Morris *et al.*, (1996) revised subtribe Dendrobiinae using anatomical characters of vegetative structures. The result showed that the anatomy reflected a high degree of diversity and many of anatomical characters appeared to be homoplasous. When these data were used to interpret the systematic relationships among the genera, they indicated that *Dendrobium* is

not monophyletic. Lack of resolution in the strict consensus tree illustrated the difficulty of determining the phylogenetic relationships of many of Schlechter's sections using anatomical characters.

Stern and Judd (2002) revised the tribe Cymbideae using anatomical characters of 23 genera. They found that anatomical features of Cymbideae were relatively homogenous with the exception of genus *Govenia*, in which roots lack velamen and pseudobulb vascular bundles lack sclerenchyma, conditions that do not obtain in the other genera. The cladistic analysis showed that anatomical characters are of limited values in assessing affinities within this tribe.

3.2.3 Leaf surfaces anatomy

Another important feature of leaf for taxonomic purpose is the epidermis and cuticle. These data have been widely used because they can provide valuable information and can show useful patterns of variation (Stace, 1984; Stuessy, 1990). The epicuticular waxes have been studied by TEM and SEM, previously. They can show patterns of variation, especially in infraspecific taxa (Stuessy, 1990).

Yukawa *et al.* (1991) examined leaf surface of some species in genus *Dendrobium* sensu lato and found that the leaf surface character of the genus is diverse. They recognized several natural groups of the species that correlate with the classification in sectional level.

Yukawa *et al.* (1992) continued to investigate stomata in 153 species of the genus *Dendrobium*. They concluded that there are two different shapes of stomatal ledge, viz. stoma I and II. Stoma I is characterized by a gradual side slope (Fig. 3.1A). Whilst, stoma II is characterized by a steep side slope (Fig. 3.1B).

As mentioned in previous chapters that the sectional circumscription of *Dendrobium* section *Formosae* is still dubious because some *Formosae* species do not have the diagnostic character, i.e. blackish hairs on leaves and leaf sheath, while some species in the other sections possess these features. In this study, I

hypothesized that the leaf surfaces anatomy is possibly the informative taxonomic evidence for unraveling this problem.

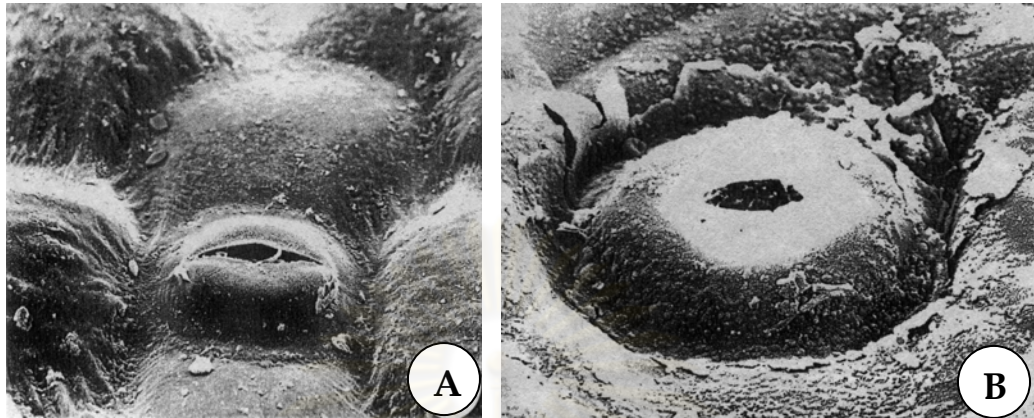


Figure 3.1 SEM micrographs of two stomatal types on *Dendrobium* leaf surface; A. a representative of the stoma I; B. a presentative of the stoma II (Yukawa *et al.* 1992).

3.3 Materials and Methods

3.3.1 Plant materials

Living materials were collected from the natural habitats throughout Thailand and also from cultivated plants of Tsukuba Botanical Garden, Japan. In total, 63 sampled taxa were investigated. Of these represented 37 species of *Dendrobium* section *Formosae* sensu lato and 5 species of genus *Dendrobium* from the other 3 sections, i.e. *Conostalix*, *Dendrobium*, *Distichophyllum*, were also investigated. The studied species are listed in Table 3.1. Voucher specimens were deposited at TNS and BCU.

3.3.2 Specimens preparation for SEM observation

Scanning electron microscope was used for investigating the epidermal characters of leaf. Mature leaves were cut into small pieces, approximately 5 mm by 5 mm, from the central area of leaf blade, including the mid-vein and the lateral area of each side of the mid-vein. The plant materials were fixed in FAA (9 parts of 70% ethanol, 0.5 parts of glacial acid, and 0.5 parts of commercial formalin) for at least overnight.

The preserved materials were rinsed twice in phosphate buffer for 15-20 minutes/each and once in distilled water for 10 minutes. They were then dehydrated with a graded series of ethanol (30%, 50%, 70%, 90% ethanol for 15-20 minutes/each and absolute ethanol 3 times, 15 minutes/each), critical-point-dried (Critical point dryer, Balzers model CPD 020) and subsequently mounted on aluminum stub and sputter-coated with gold (Sputter coater, Balzers model SCD 040). Then, the specimens were observed under SEM model JEOL JSM-5410 LV. The SEM micrographs were taken with 35-1,000 magnifications at 15 kV.

The following characters were observed: stomatal density (per a square millimeter), distribution of stomata, stomatal type and shape, hairs and cuticular sculpture. Classification of stomatal type was based on Dickison (2000).

Table 3.1 Taxa samples for leaf surface investigation and their characters.

SM = Smooth cuticular sculpture, ST = Striate cuticular sculpture, IR = Irregulars cuticular sculpture, "*" after each species = species classified into section *Formosae* by previous taxonomist but the plant do not have any black hair on any part.

No.	Section/Species	Collector number	Cuticular sculpture		Stomatal type	Stomatal shape
			Adaxial surface	Abaxial surface		
Section <i>Formosae</i> sensu lato						
1	<i>D. ayubii</i>	TBG 157517	SM	ST	Tetracytic	II
2	<i>D. bellatulum</i>	A. Sathapattayanon 414	ST	IR	Tetracytic	II
3	<i>D. bostrychodes</i>	TBG 141080	SM	ST	Tetracytic	II
4	<i>D. cariniferum</i>	A. Sathapattayanon 380	ST	ST	Tetracytic	II
5	<i>D. cariniferum</i>	A. Sathapattayanon 391	ST	ST	Tetracytic	II
6	<i>D. christyanum</i>	A. Sathapattayanon 395	SM	ST	Tetracytic	II
7	<i>D. christyanum</i>	A. Sathapattayanon 405	SM	ST	Tetracytic	II
8	<i>D. christyanum</i>	A. Sathapattayanon 406	SM	ST	Tetracytic	II

No.	Section/Species	Collector number	Cuticular sculpture		Stomatal type	Stomatal shape
			Adaxial surface	Abaxial surface		
9	<i>D. christyanum</i>	A. Sathapattayanon 410	SM	ST	Tetracytic	II
10	<i>D. christyanum</i>	A. Sathapattayanon 430	SM	ST	Tetracytic	II
11	<i>D. cruentum</i>	A. Sathapattayanon 392	ST	ST	Tetracytic	II
12	<i>D. dearei</i> ^a	TBG s.n.	SM	SM	Tetracytic	II
13	<i>D. draconis</i>	A. Sathapattayanon 388	SM	ST	Tetracytic	II
14	<i>D. draconis</i>	A. Sathapattayanon 423	SM	ST	Tetracytic	II
15	<i>D. flexuosum</i>	Tanaka et al. s.n.	SM	ST	Tetracytic	II
16	<i>D. formosum</i>	A. Sathapattayanon 393	SM	SM	Tetracytic	II
17	<i>D. formosum</i>	A. Sathapattayanon 396	SM	ST	Tetracytic	II
18	<i>D. formosum</i>	A. Sathapattayanon 428	SM	ST	Tetracytic	II
19	<i>D. hirsutum</i>	A. Sathapattayanon 403	SM	ST	Tetracytic	II
20	<i>D. hirsutum</i>	A. Sathapattayanon 433	SM	ST	Tetracytic	II
21	<i>D. hirsutum</i>	A. Sathapattayanon 436	SM	ST	Tetracytic	II
22	<i>D. hirsutum</i>	TBG 156630	SM	ST	Tetracytic	II
23	<i>D. infundubulum</i>	A. Sathapattayanon 396	SM	ST	Tetracytic	II
24	<i>D. infundubulum</i>	A. Sathapattayanon 419	SM	ST	Tetracytic	II
25	<i>D. infundubulum</i>	A. Sathapattayanon 422	SM	ST	Tetracytic	II
26	<i>D. infundubulum</i>	A. Sathapattayanon 425	SM	ST	Tetracytic	II
27	<i>D. infundubulum</i>	A. Sathapattayanon 426	SM	SM	Tetracytic	II
28	<i>D. jamesianum</i>	TBG s.n.	SM	ST	Tetracytic	II
29	<i>D. jerdonianum</i>	A. Sathapattayanon s.n.	SM	SM	Tetracytic	II
30	<i>D. jerdonianum</i>	TBG 156717	SM	ST	Tetracytic	II
31	<i>D. kontumense</i>	A. Sathapattayanon 408	SM	ST	Tetracytic	II
32	<i>D. kontumense</i>	A. Sathapattayanon 409	SM	ST	Tetracytic	II
33	<i>D. kontumense</i>	A. Sathapattayanon 432	SM	ST	Tetracytic	II
34	<i>D. kontumense</i>	A. Sathapattayanon 435	SM	ST	Tetracytic	II
35	<i>D. longicornu</i>	TBG 122802	SM	ST	Tetracytic	II
36	<i>D. lowii</i>	TBG s.n.	SM	ST	Tetracytic	II
37	<i>D. ochraceum</i>	TBG 122822	SM	ST	Tetracytic	II
38	<i>D. ovipositoriferum</i>	TBG s.n.	SM	ST	Tetracytic	II
39	<i>D. parthenium</i> *	TBG 142271	SM	ST	Tetracytic	II
40	<i>D. roseiodorum</i>	TBG 118270	SM	ST	Tetracytic	II
41	<i>D. sanderae</i> var. <i>luzonicum</i> *	A. Sathapattayanon 438	SM	ST	Tetracytic	II
42	<i>D. sanderae</i> var. <i>major</i> *	TBG 120503	SM	ST	Tetracytic	II

No.	Section/Species	Collector number	Cuticular sculpture		Stomatal type	Stomatal shape
			Adaxial surface	Abaxial surface		
43	<i>D. sanderae</i> var. <i>surigaense</i> *	TBG s.n.	SM	ST	Tetracytic	II
44	<i>D. scabrilingue</i>	A. Sathapattayanon 375	SM	ST	Tetracytic	II
45	<i>D. schrautii</i>	A. Sathapattayanon 429	SM	ST	Tetracytic	II
46	<i>D. sinense</i>	A. Sathapattayanon 407	SM	ST	Tetracytic	II
47	<i>D. singkawangense</i>	TBG s.n.	SM	ST	Tetracytic	II
48	<i>D. spectatissimum</i>	TBG 133587	SM	ST	Tetracytic	II
49	<i>D. suzukii</i>	TBG 132872	SM	ST	Tetracytic	II
50	<i>D. tobaense</i>	TBG 126681	SM	ST	Tetracytic	II
51	<i>D. trankimianum</i>	TBG 133192	SM	ST	Tetracytic	II
52	<i>D. trigonopus</i>	A. Sathapattayanon 394	IR	IR	Tetracytic	II
53	<i>D. trigonopus</i>	A. Sathapattayanon 416	IR	IR	Tetracytic	II
54	<i>D. vogelsangii</i>	TBG s.n.	ST	ST	Tetracytic	II
55	<i>D. wattii</i>	TBG s.n.	SM	ST	Tetracytic	II
56	<i>D. williamsonii</i>	TBG 119270	SM	SM	Tetracytic	II
57	<i>D. xanthophebium</i>	A. Sathapattayanon 431	SM	SM	Tetracytic	II
Section <i>Districhophyllum</i>						
58	<i>D. ellipsophyllum</i>	TBG 126635	SM	ST	Tetracytic	II
59	<i>D. lamrianum</i>	TBG s.n.	SM	SM	Tetracytic	II
60	<i>D. nemorale</i>	TBG s.n.	SM	ST	Tetracytic	II
Section <i>Conotalix</i>						
61	<i>D. pachyglossum</i>	A. Sathapattayanon 431	SM	SM	Tetracytic	II
62	<i>D. pachyglossum</i>	A. Sathapattayanon 434	SM	SM	Tetracytic	II
Section <i>Dendrobium</i>						
63	<i>D. senile</i>	A. Sathapattayanon 440	SM	SM	Anomocytic	I

3.4 Results and discussions

3.4.1 Stomatal shape

It is evident from this study (Table 3.1) that stomatal shape has a taxonomic value to separate the section in the genus *Dendrobium*. It was found that species of the section *Dendrobium* has stoma I, while members of the section *Formosae*, *Distichophyllum* and *Conotalix* have stoma II (Fig. 3.2). This finding is in agreement with Yukawa *et al.* (1992).

3.4.2 Stomatal density

Stomatal density of the 4 sections in the genus *Dendrobium* is rather variable (Table 3.2). It can be seen that the section *Formosae* has the most variable values of stomatal density. This result suggested that stomatal density has no taxonomic value.

Table 3.2 Stomatal density of the 3 sections in the genus *Dendrobium*.

Section	Stomatal density (number/mm ²)
<i>Conostalix</i>	98
<i>Dendrobium</i>	55
<i>Distichophyllum</i>	74
<i>Formosae</i>	33-122

3.4.3 Distribution of stomata

All of the *Dendrobium* species in this study have stomata only on abaxial surface. This result corresponded with Yukawa *et al.* (1990) who found 5 out of 156 species have stomata on both surface. So it can be concluded that most *Dendrobium* are hypostomatous species. This is the most common feature in plant (Dickison, 2000). The examples SEM micrographs of distribution of stomata of some species from each section in this study were shown in Fig. 3.3.

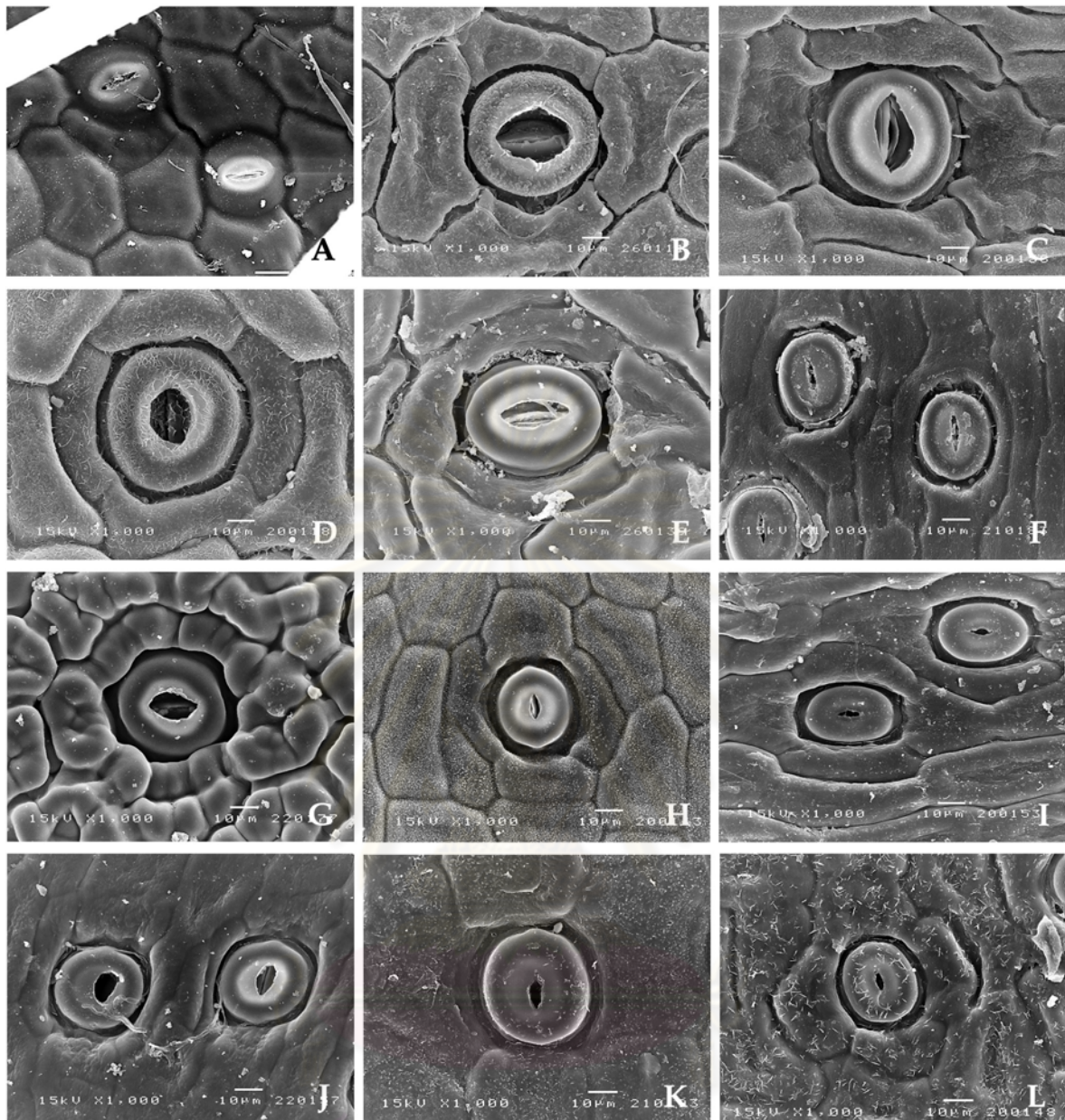


Figure 3.2 Stomata on abaxial surface: A. Stomatal type I, section *Dendrobium*: *D. senile*; B.-L. Stomatal type II, B.-I. section *Formosae*: B. *D. kontumense*, C. *D. ovipostoriferum*, D. *D. roseiodorum*, E. *D. schrautii*, F. *D. jerdonianum*, G. *D. trigonopus*, H. *D. dearei*, I. *D. sanderae* var. *surigaense*; J. section *Conostalix*: *D. pachyglossum*; K.-L. section *Districhophyllum*: K. *D. lamrianum* and L. *D. ellipsophyllum*.

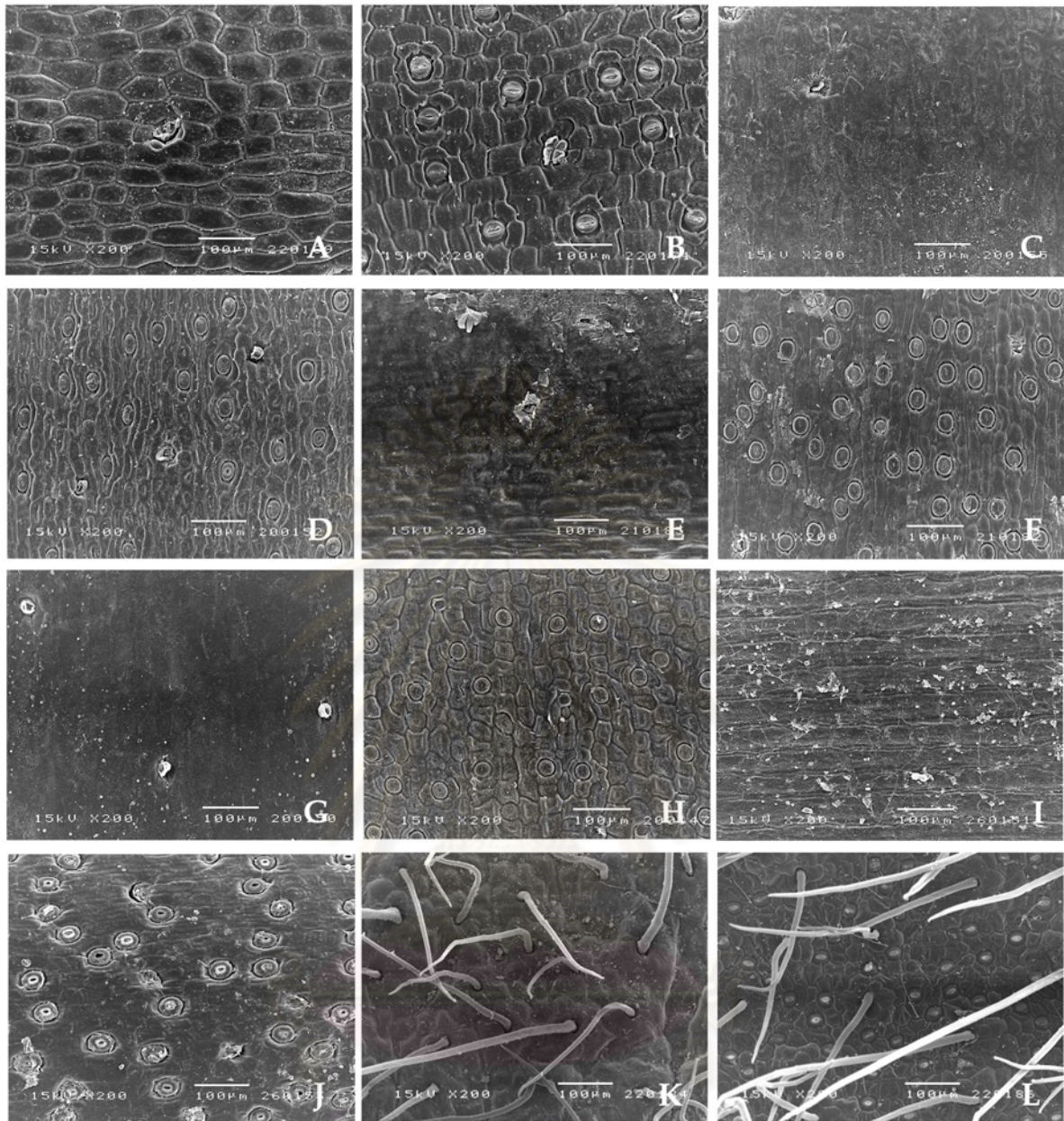


Figure 3.3 Distribution of stomata: A.-B. *Dendrobium infundibulum* (section *Formosae*): A. adaxial surface, B. abaxial surface; C.-D. *D. sanderae* var. *surigaense* (section *Formosae*): C. adaxial surface, D. abaxial surface; E.-F. *D. jerdonianum* (section *Formosae*): E. adaxial surface, F. abaxial surface; G.-H. *D. ellipsophyllum* (section *Districhophyllum*): G. adaxial surface, H. abaxial surface; I.-J. *D. pachyglossum* (section *Conostalix*): I. adaxial surface, J. abaxial surface; K.-L. *D. senile* (section *Dendrobium*): K. adaxial surface, L. abaxial surface.

3.4.4 Stomatal type

It can be concluded from Table 3.1 that all sampled species of section *Formosae*, *Distichophyllum* and *Conostalix*, such as *D. pachyglossum*, have tetracytic stoma, while section *Dendrobium*, such as *D. senile*, has anomocytic stoma. This finding indicated that common stomatal type of the genus *Dendrobium* is tetracytic stoma.

3.4.5 Hair characters

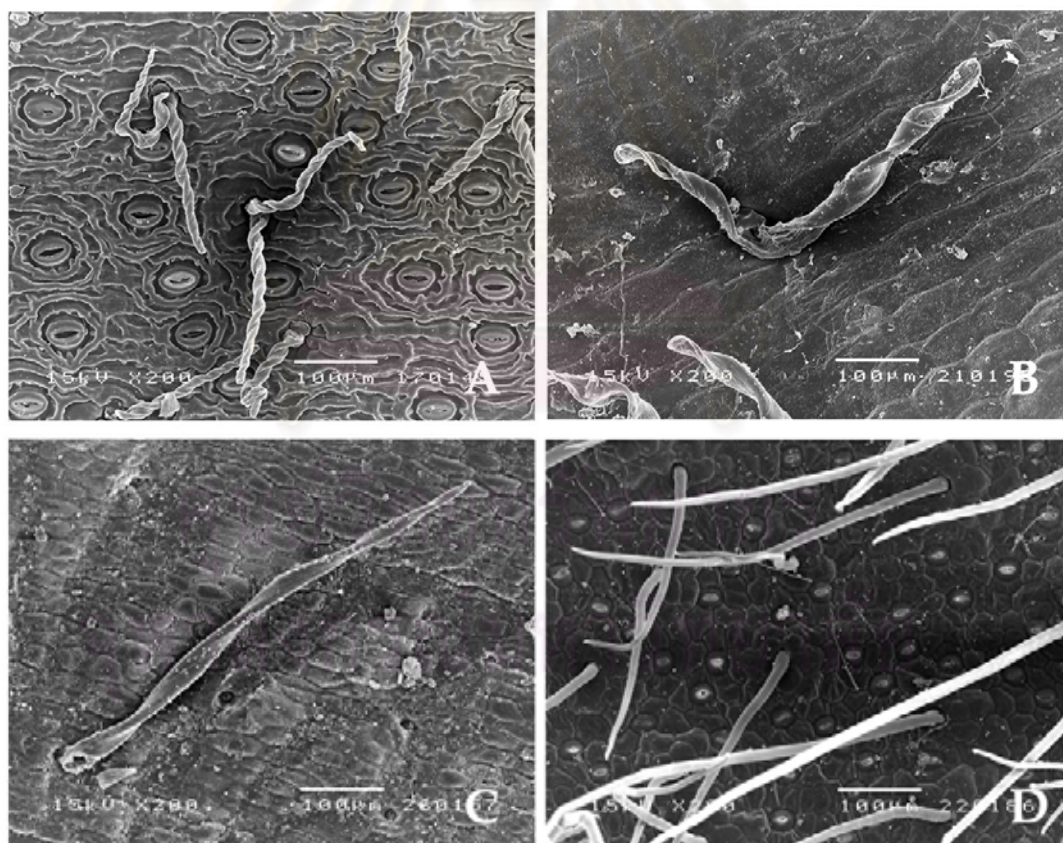
Hair characters were observed in the four sections of the genus *Dendrobium* (Table 3.3). It can be concluded that each section has a set of characters that are different from the other. The species in the section *Formosae* have long, unicellular, twisted and aduncate hairs (Fig. 3.4 A). These hairs are black, patent, caducous with age and moderate density. However, some species in this section lack the character of having hair, i.e. *D. dearei*, *D. parthenium*, *D. sanderae* var. *luzonicum*, *D. sanderae* var. *major* and *D. sanderae* var. *surigaense*.

On the other hand, some species in section *Distichophyllum*, i.e. *D. lamrianum* and *D. nemorale*, have the hairiness characters and their hair characters are mostly similar to *Formosae* and *Conostalix*. Those species have slightly twisted and not aduncate hairs, patent and high hair density (Fig. 3.4 B).

While a representative species of section *Conostalix*, i.e. *D. pachyglossum* has long, unicellular, twisted, but not aduncate hairs (Fig. 3.4 C). These hairs are black, appressed, caducous with age and high density. In contrast, a representative species of section *Dendrobium*, i.e. *D. senile* has long, unicellular, smooth and tapered hairs (Fig. 3.4 D). These hairs are white, patent, persistent and high density.

Table 3.3 Hair characters of the 4 sections of the genus *Dendrobium*.

<i>Formosae</i> (excepting for 5 hairless taxa)	<i>Distichophyllum</i> (<i>D. lamrianum</i> and <i>D. nemorale</i>)	<i>Conostalix</i> (<i>D. pachyglossum</i>)	<i>Dendrobium</i> (<i>D. senile</i>)
Twisted and aduncate hairs	Slightly twisted, not aduncate hairs	Slightly twisted, not aduncate hairs	Smooth and tapered hair
Unicellular	Unicellular	Unicellular	Unicellular
Black	Black	Black	White
Patent	Patent	Appressed	Patent
Caducous	Caducous	Caducous	Persistent
Moderate density	High density	High density	High density

**Figure 3.4** Hair characters: A. *Dendrobium infundibulum* (section *Formosae*); B. *D. lamrianum* (section *Distichophyllum*); C. *D. pachyglossum* (section *Conostalix*); D. *D. senile* (section *Dendrobium*).

3.4.5 Cuticular sculpture

Three kinds of cuticular sculpture were observed on leaf surfaces of 63 *Dendrobium* samples (Table 3.1), i.e. smooth, striated and irregular (Fig. 3.5).

Forty-six sampled species of *Dendrobium* in this study have smooth cuticular sculpture on adaxial surface but striated on abaxial surface. There are 44 species from section *Formosae* and 2 species from section *Distichophyllum*, including *D. ellipsophyllum* and *D. nemorale*. Four samples from section *Formosae* have striated cuticular sculpture on both leaf surfaces, namely *D. cariniferum* (A. Sathapattayanon 380 & A. Sathapattayanon 391), *D. cruentum* (A. Sathapattayanon 392) and *D. vogelsangii* (TBG s.n.). On the other hands, 10 samples from all 4 sections have smooth cuticular sculpture on both leaf surfaces, including section *Formosae*: *D. dearei* (TBG s.n.), *D. formosum* (A. sathapattayanon 393), *D. infundibulum* (A. sathapattayanon 426), *D. jerdonianum* (A. sathapattayanon s.n.), *D. williamsonii* (TBG 119270) and *D. xanthophlebium* (A. sathapattayanon 431); section *Distichophyllum*: *D. lamrianum*; section *Conostalix*: *D. pachyglossum* (A. sathapattayanon 431 & A. sathapattayanon 434); section *Dendrobium*: *D. senile* (A. sathapattayanon 440). The irregular cuticular sculpture was found in 3 samples of section *Formosae*. *D. bellatum* (A. sathapattayanon 414) has striated cuticular sculpture on adaxial surface but irregular on abaxial surface (Fig 3.5 C). Two samples of *D. trigonopus* have irregular cuticular sculpture on both surfaces (Fig 3.5 D). Among these, the irregular cuticular sculptures between 2 species are different.

Dickison (2000) noted that the cuticular surface is the border layer between the environment and the plant body, so it is not surprising that this section exhibits a great deal of structural variability. Since the samples of the *Dendrobium* species from this study, even from the same section came from various sources of different habitats, so they should have different cuticular sculpture as well.

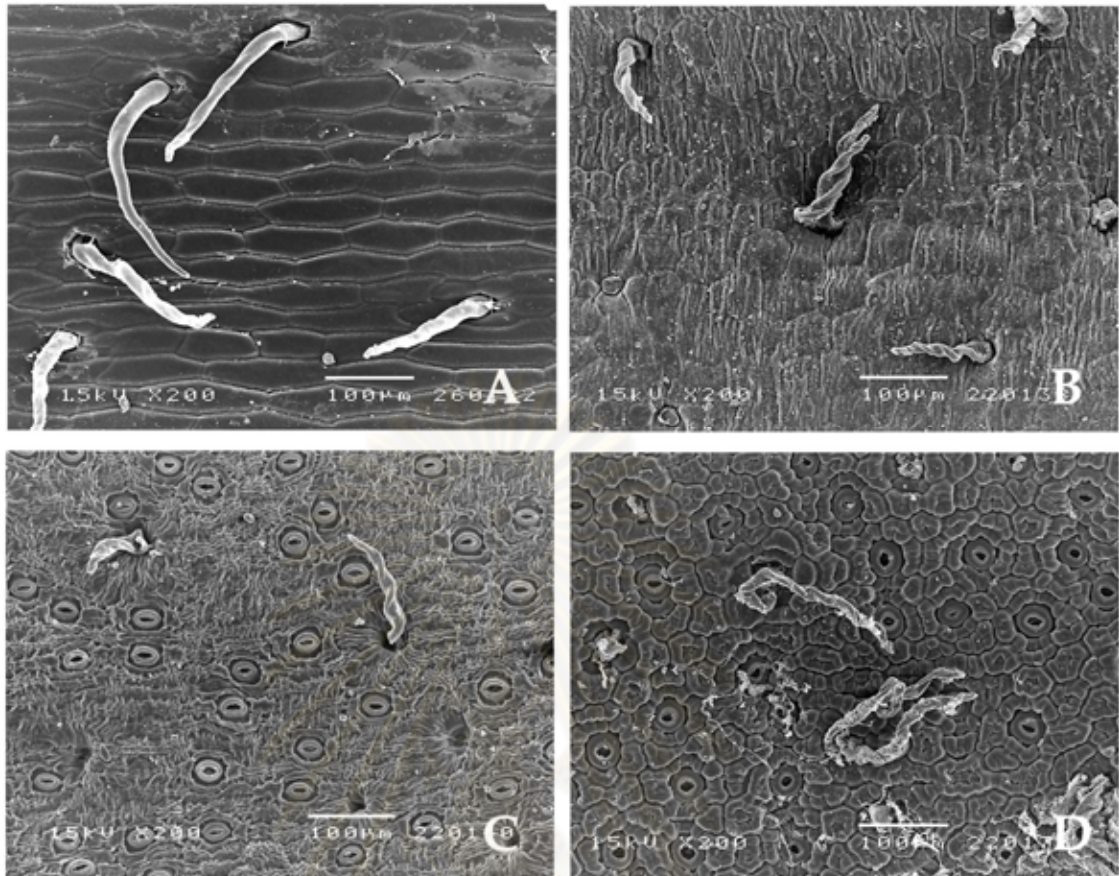


Figure 3.5 Cuticular sculptures: A. Smooth cuticular sculpture, *Dendrobium kontumense*, adaxial surface; B. Striated cuticular sculpture, *D. bellatulum*, adaxial surface; C.-D. Irregular cuticular sculpture: C. *D. bellatulum*, abaxial surface and D. *D. trigonopus*, abaxial surface.

3.5 Conclusion

It is evident from this study that anatomical characters of leaf surface are taxonomic useful for grouping taxa in the genus *Dendrobium* at sectional level. The most important and informative characters are stomatal shape, stomatal type and hair characters. While the cuticular sculpture can be partially used to segregate some specific species of the section *Formosae*.

Wood (2006) moved *Dendrobium senile* from the section *Dendrobium* to the section *Formosae*. Due to the species has the hairs on leaf blades and leaf sheaths and also the remarkable similarity of flower to *D. trigonopus*

(section *Formosae*). However, hairs of *D. senile* are structurally different from hairs of all species in the section *Formosae*. In addition, *D. senile* also has different stomatal type and stomatal shape with the other members of the section *Formosae* (Table 3.1). So, it is evident from this study that *D. senile* should not include in the section *Formosae*.

It is worth noting that three species and three varieties, namely *D. dearei*, *D. parthenium*, *D. sanderae* var. *luzonicum*, *D. sanderae* var. *major* and *D. sanderae* var. *surigaense* (Table 3.1) are members of the section *Formosae*, but they do not have black hairs on any plant parts. However, these species and varieties do share the common characters of stomatal shape and stomatal type of the section *Formosae*, i.e. tetracytic stomatal type and stoma type II. This finding emphasized that anatomical characters of orchids are rather homogenous as was found by Morris *et al.*, (1996) in the subtribe Dendrobiinae and Stern and Judd (2002) in the tribe Cymbideae.



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CHAPTER IV

MOLECULAR STUDY

4.1 Introduction

Molecular data have had a profound impact on the field in plant systematics. Previously, the majority of data used in plant molecular phylogenetic studies mostly derives from chloroplast DNA and nuclear rDNA (Small *et al.*, 2004). In recent years, most of the orchids phylogenetic relationship studies were based on molecular evidences (e.g., Yukawa *et al.*, 1993; Cameron *et al.*, 1999; Pridgeon *et al.*, 2001; Gravendeel *et al.*, 2001; Salazar *et al.*, 2003; 2006; Whitten *et al.*, 2007; Freudenstein and Senyo, 2008) due to the efficiency to provide more accurate insights into phylogeny than the classical approaches (Hillis *et al.*, 1996; Soltis *et al.*, 1998). The phylogenetic analyses of *Dendrobium* based on macromolecular data indicated the polyphyly of section *Formosae* (Yukawa *et al.*, 1993; Wongsawad *et al.*, 2005). Yukawa *et al.* (1993) implicated the phylogeny of plastid DNA restriction site in subtribe Dendrobiinae. He found the un-resolved phylogeny among section *Dendrobium*, *Callista*, *Pedilonum*, *Formosae* and *Distichophyllum*. The most recently study on molecular phylogeny of genus *Dendrobium* performed by Wongsawad *et al.* (2005), based on *matK* and ITS sequences, demonstrated that section *Formosae* is not the monophyletic group. The 4 *Formosae* sampled taxa were distinguished into 2 clades that closely related to section *Distichophyllum* and section *Conostalix*. These data suggest the necessity of re-examination of this section.

4.1.2 The *matK* gene

The gene, $\approx 1,500$ base pairs (bp), is located within the intron of the chloroplast gene *trnK* (Fig. 4.1), on the large single-copy section adjacent to the inverted repeat. Several studies indicates that the 102 amino acid positions at the carboxyl terminus are structurally related to portions of maturase-like

polypeptide and might be involved in splicing Group II introns (Sugita, Shinozaki and Sugiura, 1985; Neuhaus and Link, 1987; Mohr, Perlman and Lambowitz, 1993; Ems *et al.*, 1995).

The rate of evolution of *matK* makes this gene appropriate for resolving infrageneric relationship and also has great potential for retrieving phylogeny within subtribe of seed plants (Soltis and Soltis, 1998). The gene *matK* appears as a pseudo-gene both in Orchidaceae and probably also in majority of angiosperm (Kores *et al.*, 2000). Analysis of *matK* gene was successfully conducted to determine a degree of relationship between various groups of Orchidaceae, such as Pleurothallidinae (Pridgeon *et al.*, 2000) and Epidendreae (van den Berg *et al.*, 2005).

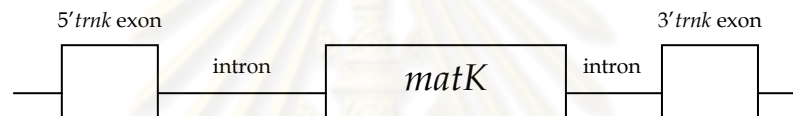


Figure 4.1 Sequence of *matK* gene

4.1.3 The Internal Transcribed Spacer

The nuclear ribosomal DNA (nrDNA) is organized as individual chromosomal units that are repeated thousands of times in most of the higher plant genomes. Each repeat contains a transcribed region, which is separated from the adjacent repeat by a long non-transcribed intergenic spacer (IGS) (Hamby & Zimmer, 1992). Within the transcribed region are three conserved ribosomal RNA regions and the 2-noncoding spacer regions. The conserved regions, comprising the ribosomal RNA gene (Fig. 4.2), are arranged in 5'-18S-5.8S-26S-3' order with the ITS spacers (designated as ITS-1 and ITS-2) flanking the 5.8S region, an evolutionary highly conserved sequence. In addition, an external transcribed spacer region (ETS) is situated at the beginning of the 5' end of the transcribed unit.

The occurrence of high nucleotide variability in combination with low length variation found in both of the internal transcribed spacer regions (ITS-1 and ITS-2), suggested that this part of the rDNA gene could be used in reconstructing phylogenies within plant genera. Therefore, sequences could be readily aligned across related species and yet would contain sufficient variations for resolution of phylogeny (Baldwin *et al.*, 1995).

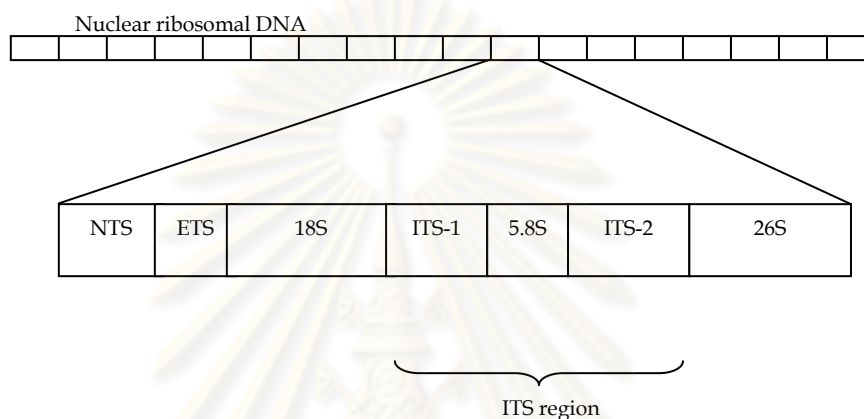


Figure 4.2 Sequence of ITS region

4.2 Materials and methods

The molecular research was undertaken at the DNA laboratory, Tsukuba Botanical Garden, National Museum of Nature and Science, Tsukuba, Japan.

Plant materials

The materials were obtained from cultivated plants of Tsukuba Botanical Garden, Japan (TBG) and wild-collected plants. The details of materials are shown in Table 4.2 In total, 50 sampled taxa were included, representing 37 species and 2 affinities of *Dendrobium* section *Formosae* sensu lato, demonstrated all major morphological groups of the section. Twenty-eight sampled taxa of genus *Dendrobium* from 9 sections: *Amblyanthus*, *Callista*, *Conostalix*, *Cuthbertsonia*, *Dendrobium*, *Distichophyllum*, *Pedilonum*, *Rhopalanthe*

and *Stachyobium*, were also included to determine monophyly of section *Formosae* on the basis of molecular phylogeny of genus *Dendrobium* (Wongsawad *et al.*, 2005). One *Dendrobium* species of section *Inobulbun*, *D. muricatum*, were used as outgroups. Voucher specimens were deposited at TNS and BCU.

Amplification and sequencing

Total DNA was extracted from fresh or silica-dried plant materials with a QIAGEN DNeasy Mini Plant Kit following the manufacture's instructions.

For *matK* sequences, amplification was performed via the polymerase chain reaction (PCR) using several combinations of primers (Table 4.1). The amplification reaction included Ex-Taq buffer and Ex-Taq DNA-polymerase (Takara Bio). The polymerase chain reaction (PCR) profile consisted of an initial 5-min premelt at 94°C and 30 cycle of 30 s at 94°C (denaturation), 30 s at 53°C (annealing), and 3 min at 72°C (extension), followed by a final 7-min at 72°C.

The amplification products of ITS region were also carried out using several combinations of primers (Table 4.1). The amplification region include GC buffer I or II and LA Taq DNA-polymerase (Takara Bio). The PCR profile consisted of an initial 2-min premelt at 94°C and 30 cycles of 50 s at 94°C (denaturation), 1 min at 60°C (annealing), and 30 s at 72°C (extension), followed by a final 7-min extension at 72°C.

The PCR products were cleaned using ExoSAP-IT (USB Corporation), following the manufacture's instructions. Then they were used for auto-cycle sequencing reaction following the instructions of the manufacturer (Beckman Coulter). An ethanol precipitation was performed to clean the auto-cycle sequencing products.

Both forward and reverse sequences were sequenced by Applied Biosystems 3130xl Genetic Analyzer (Applied Biosystems) and assembled with Genetyx-ATGC version 4.2.9 (Genetyx Corporation).

Table 4.1 List of primers used for amplification and sequencing.

Marker	Name	Sequence
<i>matK</i>		
forward	OMAT1F	5'-CCGTTMTSACCATATTGC-3'
reverse	OMAT2R	5'-CAAATTATGATATTCGTARA-3'
forward	matK841F	5'-CTTTCATACATTATGTTCGA-3'
reverse	OMAT3R	5'-ATCGGTCCAGATCGGTTT-3'
forward	mat396F	5'-CAGAATTTACGATCTATTCAT-3'
reverse	trnK-2R	5'-AACTAGTCGGATGGAGTAG-3'
forward	matK-19F	5'-CGTTCTGACCATATTGCACTATG-3'
reverse	OMAT4Rn	5'-TCGACACGACTTCCCTA-3'
ITS		
forward	AB101	5'-ACGAATTCATGGTCCGGTGAAGTGTTCTTCG-3'
reverse	ITS2	5'-GCTGCGTTCTTCATCGATGC-3'
forward	ITS3	5'-GCATCGATGAAGAACGCAGC-3'
reverse	AB102	5'-TAGAATTCCCCGGTTCGCTCGCCGTTAC-3'

Phylogenetic analyses

DNA sequences obtained from both ITS and *matK* region were initially aligned with Genetyx-MAC version 13.0.16 (Gynetyx Corporation) and were further adjusted manually. Phylogenetic analyses based on the maximum parsimony criterion were performed using PAUP* version 4.0b10 (Swofford 2002) for two data sets: *matK*, ITS and combination of the two. The congruence between *matK* and ITS data was tested with the incongruence length difference (ILD) test (Mickeych and Farris, 1981; Farris *et al.*, 1995) using the Partition-homogeneity command in PAUP*. The probability values (*P*) greater than 0.05 were used to identify data sets that the data were not significantly incongruent from one another and they could therefore be combined. Insertions and deletions were treated as missing data. All characters were equally weighted and unordered (Fitch 1971). All data set

were analyzed by the heuristic search method with tree bisection-reconnection (TBR) branch swapping. Distance trees were obtained using the neighbor-joining (NJ) method (Saitou and Nei, 1987) with a Kimura two-parameter correction (Kimura, 1980). To assess the relative robustness for branches, the bootstrap method (Felsenstein, 1985) was used with 1,000 replicates. The number of steps, consistency indices (CI) and retention indices (RI) were calculated using the Tree Scores command in PAUP*. The combined of *matK* and ITS data sets were analyzed with the same method as described earlier.

Table 4.2 Plant materials examined in this study.

Taxon	Origin	Voucher
Section <i>Formosae</i>		
<i>Dendrobium ayubii</i>	Sumatra & Sulawesi	TBG157517
<i>Dendrobium bellatulum</i>	Thailand	AS433
<i>Dendrobium bellatulum</i>	Vietnam	TBG133256
<i>Dendrobium bostrychodes</i>	Borneo	TBG141080
<i>Dendrobium cariniferum</i>	Myanmar	TBG128900
<i>Dendrobium cariniferum</i>	Thailand	AS421
<i>Dendrobium christyanum</i>	Thailand	AS395
<i>Dendrobium christyanum</i>	Vietnam	TBG124369
<i>Dendrobium cruentum</i>	Thailand	TBG134572
<i>Dendrobium dearei</i>	Borneo	TBG s.n.
<i>Dendrobium dearei</i>	Philippines	TBG144587
<i>Dendrobium draconis</i>	Thailand	AS450
<i>Dendrobium draconis</i>	Vietnam	TBG118276
<i>Dendrobium flexuosum</i>	Myanmar	TBG s.n.
<i>Dendrobium formosum</i>	Myanmar	TBG128902
<i>Dendrobium hirsutum</i>	China	TBG124454
<i>Dendrobium hirsutum</i>	Laos	AS433
<i>Dendrobium hirsutum</i>	Vietnam	TBG156630
<i>Dendrobium infundibulum</i>	Myanmar	TBG s.n.

Taxon	Origin	Voucher
<i>Dendrobium infundibulum</i>	Thailand	AS442
<i>Dendrobium jamesianum</i>	Myanmar	TBG128905
<i>Dendrobium jerdonianum</i>	India	TBG156717
<i>Dendrobium kontumense</i>	sin. loc.	TBG126642
<i>Dendrobium longicornu</i>	India	TBG122802
<i>Dendrobium longicornu</i>	Nepal	TBG s.n.
<i>Dendrobium lowii</i>	Borneo	TBG134848
<i>Dendrobium ochraceum</i>	Vietnam	TBG122822
<i>Dendrobium ovipostoriferum</i>	Borneo	TBG s.n.
<i>Dendrobium parthenium</i>	Borneo	TBG142271
<i>Dendrobium roseiodorum</i>	Vietnam	TBG118270
<i>Dendrobium sanderae</i> var. <i>luzonicum</i>	Philippines	TBG120510
<i>Dendrobium sanderae</i> var. <i>major</i>	Philippines	TBG120503
<i>Dendrobium sanderae</i> var. <i>surigaense</i>	Philippines	TBG s.n.
<i>Dendrobium scabrilingue</i>	Thailand	AS415
<i>Dendrobium schrautii</i>	Laos	AS429
<i>Dendrobium schrautii</i>	Vietnam	TBG118323
<i>Dendrobium schuetzei</i>	Philippines	TBG119088
<i>Dendrobium sinense</i>	China	Cheng Jin s.n.
<i>Dendrobium sinense</i>	Thailand	AS439
<i>Dendrobium sinense</i>	Thailand	TBG123793
<i>Dendrobium singkawangense</i>	Borneo	TBG141081
<i>Dendrobium spectatissimum</i>	Borneo	TBG133877
<i>Dendrobium sutepense</i>	Thailand	TBG124385
<i>Dendrobium suzukii</i>	Vietnam	TBG132872
<i>Dendrobium tobaense</i>	Sumatra & Sulawesi	TBG126681
<i>Dendrobium trankimianum</i>	Vietnam	TBG127512
<i>Dendrobium trigonopus</i>	Myanmar	TBG119100
<i>Dendrobium vogelsangii</i>	Sumatra & Sulawesi	TBG s.n.
<i>Dendrobium wattii</i>	Vietnam	TBG s.n.
<i>Dendrobium williamsonii</i>	India	TBG119271
<i>Dendrobium xanthophlebium</i>	sin. loc.	TBG s.n.

Taxon	Origin	Voucher
Section <i>Amblyanthus</i>		
<i>Dendrobium melanostictum</i>	sin. loc.	TBG s.n.
<i>Dendrobium stockeri</i>	sin. loc.	TBG130082
Section <i>Callista</i>		
<i>Dendrobium densiflorum</i>	India	TBG s.n.
<i>Dendrobium farmeri</i>	India	TBG s.n.
<i>Dendrobium palpebrae</i>	Thailand	TBG s.n.
<i>Dendrobium sulcatum</i>	India	TBG s.n.
Section <i>Conostalix</i>		
<i>Dendrobium lobbii</i>	sin. loc.	TBG s.n.
<i>Dendrobium pachyglossum</i>	Thailand	TBG124380
Section <i>Cuthbertsonia</i>		
<i>Dendrobium cuthbertsonii</i>	sin. loc.	TBG s.n.
Section <i>Dendrobium</i>		
<i>Dendrobium anosmum</i>	sin. loc.	TBG s.n.
<i>Dendrobium atavous</i>	sin. loc.	TBG s.n.
<i>Dendrobium chrysanthum</i>	sin. loc.	TBG s.n.
<i>Dendrobium fimbriatum</i>	sin. loc.	TBG s.n.
<i>Dendrobium hancockii</i>	sin. loc.	TBG s.n.
<i>Dendrobium linawianum</i>	sin. loc.	TBG s.n.
<i>Dendrobium luteolum</i>	sin. loc.	TBG122798
<i>Dendrobium moniliforme</i>	sin. loc.	TBG s.n.
<i>Dendrobium nobile</i>	sin. loc.	TBG s.n.
Section <i>Distichophyllum</i>		
<i>Dendrobium bifarium</i>	sin. loc.	TBG s.n.
<i>Dendrobium ellipsophyllum</i>	sin. loc.	TBG126635
<i>Dendrobium lamrianum</i>	Borneo	TBG s.n.

Taxon	Origin	Voucher
<i>Dendrobium maraiparense</i>	Borneo	TBG137292
<i>Dendrobium nemorale</i>	Philippines	TBG s.n.
<i>Dendrobium uniflorum</i>	sin. loc.	TBG120499
Section <i>Inobulbum</i>		
<i>Dendrobium muricatum</i>	sin. loc.	TBG s.n.
Section <i>Pedilonum</i>		
<i>Dendrobium secundum</i>	sin. loc.	TBG s.n.
Section <i>Rhopalanthe</i>		
<i>Dendrobium crumenatum</i>	sin. loc.	TBG s.n.
Section <i>Stachyobium</i>		
<i>Dendrobium delacourii</i>	sin. loc.	TBG s.n.
<i>Dendrobium diodon</i>	sin. loc.	TBG116089

* TBG series indicate accession numbers of the living collection database at Tsukuba Botanical Garden.

4.3 Results

The strict consensus tree (Fig. 4.3), derived from phylogenetic analyses of ITS sequences, demonstrated that *Dendrobium* section *Formosae* sensu lato comprised 2 clades with 2 taxa, *D. trigonopus* and *D. jerdonianum*, being placed outside these two clades. Eight subclades with high bootstrap supports and seven subclades with less 50% bootstrap values were well resolved in CladeA. Sampled taxa of the same species were placed in the same subclade. In the other clade, much fewer taxa were included, i.e. *D. dearei*, *D. schuetzei*, *D. parthenium*, and *D. sanderae*, with 100% bootstrap value. Although it seemed that *D. jerdonianum* was placed as the sister taxon to CladeB but its support was less than 50% bootstrap value. In the ITS tree, it should be noted that supports for individual section of genus *Dendrobium* were high, ranging

from 80% to 100%, but their relationships appeared ambiguous and less support (bootstrap values less than 50%).

The cladogram derived from phylogenetic analysis of *matK* sequences are shown in Fig. 4.4. Members of section *Formosae* were sorted into 2 clades with *D. jerdonianum* and *D. trigonopus* being placed in neither clades. Rather, *D. jerdonianum* was placed as a sister taxon of section *Stachyobium* while *D. trigonopus* was placed with members of section *Dendrobium*, section *Callista* and section *Districhophyllum*. In both cases, bootstrap supports were less than 50%.

CladeA of the *matK* tree had bootstrap support of 74% and seven recognized subclades with bootstrap supports more than 80%. Subclade A-2, A-4 and A-6 were still withstand while other subclades were broken into many smaller subclades or polytomy, when compared with the ITS tree.

CladeB of *matK* tree comprised the set of taxa as in that of the ITS tree, excepting for the placement of *D. parthenium*. The taxon was placed as the basal lineage in the *matK* tree whereas the sister taxon to *D. sanderae* in the ITS tree. The support of CladeB in the *matK* tree is also very high at 100%.

Both ITS and *matK* tree are similar in suggesting that section *Formosae* may not be a monophyletic group. In addition, two members of section *Formosae*, namely *D. jerdonianum* and *D. trigonopus* were placed in neither CladeA nor CladeB. Moreover regardless on these two taxa, other taxa included in CladeA and CladeB of both the ITS tree and the *matK* tree, were similar although their relationships among subclades were apparently different. It seem also that the ITS tree was somewhat better resolved than the *matK* tree, which may be due to differences in phylogenetically information sites in both datasets. As both the ITS tree and the *matK* tree were not much different, both datasets could be combined for total evidence analysis. The ILD test had been employed before combining datasets and it showed that the datasets were not statistically incongruent. Thus the analyses of combined ITS and *matK* datasets were conducted.

Combined *matK* and ITS datasets analysis

The results of ILD test between *matK* and ITS datasets showed that the original ILD values were lower than 95% of the ILD values determined through random partitioning indicating that the two datasets were not significantly incongruent (Huelsenbeck *et al.*, 1996; Darlu and Lecointre, 2002). In this case, analyses of combined datasets provided better phylogenetic resolutions than do individual datasets (e.g., Olmstead and Sweere, 1994; Yukawa *et al.*, 2002; Topik *et al.*, 2005). Therefore, the combined analysis of *matK* and ITS datasets was performed.

The combined data matrix yielded 2 MPTs (length = 1,849; CI = 0.44; RI = 0.71). The bootstrap analyses of combined datasets provided more resolution and higher than internal support for relationships than both of individual datasets (Table 4.3). The strict consensus tree with the bootstrap support and the nucleotide substitutions was shown in Fig. 4.5.

Notably, members of *Dendrobium* section *Formosae* are separated into 2 clades with 100% bootstrap support for both clades: CladeA consisting of 31 species and CladeB consisting of 4 species and 3 varieties. CladeA appeared at somewhat “basal” position whereas CladeB occupied relative terminal on the strict consensus tree.

Within CladeA, the strongly supported clades (BP=100) unite all species of section *Formosae*, which originate from southeastern mainland Asia and Indonesian Islands. There are 10 subclades in CladeA, i.e. subclade A-1 to subclade A-10 (Fig. 4.5), and the relationships among these are ambiguous. Three subclades comprise only one species: *D. jamesianum* (subclade A-8), *D. scabrilingue* (subclade A-9) and *D. xanthophlebium* (subclade A-10).

The subclade A-1, with the least bootstrap support (52%) composed of the largest species within CladeA. There are 7 species within A-1 and they subdivided into two with the high bootstrap supports. The first is of *Dendrobium infundibulum* and *D. sutepense* (BP=100) while its sister composed of *D. sinense*, *D. hirsutum*, *D. longicornu*, *D. flexuosum* and *D. wattii*.

The subclade A-2 is of *Dendrobium ayubii*, *D. tobaense*, *D. cruentum* and *D. suzukii* with 68% bootstrap support.

The subclade A-3 contributed *Dendrobium bellatulum* and *D. christyanum* with 100% bootstrap support.

The subclade A-4 consisted of *Dendrobium ovipostoriferum*, *D. singkawangense*, *D. lowii* and *D. bostrychodes* with 100% bootstrap support as well.

The subclade A-5 which consisted *Dendrobium draconis*, *D. kontumense*, *D. ochraceum*, *D. roseiodorum* and *D. trankimianum* with 89% bootstrap support.

The subclade A-6 is of *Dendrobium spectatissimum* and *D. vogelsangii* with 100% bootstrap support.

The subclade A-7 consisted of *Dendrobium cariniferum*, *D. willimsonii*, *D. schrautii* and *D. formosum* with 100% bootstrap support.

In the other clade of *Formosae*, CladeB is clearly separated from the other species of the section with high bootstrap support well resolved. This clade consisted of 6 taxa: *Dendrobium dearei* formed the basal lineage to the clade of *D. parthenium*, *D. sanderae* (all 3 varieties: var. *luzonicum*, var. *major* and var. *surigaense*) and *D. schuetzei*, whose the relationships are ambiguous.

Dendrobium trigonopus and *D. jerdonianum* were not resolved as any member of any clade, neither CladeA nor CladeB of section *Formosae* nor other sections.

Table 4.3 Statistics from overall parsimony analyses of the separate and combined data matrices.

	<i>matK</i> (excluding parts of <i>trnK</i> intron)	ITS	Combined sequences
No. of sites	1,588	795	2,383
No. of constant sites (%)	1,365 (85.9)	338 (42.5)	1,703 (71.4)
No. of variable sites (%)	141 (8.9)	116 (14.6)	257 (10.8)
No. of informative sites (%)	82 (5.16)	341 (42.9)	423 (17.8)
No. of steps (substitution)	289	1,546	1,849
No. of MPts	5,000+	3	2
CI (excluded uninformative characters)	0.6738	0.4250	0.4437
RI	0.8847	0.6844	0.7068
No. of clades and subclades with BP > 80	18	37	45

4.4 Discussion

The following discussions were based on combined ITS and *matK* datasets phylogenetic analysis:

Monophyly and circumscription of section *Formosae* sensu stricto

The phylogenetic analysis results do not support the monophyly of *Dendrobium* section *Formosae* sensu lato. The species of *Formosae* as currently circumscribed fell into 2 separate well-supported clades with high bootstrap support for each clade. Lindley (1859), who first established this orchid group under the subsection namely *Nigrohirsutae*, characterized the group by the presence of short black hairs on leaves and leaf sheaths. All species of CladeA, including *D. trigonopus* and *D. jerdonianum*, possess blackish hairs on leaves and leaf sheaths. On the other hand, after much extensive examination on living plant

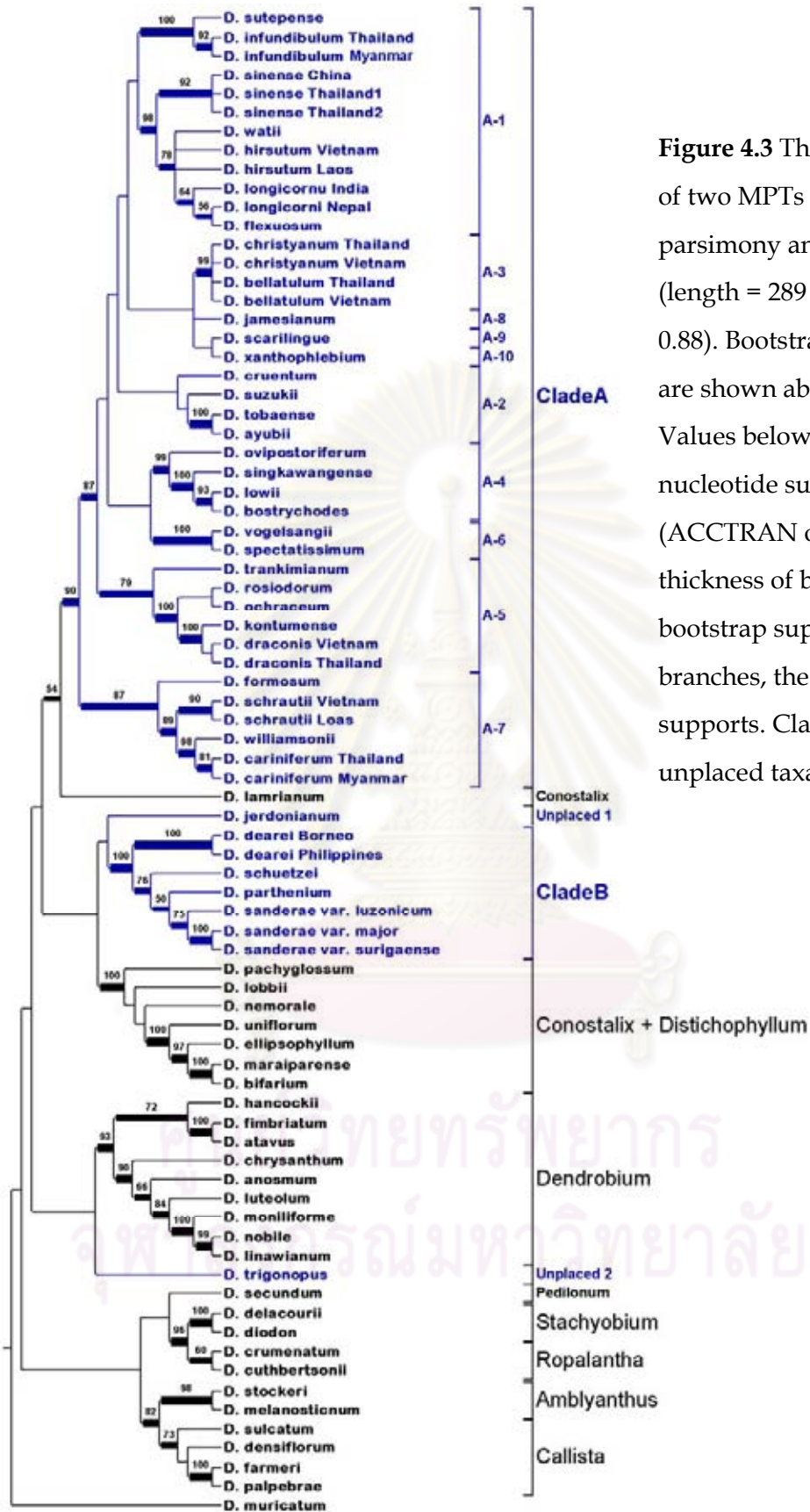


Figure 4.3 The strict consensus tree of two MPTs derived from the parsimony analysis of ITS dataset (length = 289 steps, CI = 0.67, RI = 0.88). Bootstrap percentages of >50 are shown above each branch. Values below each branch indicate nucleotide substitutions (ACCTRAN optimization). The thickness of branch represents the bootstrap support: the thicker the branches, the higher bootstrap supports. CladeA, CladeB and 2 unplaced taxa are of section

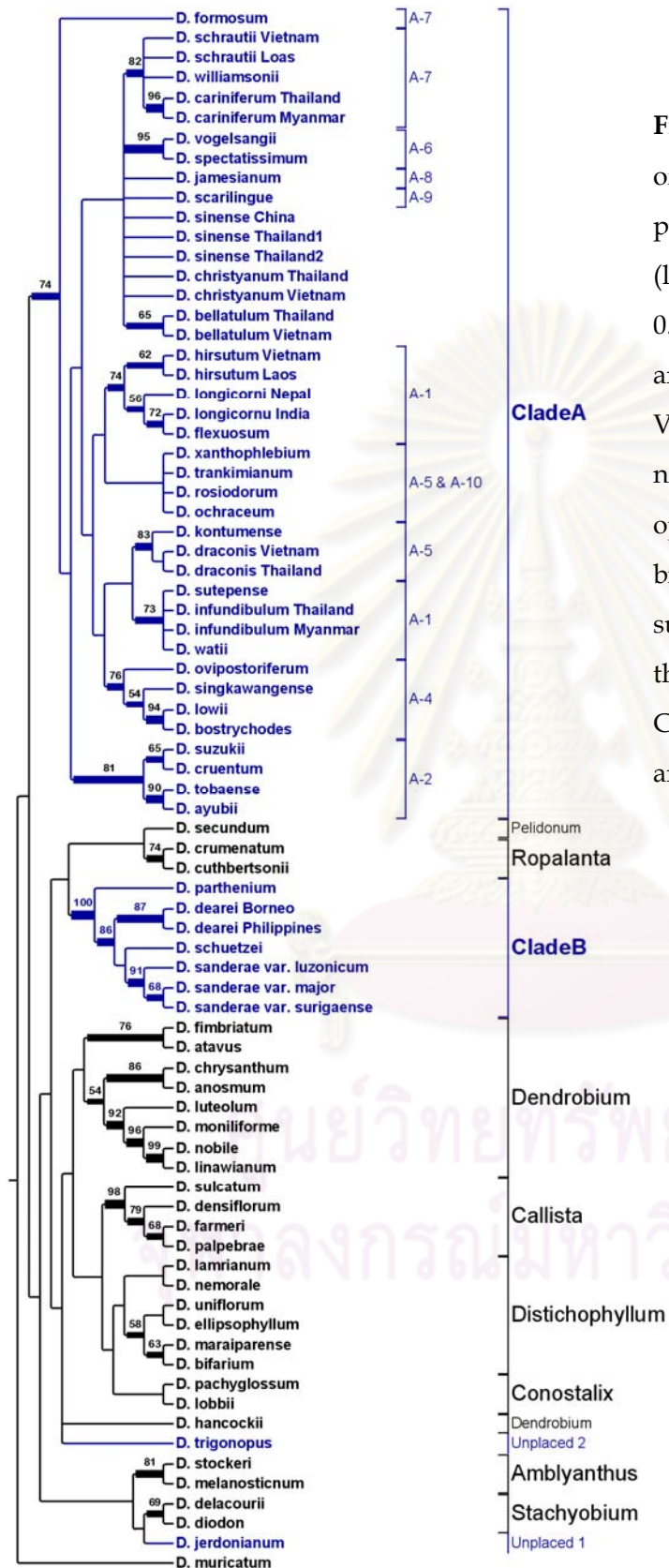


Figure 4.4 The strict consensus tree of two MPTs derived from the parsimony analysis of *matK* dataset (length = 1,546 steps, CI = 0.43, RI = 0.68). Bootstrap percentages of >50 are shown above each branch. Values below each branch indicate nucleotide substitutions (ACCTRAN optimization). The thickness of branch represents the bootstrap support: the thicker the branches, the higher bootstrap supports. CladeA, CladeB and 2 unplaced taxa are of section *Formosae*.

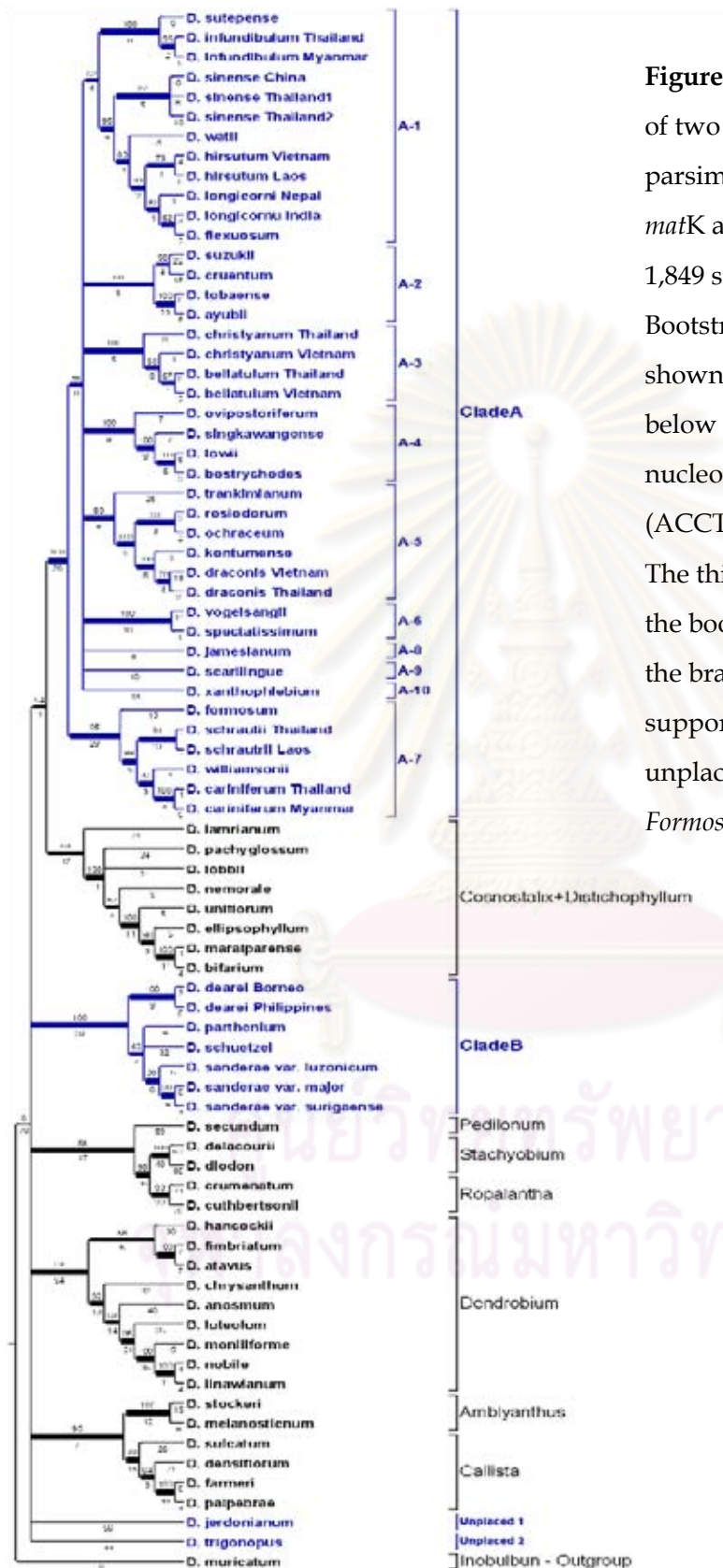


Figure 4.5 The strict consensus tree of two MPTs derived from the parsimony analysis of a combined *matK* and ITS dataset (length = 1,849 steps, CI = 0.44, RI = 0.71). Bootstrap percentages of >50 are shown above each branch. Values below each branch indicate nucleotide substitutions (ACCTRAN optimization). The thickness of branch represents the bootstrap support: the thicker the branches, the higher bootstrap supports. CladeA, CladeB and 2 unplaced taxa are of section *Formosae*.

materials, it was found that all species of CladeB do not have any hairs or trichomes on their leaves and leaf sheaths. If not considering *D. trigonopus* and *D. jerdonianum* that they were not included in CladeA, these two taxa and the member of CladeA fit very well with the diagnostic character of section *Formosae*. It could be supposed that only putative synapomorphic character of *Dendrobium* section *Formosae* sensu lato (CladeA & CladeB) is the white or yellowish white flower with hard texture perianths.

Accordingly, to resolve the polyphyly of section *Formosae*, one may choose to include only species in CladeA as the section *Formosae*. Morphologically, *D. trigonopus*, *D. jerdonianum* and some species of *Distichophyllum* and *Conostalix* also have the blackish hairs or trichomes on leaves and leaf sheaths. It is reasonable to add more characters for delimiting the section *Formosae* sensu stricto. It appeared that all members of CladeA have flowering shoots with far distichous leaves that are not imbricate, and flowers whose labellum are with more or less callus.

Hence, section *Formosae* can be defined as having these three characters, namely (i) blackish hairs on leaves and leaf sheaths, (ii) stem with far distichous leaves that is not imbricate and (iii) flower with more or less callus on labellum.

The molecular phylogeny could not suggest an unambiguous relationship of CladeB to any of CladeI to CladeIV, nor to *Dendrobium jerdonianum* nor to *D. trigonopus*. Therefore, the establishment of the new section for cladeB was suggested. This section would be characterized by stem with rather close distichous leaves, leaf base being imbricate and labelleum without callus.

In addition, *Dendrobium jerdonianum* and *D. trigonopus* should be removed from section *Formosae*, and further determination of their affinity should be conducted. These two species have the blackish hairs on their leaves and leaf sheaths, as other members of section *Formosae* sensu stricto, however, all analyses in this study did not resolve their relationship to any clades.

Morphological variation among subclades of section *Formosae*

After delimitation of section *Formosae* based on molecular phylogeny in this study, *Formosae* as here recognized is monophyletic. Within the section, the taxa form into 10 subclades. The relationships within each subclade based on morphological characters (Table 4.4) are discussed following:

Subclade A-1 to A-6 and A-8 were nested together. However, there are diverse morphological characters among or even within each subclade.

Subclade A-1 is the largest subclade in CladeA. Most taxa, contained in this subclade, are similar in having the straight or flexuous pseudobulbs and in having the white flowers with narrowly conical mentum and low keel on the abxial surface of sepals. Only *D. sinense* have fusiform pseudobulbs, broadly conical mentum and obscure keel on back of sepals. It is surprisingly that it was included in subclade A-1 but not subclade A-3 because the characters of *D. sinense* is similar to all members of subclade A-3. Its flowers are almost identical with *D. christyanum*, and its fusiform pseudobulbs also similar with *D. bellatulum*. However, the *matK* tree shows that *D. sinense* was not nested with the members of subclade A-1 while they were included together in the ITS tree. These could be assumed that *D. sinense* is descendant species, arose from the taxa of both subclade A-1 and A-3.

Subclade A-2 included the closely related species of *Dendrobium cruentum*, *D. ayubii*, *D. tobaense* and *D. suzukii*. They shared several synapomorphic characters of floral morphology. The members of this subclade could be easily recognized by greenish yellow flower colour, linear to lanceolate petals, broadly conical mentum, the thick and hard labellum with red stiff callus and the triangular falcate side lobes of the labellum. However, they also obviously differ in the shape of mid-lobe and detail of callus on the labellum.

Subclade A-3 consists *Dendrobium bellatulum* and *D. christyanum*. They all have broadly conical mentum and reniform mid-lobe of the labellum.

Subclade A-4 and A-6 consists the species originated from Borneo, Sumatra and Sulawesi Islands. Subclade A-4 demonstrates that *Dendrobium bostrychodes* and *D. lowii* are the closely related species. This agrees with the floral morphology: the very narrowly conical mentum and the wing-like keel on abaxial surface of sepals. *D. singkawangense* was also nested in this subclade although it has shortly conical mentum and its keel on abaxial surface of sepals lacks the wing-like character. However, the species shared the yellowish flower's colour with *D. bostrychodes* and *D. lowii* and its verrucose callus on labellum is also similar to *D. bostrychodes*. *D. ovipostoriferum* was also included in subclade A-4. The species has the similar characters in having white flower, very narrowly conical mentum, keel on the abaxial surface of sepals and verrucose callus on labellum. Subclade A-6 comprises *D. spectatissimum* and *D. vogelsangii*. They are similar in having the white colour flowers and shortly conical mentum.

Although subclades A-4 and A-6 were not formed the sister taxa despite the same geographic distribution, both subclades are resembled in having the flexuous pseudobulbs with rather short leaf blades. Unfortunately, there are no more plant materials of other *Formosae* species originated from Borneo, Sumatra and Sulawesi Islands, which are rare and seem extinct nowadays due to the over collecting from the natural habitats and deforestation. However, it could be postulated that *D. erythropogon*, *D. radians* and *D. sculptum* may be placed in subclades A-4 because they have the character of very narrowly conical mentum. On the other hands, *D. sisuroense*, may be included in subclades A-6 because it has white flower and shortly conical mentum similar to *D. spectatissimum* and *D. vogelsangii*.

Subclade A-5 contains taxa with the following floral characters: a slender, narrowly conical mentum, a dilated base of the column and a raised margin of the column foot.

The taxa included in subclade A-7 are clearly separated from the other 9 subclades. Morphologically, they are similar in having flowers with narrowly

conical or shortly conical mentum and the elongated or hair-like callus on the labellum.

Subclade A-8 to A-10 has only 1 taxon in each subclade, *Dendrobium jamesianum*, *D. scabrilingue* and *D. xanthophlebium*, respectively. *D. jamesianum* have the similar floral character with *D. infundibulum* but was not included in any subclades, even subclade A-1. To reexamined *D. infundibulum* complex, much larger plant materials are needed. Morphologically, *D. scabrilingue* and *D. xanthophlebium* are resembled to *D. stepense*, the taxa included in subclade A-1, in their floral character: the shortly conical mentum, the low keeled on abaxial surface of sepals, the petals more or less same size with dorsal sepal and the wart-like callus on their labellum. In this case, the other molecular markers are needed for further study.

Biogeography of each subclade of section *Formosae*

When considering the phylogenetic tree derived from the combined ITS and *matK* datasets in the sight of geographic distribution (Fig. 4.6). It was found that 7 subclades of CladeA, A-1, A-3, A-5, A-7, A-8 to A-10, were the mainland taxa. They distributed from northeast of India eastward to southern China and southward to Myanmar, Thailand and Indochina. The other 3 subclades of, A-2, A-4 and A-6, CladeA restricted to southern Thailand, Malay peninsular and Sumatra Island (subclade A-2) and to Borneo Island (subclade A-4 and A-6). It appears that CladeA of section *Formosae* occupied quite large area and it seems that the central distribution of the section may on northern Myanmar, northern Thailand and northern Indochina. This is in agreement with Lavarack *et al.* (2000) and Aubroun (2005).

In contrast, CladeB of section *Formosae* are restricted to the Philippines Islands. Biogeographically, CladeB is isolated from CladeA of section *Formosae*. The morphological, molecular information are agreed with the biogeography that CladeB is apart from other *Formosae* members. Therefore, it may be expected

that taxa of CladeB speciated from the unknown local ancestor but not from same ancestor of CladeA.

Dendrobium jerdonianum, the endemic species to southwestern India and Sri Langka (Manilal & Kumar, 2004), is also isolated geographically from other members of both CladeA and CladeB. The species may from its unique speciation from local ancestor as same as expecting of CladeB. In contrast, *D. trigonopus* has its distribution overlapping with other taxa of CladeA. It could be arisen from the species hybridization but more works are needed to verify this argument.



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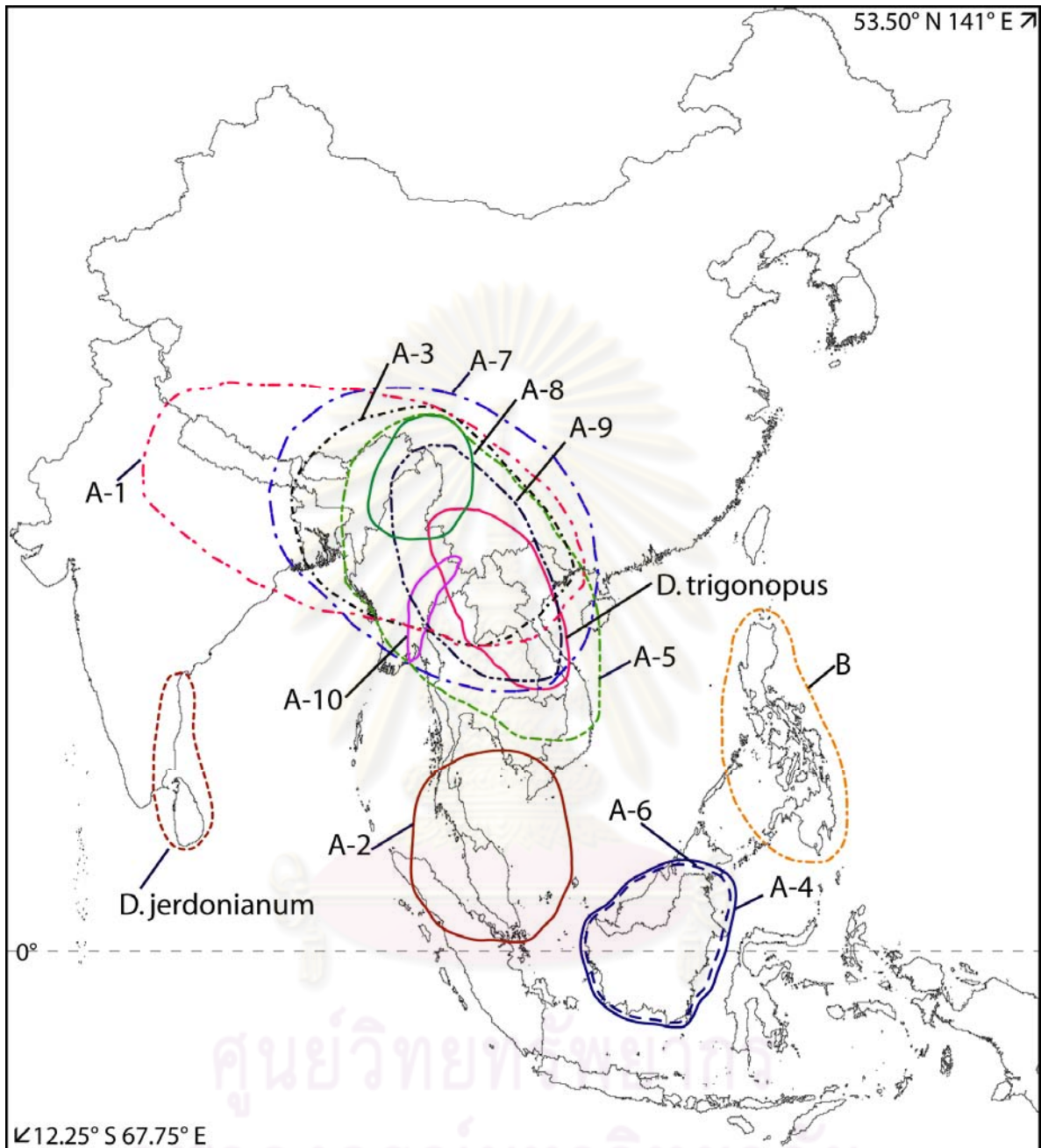


Figure 4.6 Geographic distribution of taxa in clades and subclades recognized from the combined datasets analysis of *Dendrobium* section *Formosae*. *D. trigonopus* and *D. jerdonianum* were unplaced taxa formerly classified in section *Formosae*.

Table 4.4 Morphological characters in each clade and subclade of *Dendrobium* section *Formosae*.

Subclade	Pseudobulbs	Leaves arrangement	Flower colour	Shape of mentum	Size of petals compare with size of dorsal sepal	Keel on back of sepals	Callus on labellum
A-1	Straight or flexuous or fusiform	Far distichous	White	Narrowly conical or broadly conical	Boarder or the same size	Low keel or obscure keel	Hair-liked
A-2	Straight or flexuous	Far distichous	Light green	Broadly conical	Narrower	Obscure	Wart-liked
A-3	Fusiform or straight	Far distichous	White	Broadly conical	More or less the same	Obscure	Wart-liked
A-4	Flexuous	Far distichous	Yellow or white	Very narrowly conical or shortly conical	Boarder or the same size	Wing-like keel or low keel	Wart-liked or hair-liked
A-5	Straight	Far distichous	Yellow or white	Very narrowly conical or narrowly conical	More or less the same	Low keel	Wart-like callus, without callus in <i>D. kontumense</i>
A-6	Flexuous	Far distichous	White	Shortly conical	Boarder or the same size	Wing-like keel or obscure	Wart-like callus
A-7	Straight or flexuous	Far distichous	White or creamy yellow	Narrowly conical or shortly conical	Boarder or the same size	Wing-like keel or low keel	Hair-like callus
A-8	Straight	Far distichous	White	Narrowly conical	Boarder	Low keel	Hair-like callus
A-9	Fusiform or straight	Far distichous	White	Shortly conical	More or less the same	Obscure	Wart-like callus
A-10	Straight	Far distichous	White	Shortly conical	More or less the same	Low keel	Wart-like callus
B	Straight	Close distichous	White	Broadly conical or narrowly conical or very narrowly conical	Boarder	Wing-like keel	Absent
<i>D. trigonopus</i>	Straight	Far distichous	Yellow	Broadly conical	More or less the same	No keel	Lamella
<i>D. jerdonianum</i>	Straight or flexuous	Far distichous	Orange	Broadly conical	More or less the same	Low keel	Wart-like callus

4.5 Conclusion

The phylogenetic analyses result in this study indicated the non-monophyly of *Dendrobium* section *Formosae* sensu lato. The result resolved the position of the *Formosae* hairless species from the Philippines Islands. It is here recognized as clearly separated group from the *Formosae* hairy species on the basis of molecular, morphological and biogeographical informations.

Accordingly, I suggest that section *Formosae* sensu stricto should be included only taxa in CladeA whereas CladesB should be established as a new section of the genus *Dendrobium*. The unplaced taxa, *D. jerdonianm* and *D. trigonopus*, should be removed from section *Formosae* and further investigation of their affinity to other section is required.



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CHAPTER V

TAXONOMIC STUDY

5.1 Introduction

This chapter aims to provide a taxonomic revision of the genus *Dendrobium* section *Formosae* in Thailand and adjacent areas. The geographic areas included in this study were Sri Lanka, India, Nepal, Bangladesh, Bhutan, Myanmar, China, Thailand, Laos, Vietnam, Cambodia, Malaysia, Indonesia and the Philippines.

5.2 Materials and methods

5.2.1 Plant materials

The orchids genus *Dendrobium* section *Formosae* were studied from herbarium specimens deposited at the Department of Systematic Botany, University of Aarhus (AAU); Harvard University, Oakes Ames Orchid Herbarium, United state of America (AMES); Kasin Suvathabhandhu Herbarium, Department of Botany, Chulalongkorn University, Bangkok, Thailand (BCU); Herbarium, Botanical Section, Department of Agriculture, Bangkok, Forest Herbarium, Thailand (BK); National Park, Wildlife and Plant Conservation Department, Bangkok, Thailand (BKF); British Natural History Museum Herbarium (BM); National Botanic Garden of Belgium, Belgium (BR); Botanical Museum, University of Copenhagen, Denmark (C); Department of Biology, Chiang Mai University Herbarium (CMU); Royal Botanic Garden, Edinburgh, U.K. Scotland (E); Royal Botanic Gardens, Kew, England (K); Khon Kaen University Herbarium (KKU); National Herbarium Netherland University of Leiden branch, The Netherlands (L); Botanische Staatssammlung Muenchen, Munich, Germany (M); Muséum National d'Histoire Naturelle, Paris, France (P); Queen Sirikit Botanic Gardens, Herbarium, Thailand (QBG); National Museum of Nature and Science, Tsukuba, Japan (TNS); Singapore Botanic Gardens, Singapore (SING) and

Naturhistorisches Museum Wien, Austria (W). Approximately 1,000 specimens were examined.

In addition, orchid specimens also collected from their natural habitats throughout Thailand. The photographs of the plants habit and the flower were taken for each material. Specimens were prepared according to standard procedures for herbarium materials (Bridson & Forman, 1999), and deposited at BCU. When feasible, fresh materials were prepared as following: the flowers were preserved in 70% ethanol for further morphological study, the mature leaves were preserved in 70% FAA for anatomical study and the young leaves or flowers were preserved in silica gel for molecular study. In addition, herbarium specimens were prepared and kept at the Professor Kasin Suvatabhundu Herbarium, Department of Botany, Chulalongkorn University (BCU) and the Forest Herbarium (BKF).

5.2.2 Laboratory work

In order to examine the dried herbarium materials, the specimens were rehydrated by boiling in water for approximately 3-5 minutes until soft. After examination rehydrated herbarium materials were dried and returned to a packet on the sheet. The standard dissection procedure was adopted for floral examination. Each sepals, petals and labellum were removed and measured. Then, they were flattened and dawn with the inner surface, occasionally outer surface. Both vegetative and floral characters were observed by stereomicroscope (Nikon SMZ-1B) and measured by using ruler or vernire. The type or quationable specimens were photographed for further examination. The line drawing iullustrations of each species were prepared by Mr. Tanucha Boonjarus and Ms. Sirilax Tapdechachan.

5.2.3 Determination

Determination of taxonomic entities of each specimen was based on the existing diagnostic keys available from Floras or manuals of orchids of Thailand and neighboring countries. Then, Botanical name of specimens were confirmed by comparing the specimen to the type specimens.

5.2.4 Classification

In this work, the section and species have been arranged according to Hooker (1890) and Seidenfaden (1895).

5.2.5 Taxonomic treatment

Taxonomic treatments of species and variety of *Dendrobium* section *Formosae* were based mainly on morphological data. Each species were described and illustrated. Keys to species and varieties, if any, were constructed. Ecological and geographical data of each species were noted.

5.3 Results

According to the examination of plant collections from the herbarium and addition collections in the fields in Thailand and adjacent areas during July 2005-December 2008, 45 species and 4 varieties in section *Formosae* sensu lato Hooker (1890) are enumerated. Both morphological and molecular studies suggested that 6 species and 4 varieties should be removed from the section. Among these, 4 species and 4 varieties were proposed to erect as the new section and 2 species were leaved as the unplaced taxa, i.e. no definitive section, for future studies. Consequently, 39 species were retained in the section *Formosae*.

SECTION FORMOSAE

(Benth. & Hook. f.) Hook. f., Fl. Brit. Ind. 5: 710. 1890. Type: *Dendrobium formosum* Roxb. ex Lindl.

Dendrobium subsection *Nigrohirsutae* Lindl., Journal of the Proceedings of the Linnean Society of London, Botany, 3: 16. 1859.

Dendrobium subsection *Formosae* Benth. & Hook. f., Genera Plantarum, 3: 500. 1883.

Dendrobium subgenus *Nigrohirsuta* Kraenzl., Das Pflanzenreich, IV, 50. II. B. 21, Part 1, p. 85. 1910.

Dendrobium section *Oxygenianthe* Schltr., Repert. Spec. Nov. Regni Veg. Beih. 1(6): 448. 1912.

Flowering shoots erect, thick and leafy. **Leaves** rather far distichous, dark hirsute hairs covered on leaves and leaf sheaths, especially when young. **Inflorescences** one-flowered or 3- to 4-flowered, up to 6-flowered, usually borne on distal part of stems. **Flowers** large, usually white, rarely yellow or with a contrasting labellum. **Mentum** prominent, usually straight, conical. **Labellum** 3-lobed, with more or less callus (excepting for *Dendrobium kontumense*). **Operculum** not bent upward.

DISTRIBUTION – The *Formosae* species distribute in mainland Asia from Northwest India and South China to Myanmar, Thailand and Indochina. They also distribute from Sumatra to Borneo Islands.

ETYMOLOGY – Latin: *formosus*, beautiful, finely formed.

KEY TO SPECIES

- 1-a. Mentum broadly conical.2.
- 1-b. Mentum shortly conical.9.
- 1-c. Mentum narrowly conical.16.
- 1-d. Mentum very narrowly conical.26.
- 2-a. Petals lanceolate.3.
- 2-b. Lateral, petals ovate.7.
- 3-a. Mid-lobe of the labellum triangular when un-flattened or obovate when flattened.4.
- 3-b. Mid-lobe of the labellum clavate, margin involute.5.
- 4-a. Disc of the labellum with 3 median keels between the 2 outer keels, margin of mid-lobe denticulate.**6. D. cruentum**
- 4-b. Disc of the labellum with 5 median keels between the 2 outer keels, margin of mid-lobe undulate.**31. D. suzuki**
- 5-b. Mid-lobe of the labellum with narrowed basal claw.**32. D. tobaense.**
- 5-b. Mid-lobe of the labellum sessile.6.
- 6-a. Disc of the labellum with 3 low median keels between the 2 higher outer keels.**1. D. ayubii**
- 6-b. Disc of the labellum with a low median keels between the 2 higher outer keels.**33. D. toppii**
- 7-a. Side lobes of the labellum obliquely obovate, mid-lobe recurved backwards more than 90 degree of angle.**2. D. bellatulum**
- 7-b. Side lobes of the labellum obliquely widely elliptic, mid-lobe recurved backwards less than 90 degree of angle.8.

- 8-a. Keels on the disc labellum indistinct and bearing verrucose callus.
..... **5. D. christyanum**
- 8-b. Keels on the disc labellum distinct and smooth.**26. D. sinense**
- 9-a. Petals distinctly broader than dorsal sepal.....10.
- 9-b. Petals more or less same size with dorsal sepal.....11.
- 10-a. Side lobes of the labellum obliquely semi-circle, mid-lobe oval.
.....**29. D. spectatissimum**
- 10-b. Side lobes of the labellum obliquely triangular, mid-lobe transversely
oblong..... **10. D. formosum**
- 11-a. Mid-lobe of the labellum suborbicular.**39. D. xanthophlebium**
- 11-b. Mid-lobe of the labellum elliptic or obovate.12.
- 12-a. Ratio between length of mentum and length of dorsal sepal equal or less
than 2:5.13.
- 12-a. Ratio between length of mentum and length of dorsal sepal more than 2: 5.
.....15.
- 13-a. Side lobes of the labellum with many transversely papillose-verrucose
callus, mentum up-curved. **36. D. vogelsangii**
- 13-b. Side lobes of the labellum with warty elevated veins running along the
length, mentum straight.14.
- 14-a. Mid-lobe of the labellum thick, apex acute.**23. D. scabrilingue**
- 14-b. Mid-lobe of the labellum thick at the median area, the lateral areas thin,
apex acuminate. **30. D. sutepense**
- 15-a. Mid-lobe of the labellum with claw, margin crenulate, not undulate.
.....**28. D. sisuroense**
- 15-b. Mid-lobe of the labellum without claw, margin undulate.
.....**27. D. singkawangense**

- 16-a. Petals distinctly broader than dorsal sepal.17.
- 16-b. Petals more or less same size with dorsal sepal.21.
- 17-a. Side lobes of the labellum obliquely triangular, mid-lobe transversely oblong, disc with 5 distinct keels**18. D. multilineatum**
- 17-b. Side lobes of the labellum obliquely ovate.18.
- 18-a. Mid-lobe of the labellum same size with each side lobe, apex rounded or retuse.**37. D. wattii**
- 18-b. Mid-lobe of the labellum bigger than each side lobe, apex emarginated.
.....19.
- 19-a. The keels at apical part of disc and the slightly elevated veins on side lobes of the labellum bearing short hair-like callus.**14. D. jamesianum**
- 19-b. The keels at apical part of disc and the slightly elevated veins on side lobes of the labellum bearing minutely wart-like callus.20.
- 20-a. Disc of the labellum with “two singular, thickened, ligulate lines” (after Reichenbach’s original description). **35. D. virgineum**
- 20-b. Disc of the labellum lack the above character, apex of the mid-lobe deeply emarginated, V-shaped sinus **13. D. infundibulum**
- 21-a. Labellum without any callus, excepting for 3-5 verruculose keels on the mid-lobe.**34. D. frankimianum**
- 21-b. Labellum with long hair-like callus.22.
- 21-c. Labellum with wart-like or minutely hair-like callus.24.
- 22-a. Flowers resupinate.23.
- 22-b. Flowers not resupinate. **24. D. schrautii**
- 23-a. Abaxial surface of each sepal with wing-like keel, each keel continuing downwards to ovary, mid-lobe of the labellum transversely oblong.
.....**4. D. cariniferum**

- 23-b. Abaxial surface of each sepal with obtuse keel, each keel, mid-lobe of the
labellum orbicular or very widely ovate.....**38. D. williamsonii**
- 24-a. Petals lanceolate or narrowly elliptic, labellum with wart-like callus.
.....25.
- 24-b. Petals obovate or elliptic or rhombic, labellum with minutely hair-like
callus. **11. D. hirsutum**
- 25-a. Mentum longer than dorsal sepal, margin of mid-lobe fimbriate.
..... **16. D. longicornu**
- 25-b. Mentum as long as dorsal sepal, margin of mid-lobe undulated and crisped.
..... **9. D. flexuosum**
- 26-a. Labellum without any callus.27.
- 26-b. Labellum with verrucose callus.....28.
- 26-c. Labellum with hair-like callus.....31.
- 26-d. Labellum with transversely rugulose callus.....32.
- 27-a. Length of side lobes shorter than length of mid-lobe, mid-lobe elliptic when
flattened.**7. D. draconis**
- 27-b. Length of side lobes as same as length of mid-lobe, mid-lobe orbicular.
.....**15. D. kontumense**
- 28-a. Petals more or less same size with dorsal sepal.29.
- 28-b. Petals broader than dorsal sepal.30.
- 29-a. Petals elliptic-rhombic, labellum with densely verrucose callus on side lobes
and the median area of mid-lobe.**22. D. roseiodorum**
- 29-b. Petals narrowly elliptic, labellum with verrucose callus only on veins of side
lobes and mid-lobe.**19. D. ochraceum**
- 30-a. Mid-lobe of the labellum semi-circle or transversely oblong.
..... **3. D. bostrychodes**

- 30-b. Mid-lobe of the labellum ovate.**20. D. ovipostoriferum**
- 31-a. Side lobes of the labellum triangular obovate, mid-lobe with long claw,
keels on mid-lobe bearing long hair-like callus.**17. D. lowii**
- 31-b. Side lobes of the labellum triangular widely obovate, mid-lobe with shorter
claw, keels on mid-lobe bearing shorter hair-like callus.
..... **8. D. erythropogon**
- 32-a. Side lobes of the labellum obscure, very broadly semi-circle, sometime side
lobes absent, mid-lobe with a central orange blotch. **25. D. sculptum**
- 32-b. Side lobes of the labellum more distinct.33.
- 33-a. Base of the labellum with 2 elevated callus, mid-lobe with a central orange
blotch. **12. D. igneoveneum**
- 33-b. Base of the labellum without elevated callus, mid-lobe lack of colour blotch.
.....**21. D. radians**

1. *Dendrobium ayubii* J.B. Comber & J.J. Wood, *Orchid Rev.* 107: 89. 1999; J.B. Comber, *Orchids of Sumatra*: 595. 2001; H.P. Wood, *The Dendrobiums*: 596. 2006. Type: *Parnata s.n.* (holotype K!, spirit collection), Indonesia, West Sumatra, Kerinci Mountain, 1998. Fig. 5.1; Pl. 4: A.

Flowering shoots cluster, erect, slender, cylindrical, 27-45 cm tall, internodes 2-3 cm long, 0.4-0.6 cm in diameter, leafy along the upper part of stem, bearing approximately 15 leaves. **Leaves** distichous, spreading, coriaceous, both surfaces densely covered with short black hirsute hairs, mid-vein grooved above and ribbed below, oblong, apex unequally bi-lobed, each lobe subacute or obtuse, 3.8-5.5 cm long, 1.8-2.5 cm wide; leaf-sheaths covered with short black hirsute hairs, 1.6-2.7 cm long. **Inflorescences** abbreviated, 1-flowered, borne at the apical part of both leafy and leafless stems, emerging from base of leaf sheaths opposite the blade; peduncle and rachis glabrous, 0.5-0.9 cm long; floral bracts concave, abaxial surface covered with dense black hirsute hairs, adaxial surface glabrous, narrowly lanceolate, apex acute, base truncate, 2- to 4-veined, 1-1.8 cm long, 0.2-0.5 cm wide. **Flowers** resupinate, mostly cream with pale green nerves, lip pale yellow with bright red keels. **Sepals** spreading, slightly recurved distally, margin entire, abaxial surface with inconspicuous keel; dorsal sepal lanceolate, apex acuminate or attenuate, base truncate, 3-veined, 2-2.9 cm long, 0.8-1.2 cm wide; lateral sepals obliquely triangular-lanceolate, apex acuminate or attenuate, base obliquely truncate, 5- to 7-veined, posterior margin 2.2-3 cm long, anterior margin 2.8-3.5 cm long, 1.2-1.7 cm wide at base, c. 0.2 cm wide at apex. **Mentum** broadly conical, saccate, apex obtuse, 1-1.5 cm long. **Petals** recurved backwards, linear or narrowly lanceolate, apex acute, base truncate, distal margins minutely erose, basal half margin entire, 3-veined, 1.8-2.5 cm long, 0.5-0.8 cm wide at base. **Labellum** 3-lobed, 2.1-2.5 cm long, 2.1-2.5 cm wide across side lobes; claw shallowly triangular, 3-4 mm long; side lobes obliquely narrowly triangular, falcate, apex acute, margin entire; disc oblong, prominent, with 5 keels, rough at apical part, the outer two keels taller than the three middle keels; mid-lobe

thickening, hard, decurved, apex acute, margins folded tightly inwards forming a narrow clavate structure, 1.1-1.6 cm long, 0.2-0.4 cm wide. *Column* surface smooth, dilated at base, 4-5 mm long, 4-6 mm wide at base; foot surface smooth, 10-13 mm long, ca. 11 mm wide at base; stigmatic cavity widely obovate or widely oblong; stelidia triangular; connective linear or narrowly triangular; anther cap widely ovate, surface minutely papillose, apex emarginate, basal margin ciliate, adaxial surface sulcate, 2.9-3.5 mm long, 3.9-4.2 mm wide; pollinia 4, in 2 pairs, each pollinium narrowly elliptic, without caudicle and visidium. *Ovary* (including pedicel) clavate, glabrous, 6-grooved, 1.9-2.2 cm long. *Capsule* not seen.

DISTRIBUTION. – Indonesia.

HABITAT AND ECOLOGY. – Unknown

SPECIMENS EXAMINED. – INDONESIA: Ex Cult. *Ayub Parnara s.n.* (K), West Sumatra, Mt. Kerinci, 1998.

NOTE. – *Dendrobium ayubii* is similar to *D. tobaense* but its side lobes of the labellum are boarder than those of *D. tobaense*. The disc of the labellum lack the verrucose callus but insteaded has 5 ridges and the mid-lobe is not narrowed basally.

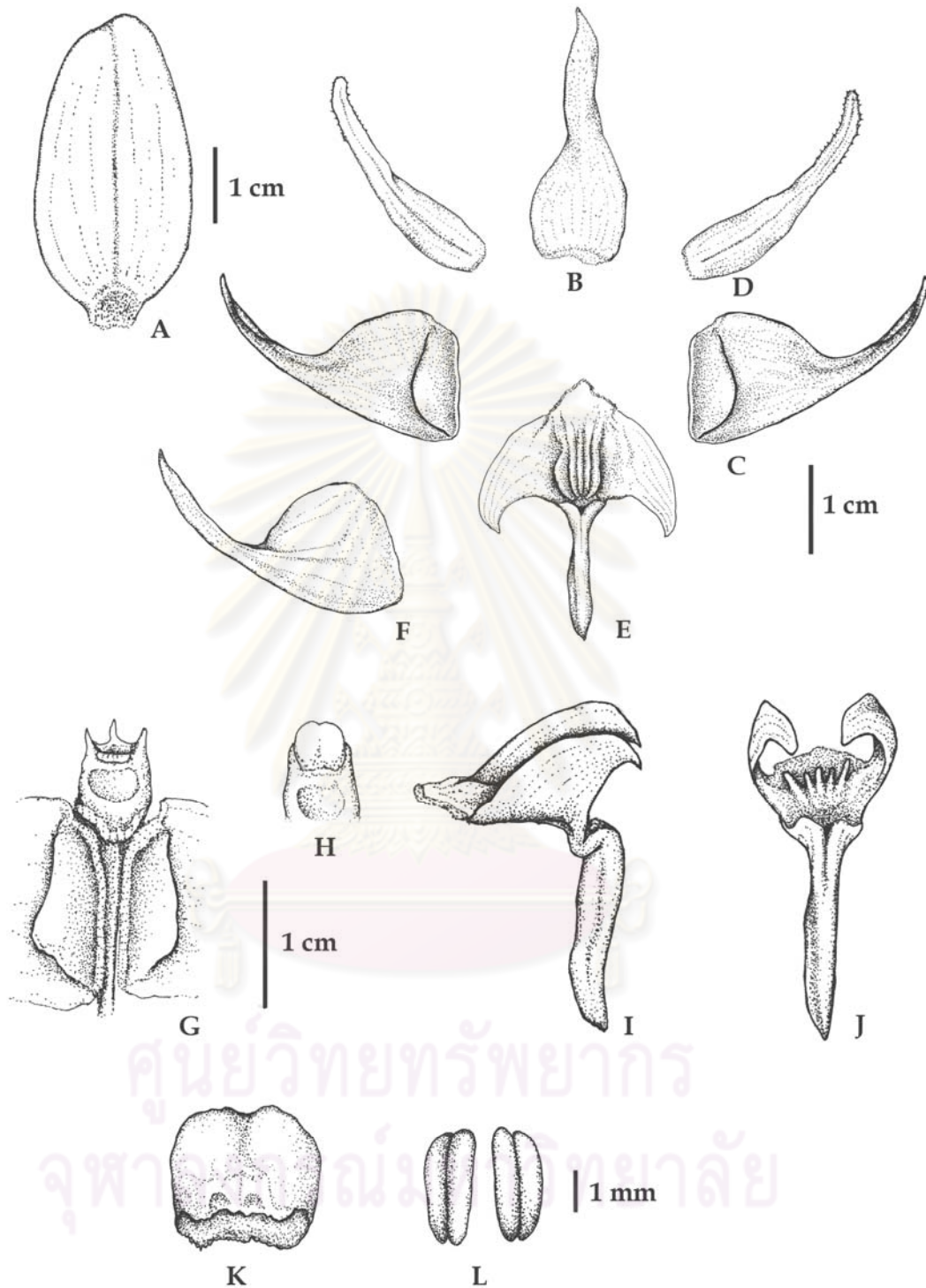


FIGURE 5.1. *Dendrobium ayubii* J.B. Comber & J.J. Wood A. Leaf; B. Dorsal sepal; C. Lateral sepal; D. Petal; E. Labellum; F. Lateral sepal, abaxial surface; G. Column and column foot, from below, anther cap removed; H. Column, from below; I. Labellum, side view; J. Labellum, front view; K. Anther cap; L. Pollinia. Drawn from *Ayub (Parnata s.n.) s.n.* (holotype) by Mr. Tanucha Boonjaras.

2. *Dendrobium bellatulum* Rolfe, J. Linn. Soc., Bot. 36: 10. 1903; Thaithong, Thai Orchid: 174. 2000. Type: *A. Henry 11,109* (holotype K!), China, Yunnan, Mengtze, Southeast mountain-forest, at 5,000 ft alt. Fig. 5.2; Pl. 4: B.

D. bellatulum var. *cleistogamia* Pradhan, Indian Orchids: Guide Identif. & Cult. 2:331. 1979. Type: *U. C. Pradhan's Collector 11/75* (holotype PH), India, Manipur.

Flowering shoots erect, fusiform or cylindrical, sulcate, slightly constricted at nodes, yellowish green or green or brown or fulvous, 4-7 cm tall, internodes 0.9-1.7 cm long, 0.5-1.2 cm in diameter, leafy at upper part of stem, up to 4-6 leaves. **Leaves** distichous, spreading, sometime twist at base, thinly coriaceous, mid-vein grooved above and ribbed below, both surfaces particularly covered with black hirsute hairs, green or dull green, oblong or elliptic-oblong, apex unequally bilobed, each lobe obtuse or subacute, 2.8-3.5 cm long, 1-1.7 cm wide; leaf-sheaths covered with black hairs, ca. 1 cm long. **Inflorescences** abbreviated, 1- to 2-flowered, borne from nodes at the uppermost or sometime middle portion of both leafy and leafless stems; peduncle and rachis glabrous, light green, 0.2-0.3 cm long, covered with bracts; floral bracts abaxial surface covered with sparsely black hairs, adaxial surface glabrous, greenish brown or brown, oblong or elliptic-oblong, concave, apex acuminate or attenuate, base truncate, 2- to 4-veined, 0.5-0.9 cm long, ca. 0.4 cm wide. **Flowers** papyraceous, resupinate, unscented, up to c. 2.5 cm in diameter; sepals and petals white or creamy white; mentum orangish white from outside; labellum red or reddish orange, side lobes and disc pale red, becoming dull red with age, mid-lobe yellow when young, turning to yellowish orange or reddish orange; column white, pale red below stigmatic cavity, foot dark red, stigmatic cavity white, anther-cap white, pollinia yellow, pedicellate ovary yellowish green to light green. **Sepals** spreading, slightly recurved distally, margin entire, abaxial surface without keel; dorsal sepal elliptic-oblong or ovate-oblong, apex acuminate or acute, base truncate, 3-

to 5-veined, 1.1-1.6 cm long, 0.5-0.9 cm wide; lateral sepals obliquely triangular-ovate or triangular-oblong, apex acuminate, base obliquely truncate, 5-veined, hardly visible, posterior margin 1.2-2.3 cm long, anterior margin 2-2.4 cm long, 0.9-1.5 cm wide at base, ca. 0.3 cm wide at apex. *Mentum* broadly conical, saccate, apex obtuse, 1.4-2.1 cm long, 0.4-0.7 cm in diameter. *Petals* spreading, ovate or oblong-ovate, slightly cuneate at base, apex acute or acuminate, base truncate, margin entire, 1.3-1.8 cm long, 0.6-1 cm wide. *Labellum* 3-lobed, pandulate in outline, 2.1-2.9 cm long, 1.2-1.7 cm wide across side lobes; claw transversely oblong or shallowly triangular, ca. 2 mm long; side lobes obliquely obovate, apex obtuse or subacute, margin entire, 3 to 5 slightly elevated veins running along each side lobe; disc thickening, warty 5-keeled, narrowly oblong; mid-lobe reniform, with short claw, extremely recurved backward, more than 90 degree of angle, apex emarginate, margin entire or slightly undulate, median ridge somewhat thick, bearing wart-like callus, continuing from disc, 0.9-1.3 cm long, 1.2-1.6 cm wide. *Column* 5-8 mm long, 7-9 mm wide at base; foot concave, cymbiform, broad at middle, waxy, 2-obtusely caninated, 12-15 mm long, 10-15 mm wide at middle; stigmatic cavity circular or ovate sometime obcordate; stelidia triangular; connective narrowly triangular; anther cap orbicular or widely obovate, surface minutely papillose, adaxial side sulcate, apex emarginated, basal margin minutely ciliate, 2.3-2.5 mm long, 2.1-2.6 mm wide; pollinia 4, in 2 pairs, each pollinium narrowly elliptic, without caudicle and visidium. *Ovary* (including pedicel) narrowly clavate, curved, glabrous, somewhat waxy with 6-grooves, 1.2-1.9 cm long. *Capsule* dehiscent, green or dull green, ovate or ovate-elliptic with 3 obtuse keels, apex with persistent dried perianth, 2-2.7 cm long, 2-2.5 cm wide.

DISTRIBUTION. — China, Myanmar, Laos, Thailand and Vietnam.

HABITAT AND ECOLOGY. — Epiphytes s in dry evergreen forest or pine forest, at 1,000-1,500 m alt. Flowering period: January-April.

VERNACULAR.— Ueang sae phu (เอื้องแซะภู), Ueang sae doi pui (เอื้องแซะคอยปุย)
(Chiang Mai).

SPECIMENS EXAMINED.— CHINA: *A. Henry* 11109 (E, K), Yunnan, Mengtze, S.E. mountain-forest, 5,000 ft alt.

MYANMAR: *W. Micholitz s.n.* (K), southern Shan State, Pekon, 15 Dec. 1909;
R. H. Phillemore s.n. (K), S. Shan State, Keug Tung, 3,000-4,000 ft alt., Feb. 1910.

LAOS: *A. D. Kerr* 1645 (C), Bolovens, 1,000 m alt.; *A. D. Kerr* 2578 (K).

THAILAND: *Kai Larsen, Esbern Warncke & Tem Smitinand* 2,489 (AAU), Doi Sutep, Chiang Mai, 1,500 m alt.; *Kai Larsen, T. Santisuk & E. Warncke* 2,146 (AAU), Doi Pha Dam between Hang Dong and Bo Luang, 1,200 m alt., 5 July 1968; *A. Sathapattayanon* 414 (BCU), sine loc., 04 Jan. 2006; *O. Thaithong* 333 (BCU), sine loc., 14 Jan. 1988; *O. Thaithong s.n.*, sine loc., 04 Dec. 1989; *C. Chermisriwatthana* 923 (BK), Loei, Phu Rua, 1,170 m alt., 17 Apr. 1968; *Cumberleg/Reeves* 19 (C), Chiang Mai, Doi Inthanond; *H. B. G. Garrett* 834 (K), Doi Langka, Me Sawi drainage, 1,480 m alt., 20 Nov. 1933; *H. B. G. Garrett* 746 (BKF), Doi Pa Na Tu between Hui Toh Noi, Chiang Rai and Hiu Pa Na Tu, Chiang Mai, 1,550 m alt., 28 Dec. 1931; *H. B. G. Garrett* 746 (K), Watershed between Me Iao, Chiang Rai District and Me Kuang, Chiang Mai District, 1,580 m alt., 28 Dec. 1931; *A. F. G. Kerr s.n.* (K), Chiang Mai Province, 3 Dec. 1930; *Kerr s.n.* (P), Chiang Mai, 15 Jan. 1915; *Kerr s.n.* (P), Chiang Mai, Doi Sutep, 4,500-5,000 ft alt., 27 June 1909; *Koonkhunthod et al. s.n.* (BKF), Northeast, 28 Apr. 04; *Larsen* 2489 (C), Chiang Mai, Doi Sutep, Doi Pui, 1,500 m alt.; *K. Larsen, T. Santisuk & E. Warncke* 2489 (BKF), Chiang Mai, Doi Sutep, Doi Pui (18°50' N, 98°54' E), 1,500 m alt., 15 July 1968; *J. F. Maxwell* 91-235 (CMU), Chiang Mai, Jawm Thong District, Mae Soi Subdistrict, Mae Soi Ridge, near Ban Bah Gluay, 1,200 m alt., 8 Mar. 1991; *J. F. Maxwell* 96-24 (BKF, CMU, L),

Lampang, Muang Bahn (Pan) District, Jae Sawn National Park, pine ridge off the dirt road to Bah Miang Village, 1,250 m alt., 07 Jan. 1996; *J. F. Maxwell* 96-99 (BKF, CMU, L), Chiang Mai, Doi Chiang Dao Wildlife Sanctuary, east of Huay Mae Gawk Station, pine ridge west of Doi Luang Mountain, 1,450 m alt., 27 Jan. 1996; *Menzies & Du Puy* 325 (K), Chiang Mai, Doi Inthanon National Park, along road to Mae Chaem, 1,000 m alt., Feb. 1983; *W. Nanakorn et al.* 10556 (QBG), Chiang Mai, Muang District, Doi Sutep-Pui, 1,400 m alt., 03 Feb. 1997; *S. Pumicong & M. Wongnak* 515 (QBG), Mae Hong Son, Doi Kowaloo, Ban Hauy Tong, 1,160 m alt., 20 Dec. 2006; *Put* 3461 (BK, K), Chiang Mai, Doi Nang Ka, 17 Nov. 1930; *A. Sathapattayanon* 418 (BCU), Chiang Mai, Doi Sutep-Pui National Park, Pha Dam Unit, 1,360 m alt., 15 Feb. 2006; *A. Sathapattayanon* 443 (BCU), Loei, Phu Luang Wildlife Sanctuary, Kok Huai-toei to Pha Ta-loen, 10 Jan. 2007; *Soradet* 31 (BKF, C), Chiang Mai, Doi Sutep, Doi Pui; *GT* 5197 (C), Mae Hong Son, SW of Ban Luang at km 45-47, 1,140 m alt., 29 Jan. 1964; *GT* 7046 (C), Mae Hong Son, Doi Chick Chong, W. of Pai, 1,500-1,700 m alt., 18 Feb. 1968; *GT* 7646 (C), Mae Hong Son, Mae Lanam, Pune Station, 1,200 m alt., 06 Mar. 1971; *GT* 7646 (C), Mae Hong Son, Mae Lanam near Boduang, 1,000-1,100 m alt., 06 Mar. 1971; *GT* 8428 (C), Chiang Mai, NE of Khun Mae Surin, 1,200 m alt., 13 Mar. 1978.

VIETNAM: *L. Averyanov et al.* VH 2,297 (AAU), Kon Tum, Dak Gley, 1,400-1,500 m alt., 06. Dec. 1995; *L. Averyanov, N.Q. Binh & P.K. Loc* VH 2,693 (AAU), Lam Dong, Lac Duong, Da Chay, Klong Lanh village, 1,600-1,700 m alt., 15 Mach 1997; *Chevalier* 30699 (P), Dalat, Lang Bian, 1,400 m alt., 15 Feb. 1914; *Eberhardh* 69B (P); *F. Evrard* 937 (P), Dalat, 23 June 1924; *F. Evrard* 1798 (P), Dalat, Lang Bian, 14 Nov. 1924; *F. Evrard* 1880 (P), Dalat, arboretum, 24 Nov. 1924; *F. Evrard* 1913 (P), Dalat, 27 Nov. 1924; *F. Evrard* 1962 (P), Dalat, 01 Dec. 1924; *F. Evrard* 2168 (P), Dalat, 11 Dec. 1924; *A. D. Kerr s.n.* (C), NC Dalat, Jan. 1974; *W. Micholitz s.n.* (K), French Indo-China, Lang Bian, 1,400-1,500 m alt., 27 Nov. 1903; VH 2297 (P), Kon Tum, Dak Gley, 1,400-1,500 m alt., 06 Dec. 1995.

LOCALITY UNKNOWN: *Chase* 15218 (K); *F. Kingdon-Ward s.n.* (K), 18 May 1954; *sine coll.* ID 20853 (K), 10 Mar. 1958; *sine coll.* ID 20856 (K), 01 Feb. 1932.

NOTE.— Udai C. Prahan noted that *Dendrobium bellatulum* var. *cleistogamia*, which received from Manipur are cleistogamous. However there was no difference in floral features therefore this name was reduced to the synonymous name.



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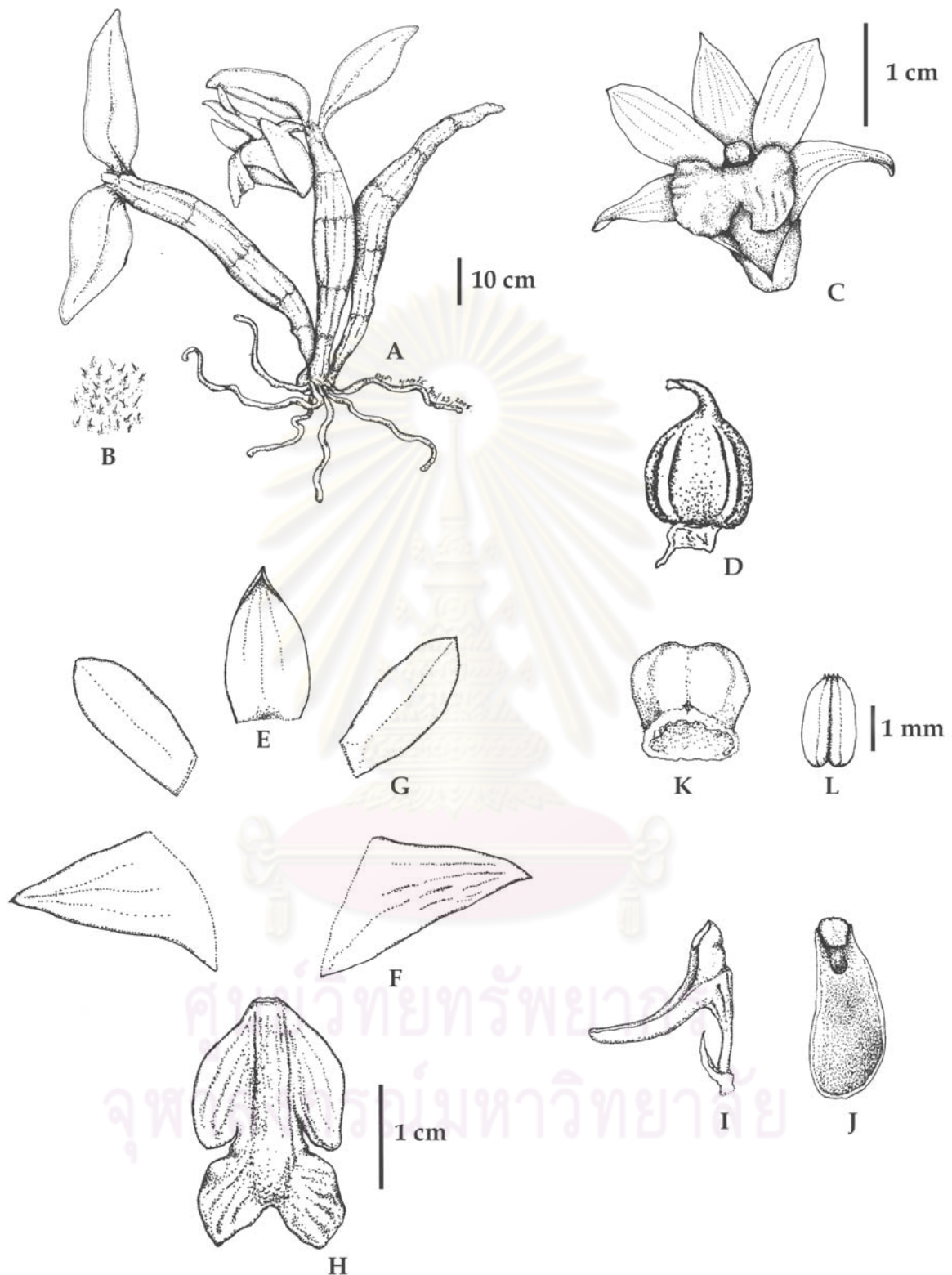


FIGURE 5.2. *Dendrobium bellatulum* Rolfe A. Habit; B. Hairs, on leaf; C. Flower, front view; D. Fruit; E. Dorsal sepal; F. Lateral sepal; G. Petal; H. Labellum; I. Column and column foot, side view; J. Column, from below; K. Anther cap; L. Pollinia. Drawn from A. Sathapattayanon 443 by Mr. Tanucha Boonjaras.

3. *Dendrobium bostrychodes* Rchb. f., Gard. Chron. 1880 (2): 748. 1880. Type: *Boxall s.n.* (holotype W!), Indonesia, Borneo, precise locality unknown. Fig. 5.3; Pl. 4: C.

Dendrobium hallieri J.J. Sm., Bull. Jard. Bot. Buitenzorg, ser. 2, 8: 40. 1912; J.J. Wood, Orchid of Borneo 4: 91. 2003. Type: *Hallier 2,313* (holotype BO; isotype K!, L!), Indonesia, Borneo, Kalimantan Barat, Kelam Hill, 1894.

Flowering shoots erect, cylindrical, flexuose, especially distally, sulcate, brownish green or greyish green, 30-50 cm tall, internodes 3.5–4.5 cm long, 0.5-1.1 cm in diameter, leafy. **Leaves** distichous, spreading, coriaceous, both surfaces covered with black hirsute hairs, adaxial surface becoming glabrous when mature, mid-vein grooved above and ribbed below, green, oblong-elliptic, oblong-ovate or oblong, shortly contracted and sulcate at the base, apex unequally bi-lobed, each lobe obtuse, 7-11.5 cm long, 1.6-3.5 cm wide; leaf-sheaths covered with short black hirsute hairs, becoming glabrous, 3.6-4.2 cm long. **Inflorescences** abbreviated, 2- to 7-flowered, borne along the upper portion of the stem, emerging from the base of leaf-sheaths opposite the blades; peduncle and rachis glabrous, light green, 0.8-2.6 cm long, entirely covered by bracts; floral bracts concave, abaxial surface covered with dense black hirsute hairs, adaxial surface glabrous, brown or greenish brown, oblong-ovate, apex acuminate, base truncate, 7- to 9-veined, 1.5-1.7 cm long, 0.5-0.8 cm wide. **Flowers** thinly coriaceous, resupinate, waxy, veins obscured, sweetly scented, 2-2.7 cm in diameter; sepals and petals yellow or dull yellow; mentum yellow from outside; labellum creamy yellow, claw and side lobes creamy yellow or pale yellow, disc with red longitudinal lines; mid-lobe yellow, with rows of orange warts; column orange-yellow, foot orange-yellow, flushed red, anther-cap yellow or orange-yellow, pollinia yellow, pedicellate ovary yellowish green, pale green below. **Sepals** extremely recurved, margin entire; dorsal sepal oblong, apex acute or obtuse, base truncate, abaxial surface without keel, 5- to 7-veined, 1.6-1.8 cm

long, 0.7-0.9 cm wide; lateral sepals obliquely triangular-ovate, apex acute to acuminate, base obliquely truncate, abaxial surface with distinct keel, wing-like at apex, 7-veined, posterior margin 1.7-2.9 cm long, anterior margin 2.8-3.2 cm long, 1.3-1.8 cm wide at base, *c.* 0.2 cm wide at apex. *Mentum* very narrowly conical, ovipositor-shaped, descending, slightly recurved, apex obtuse, 2.5-2.9 cm long, ca. 0.2 cm in diameter. *Petals* extremely recurved, obliquely ovate, apex acute to obtuse, base obliquely truncate, margin undulate, 5-veined, 1.8-2.2 cm long, 1.1-1.4 cm wide at base. *Labellum* 3-lobed, pandurate in outline, adaxial surface verruculose, except around the central area, 2.3-2.8 cm long, 1.5-1.7 cm wide across side lobes; claw narrowly triangular, ca. 0.5-0.9 cm long; side lobes broadly semi-circle or narrowly oblong, margin minutely crenulate or subentire; disc oblong, with indistinct keels along the median line, 2 keels commence at the tip of the claw and become broader, uniting in the middle to form a broad, low ridge, 2 narrow keels emerge from this ridge and extend forwards to the base of the mid-lobe; mid-lobe semi-circle, transversely oblong, apex rounded, margin undulate, crisped, 0.5-0.7 cm long, 1.1-1.3 cm wide. *Column* surface smooth, 4-5 mm long, ca. 4 mm wide at base; foot concave, cymbiform, surface smooth, grooved, 25-29 mm long, 5-7 mm wide at base; stigmatic cavity quadrangular; stelidia broadly triangular; connective narrowly triangular; anther cap widely ovate, surface minutely papillose, apex round or truncate, basal margin ciliate, adaxial surface sulcate, 2.9-3.1 mm long, 3-3.2 mm wide; pollinia 4, in 2 pairs, each pollinium narrowly elliptic, without caudicle and visidium. *Ovary* (including pedicel) narrowly clavate, glabrous, 6-grooved, 4-5.2 cm long. *Capsule* dehiscent, green or dull green, elliptic, apex with persistent dried perianth, 3-3.5 cm long, 1.9-2.5 cm wide.

DISTRIBUTION.— Indonesia.

HABITAT AND ECOLOGY.— Epiphytes in lowlands forest at altitude near sea level. Flowering period: January and from July to August.

SPECIMENS EXAMINED. — INDONESIA: *A. H. G. Alston* 13205 (K), Borneo, 14 km E. of Sampit, near sea level, 22 Jan. 1954; *H. Hallier* 2313 (L, K-isotype of *D. hallieri*), Borneo, S. Kelan, 1893-94.

LOCALITY UNKNOWN: *sine coll.* (BM), Malaya; *sine coll.* TBG 141080 (TNS), 26 July 2007.

NOTE. — The sketch of the type flower in the Reichenbach Orchids Herbarium in Vienna (W) shows it is conspecific with *D. hallieri*, described from West Kalimantan by J.J. Smith in 1912.

Dendrobium bostrychodes is closely related to *D. erythropogon* and *D. lowii*. The species is easily distinguished by its shallowly-lobed verruculose labellum and lacking of hairs on the mid-lobe.



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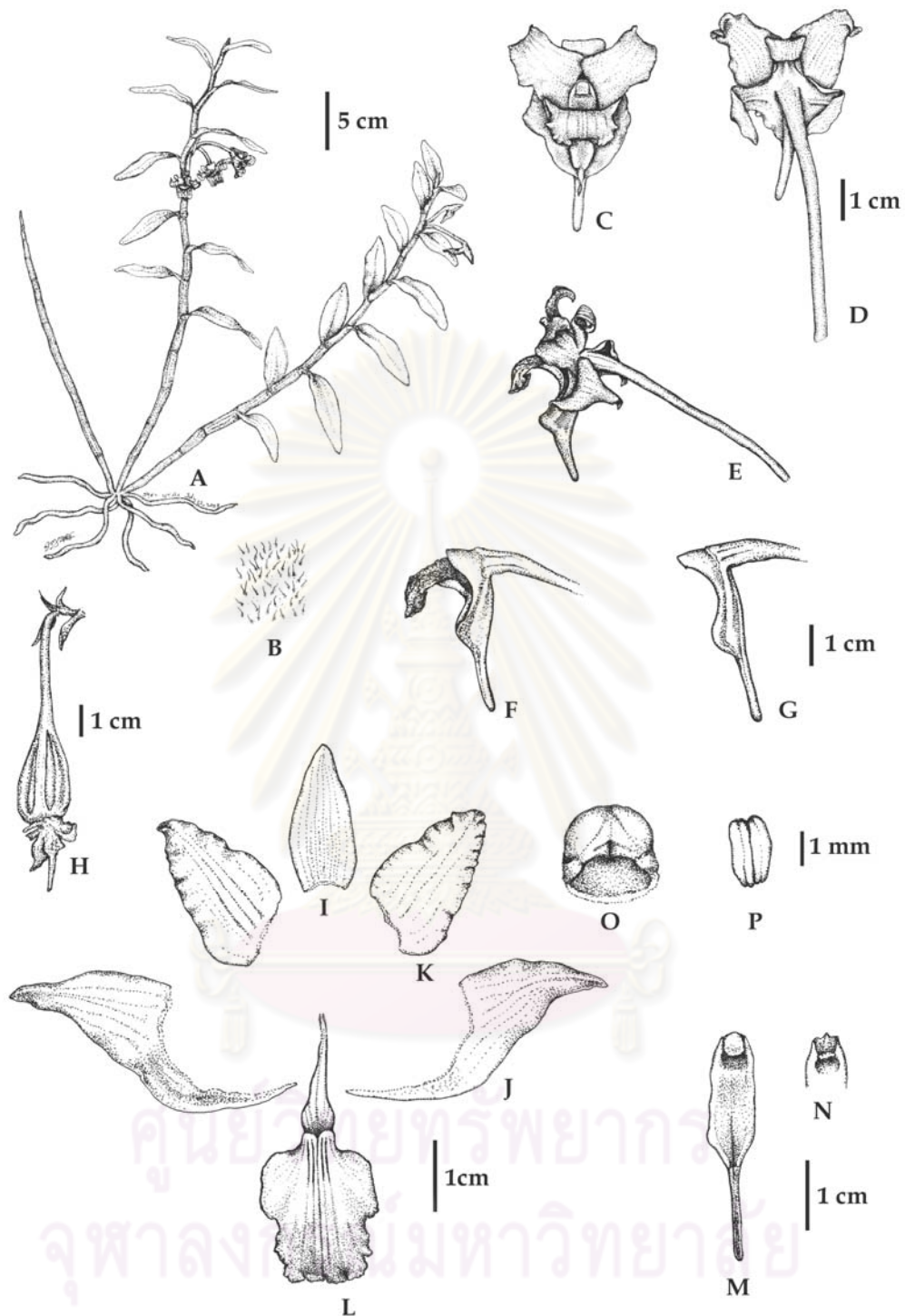


FIGURE 5.3. *Dendrobium bostrychodes* Rchb.f. **A.** Habit; **B.** Hairs, on leaf; **C.** Flower, front view; **D.** Flower, from above; **E.** Flower, side view; **F.** Labellum and mentum, side view, sepals and petals removed; **G.** Column and column foot, side view; **H.** Fruit; **I.** Dorsal sepal; **J.** Lateral sepal; **K.** Petal; **L.** Labellum; **M.** Column and column foot, from below; **N.** Column, from below, anther cap removed; **O.** Anther cap; **P.** Pollinia. Drawn from *Hort. Tsukuba Botanical Garden accession number 141079* by Mr. Tanucha Boonjaras.

4. *Dendrobium cariniferum* Rchb. f., Gard. Chron. 1869: 611. 1869; Thaithong, Thai Orchid: 177. 2000. Type: cult. *Marshall s.n.* (holotype W!), Northeastern India, precise locality unknown. Fig. 5.4; Pl. 4: D.

Dendrobium cariniferum Rchb. f. var. *lateritium* Rchb. f., Gard. Chron. 1883: 658. 1883. Type: *Sander s.n.* (holotype W!), locality unknown.

Callista carinifera (Rchb. f.) Kuntze, Revis. Gen. Pl. 2: 654. 1891.

Flowering shoots caespitose, erect, somewhat zigzag, constricted at nodes, fusiform or cylindrical, tapering downward base, sulcate, green or greenish brown, yellowish green or yellowish brown or ferruginous, old stems yellow, sometime glossy yellow, 17-32 cm tall, internodes 2.7-4.5 cm long, 1.4-2.2 cm in diameter, leafy along the upper part of stem. **Leaves** distichous, spreading or slightly recurved, often twisted at middle or basal part, coriaceous, both surfaces covered with black hirsute hairs, densely hairy on abaxial surface and young leaves, glabrate on adaxial surface, somewhat waxy, mid-vein grooved above and ribbed below, green or dull green, elliptic-oblong or narrowly elliptic, apex unequally bi-lobed, each lobe obtuse, 7.3-13.5 cm long, 1.9-2.6 cm wide; leaf-sheaths covered with dense black-hirsute hairs, 1.8-2.4 cm long. **Inflorescences** abbreviated, 1- to 3-flowered, often 2-flowered, borne at the apical part or uppermost node of stems; peduncle and rachis, glabrous, sometime glaucous, green or light green, ca. 0.4 cm long, covered with bracts; floral bracts concave, abaxial surface densely covered with black hairs, adaxial surface glabrous, pale brown or tawny, ovate-oblong, apex acute, base truncate. **Flowers** thick, veins hardly visible, resupinate, scented, 3.7-4.5 in diameter; sepals yellowish white or pale yellow, abaxial surface darker than adaxial surface, becoming orange yellow when aged; mentum orange yellow or orange from out side; petals creamy white becoming creamy orange when aged; labellum orange with orange veins and orange hair-like callus on each vein, claw orange, side lobes orange, sometime with creamy white margin, disc pale yellowish orange or creamy orange,

becoming yellow or yellowish orange at the end, mid-lobe creamy white; column white, foot bright orange, becoming dark orange or reddish orange at the lower part, stigmatic cavity white or ivory white, anther-cap white, pollinia yellow, pedicellate ovary light green or greenish white. *Sepals* spreading, recurved distally, adaxial surface waxy, abaxial surface distinctly keeled and wing-like keeled at apex, mid-vein grooved on adaxial surface; dorsal sepal elliptic or elliptic-oblong, apex acuminate or attenuate, base truncate, margin entire, obscurely 3- to 5-veined, 1.7-2.6 cm long, 0.8-1.3 cm wide; lateral sepals obliquely triangular-oblong, apex acuminate or attenuate, base obliquely truncate, obscurely 5- to 7-veined, posterior margin 1.9-2.5 cm long, anterior margin 3.6-4.3 cm long, 0.8-1.2 cm wide at base, c. 0.4 cm wide at apex. *Mentum* narrowly conical, apex obtuse, bent downward, 1.8-2.4 cm long, 0.4-0.6 cm in diameter. *Petals* recurved, ovate or elliptic or elliptic-oblong, adaxial surface waxy, apex acuminate or apiculate, base truncate, margin entire, 5- to 7-veined hardly visible, 1.8-2.6 cm long, 1-1.4 cm wide. *Labellum* 3-lobed, without sinus between side lobes and mid-lobe, 3.9-5.4 cm long, 2.3-2.8 cm wide across side lobes; claw linear or narrowly triangular, 15-19 mm long; side lobes obliquely elliptic or rounded, 7 or 8 slightly elevated veined running along each side lobe, sparsely hair-like callous along distal half of each vein, apex obtuse, margin crenate and slightly undulate; disc oblong or narrowly oblong, smooth, somewhat waxy, distinctly swollen at the middle, 3-ridged at the end, continuing to mid-lobe; mid-lobe orbicular or obovate, with 2 or 4 elevated veins continued from side lobes and 2 ridges continued from disc, sparsely hair-like callous on each vein and ridge, apex emarginated, margin crenate and crisped, 0.9-1.4 cm long, 1-1.7 cm wide. *Column* surface smooth, waxy, 4-6 mm long, 5-6 mm wide at base; foot concave, tapering downwards, 24-29 mm long, 6-9 mm wide at entrance of mentum; stigmatic cavity oblong or ovate-oblong; stelia broadly triangular, apex acute; connective linear or narrowly triangular; anther cap obovate or elliptic, surface minutely papillose, apex emarginated, basal margin ciliate, adaxial surface sulcate, 3.7-5 mm long, 2.7-3.4 mm wide; pollinia 4, in 2 pairs,

each pollinium narrowly elliptic, without caudicle and visidium. *Ovary* (including pedicel) clavate, triangular in cross-section, glabrous, sometime glaucous, 3-distinctly wing-like keeled, continued from the abaxial surface of sepal, 2.7-3.5 cm long. *Capsule* dehiscent, green or dull green, elliptic, with 3 distinct keels, apex with persistent dried perianth, 2.8-3.7 cm long, ca. 2 cm wide.

DISTRIBUTION.— India, China, Myanmar, Laos, Thailand and Vietnam.

HABITAT AND ECOLOGY.— Epiphytes in dry evergreen forest or deciduous forest. Flowering period: March-May.

VERNACULAR.— Pho-mue-kha-pha-do (พอมือคาพะโด), Ueang kachok (เอื้องกาจก), Ueang sae lueang (เอื้องแซะเหลียง), Ueang sae dong (เอื้องแซะดง), Ueang tueng (เอื้องตึง)

SPECIMENS EXAMINED.— CHINA: *P. J. Cribb* ASBK 291 (K), Pingmeng Town, Nianjing Village, South of Napo Mountain, 3 km south of the village, mixed deciduous/evergreen forest, on the top of limestone hill, 1,220 m alt., 29 Apr. 1997.

MYANMAR: *Foerstermann.s.n.* (W), Bhamo; *Lois Egerod* B-16 (K), Southern Shan State, Taunggyi, 4,500 ft alt., 24 Jan. 1957; *Lois & Soren Egerod* B-48 (K), Southern Shan State, Taunggyi, 5,000 ft alt.; *J. H. Wibbe* 13 (BR); *Cult. Hort. Kew. Entry No. 395-1935* (K), 02 Apr. 1934; *Cult. Hort. Kew. Entry No. 324-1936* (K), S. Shan State, 23 Apr. 1934.

THAILAND: *A. Buakhlai* 133 (BCU), Nan, Pua District, Doi Phu Kha National Park, 12 Mar. 2005; *A. Sathapattayanon* 380 (BCU), Chiang Mai, Doi Sutep-Pui National Park, 1,450 m alt., 26 Feb. 2005; *A. Sathapattayanon* 391 (BCU), Nan, Pua, Doi Phu Kha National Park, 1,300 m alt., 19 Mar. 2005; *A. Sathapattayanon* 421 (BCU), Chiang Mai, Doi Ang-khang, 14 Feb. 2006; *A. Sathapattayanon* 424 (BCU), Nong Khai, 10 Mar. 2006; *A. Sathapattayanon* 449 (BCU), Nong Khai, Pone Pi-sai,

Talad lao (Laotian market), 06 Mar. 2007; *O. Thaihong* 259 (BCU), sine loc.; *C. Thorat s.n.* (BCU), sine loc., 27 Nov. 1994; *J. F. Maxwell* 88-399 (CMU), Chiang Mai, Muang, Doi Sutep, summit at Sanh Goo Ruins, 1,600 m alt., 27 Mar. 1988; *J. F. Maxwell* 88-661 (CMU), Chiang Mai, Muang, Doi Sutep summit, 1,600 m alt., 19 May 1988; *J. F. Maxwell* 91-240 (CMU, L), Chiang Mai, Mae Jam District, Tapah Subdistrict, Ban Bah Sohn Mai, Mae Soi Ridge, west side, 1550 m alt., 09 Mar. 1991; *J. F. Maxwell* 95-199 (CMU), Chiang Mai, Doi Chiang Dao Wildlife Sanctuary, east of Huay Mae Gawk Station, 1,450 m alt., 04 Mar. 1995; *S. J. Chittipanich* 7 (K), South Thailand, Satool, 22 Mar. 1978; *P. J. Cribb* 99B (K), 09 May 1979; *Cumberlege* 1302 (BKF), Ban Mae Lai, 1,350 m alt.; *S. Dyson & Chandlerville s.n.* (K), Nan Province; *Cult. J. Hermans* 1698 (K), 11 Jan. 1995; *P. Jaicham* 16 (QBG), Chiang Mai, Mae Rim, Thong Doi Yud, 1,100 m alt., 29 Apr. 1998; *A. F. G. Kerr* 20 (K), Chiang Mai, Muang Fang, 180 miles N of Thailand, 2,000 ft alt., 30 Mar. 1909; *A. F. G. Kerr* 248 (K), Ban Pong Yens, 750 m alt., 30 Mar. 1915; *A. F. G. Kerr* 273 (K), Chiang Mai, Doi Sutep, 5,000 ft alt., 09 Apr. 1911; *A. Morrison* 1026 (K), Near road, 2 km from Mae Tho, in mixed deciduous forest, 05 Feb. 1978; *S. Pumicong* 143 (QBG), Chiang Mai, Mae Rim, Huai Pan See, ca. 800 m alt., 03 Mar. 2006; *Put* 3824 (BK, K, L), Chiang Mai, Pang Tawn, 30 Apr. 1931; *T. Smitinand s.n.* (C), Mae Hong Son, Mae Sarieng, en route to Ban Papae, c. 700 m alt., 05 Feb. 1969; *W. Songkakul* 49 (BKF), Chiang Mai, 18 Mar. 1989; *Th. Sorensen* 150 (C), Chiang Mai, Doi Sutep; *P. Srisanga with C. Maknoi, P. Panyachan & P. Tatiya* 2826 (QBG), Nan, Pua District, Doi Phu Kha National Park (19°12' N, 101°5' E), 1,500 m alt., 11 May 2006; *S. Suddee et al.* 2141 (BKF), Chiang Mai, Road to Ang Khang from Ban Arunothai, 1,500 m alt., 23 Mar. 2005; *S. Watthana* 1209 (QBG), Chiang Mai, Chiang Dao, 3 km from Den Yaakat to Doi Luang Doi Chiang Dao, ca. 1,400 m alt., 21 Mar. 2001; *S. Watthana & M. Wongnak* 1896 (QBG), Mae Hong Son, Muang District, Huai Pu Loei, 1,400 m alt., 26 Mar. 2006; *GT* 3303 (C), Mae Hong Son, Baw Luang, Feb. 1959; *GT* 5017 (C), Mae Hong Son, North of Omkoi, 1,080 m alt., 19 Jan. 1964; *GT* 5019 (C), Mae Hong Son, North of Omkoi, 1,080 m alt., 19 Jan. 1964; *GT* 5020 (C), Mae Hong Son, North of Omkoi, 1,080 m alt., 19 Jan. 1964;

GT 5053 (C), Mae Hong Son, South of Omkoi, 1,100-1,200 m alt., 21 Jan. 1964; GT 5054 (C), Mae Hong Son, South of Omkoi, 1,100-1,200 m alt., 21 Jan. 1964; GT 5055 (C), Mae Hong Son, South of Omkoi, 1,100-1,200 m alt., 21 Jan. 1964; GT 5104 (C), Mae Hong Son, Kong Laung Range, 1,200-1,540 m alt., 22 Jan. 1964; GT 5217 (C), Mae Hong Son, S.W. of Baw Luang, 1,140 m alt.; GT 5229 (C), Mae Hong Son, Mae Sarieng, Baw Luang, Km 72, 1,290 m alt., 30 Jan. 1964; GT 5230 (C), Mae Hong Son, Mae Sarieng, Baw Luang, Km 72, 1,290 m alt., 30 Jan. 1964; GT 5231 (C), Mae Hong Son, Mae Sarieng, Baw Luang, Km 72, 30 Jan. 1964; GT 5239 (C), Mae Hong Son, Mae Sarieng, Baw Luang, km 33-39, 930-1,100 m alt., 01 Feb. 1964; GT 7673 (C), Mae Hong Son, Mae Lanam, Pune Center, 06 Mar. 1971; GT 8494 (C), Mae Hong Son, NW of Pai, 1,450 m alt., 16 Mar. 1978; GT 8367 B (C), Chiang Mai, Doi Pui, Doi Sutep, 1,530 m alt., 09 Mar. 1978; GT 8381 (C), Chiang Mai, Doi Pui, Doi Sutep, 1,530 m alt., 09 Mar. 1978; GT 8430 (C), Chiang Mai, NE of Khun Mae Surin, 1,225 m alt., 13 Mar. 1978; GT 8476 (C), Chiang Mai, Namtok, Huay Mae Surin, 1,260 m alt., 15 Mar. 1978; *J.F. Maxwell* 91-240 (L), Chaing Mai, Mae Jam, 1,550 m alt., 9 Mach 1991; *Put* 3,824 (L), Chaing Mai, Pang Tawn , 20 April 1981.

LAOS: *Poilane* 25892 (C), Between Phu Den Don & Cai Chan, 24 Apr. 1936; *Poilane* 25892 (P), Phong saly to Lai Chan, 1,500 m alt., 26 Apr. 1936; *Poilane* 26035 (P), Phong saly to Ban Rai, 1,500 m alt., 09 May 1936.

VIETNAM: *P.K. Loc, P.H. Hoang & L. Averyanov* CBL 1,852 (AAU), Ha Giang, distr. Meo Vac, Sung Chang, Lu Lu Phin village, 1,300-1,400 m alt., 29 April 1999; *L. Averyanov et al.* VH 127 (AAU), Kon Tum 1,400 m alt., 23 Feb 1995; *L. Averyanov et al.* VH 563 (AAU), Kon Tum 2,400 m alt., 07 Mach 1995; *L. Averyanov et al.* VH 950 (AAU), Kon Tum 1,700-1,800 m alt., 24 Mach 1995; *L. Averyanov et al.* VH 110 (AAU), Kontum 2,000 m alt., 23 Feb 1995.

LOCALITY UNKNOWN: GT 4146 (BKF); *Cult. Hort. Kew. Entry No.* 377-1948

(K), 07 July 1948; *Copenhagen Botanic Garden* 5231 (K), 1965; *Cult. Gardens, St Allam s.n.* (K), 18 June 1951; *Cult. H. Low. s.n.* (W), 20 June 1873; *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 834 (W); *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 14838 (W); *William Bull & F.L.S.* 718. Reichb.f. Orchids Herb. no. 867 (W).



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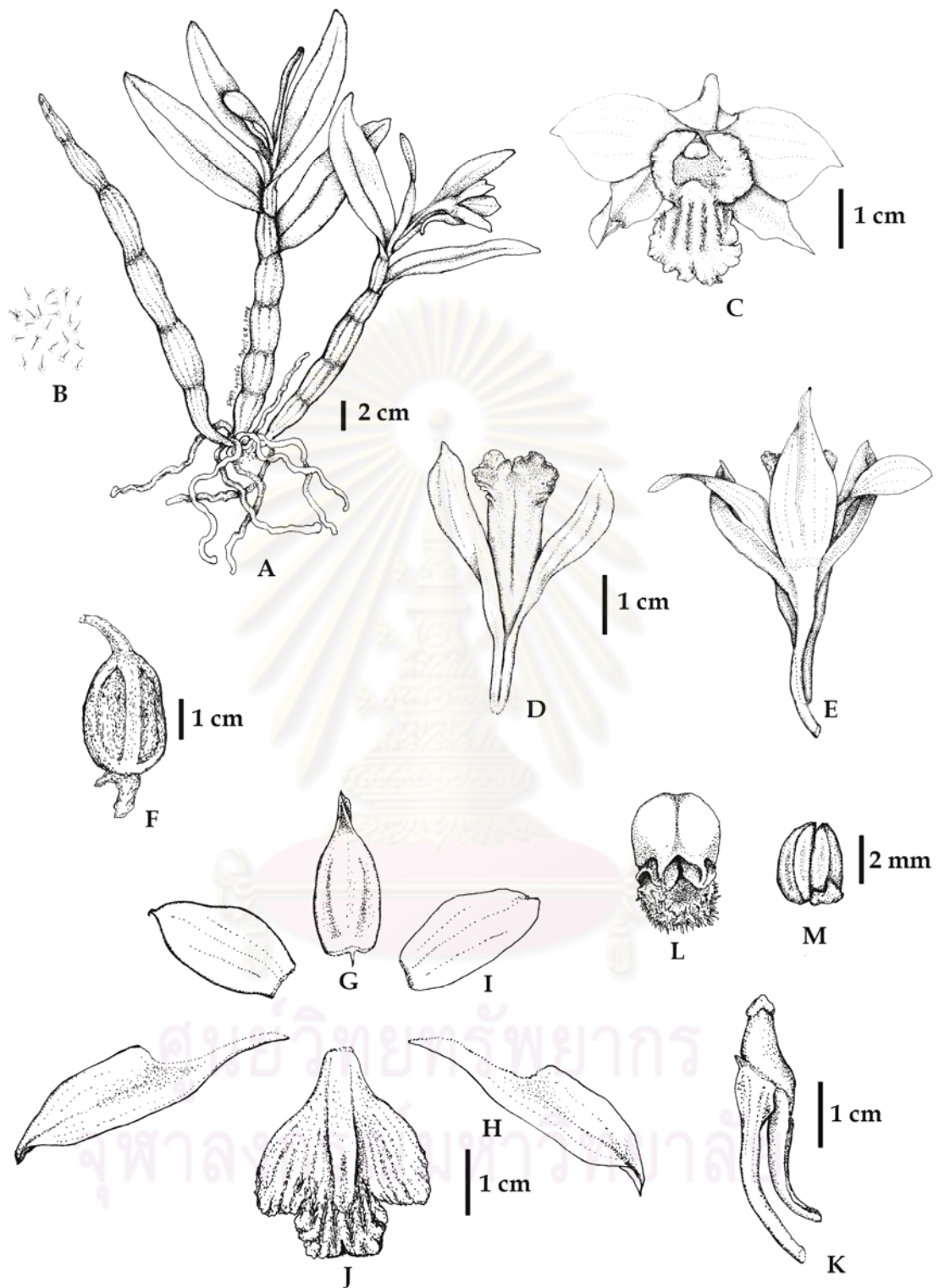


FIGURE 5.4. *Dendrobium cariniferum* Rchb.f. **A.** Habit; **B.** Hairs, on leaf; **C.** Flower, front view; **D.** Flower, from below; **E.** Flower, from above; **F.** Fruit; **G.** Dorsal sepal; **H.** Lateral sepal; **I.** Petal; **J.** Labellum; **K.** Column and column foot, side view; **L.** Anther cap; **M.** Pollinia. Drawn from A. Sathapattayanon 391 by Mr. Tanucha Boonjaras.

5. **Dendrobium christyanum** Rchb.f., Gard. Chron. 1882(1): 178. 1882; Thaithong, Thai Orchid: 178-179. 2000. Type: *Christy s.n.* (holotype W!), Thailand, locality unknown. Fig. 5.5; Pl. 4: E.

Dendrobium fuerstenbergianum Schltr., Repert. Spec. Nov. Regni Veg. 3: 277. 1907.

syn. nov. Type: *Hosseus s.n.* (holotype B; destroyed in the Second World War), Thailand, locality unknown.

Dendrobium margaritaceum Finet, Bull. Soc. Bot. France 50: 379. 1903. Type: *Vernet2* (holotype P!), Vietnam, Haut Donnay.

Flowering shoots erect, fusiform, sulcate, slightly constricted at nodes, green or brownish green, 5-22 cm tall, internodes 1.2-1.7 cm long, 0.5-0.7 cm in diameter, leafy along upper part of stem. *Leaves* distichous, spreading, thinly coriaceous, mid-vein grooved above and ribbed below, both surfaces particularly covered with black hirsute hairs, green or dull green, oblong or elliptic-oblong, apex unequally bi-lobed, each lobe acute or obtuse, 4-5.5 cm long, 0.5-1.3 cm wide; leaf-sheaths covered with black hairs, ca. 1 cm long. *Inflorescences* abbreviated, 1- to 2-flowered, often 1-flowered, borne from nodes at the uppermost of both leafy and leafless stems; peduncle and rachis glabrous, light green, 0.2-0.3 cm long, covered with bracts; floral bracts abaxial surface covered with sparsely black hairs, becoming glabrous, adaxial surface glabrous, brown, oblong or ovate-oblong, concave, apex acuminate or acute, base truncate, 2- to 4-veined, 0.4-1.0 cm long, 0.2-0.3 cm wide. *Flowers* papyraceous, resupinate, unscented, 3 - 4 cm in diameter; sepals and petals white; mentum white or yellowish white from outside; labellum white or yellowish white, claw yellowish orange, side lobes and mid-lobe white or yellowish white, disc red and yellowish orange; column white, , foot pale orange, stigmatic cavity white, anther-cap white, pollinia yellow, pedicellate ovary yellowish green to light green. *Sepals* spreading, slightly recurved distally, margin entire, abaxial surface without keel; dorsal sepal elliptic-oblong or ovate-oblong, apex acuminate or acute, base truncate, 5-

to 7-veined, 1.5-2.5 cm long, 0.7-1.2 cm wide; lateral sepals obliquely triangular-ovate, apex acuminate, base obliquely truncate, 5-veined, posterior margin 1.5-2.4 cm long, anterior margin 2.3-2.7 cm long, 1-1.5 cm wide at base, ca. 0.3 cm wide at apex. *Mentum* broadly conical, saccate, apex obtuse, 0.5-0.9 cm long, ca. 0.5 cm in diameter. *Petals* spreading, oblong or obovate, slightly cuneate at base, apex acute or acuminate, base truncate, margin entire, 3- to 5-veined, 1.9-2.5 cm long, 0.7-0.9 cm wide. *Labellum* 3-lobed, 2.9-3.2 cm long, 2.5-3.3 cm wide across side lobes; claw transversely oblong or shallowly triangular, ca. 2 mm long; side lobes obliquely widely elliptic or obliquely widely oblong, apex truncate or obtuse, front margin subentire, lateral margin entire, 5 to 7 slightly elevated veins running along each side lobe, each vein bearing wart-like callus along basal half of the length; disc narrowly oblong, thickening, with 3-keeled, bullate on each keel, appearing rough and discontinuous keels; mid-lobe reniform, recurved backward, less than 90 degree of angle, apex emarginate, margin crenulate and slightly undulate, basal part with many bullate callus, continuing from disc, 0.8-1.3 cm long, 1.5-1.9 cm wide. *Column* 4-5 mm long, 4-4.5 mm wide at base; foot concave, cymbiform, broad at middle, waxy, 9-10 mm long, 4.3-5 mm wide at base; stigmatic cavity oblong or ovate-oblong; stamens triangular; connective narrowly triangular; anther cap widely obovate, surface minutely papillose, adaxial side sulcate, apex emarginate, basal margin minutely ciliate, 2.8-3 mm long, 2-2.5 mm wide; pollinia 4, in 2 pairs, each pollinium narrowly elliptic, without caudicle and visidium. *Ovary* (including pedicel) narrowly clavate, curved, glabrous, somewhat waxy with 6-grooves, 2.5-2.8 cm long. *Capsule* not seen.

DISTRIBUTION. – China, Thailand and Vietnam.

HABITAT AND ECOLOGY. – Epiphytes in dry evergreen forest or pine forest, at 1,000-1,500 m alt. Flowering period: May-September.

VERNACULAR. – Ueang sae phu kradueng (เอื้องแซะภูกระดิ่ง)

SPECIMENS EXAMINED. – CHINA: *Tse-tsun Yu* 16374 (E), Yunnan, Huaiyaupu, Shunning, 2,100 m alt., 19 June 1938.

THAILAND: *Sine coll.* 318 (K), Chiang Mai, Doi Sutep, 4,600 ft alt., 02 Aug. 1921; *C. Chermisrivatthana* 1,546 (BK), Loei, Phu Luang, 21 Sep. 1969; *J. B. Comber* 1753 (K), 02 July 1988; *P. J. Cribb* 99B (K-SPIRIT), Chiang Mai, Doi Suthep, 1,600 m alt., 26 Jan. 1978; *Din* 166 (BKF, C), Loei, Wang Sapung, Phu Krading, Lang Pae, 1,045 m alt., 16 Apr.; *H. B. G. Garrett* 772 (K), Mae Hong Son, Doi Hua Mot, Me Lao drainage, 1,530 m alt., 18 May 1933; *H. B. G. Garrett* 797 (BKF, C), Mae Hong Son, Doi Hua Mot, Mae Lao drainage, on ridge, 1,450 m alt., 06 June 1933; *GT* 5078 (C), I. Kong Saug Range, 1,200-1,540 m alt., 22 Jan. 1964; *GT* 8131 (C), Chaiyaphum, Phu Kaeo, 800-1,000 m alt., July 1973; *GT* 8367 A (C), Chiang Mai, Doi Pui, Doi Sutep, 1,530 m alt., 09 Mar. 1978; *GT* 8605 (C), Loei, Phu Luang, 1,300-1,400 m alt., 14 Mar. 1980; *GT* 8606 (C), Loei, Phu Luang, 1,300-1,400 m alt., 14 Mar. 1980; *A. F. G. Kerr* 104 (K), Chiang Mai, Doi Sutep, 4,500-5,000 ft alt., 27 Jan. 1909; *A. F. G. Kerr s.n.* (K), Chiang Mai, 15 July 1915; *A. F. G. Kerr s.n.* (K), Chiang Mai, 1,000 m alt., 02 Jan. 1922; *A. F. G. Kerr s.n.* (K), 06 Sep. 1931; *J. F. Maxwell* 88-915 (CMU), Chiang Mai, Muang, Doi Sutep, Pu-ping Palace area, 1,450 m alt., 25 July 1988; *Menzies & Du Puy* 499A (K-SPIRIT), Loei, Phu Luang Wildlife Sanctuary, 1,500 m alt., Feb. 1983; *P. Palee* 229 (CMU, L), Chiang Mai, summit of Doi Sutep-Pui National park, Sanh Goo Ruins, 1,600 m alt., 17 July 1994; *P. Sangkhachand* 2103 (BK), Loei, Phu Krading, 16 Sep. 1969; *T. Smitinand* 337 (BKF, P), Loei, Summit of Phu Krading, 1,045-1,300 m alt., 08 May 1951; *W. Songkakul* 20 (BKF), Loei, Phu Luang, 02 June 1988; *Cult. J. R. Sould, Lustleigh, Devon s.n.* (K-SPIRIT), Chiang Mai, 03 Nov. 1938; *K. Suvatabundhu* 231 (BCU, BK), Loei, Kao Krading, 15 Apr. 1948; *S. Suvarnasuddhi* 497 (BKF), Loei, Phu Krading, 11 Apr. 1941; *C. Thorat* 163 (BCU), Loei, Phu Luang.

VIETNAM: *VH 110* (P), S. Vietnam, Prov. Kontum, 2,000 m alt., 23 Feb. 1995; *VH 127* (P), S. Vietnam, Prov. Kontum, 1,400 m alt., 23 Feb. 1995; *VH 563* (P), S. Vietnam, Prov. Kontum, 2,400 m alt., 07 Mar. 1995; *VH 950* (P), S. Vietnam, Prov. Kontum, 1,700-1,800 m alt., 24 Mar. 1995; *Poilane 4080* (P), 1,500 m alt., 25 June 1922; *Poilane 30229* (P), Sud du Bi-Daup: Hout Donai, 1,400 m alt., 24 Aug. 1940; *Poilane 32931* (P), Dak Gley, Kontum, 1,300 m alt., 31 Jan. 1947; *M. G. Vernet 2* (P), Haut Donnay, Lang Bian, 05 Feb. 1901.

LOCALITY UNKNOWN: *A. Sathapattayanon 395* (BCU), 08 May 2005; *A. Sathapattayanon 404* (BCU), 13 July 2005; *A. Sathapattayanon 405* (BCU), 13 July 2005; *A. Sathapattayanon 406* (BCU), 17 July 2005; *A. Sathapattayanon 410* (BCU), 29 Aug. 2005; *A. Sathapattayanon 430* (BCU), 25 June 2006; *K. Chankaew 06* (BKF), 25 June 03; *GT 8366B* (C), 31 July 1978; *Hansen s.n.* (C), 28 Aug. 1961; *Trudel 205* (C); *Trudel 779* (C); *sine coll. 37996* (K-SPIRIT), 23 Nov. 1976; *sine coll. ID 37997* (K-SPIRIT).

NOTE.— *Dendrobium fuerstenbergianum*, the questionable species, characterized by its longer stem (Schlechter, 1907; Seidenfaden, 1985) than *D. christyanum* but identical in their floral characters. The molecular study found that the macromolecular characters of both plants are mostly the same. Moreover, the studies of distribution (southern China, northern Thailand and northern Vietnam) and flowering period (June to October) of these two taxa also overlap. Therefore, I reduced *D. fuerstenbergianum* to the synonym of *D. christyanum* in this study.

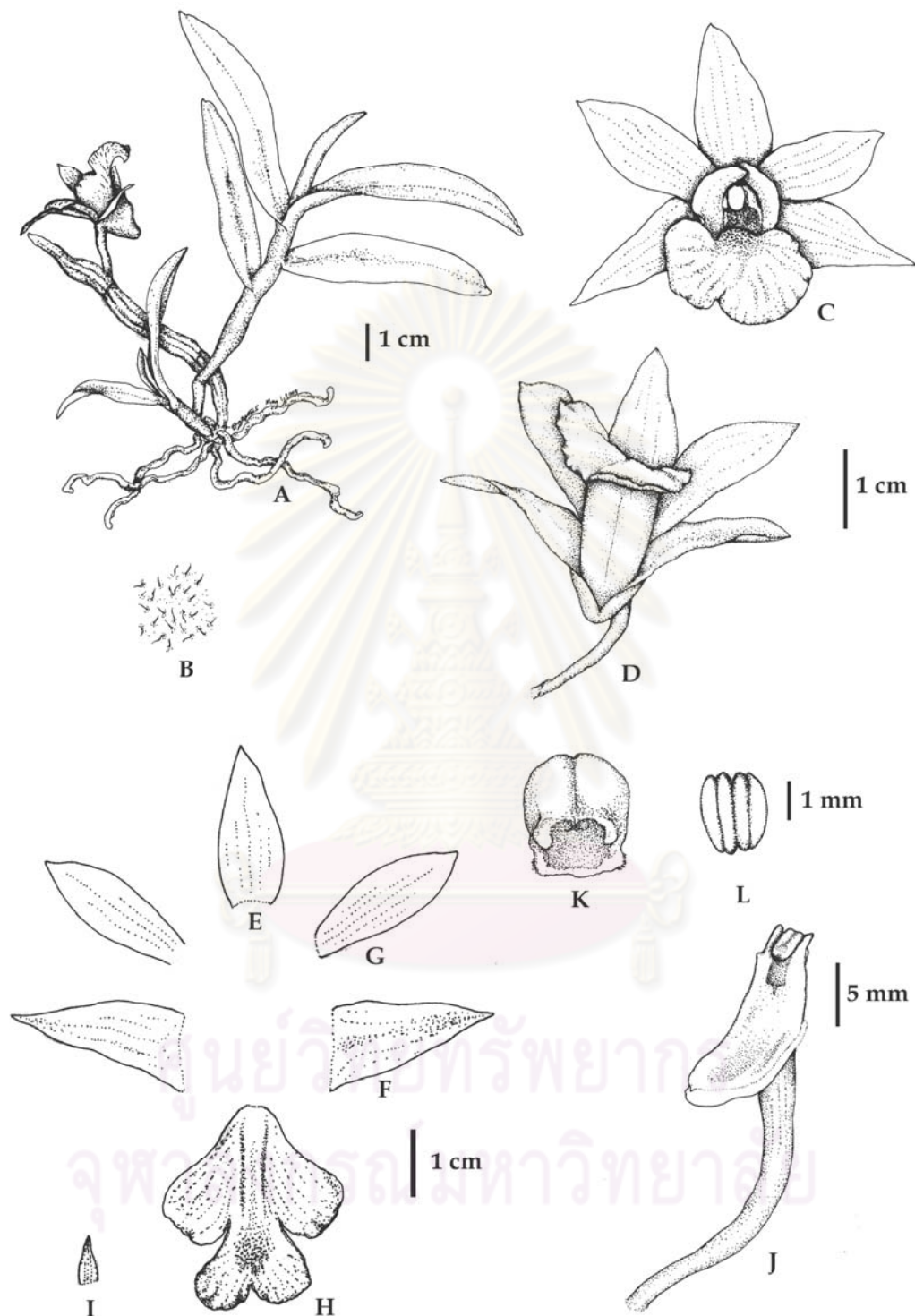


FIGURE 5.5. *Dendrobium christyanum* Rchb.f. **A.** Habit; **B.** Hairs, on leaf; **C.** Flower, front view; **D.** Flower, from below; **E.** Dorsal sepal; **F.** Lateral sepal; **G.** Petal; **H.** Labellum; **I.** Floral bract; **J.** Column, column foot and pedicellate ovary; **K.** Anther cap; **L.** Pollinia. Drawn from A. *Sathapattayanon 406* by Mr. Tanucha Boonjaras.

6. **Dendrobium cruentum** Rchb.f., Gard. Chron. 1884(1): 604. 1884; Thaithong, Thai Orchid: 186. 2000. Type: *Foerstermann s.n.* (holotype W!), locality unknown, probably southern part of Thailand. Fig. 5.6; Pl. 4: F.

Callista cruenta (Rchb.f.) Kuntze, Revis. Gen. Pl. 2: 654. 1891.

Flowering shoots erect, slender, cylindrical, gently fractiflex, constrict at nodes, narrowly fusiform, weakly sulcate when aged, green or brownish green, 9-17 cm tall, internodes 1-1.3 cm long, 0.7-1 cm in diameter, lower internodes the narrowest, leafy along the upper part of stem. **Leaves** distichous, spreading, thinly coriaceous, adaxial surface glabrate, abaxial surface covered with sparsely short black hirsute hairs, mid-vein grooved above and ribbed below, green or dull green, oblong or oblong-lanceolate, apex unequally bi-lobed, each lobe subacute or obtuse, 3.4-4.5 cm long, 0.8-1.1 cm wide; leaf-sheaths covered with short black hirsute hairs, 1.2-1.4 cm long. **Inflorescences** abbreviated, 1-to 2-flowered, borne along apical half of leafy stems, emerging from base of leaf sheaths opposite the blade; peduncle and rachis glabrous, 0.3-0.5 cm long; floral bracts concave, abaxial surface covered with sparsely black hirsute hairs, adaxial surface glabrous, brown, ovate-oblong or lanceolate, apex acuminate, base truncate, 3- to 5-veined, 1.5-1.7 cm long, 0.5-0.7 cm wide. **Flowers** resupinate, thick, rigid, glaucous, unscented, veins visible; sepals and petals light green or pale yellowish green, veins darker, 3-3.4 cm in diameter; mentum pale yellowish green from outside; labellum pale yellowish green and red, claw red, side lobes red with light green colour at apex and margin; disc red; mid-lobe light green with red callus at median ridge and red lateral margin; column light green, foot light green with red lines, stigmatic cavity pale green or yellowish green, anther-cap light green or whitish green, pollinia organish yellow, pedicellate ovary green or light green. **Sepals** spreading, margin entire, abaxial surface with inconspicuous keel; dorsal sepal ovate or lanceolate, apex acute, base truncate, 5- or 7-veined, 2.1-2.7 cm long, 1.1-1.4 cm wide; lateral sepals obliquely triangular-

ovate, apex acute, base truncate, 5-to 7-veined, posterior margin 2.4-2.8 cm long, anterior margin 2.5-2.9 cm long, 1.5-1.8 cm wide at base, ca. 0.5 cm wide at apex. *Mentum* broadly conical, saccate, apex obtuse, 1.1-1.4 cm long. *Petals* recurved backwards, linear or narrowly lanceolate, apex acute, base truncate, margin entire, 3-veined, 2.2-2.6 cm long, 0.3-0.5 cm wide. *Labellum* 3-lobed, 2.6-3.1 cm long, 2.8-3.3 cm wide across side lobes; claw shallowly triangular, ca. 5 mm long; side lobes obliquely narrowly triangular, falcate, apex acute, margin entire; disc oblong, basal part thickened, hard, with 3-5 keels, each keel bearing verrucose callus, continuing to mid-lobe; mid-lobe thickened, hard, decurved, widely obovate or very widely obovate, adaxial surface with strongly callus verrucose at median ridge, apex acuminate, margin hard, denticulate or minutely erose, 1.5 - 1.9 cm long, 1.5-1.8 cm wide. *Column* surface smooth, 4-5 mm long, 4-5 mm wide at base; foot surface smooth, slightly concave, dilated at base, 7-9 mm long, 7-8 mm wide at entrance of mentum; stigmatic cavity transversely elliptic or transversely elliptic; stelidia short, triangular; connective linear or narrowly triangular; anther cap very widely ovate or quadrate, surface minutely papillose, apex emarginate, basal margin minutely ciliate, adaxial surface sulcate, 3.1-3.3 mm long, 3.5-3.9 mm wide; pollinia 4, in 2 pairs, each pollinium narrowly elliptic, without caudicle and visidium. *Ovary* (including pedicel) clavate, glabrous, 6-grooved, 1.9-2.5 cm long. *Capsule* not seen.

DISTRIBUTION.— Thailand (endemic to Peninsular Thailand).

HABITAT AND ECOLOGY.— Epiphytes in evergreen forest. Flowering period: October-February.

VERNACULAR.— Pak nok kao (ปากนกแก้ว), Ueang nok kao (เอื้องนกแก้ว)

SPECIMENS EXAMINED.— THAILAND: *J. B. Comber* 1772 (K), South Thailand, 17 Dec. 1988; *GT 6164* (C), Ranong, Muang Lan, 11 Jan. 1966; *GT 6192* (C), Ranong, Muang Lan, 12 Jan. 1966; *A. F. G. Kerr* 477 (BK, K), Satul, Tula, 50 m alt., 03 Jan.

1928; *A. F. G. Kerr 510* (BK, K), Nakhon Si Thammarat, Ta Samet, under 50 m alt., 29 Jan. 1928; *A. F. G. Kerr s.n.* (K), Satul, Tung Wa, 50 m alt., 06 Jan. 1928; *Cult. Kew Collection s.n.* (K-SPIRIT), 03 Mar. 1983; *Menzies, D.; Dupuy, D. 58* (K-SPIRIT), Feb. 1983; *S. Pumicong 54* (QBG), Phang-nga, Thung Hla, 23 Jan. 2006; *H. N. Ridley s.n.* (BM), sine loc.; *de Long s.n.* (SING), Kopah, June 1894; *Leutis s.n.* (SING), Tonghah, June 1893; *Singapore Field Coll. no. 2709* (SING), Kopah Jaujau, 10 Dec. 1917.

LOCALITY UNKNOWN: *A. Sathapattayanon 392* (BCU), 24 Mar. 2005; *A. Sathapattayanon 411* (BCU), 29 Aug. 2005; *O. Thaithong 761* (BCU), 09 Oct. 1989; BKF: *C. N. 2134* (BCU), 04 Mar. 1991; *Cult. Sander s.n.* (K), Indo-China, May 1895; *M. Seyer & Tropp s.n.* (K), Indo-China, Mar. 1889.

LOCALITY UNKNOWN: *Foerstermann. s.n.*(W); *Rimann s.n.* (W); *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 7022 (W).

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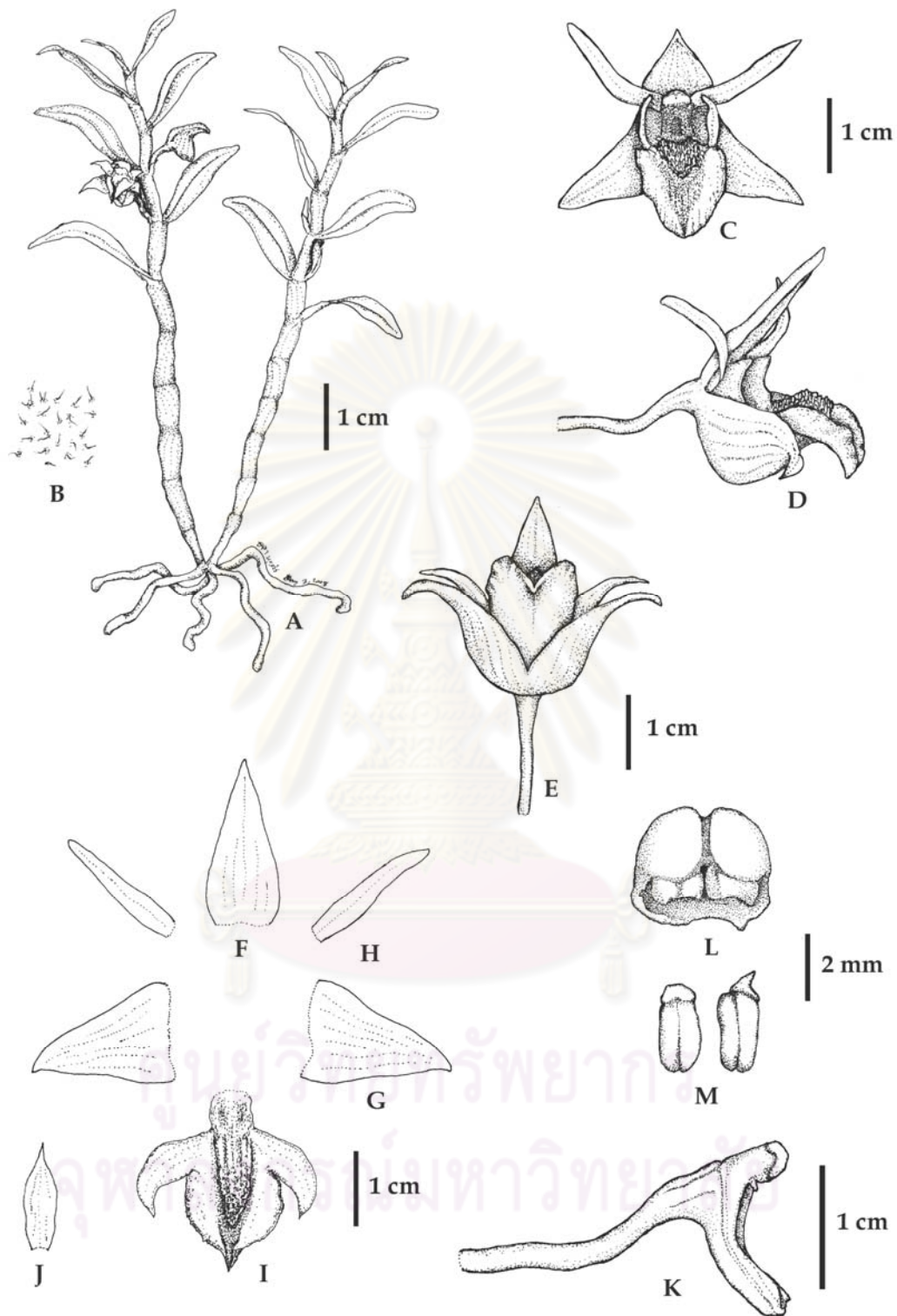


FIGURE 5.6. *Dendrobium cruentum* Rchb.f. **A.** Habit; **B.** Hairs, on leaf; **C.** Flower, front view; **D.** Flower, side view; **E.** Flower, from below; **F.** Dorsal sepal; **G.** Lateral sepal; **H.** Petal; **I.** Labellum; **J.** Floral bract; **K.** Column and column foot, side view; **L.** Anther cap; **M.** Pollinia. Drawn from *A. Sathapattayanon 411* by Mr. Tanucha Boonjaras.

7. *Dendrobium draconis* Rchb.f., Bot. Zeitung (Berlin) 20: 214. 1862; Thaithong, Thai Orchid: 193. 2000. Type: *Parish 1365* (holotype W!), Myanmar, Moulmein (Mawlamyaing City). Fig. 5.7; Pl. 4: G.

Dendrobium eburneum Rchb. f. ex Bateman, Bot. Mag. 90: t. 5459. 1864. Type: *Parish 131* (holotype K!, Lindley's collection; isotype K!), Myanmar, Moulmein, February 1862.

Dendrobium andersonii J. Scott, J. Agri-Hort. Soc. W. India, n.s., 3: 117. 1864. Type: *Anderson s.n.* (holotype, unknown), China, Yunnan, 1868.

Callista draconis (Rchb. f.) Kuntze, Revis. Gen. Pl. 2: 654. 1891.

Flowering shoots erect, cylindrical, gradually reduce toward apex, slightly constricted at nodes, sulcate, green or greenish brown, 25-73 cm tall, internodes 3.2-6.1 cm long, 1.8-2.6 cm in diameter, leafy along stem. **Leaves** distichous, spreading, coriaceous, both surfaces covered with short black hirsute hairs, mid-vein grooved above and ribbed below, green or dull green, lanceolate, apex unequally bi-lobed, each lobe obtuse, 10.7-15.4 cm long, 0.6-1.1 cm wide; leaf-sheaths covered with short black hairs, 2.3-3.4 cm long. **Inflorescences** abbreviated, 1- to 4-flowered, emerging from base of leaf sheaths at upper part of both leafy and leafless stems; peduncle and rachis glabrous, light green, 0.2-0.5 cm long, covered with bracts; floral bracts slightly concave, abaxial surface covered with black hairs, adaxial surface glabrous, brown or ferruginous, triangular-ovate, apex acute or acuminate, base truncate, 2- to 4-veined, 0.3-0.5 cm long, 0.2-0.4 cm wide. **Flowers** coriaceous, resupinate, waxy and polished, faintly fragrant, long-lasting, up to ca. 6 cm in diameter; sepals and petals white; mentum white or reddish white from outside; labellum white with red lines and waxy at lower portion, claw red or pale red, side lobes white or ivory white or orange-red with red elevated veins, disc red, faded at entrance to mid-lobe, mid-lobe white with red prominent lines on median area; column white, foot red, lateral margins white, stigmatic cavity white or ivory white, anther-cap white,

pollinia yellow, pedicellate ovary white or greenish white. *Sepals* spreading, often recurved distally, margin entire or sometime slightly undulate, abaxial surface distinctly keeled; dorsal sepal lanceolate, apex acuminate, base truncate, mid-vein grooved above, other veins hardly visible, 2.8-3.7 cm long, 0.5-1 cm wide; lateral sepals obliquely triangular-lanceolate, apex acuminate, base obliquely truncate, 3-to 5-veined, hardly visible, posterior margin 2.7-3.8 cm long, anterior margin 5.5-6.7 cm long, 0.7-1.4 cm wide at base, *c.* 0.3 cm wide at apex. *Mentum* very narrowly conical, ovipositor-shaped, apex obtuse, straight or incurved distally, 2.1-2.5 cm long, *ca.* 0.2 cm in diameter. *Petals* recurved, elliptic or lanceolate, gently reduced at base, apex acute or acuminate, base truncate, margin entire, sometime slightly undulate at upper half, 5- to 7-veined, hardly visible, 2.8-3.6 cm long, 1.1-1.4 cm wide. *Labellum* 3-lobed, 4-4.8 cm long, 1.5-1.9 cm wide across side lobes; claw linear or narrowly triangular, 12-17 mm long; side lobes shallowly deltoid or obliquely widely obovate, 5-7 slightly elevated veins running along each side lobe, apex obtuse, margin entire; disc waxy, oblong or narrowly oblong, with 5 elevated veins; mid-lobe elliptic or rhombic with obvious reticulate elevated veins, apex obtuse or subacute when flatten, margin crisped or wavy, 1.9-2.3 cm long, 1-1.5 cm wide. *Column* surface minutely papillose, dilated at base, 4-5mm long, *ca.* 4 mm wide at base; foot concave, base truncate, margin raised at base, surface minutely papillose, 24-28 mm long, 4.8-5 mm wide at base; stigmatic cavity elliptic or ovate; steldia triangular; connective linear or narrowly triangular; anther cap widely obovate, surface minutely papillose, apex rounded, basal margin minutely ciliate, adaxial surface sulcate, 2.4-2.8mm long, 2.1-2.5 mm wide; pollinia 4, in 2 pairs, each pollinium narrowly elliptic, without caudicle and visidium. *Ovary* (including pedicel) slender, narrowly clavate, glabrous, 6-grooved, 2.6-2.9 cm long. *Capsule* dehiscent, green or dull green, ovate, with 3 obtuse keels, apex with persistent dried perianth, 3.5-4.3 cm long, 1.9-2.8 cm wide.

DISTRIBUTION. – Myanmar, Thailand and Vietnam.

HABITAT AND ECOLOGY.— Epiphytes in deciduous forest, at 300-700 m alt. Flowering period: March-May.

VERNACULAR.— Pho-che (พอเช), Ueang ngoen (เอื้องเงิน), Ueang tueng (เอื้องตึง)

SPECIMENS EXAMINED.— MYANMAR: *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 6603 (W); *Foerstermann. s.n.* (W).

THAILAND: *J.F. Maxwell 76-218* (AAU), Sisaket, Kantaralak, 350 m alt., 12 April 1976; *J.F. Maxwell 00-168* (L), Lampon, Toong Hoa Chang Huay Bohng (Karen) village, 550 m alt., 26 March 2000; *J.F. Maxwell 76-218* (L), Sisaket, Kantararak, 350 m alt., 12 April 1976; *A.F.G. Kerr 837* (L), Sa Kaeo, Aranyaprahet, 12 May 1930; *B.Sankhachand 40,243* (L), Lampang, Ngao, 360 m alt., 17 May 1954.

VEITNAM: *Poilane s.n.* (L), Don nai, Djiring, 18 February 1935; *Sine Coll. s.n.* (L), Annam, Nha Trang, 9 June 1901.

LOCALITY UNKNOWN: *William Bull & F.L.S. 734.* (W); *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 32003 (W); *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 3056 (W); *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 29996 (W).

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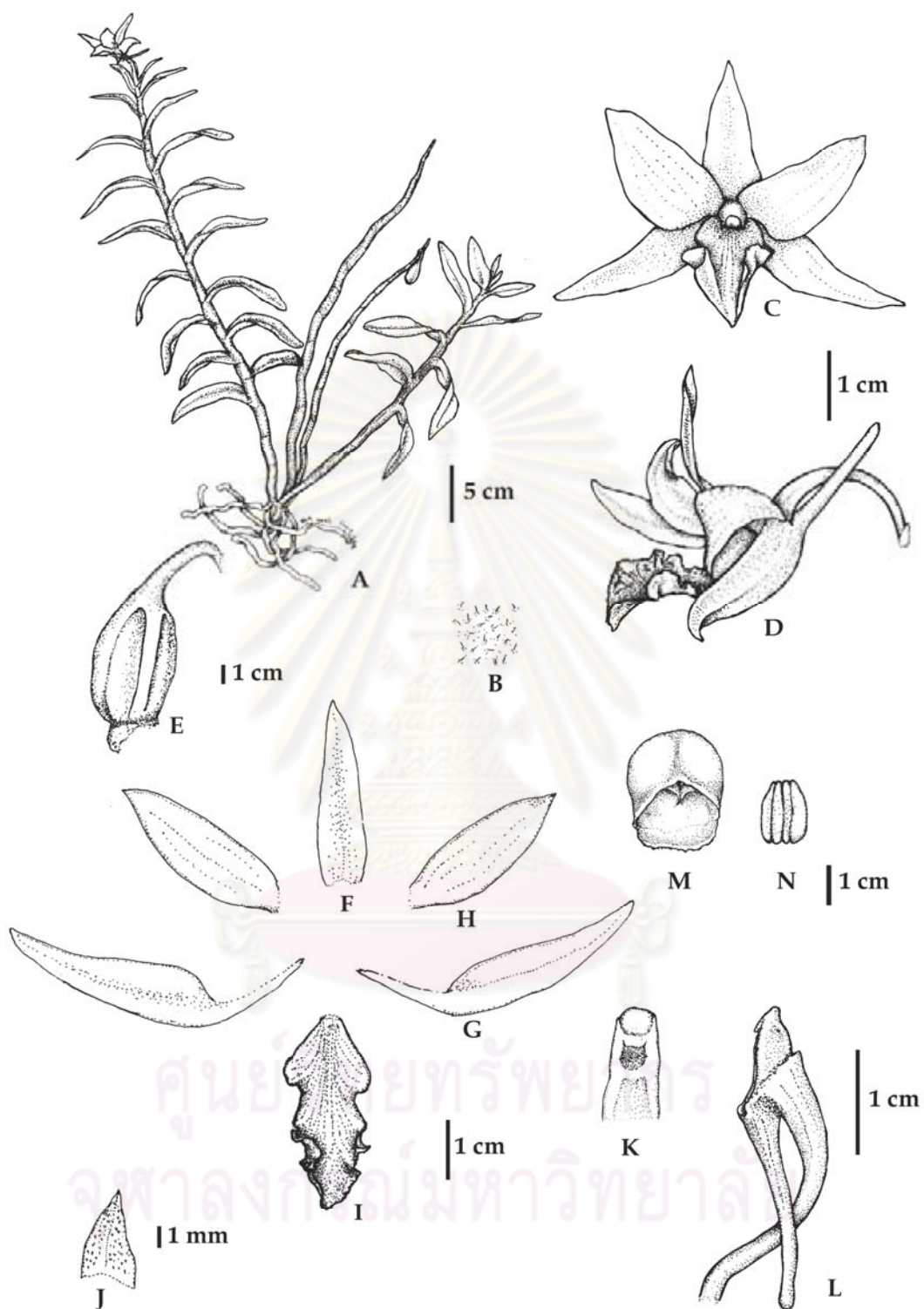


FIGURE 5.7. *Dendrobium draconis* Rchb.f. **A.** Habit; **B.** Hairs, on leaf; **C.** Flower, front view; **D.** Flower, side view; **E.** Fruit; **F.** Dorsal sepal; **G.** Lateral sepal; **H.** Petal; **I.** Labellum; **J.** Floral bract; **K.** Column, from below; **L.** Column and column foot, side view; **M.** Anther cap; **N.** Pollinia. Drawn from A. Sathapattayanon 388 by Mr. Tanucha Boonjaras.

8. *Dendrobium erythropogon* Rchb. f., Gard. Chron. 1885 (2): 198. 1885; John Day, Scrapbook 45: 73. 1885. Type: cult. *Low s.n.* (holotype W!); Colour painting of type plant drawn by John Day, Scrapbook 45, page 73, 1 August 1885, (iconotype K!). 'Sondaic Islands', precise locality unknown, probably Borneo. Fig. 5.8; Pl. 4: H&I.

Flowering shoots erect, cylindrical, slightly flexuose, sulcate, brownish green or brown, leafy. *Leaves* distichous, spreading, oblong-elliptic or oblong-ovate. *Inflorescences* abbreviated, ca. 5-flowered, emerging from the base of the leaf-sheaths along the upper portion of the stem; floral bracts concave, abaxial surface covered with black hirsute hairs, adaxial surface glabrous. *Flowers* see note below. *Sepals* concave at apex, margin entire or slightly undulate; dorsal sepal oblong-elliptic, apex acute or mucronate, base truncate, abaxial surface distinctly keeled, 5- to 6-veined, 1.9-2.2 cm long, 0.6-0.8 cm wide; lateral sepals obliquely triangular-ovate, apex acute or mucronate, base obliquely truncate, abaxial surface with distinct keel, wing-liked at apex, 7-veined, posterior margin 1.9-2 cm long, anterior margin 2.5-2.7 cm long, 0.9-1.1 cm wide at base, c. 0.8 cm wide at apex. *Mentum* very narrowly conical, ovipositor-shaped, gently decurved, apex obtuse, ca. 2.5 cm long, ca. 0.2 cm in diameter. *Petals* slightly recurved, oblong or oblong-elliptic, apex obtuse, margin undulate, 7-to 9-veined, 1.5-1.7 cm long, 1-1.2 cm wide at base. *Labellum* distinctly 3-lobed, 4.2-4.5 cm long, 1.7-1.8 cm wide across side lobes; claw linear, ca. 1-1.5 cm long; side lobes obliquely widely obovate, broader and blunter than *Dendrobium lowii*, 5- to 6- slightly elevated veins on each side lobes, bearing short hairs on each vein, margin entire; disc oblong; mid-lobe shortly clawed, spathulate-flabellate, with 7 low keels bearing short hairs, apex emarginate, decurved, front margin undulate, lateral margin entire, 1-1.2 cm long, 1.1-1.2 cm wide. *Column* 2-3 mm long; foot concave, 25-27 mm long; stigmatic cavity widely ovate; stelia triangular; connective narrowly triangular; anther cap and pollinia not seen. *Ovary* (including pedicel) narrowly clavate, curved, 3.5-4.5 cm long. *Capsule* not seen.

DISTRIBUTION – Indonesia (probably Borneo).

HABITAT AND ECOLOGY – unknown

SPECIMENS EXAMINED – INDONESIA: cult. *Low s.n.* (W), probably Borneo!; Colour painting of type plant drawn by John Day, Scrapbook 45, page 73, 1 August 1885

NOTE – Reichenbach (1885) noted on this species “The flowers are smaller than those of *Dendrobium lowii* in my herbarium, the grandest of which was kindly sent by Mr. Day, 1877. I have at hand a four-flowered raceme with well developed, very nigro-hirsute bracts. The sepals are partly most pallid whitish-ochre, partly ochre-coloured, and are deficient in that fine yellow of the typical *D. lowii*. The keels on the mid-lines are well developed. Petals oblong, well undulate. Column nearly white, with the two scarlet spots at the base as in *D. lowii*. The lip offers the very remarkable marks of distinction. It is very much like that of *D. radians*, and may be compared to that of the Burmese *D. xanthophlebium*. The side-laciniae are much developed, blunt, rectangular, white, edged crimson, quite distinct from the narrow things of *D. lowii*. Mid-lacinia of lip obcordate, undulate, toothletted, with a very short constricted base. There are seven thick crimson keels on the disc of the mid-lacinia, the two external ones have short crimson hairs on each side, and want the long yellow beard of *D. lowii*. There is a crimson wash between the crimson keels. It is a very good *Dendrobium*, as is *D. lowii*, both being uncommon and very peculiar”.

John Day painted *Dendrobium erythropogon* in his scrapbooks volume 45, dated 1 August 1885. He noted that “In addition to the form of labellum the hairs on the ridge are very much shorter on the new species. The only difference in the plants that I could detect is that the leaves of *D. erythropogon* are a little longer and narrow than those of most of the *D. lowii* at Clapton. It was received from Borneo with them”.

Reichenbach (1885) suggested that *D. erythropogon* may possibly be a natural hybrid. Unfortunately, there is no modern material of *D. erythropogon* in any herbariums, except the type specimen that deposited at W. Reichenbach's suspense still remains.



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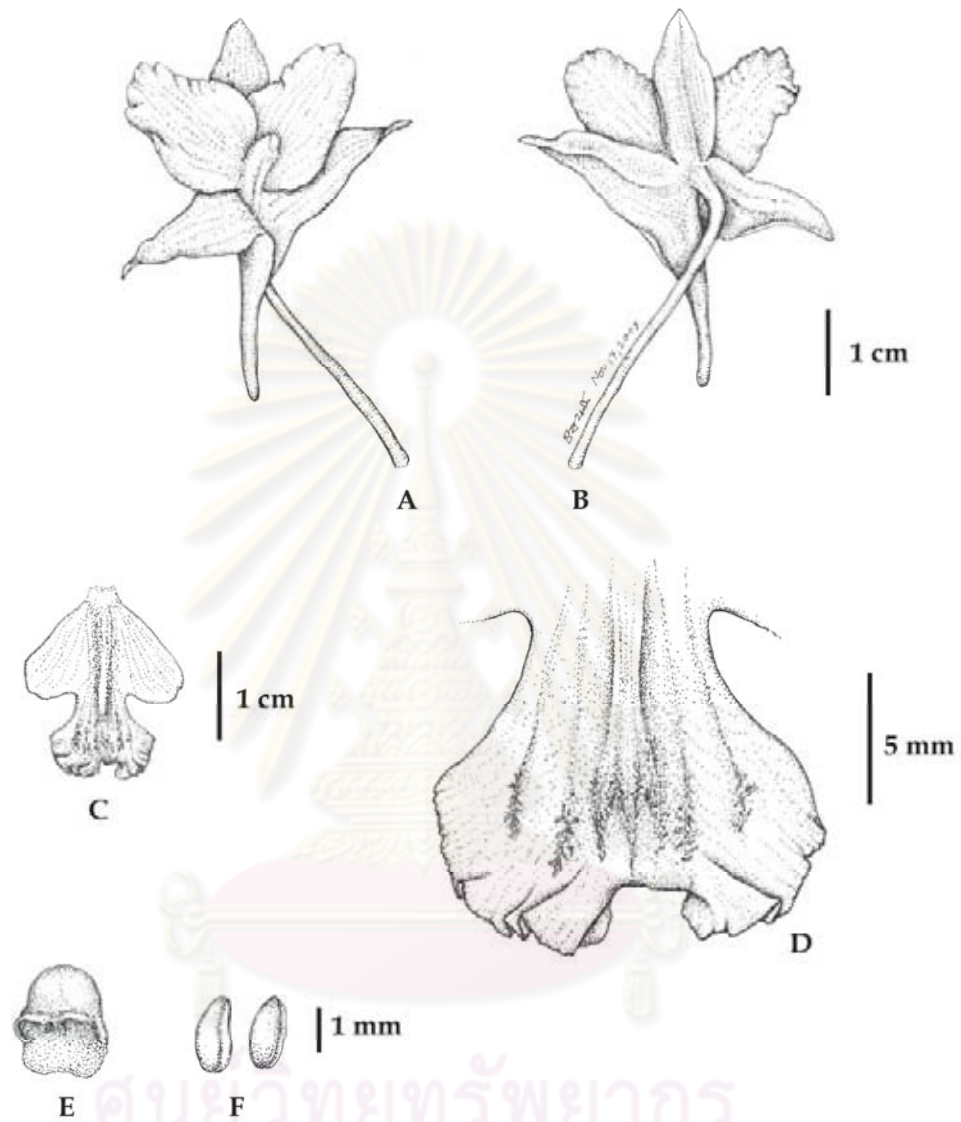


FIGURE 5.8. *Dendrobium erythropogon* Rchb.f. **A.** Flower, from below; **B.** Flower, from above; **C.** Labellum; **D.** Mid-lobe of labellum; **E.** Anther cap; **F.** Pollinia. Drawn from cult. *Low s.n.* (holotype) by Mr. Tanucha Boonjaras.

9. *Dendrobium flexuosum* Griff., Not. Pl. Asiat. 3: 317. 1851; Rchb.f., Gard. Chorn. 18: 488. 1884. Type: *Griffith s.n.* (holotype K!, Lindley's collection) p.p., India, Assam, Khasia Mountain, Churra, 20 October 1835. Fig. 5.9; Pl. 4: J.

Dendrobium longicornu auct. non Lindl., T.M. Hynniewta *et al.*, Orchid. Nagaland.: 150, fig. 45. 2000; Y. Tanaka *et al.*, Wild Orchid. Myanmar: 19. 2004.

Dendrobium bulleyi Rolfe, Note Roy. Bot. Gard. Edinburgh. 8:20. 1913. Type: *G. Forrest. 1091* (holotype E!) China, West Yunnan, at 8,000-9,000 ft alt., September 1905.

Dendrobium chapaense Aver., Rheedea 16: 3, fig. 2, 3c. 2006. **syn. nov.** Type: *Averyanov & Loc HAL 8321* (holotype HN; isotype LE!, photo seen, kindly sent by Prof. L. Averyanov) Vietnam, Lao Cai Province, Chapa District, 25 November 2005.

Flowering shoots erect, slender, cylindrical, flexuous, slightly constrict at nodes, more or less sulcate, green or brownish green, 12-22 cm tall, internodes 1.8-2.3 cm long, 0.5-0.7 cm in diameter, leafy at the upper part of stem, sometimes non flowering shoot bulbiferous at distal nodes. **Leaves** distichous, thinly coriaceous, spreading or slightly recurved, young leaves covered with dense black hirsute hairs on both sides, adaxial surface of mature leaf becoming glabrous, more or less waxy, abaxial surface sparsely covered with short black hirsute hairs, becoming glabrous with age, mid-vein grooved above and ribbed below, green or dull green, lanceolate or narrowly elliptic, apex unequally bi-lobed, each lobe acute, 3.9-4.6 cm long, 0.8-1.2 cm wide; leaf-sheaths covered with caducous black hairs, 1.4-1.8 cm long. **Inflorescences** abbreviated, often 2-flowered or solitary, subterminal on both leafy and leafless stem, raising from the base of leaf-sheaths opposite the blades; peduncle and rachis, glabrous, light green, ca. 0.3 cm long, covered with bracts; floral bracts greenish brown or brown, concave, oblong or elliptic-oblong, apex acuminate or attenuate, base truncate, abaxial surface covered with scattered black hairs, adaxial surface glabrous, 2- to 4-veined, 0.5-

1.5 cm long, 0.3-0.5 cm wide. *Flowers* papyraceous, resupinate, unscented, veins obscured, visible when aged, up to 4.3 cm in diameter; sepals and petals white; mentum white or orangish white or pale greenish white from outside; labellum various in colour from white to yellowish orange, claw orange or orangish white, side lobes white with creamy or yellowish orange veins or sometimes side lobes orange with darker orange veins on adaxial surface; disc orange or yellowish orange, sometime white; mid-lobe white or orange, with 2 to 4 yellowish orange and 3 yellowish orange or orange keels; column white or pale orange, foot white or pale orange, stigmatic cavity white or ivory white, anther-cap white, pollinia yellow, pedicellate ovary light green or greenish white. *Sepals* spreading, recurved backward, margin entire, abaxial surface waxy with distinct keel, sometime wing-liked, veins hardly visible; dorsal sepal oblong or elliptic-oblong, apex acuminate, base truncate, mid-vein grooved on adaxial surface, 5- to 7-veined, 1.7-2.3 cm long, 0.5-0.7 cm wide; lateral sepals obliquely triangular-ovate, apex acuminate, base obliquely truncate, 7- to 8-veined, posterior margin 1.8-2.3 cm long, anterior margin 2.8-3.3 cm long, ca. 1 cm wide at base, ca. 0.3 cm wide at apex. *Mentum* narrowly conical, apex obtuse, straight, 1.1-1.5 cm long, 0.4-0.6 cm in diameter at base, 0.2-0.3 cm in diameter at apical part. *Petals* spreading recurved at apex, lanceolate or narrowly elliptic or narrowly rhombic, apex acuminate, base truncate, margin entire, 3- to 5-veined, 2-2.5 long, 0.5-0.9 cm wide. *Labellum* 3-lobed, 3.5-4 cm long, 2.1-2.6 cm wide across side lobes; claw linear or narrowly triangular, 0.9-1.4 cm long; side lobes obliquely ovate or obliquely elliptic, 6- to 7-slightly elevated veins running along each side lobe, each vein branched at terminal and covered with wart-like callus along distal half, apex obtuse, margin crenate or loose lobed and slightly undulate; disc narrowly oblong, thickening, smooth, becoming 3-keeled with wart-like callus at middle part, continuing to mid-lobe; mid-lobe elliptic to widely elliptic when flatten, with 2 to 4 slightly elevated veins, bearing wart-like callus, continuing from side lobes and 3 keels, bearing wart-like callus, continuing from disc, apex acuminate, margin undulate and crisped, 0.5-0.8 cm long, 0.4-0.9 cm wide.

Column surface more or less very minutely papillose, without waxy, 3-5 mm long, 4-5 mm wide at base; foot slightly concave, tapering downwards, surface minutely papillose, without waxy, 11-15 mm long, 4-4.6 mm wide at entrance of mentum; stigmatic cavity elliptic; stelidia triangular; connective narrowly triangular; anther cap elliptic or widely obovate, surface vary minutely papillose, apex rounded, basal margin minutely ciliate, adaxial surface sulcate, 2.8-3 mm long, 2-2.2 mm wide; pollinia 4, in 2 pairs, each pollinium narrowly elliptic, without caudicle and visidium. *Ovary* (including pedicel) narrowly clavate, curved, somewhat waxy, glabrous, 6-grooved, 2.5-3.4 cm long. *Capsule* dehiscent, green or dull green, ovate or ovate-elliptic with 3 obtuse keels, apex bunt with persistent dried perianth, 2.2-2.7 cm long, 0.9-1.3 cm wide.

DISTRIBUTION. – India, Nepal, China, Myanmar and Vietnam.

HABITAT AND ECOLOGY. – Epiphytic orchids grow in evergreen forest, altitude 1,500-2,000 m. Flowering period: September to November.

SPECIMENS EXAMINED. – INDIA: *C.B. Clark* 5,727 (E); *C.B. Clarke* 15,671 (W); *C.B. Clarke s.n.* (W); *F. Kingdon-Ward* 18,127 (BM); *Griffith s.n.* (K-holotype of *D. flexuosum*); *Griffith s.n.* (K); *J.D. Hooker & T. Thomson s.n.* (BM, C, E, P); *J.D. Hooker s.n.* (K); *Lobb s.n.* (K); *N.E. Parry* 528(K); *N.L. Bor* 20,924 (L); *Parish* 43/84 (W); *Parish* 83/84 (W); *Parish* 83/85 (W); *Prain s.n.* (P); *Prain's collector* 15 (BM); *Prain's collector* 214 (E); *Rankin & Pretzlik* 24 (BM); *Sine coll. s.n.* E00266525 (E); *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 32,467 (W); *W. Griffith* 1,850 (P); *W. Griffith* 5,049 (C, L, P); *W. Griffith s.n.* (AAU, BM, C, P, W); *W.N. Koelz* 31,334 (K).

NEPAL: *de Haas J.H.* 2,846 (BM).

CHINA: *Cult. Butterfield s.n.* (K, spirit collection Vial no. 44289); *G. Forrest 1,091* (E-holotype of *D. bulleyi*); *G. Forrest 9,124* (E); *G. Forrest 18,432* (P); *G. Forrest 18,432* (P); *G. Forrest 18,434* (K); *G. Forrest 27,780* (K); *Li Heng 10,708* (E).

MYANMAR: *Cult. Hort. Kew. 321-62* (K, spirit collection Vial no. 24968); *Cult. Hort. Kew. 386-1959* (K, spirit collection Vial. no. 17966); *F. Kingdon-Ward 22,562* (BM); *F. Kingdon-Ward s.n.* (K, spirit collection Vial no. 20878); *F. Kingdon-Ward s.n.* (K, spirit collection Vial. no.19827); *F.E.W. Venning 52* (K); *J. Kivk s.n.* (K); *Kingdon-Ward, F. s.n.* (K, spirit collection Vial no. 19920); *sine coll. s.n.* (TNS).

VIETNAM: *HAL 8,321* (LE-holotype of *D. chapaense*, photo seen, kindly sent by Prof. L. Averyanov); *HAL 10,202* (LE, Photo seen, kindly sent by Prof. L. Averyanov).

LOCALITY UNKNOWN: *Lobb 47* (BM); *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 26,842 (W); *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 30,885 (W); *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 32,466 (W).

NOTE.— 1. *Dendrobium flexuosum* is distinct from *D. longicornu* in having different detail of labellum. The main difference is undulate and crisped mid-lobe margin. The colour of labellum is variable from white to orange.

2. Griffith (1851a) indicated “Assam Herb. 162” as the type specimen of *Dendrobium flexuosum*. However, there were no herbarium specimens under this number in any herbaria. It seems likely that the number is not the collection number and it may refer to the Assam herbarium’s number. There is a specimen labeled *D. flexuosum* among collections of William Griffith without a number in Lindley Herbarium of the Royal Botanic Gardens, Kew. The herbarium label noted that the plant was collected from Khasia Mountain in 1835. The collection locality and year matched with those of the type specimen of *D. flexuosum*. Morphological characters of the specimen also match with the original

description. Therefore, I confidently concluded that *Griffith s.n.*, deposited in K (Lindley Herbarium), is the holotype of *D. flexuosum*. Moreover, this specimen contains 2 types. Holotype of *D. flexuosum* was mounted on the right of the sheet while that of *D. hirsutum* was mounted on the left.



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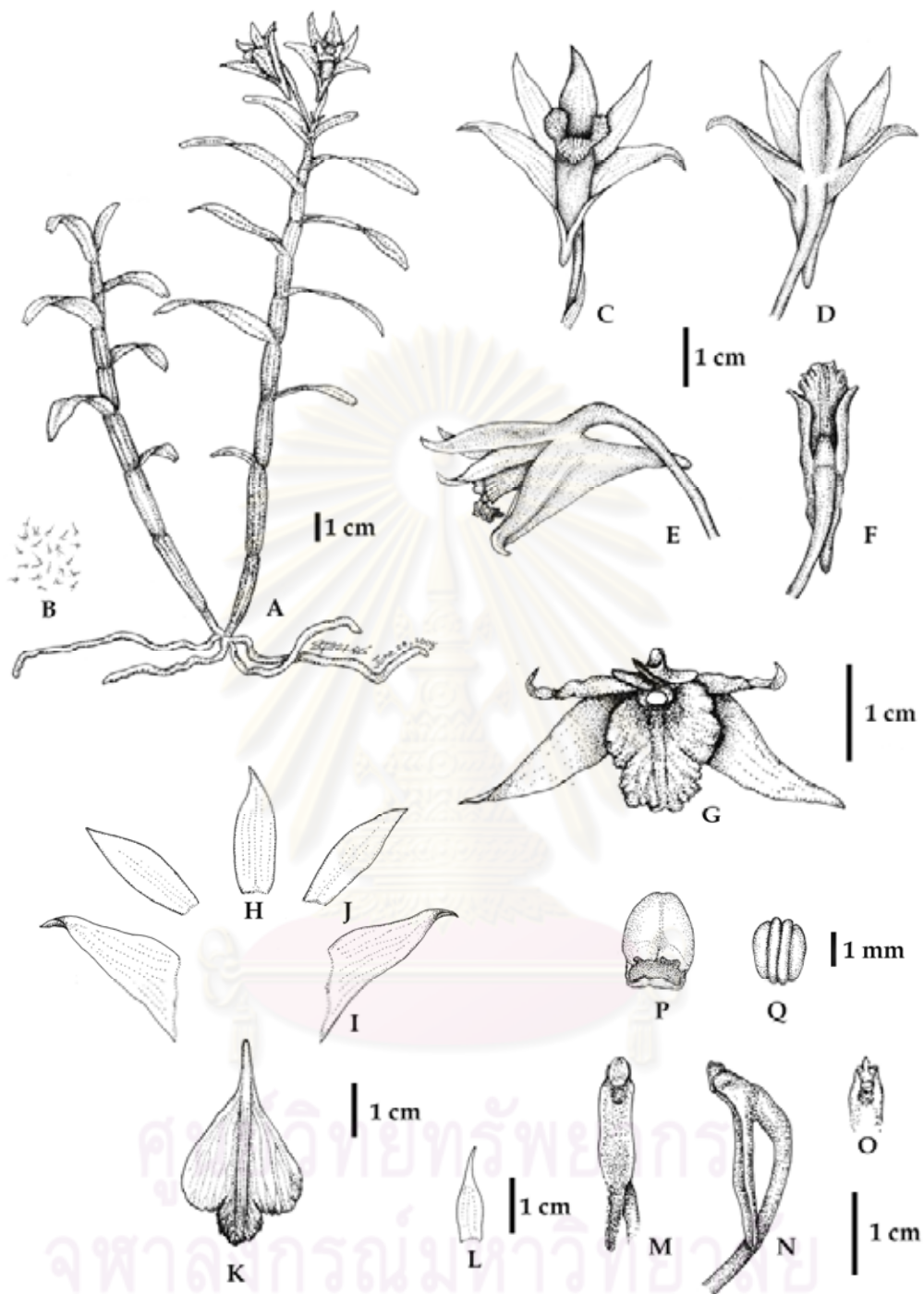


FIGURE 5.9. *Dendrobium flexuosum* Griff. **A.** Habit; **B.** Hairs, on leaf; **C.** Flower, from below; **D.** Flower, from above; **E.** Flower, side view; **F.** Labellum and mentum, from above, sepals and petals removed; **G.** Flower, front view; **H.** Dorsal sepal; **I.** Lateral sepal; **J.** Petal; **K.** Labellum; **L.** Floral bract; **M.** Column and column foot, from below; **N.** Column and column foot, side view; **O.** Column, from below, anther cap removed; **P.** Anther cap; **Q.** Pollinia. Drawn from *Hort. Tsukuba Botanical Garden accession number s.n.* by Mr. Tanucha Boonjaras.

10. *Dendrobium formosum* Roxb. ex Lindl., in Wallich, Pl. Asiat. Rar. 1: 34. 1830; Thaithong, Thai Orchid: 199. 2000. Type: *Roxburgh s.n.* (holotype BM!, BM no. 000505677) p.p., Northeastern Bangladesh, Sylhet, 1813. Fig. 5.10; Pl. 4: K.

Dendrobium formosum var. *berkeleyi* Rchb.f., Gard. Chron. 19: 210, 110. 1883. Type: *Berkeley s.n.* (holotype W!), locality unknown, 1881.

Dendrobium infundibulum auct. non Lindl.; Rchb.f., Gartenflora 36: T.1253. 1887.

Dendrobium formosum var. *gigantium* O' Brien, Gard. Chron. 3: 8. 1890. nom. nud.

Callista formosa (Roxb. ex Lindl.) Kuntze, Revis. Gen. Pl. 2: 654. 1891.

Flowering shoots erect, stout, cylindrical, slightly constricted at node, green or brownish green 18–34 cm tall, 2–2.9 cm long, 0.5–0.9 cm in diameter, leafy. **Leaves** distichous, spreading, coriaceous, both surfaces covered with black hirsute hairs, mid-vein grooved above and ribbed below, green or dull green, oblong ovate-oblong, apex unequally bi-lobed, each lobe acute, 7.5–15.5 cm long, 1.5–3.3 cm wide; leaf-sheaths covered with dense short black hirsute hairs, 1.9–2.3 cm long. **Inflorescences** abbreviated, 1- to 4-flowered, borne near the apex of the stem; peduncle and rachis glabrous, green, ca. 0.3–0.5 cm long; floral bracts concave, abaxial surface covered with dense black hirsute hairs, adaxial surface glabrous, brown, triangular-oblong or triangular-ovate, apex acuminate, base truncate, 3- to 5-veined, 0.7–1.2 cm long, 0.5–0.8 cm wide. **Flowers** resupinate, faintly fragrant, veins visible, 5–9.2 cm in diameter; sepals and petals pure white; mentum yellowish white from outside; labellum white with a yellow band at the middle, claw pale yellow, side lobes white, disc light yellow to yellow, mid-lobe white with large yellow band, slightly elevated veins on mid-lobe yellow; column white, foot white, pale yellow to greenish yellow at base, stigmatic cavity white, anther-cap white, pollinia yellow, pedicellate ovary white. **Sepals** spreading, margin entire, mid-vein grooved on adaxial surface, abaxial surface keeled, conspicuous at apical part; dorsal sepal oblong or elliptic-oblong, apex acuminate, base truncate, 3- to 5-veined, 2.8–3.6 cm long, 1.2–1.8 cm wide; lateral

sepals, obliquely triangular-ovate, apex acuminate, base obliquely truncate, 3- to 5-veined, posterior margin 3.2-4 cm long, anterior margin 5.4 -6.2 cm long, 1.4-1.8 cm wide at base, *c.* 0.3 cm wide at apex. *Mentum* shortly conical, straight, apex obtuse, 1.3-2.2 cm long, *ca.* 0.4 cm in diameter. *Petals* spreading, recurved backwards at middle, reticulately-veined, widely obovate or suborbicular, apex obtuse or subacute, base cuneate, margin slightly undulate, 7- to 9-veined, 4.2-6.6 cm long, 3.1-4.3 cm wide near base. *Labellum* 3-lobed, 5.5-7.6 cm long, 3.2-5 cm wide across side lobes; claw linear, *ca.* 10 mm long; side lobes obliquely triangular, surface smooth, apex round, margin slightly undulate; disc narrowly oblong, distal half with many papillose and scabrous callus, extending to the mid-lobe; mid-lobe transversely widely oblong, basal half scabrous, with 3-5 slightly elevated veins, each vein bearing papillose and scabrous callus along half way, apex emarginate, margins undulate, 1.8-2.5 cm long, 2.2-3 cm wide. *Column* surface smooth, 0.7-0.9 mm long, 0.7-1 mm wide at base; foot broad at the middle, tapering downwards, slightly concave, grooved, surface smooth, 20-25 mm long, 9-11 mm wide at middle; stigmatic cavity widely elliptic or suborbicular; stelia broadly triangular; connective linear; anther cap widely oblong, surface minutely papillose, apex emarginate, basal margin minutely ciliate, adaxial surface sulcate, 3.5-4 mm long, *ca.* 4 mm wide; pollinia 4, in 2 pairs, each pollinium narrowly elliptic, without caudicle and visidium. *Ovary* (including pedicel) narrowly clavate, curved, glabrous, 6-grooved, 3.5-4.7 cm long. *Capsule* dehiscent, green or dull green, elliptic, with 3 distinct keels, apex with persistent dried perianth, 2.8-3.5 cm long, 1.2-1.7 cm wide.

DISTRIBUTION.— India, Nepal, Bangladesh, Myanmar, Laos and Thailand.

HABITAT AND ECOLOGY.— Epiphytes in evergreen forests, at medium altitude (700-1,000m alt.). Flowering period: September-December.

VERNACULAR.—Ueang khi phueng (เอื้องขี้ผึ้ง), Ueang ngoen luang (เอื้องเงินหลวง),
Ueang ta hoen (เอื้องตาหิน)

SPECIMENS EXAMINED.— INDIA: *Berkeley s.n.* (K), South Andaman; *Berkeley s.n.* (K), South Andaman, 1882 A.D.; *Griffith s.n.* (K), Silhet or Khasia; *Hasnilton s.n.* (BM); *Lobb 373* (BM); *Lobb 472* (BM); *R. Pantling 271* (BM, BR, K, P), Sikkim Himalaya, 1,000 ft alt., 1893 A.D.; *Rebecca G. Troth 880* (BM), Northeast section of Royal Chitwan National Park, south of Rapti River, Chitwan District, Narayani Zone, ca. 83 km 10 degree south of west from Kathmandu, 390 m alt., 09 June 1976; *Roxburgh s.n.* (BM); *Roxburgh s.n.* (BM), Northeastern Bangladesh, Sylhet, 1813.

NEPAL: *Wallich s.n.* (L); *J. D. A. Stainton 6882* (BM), East Nepal, Saktim Tea Estate, 1,500 ft alt., 22 Apr. 1971; *Wallich N. (Wall. Cat. No. 1998 B)* (BR), 1821 A.D.; *J. H. Wibbe 1325* (BR)

BANGLADESH: *J. D. Hooker and T. Thomson 1007* (K, K-LINDL); *Cult. Hort. Kew. Entry No. 346-1938* (K-SPIRIT), Kalimpong, Bagal, 03 June 1938; *Lobb 373* (K-LINDL); *Wallich s.n. (Wallich Catalogue No. 1998)* (K), Sylhet; *Wallich s.n. (Wallich Catalogue No. 1998)* (K), Sylhet.

MYANMAR: *Javay, 34 April 1901. Lobb 373* (K), Moulmein; *Lobb s.n.* (K), Moulmein; *J. F. Maxwell 98-1217* (CMU), Tenasserim Division, Tawer District, Yebyu Township, c. 5 km east of Kanbauk, 25 m alt., 20 Oct. 1998; *Shaik Mokim 481* (E), Tavoy, Mar. 1901; *Shaik Mokim 634* (BM, BR, L, P), Burma, Tavoy, Apr. 1901; *sine coll. s.n.* (TNS), 29 May 2007; *Wallace 136* (BM), South of Hyauhfyu, Rauree Is., 06 May 1945.

LAOS: *A. D. Kerr 2760* (C), Phu Bia, Xieng Khouay.

THAILAND : *S. Bloembergen* (*Kwae Noi River Basin Exp. 1946 Nr. 45*) (BK, K, L, P), Kanchanaburi, Tripagodas, Birmese Border, about 40 km north of Wangka, 280 m alt., 30 Apr. 1946; *K. Chankaew 11* (BKF), 21 July 2003; *GT 8963* (C), probably Penninsular, 1983, *GT 8964* (C), probably Penninsular, Date coll. ? 1984; *A. F. G. Kerr 315* (K), Kanchanaburi, 15 Apr. 1924; *A. F. G. Kerr s.n.* (K), 29 Oct. 1929; *Arthur Kerr s.n.* (K), Sep. 1908; *A. Kostermans* (*Kwae Noi River Basin Exp. 1946 Nr. 402*) (BK, C, K, L, P), Kanchanaburi, Tripagodas, Burmese Border, about 40 km north of Wangka, 280 m alt., 08-11 May 1946; *T. Santisuk 667* (BKF), Phangnga, Kuraburi, Nangyon, ca. 50 m alt., 23 Nov. 1973; *A. Sathapattayanon 393* (BCU), 24 Mar. 2005; *A. Sathapattayanon 396* (BCU), 08 Apr. 2005; *A. Sathapattayanon 428* (BCU), Ranong, 19 Apr. 2006; *W. Songkakul 77* (BKF), Ranong, 06 Oct. 1989; *O. Thaihong 500* (BCU), 24 Sep. 1988; *A. Uboncholaket s.n.* (BCU), 19 Nov. 1977; *Winit s.n.* (BKF), Mae Sarieng, ca. 1,000 m alt., May 1953.

LOCALITY UNKNOWN: *Leiden cult. no. 930082* (L); *Conel Berkeley s.n.* (W), 10 Jan 1888; *Wallich s.n.* Reichb.f. Orchids Herb. no. 32474 (W); *Wallich s.n.* Reichb.f. Orchids Herb. no. 32475 Cult. (W); *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 33949 (W); *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 28301 (W); *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 3341 (W); *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 31089 (W); *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 45671 (W); *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 14851 (W); *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 32525 (W); *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 32526 (W); *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 32527 (W); *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 32528 (W); *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 552 (W); *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 704 (W); *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 4568 (W).

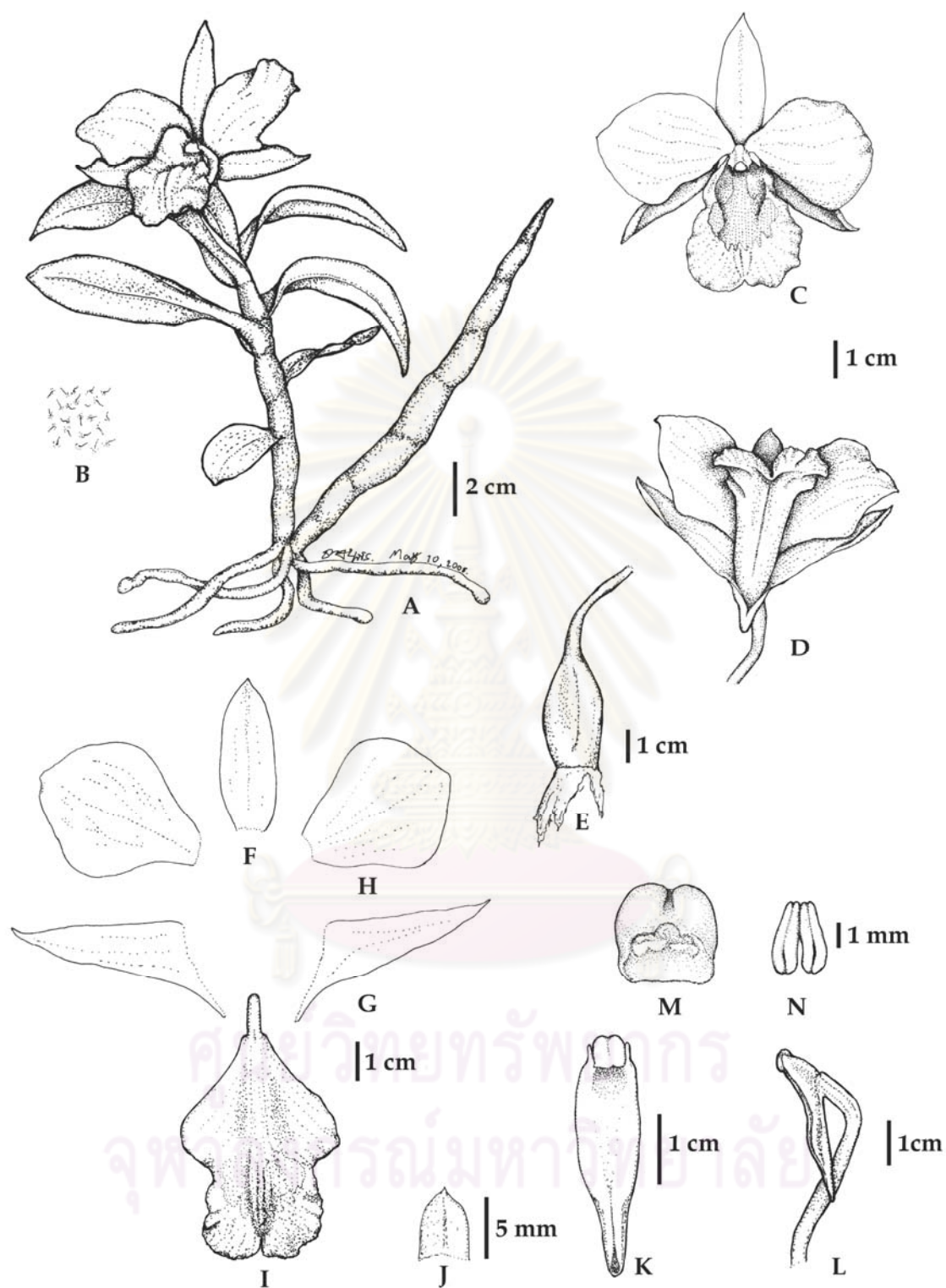


FIGURE 5.10. *Dendrobium formosum* Roxb. ex Lindl. **A.** Habit; **B.** Hairs, on leaf; **C.** Flower, front view; **D.** Flower, from below; **E.** Fruit; **F.** Dorsal sepal; **G.** Lateral sepal; **H.** Petal; **I.** Labellum; **J.** Floral bract; **K.** Column and column foot, from below; **L.** Column and column foot, side view; **M.** Anther cap; **N.** Pollinia. Drawn from A. Sathapattayanon 396 by Mr. Tanucha Boonjaras.

11. *Dendrobium hirsutum* Griff., Not. Pl. Asiat. 3: 318. 1851a; Icon. Pl. Asiat. 3: t. 305. 1851b; Rchb.f., Gard. Chorn. 18: 488. 1884. Type: *Griffith s.n.* (holotype K!, Lindley's collection) p.p., India, Assam, Khasia Mountain, Churra Ponjee. Fig. 5.11; Pl. 4: L.

Dendrobium longicornu auct. non Lindl., In: Edward's Bot. Reg. 16, an illustration on t. 1315, exclude description. 1830a; Seidenf. Opera Bot. 114: 219, fig. 139, Plate 13d. 1992; N.X.B.V.H. Dân Tộc, Phong Lan Việt Nam: 94, Hình 167. 2000.

Dendrobium longicornu var. *hirsuta* (Griff.) Hook.f., In Fl. Brit. India. 5(2): 720. 1890.

Dendrobium meghalayense C. Deori *et al.*, Rheedia 16(1): 55-58, fig 1, 2k-o. 2006. nom. illeg. Type: *H. Deka* 18385 (holotype ASSAM; isotype ASSAM) India, Meghalaya, Khasia and Jaintia Mountains, at 1,400 m alt., 19 August 1959; *C. Deori* 101162 (paratype ASSAM) India, Meghalaya, Khasia and Jaintia Mountains, 9 October 2004.

Dendrobium jaintianum C.M. Sabapathy, Indian Journal of Forestry, 30(3): 371. 2007. **syn. nov.**

Flowering shoots erect, slender, cylindrical, flexuous, slightly constrict at nodes, more or less sulcate, green or brownish green, 27-49 cm tall, internodes 2.9-4.4 cm long, 0.4-0.8 cm in diameter, leafy at the upper part of stem, sometimes non flowering shoot bulbiferous at distal nodes. **Leaves** distichous, thinly coriaceous, young leaves covered with dense, black, hirsute hairs, adaxial surface of mature leaf becoming glabrous, more or less waxy, abaxial surface sparsely with short, black, hirsute hairs, becoming glabrous with age, spreading or slightly recurved, green or dull green, lanceolate or narrowly elliptic, apex unequally bi-lobed, each lobe acute or obtuse, mid-vein grooved above and ribbed below, 7.3-8.5 cm long, 1.2-2.5 cm wide; leaf-sheaths covered with caducous black hairs, 2.2-3.4 cm long. **Inflorescences** abbreviated, often 2-flowered or solitary, up to 4-flowered,

subterminal on both leafy and leafless stem, raising from the base of leaf-sheaths opposite the blades; peduncle and rachis, glabrous, light green, 0.2-0.5 cm long, covered with bracts; floral bracts greenish brown or brown or tawny, oblong or elliptic-oblong, concave, apex acuminate, base truncate, abaxial surface covered with scattered black hairs, adaxial surface glabrous, 3- to 5-veined, 0.5-0.6 cm long, 0.2-0.4 cm wide. *Flowers* papyraceous, resupinate, unscented, veins obscured, visible when aged, up to 2-4.4 cm in diameter; sepals and petals white; mentum white or orangish white or pale greenish white from outside; labellum white, claw orange or pale orange, side lobes white with creamy or yellowish orange or reddish orange veins on adaxial surface; disc orange; mid-lobe white or yellowish orange or reddish orange, with 2 to 4 orange or reddish orange veins and 3 orange or reddish orange keels; column white or pale orange, foot white or orange, stigmatic cavity white or ivory white, anther-cap white, pollinia yellow, pedicellate ovary white or greenish white. *Sepals* spreading, slightly recurved at distal part, margin entire, abaxial surface waxy with distinct keel, wing-liked, veins hardly visible; dorsal sepal ovate or oblong-ovate, apex acuminate, base truncate, mid-vein grooved on adaxial surface, 6- to 9-veined, 1.4-2.3 cm long, 0.9-1.1 cm wide; lateral sepals obliquely triangular-oblong, apex acuminate, base obliquely truncate, 7- to 8-veined, posterior margin 1.9-2.1 cm long, anterior margin 3.5-4.5 cm long, 0.9-1.3 cm wide at base, ca. 0.2 cm wide at apex. *Mentum* narrowly conical, apex obtuse, usually bent down, 2.2-3.2 cm long, 0.4-0.6 cm in diameter at base, 0.2-0.3 cm in diameter at apical part. *Petals* spreading, slightly recurved, obovate or widely obovate or rhombic, apex acute, base truncate, margin entire, sometimes slightly undulate at upper half, 9- to 12-veined, 1.7-2.2 long, 0.9-1.3 cm wide at base. *Labellum* 3-lobed, 4-5.2 cm long, 2.5-3 cm wide across side lobes; claw linear or narrowly triangular, 1.2-2 cm long; side lobes obliquely ovate or obliquely elliptic, 6- to 7-slightly elevated veins running along each side lobe, each vein branched at terminal and covered with minutely hair-like callus along distal half, apex obtuse, margin crenate and slightly undulate; disc narrowly oblong, thickening, smooth, becoming 3-keeled

with hair-like callus at distal end, continuing to mid-lobe; mid-lobe transversely oblong, with 2 to 4 slightly elevated veins, bearing hair-like callus, continuing from side lobes and 3 keels, bearing hair-like callus, continuing from disc, apex 2-lobed or indistinctly 2-lobed, margin serrate or irregularly lobed, 0.3-0.5 cm long, 0.6-1.2 cm wide. **Column** surface more or less very minutely papillose, without waxy, 3-4 mm long, 3-4 mm wide at base; foot slightly concave, tapering downwards, surface minutely papillose, without waxy, 9-13 mm long, 4.1-4.7 mm wide at base; stigmatic cavity elliptic; stelidia triangular; connective narrowly triangular; anther cap obovate, surface vary minutely papillose, apex rounded, basal margin minutely ciliate, adaxial surface sulcate, 2.8-3.2 mm long, 2.8-3.1 mm wide; pollinia 4, in 2 pairs, each pollinium narrowly elliptic, without caudicle and visidium. **Ovary** (including pedicel) narrowly clavate, curved, somewhat waxy, glabrous, 6-grooved, 2.9-4.2 cm long. **Capsule** dehiscent, green or dull green, ovate or ovate-elliptic with 3 obtuse keels, apex with persistent dried perianth, 2.4-2.9 cm long, 1-1.6 cm wide.

DISTRIBUTION. – India, China, Myanmar, Thailand, Laos and Vietnam.

HABITAT AND ECOLOGY. – Epiphytic orchids grow in evergreen forest, altitude 1,000-2,000 m. Flowering period: August to December.

SPECIMENS EXAMINED. – INDIA: C.B. Clarke 45,482 (BM); Griffith s.n. (K-holotype of *D. hirsutum*); Griffith s.n. (K); J.D. Hooker s.n. (K); J.D. Hooker & T. Thomson s.n. (P); Mark s.n. (K); Prain's collector 37 (BM, BR, L, P); Sine coll. s.n. E00266523 (E); Sine coll. s.n. Reichb.f. Orchids Herb. no. 32,486 (W); T.R. Chand 2,062 (K); W.N. Koelz 23,419 (K); W.N. Koelz 30,713 (K); W.N. Koelz 30,918 (K).

CHINA: sine coll. s.n. TBG 124454 (TNS).

MYANMAR: *F. Kingdon-Ward* 3,531 (E); *F. Kingdon-Ward* 5,505 (E); *F. Kingdon-Ward* 13,502 (BM); *F. Kingdon-Ward* 21,258 (BM); *F. Kingdon-Ward* 21,380 (BM).

THAILAND: *W. Wichainsin et al. s.n.* (BCU); *W. Wichainsin s.n.* (BCU).

LAOS: *A. Sathapattayanon* 433, 436 (BCU); *P. Sukkakul* 9,772(C); *Sine coll. s.n.* (TNS).

VIETNAM: *HAL* 8,309 (LE, Photo seen, kindly sent by Prof. L. Averyanov); *M. Petelos s.n.* (P); *NTH* 3,460 (LE, Photo seen, kindly sent by Prof. L. Averyanov); *sine coll. s.n.* (TNS).

LOCALITY UNKNOWN: *Cult. Hort. Kew. s.n.* (K); *J.S. Gamble* 278A. (K); *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 145,92 (W); *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 28,333 (W); *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 3,408 (W); *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 31,148 (W); *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 32,468 (W); *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 32,469 (W); *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 32,470 (W); *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 33,961 (W); *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 34,571 (W); *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 35,699 (W); *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 712 (W).

NOTE.— 1. *Dendrobium hirsutum* is characterized by its broad petals together with its short and obscurely mid-lobe. The hair-like callus on labellum also differs from the former *D. longicornu* and *D. flexuosum*.

2. Griffith (1851a) referred to “Itinerary Notes p. 42, no. 670” in the protologue of *Dendrobium hirsutum*. Description of the relevant part in this reference (Griffith, 1848) are identical with the original description of *D. hirsutum*. Lindley Herbarium of the Royal Botanic Gardens, Kew deposits a Griffith’s

collection labeled *Dendrobium. hirsutum* without a number. The locality noted on the label and morphological characters of the specimen coincide with the original description. Therefore, we concluded that *Griffith s.n.*, deposited in Lindley collection at Kew Herbarium, is the holotype of *D. hirsutum*. As mentioned in the noted under *Dendrobium flexuosum* that the holotypes of *D. hirsutum* and *D. flexuosum* are mounted on the same sheet.



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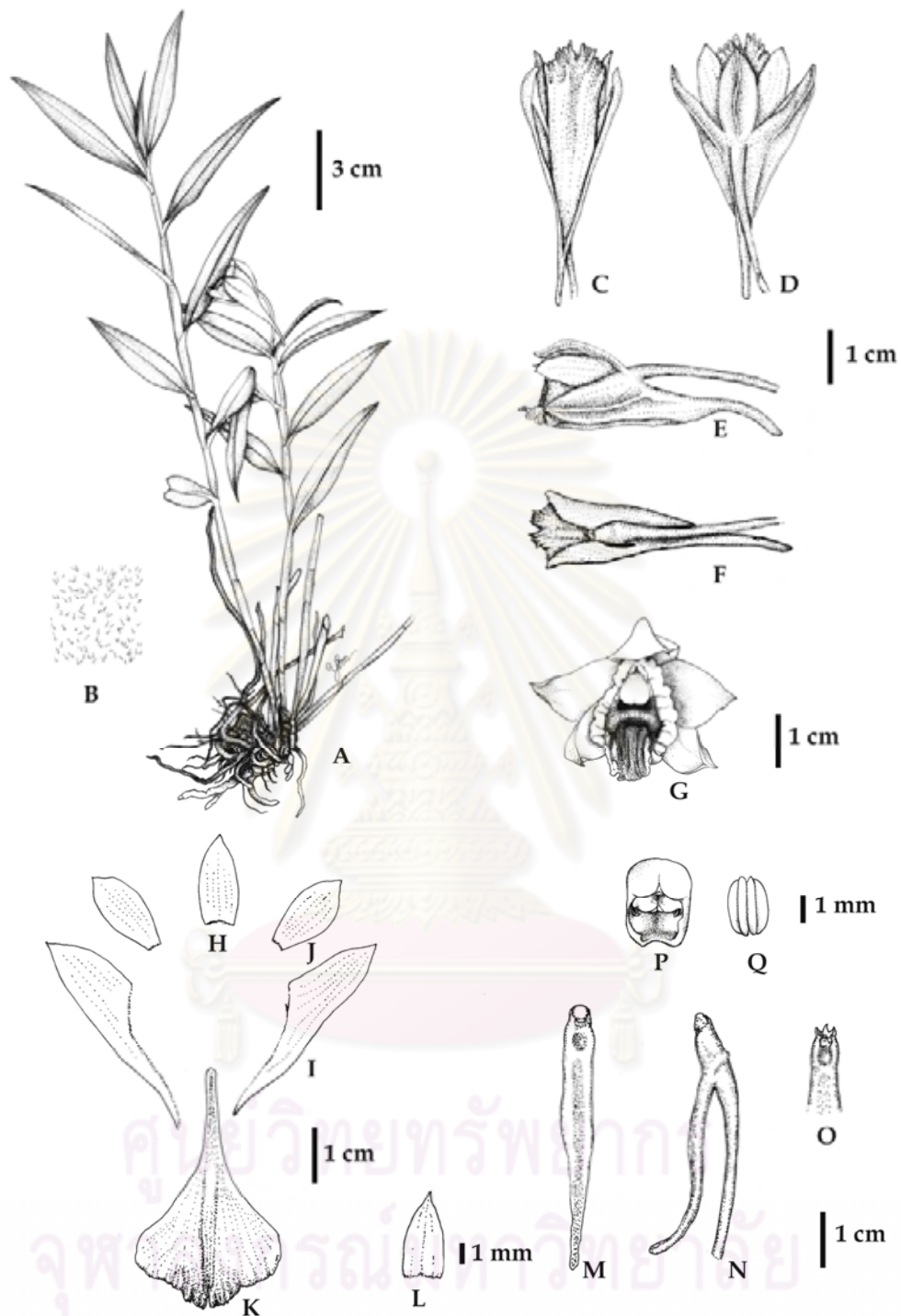


FIGURE 5.11. *Dendrobium hirsutum* Griff. A. Habit; B. Hairs, on leaf; C. Flower, from below; D. Flower, from above; E. Flower, side view; F. Labellum and mentum, from above, sepals and petals removed; G. Flower, front view; H. Dorsal sepal; I. Lateral sepal; J. Petal; K. Labellum; L. Floral bract; M. Column and column foot, from below; N. Column and column foot, side view; O. Column, from below, anther cap removed; P. Anther cap; Q. Pollinia. Drawn from A. Sathapattayanon 403 by Mr. Tanucha Boonjaras.

12. *Dendrobium igneoniveum* J.J. Sm., Bull. Jard. Bot. Buitenzorg, ser. 3, 9: 161. 1927; J.B. Comber, Orchids of Sumatra: 629. 2001. Type: cult. *E. Jacobson* s.n. (holotype, unknown), Sumatra, Tapiannoeli, Sirirok, 1859; Unpublished illustration drawn by J.J. Smith (lectotype L!, selected here). Fig. 5.12.

Flowering shoots terete, flexuose, sulcate, more than 40 cm tall, internodes 3.3 cm long, 0.6 cm in diameter. *Leaves* distichous, coriaceous, both surfaces densely covered with black hirsute hairs, mid-vein grooved above and ribbed below, dark green, oblong to ovate, apex unequally bi-lobed, each lobe obtuse, 5.3-6 cm long, 2.2-2.3 cm wide, the lower ones smaller. *Inflorescences* abbreviated, ca. 4-flowered, emerging from the base of the leaf-sheaths along the upper portion of the stem; peduncle and rachis light green, 1.25 cm long; floral bracts concave, abaxial surface covered with dense black hirsute hairs, adaxial surface glabrous, triangular, apex acute, acuminate, base truncate, 3-veined, ca. 1 cm long, 0.3-0.5 cm wide at base. *Flowers* resupinate, white, unscented, ca. 6 cm in diameter, claw of labellum brownish yellow, side lobes orange-red, mid-lobe with an orange red blotch at the base; column white with a faintly green tint. *Sepals* dorsal sepal oblong-ovate, apex obtuse, shortly apiculate, base truncate, 7-veined, ca. 2.6 cm long, ca.1.1 cm wide; lateral sepals obliquely triangular-ovate, apex acute, apiculate, base obliquely truncate, abaxial surface with distinct keel, 7-veined, posterior margin ca. 2.6 cm long, anterior margin ca. 5 cm long, ca.1.2 cm wide. *Mentum* very narrowly conical, ovipositor-shaped, apex obtuse, 2.35 cm long, 0.175 cm in diameter. *Petals* broadly oval, apex obtuse, margin slightly undulate, at least 3 cm long, 2.1 cm wide. *Labellum* 3-lobed, with two short but elevated callus at base, ca. 3.3 cm long, ca. 1.9 cm wide across side lobes, ca. 2.8 cm wide across mid-lobe; side lobes obliquely ovate, with transverse rugose at distal half, each side lobe 0.55 cm long, 0.5 cm wide, margin entire; mid-lobe transversely oval, obreniform, verrucose at base, apex retuse to emarginate, margin slightly undulate, ca. 1.9 cm long. *Column* ca. 6 mm long; foot broad at the base, concave, canaliculate, ca. 25 mm long; stigmatic cavity ovate; stelia triangular;

connective narrowly triangular; anther cap ovate, apex truncate, ca. 3 mm wide. *Ovary* (including pedicel) narrowly clavate, 6-grooved, ca. 4.9 cm long. *Capsule* not seen.

DISTRIBUTION. – Indonesia.

HABITAT AND ECOLOGY. – Unknown.

SPECIMENS EXAMINED. – INDONESIA: cult. *E. Jacobson* s.n., Sumatra, Tapiannoeli, Sirirok, 1859 Unpublished illustration drawn by J.J. Smith (L).

NOTE. – *Dendrobium igneoniveum*, the species was described by J.J. Smith in 1927. However, I had never seen the type specimen. J.J. Smith indicated that he described from the spirit specimen but did not mention about the deposited herbarium. I only have seen the species from the unpublished drawing of J.J. Smith deposited at Leiden.

J.J. Smith noted that *Dendrobium igneoniveum* is the allied species to *D. radians* and *D. ovipostoriferum* from Borneo, but labellum with more distinct side lobes and a broad kidney-shaped mid-lobe.

In my opinion, *Dendrobium igneoniveum*, *D. radians* and *D. scultum* are the very close species. They have the intermediate characters of the labellum. The differences between the three species are within the normal range of variation seen in other species, so they are probably not distinct and highly possibility to unite to one. Unfortunately, there are a few collections of *D. sculptum* and *D. radians* and only one drawing of *D. igneoniveum*. No living material for examining the fresh flower and for molecular study.

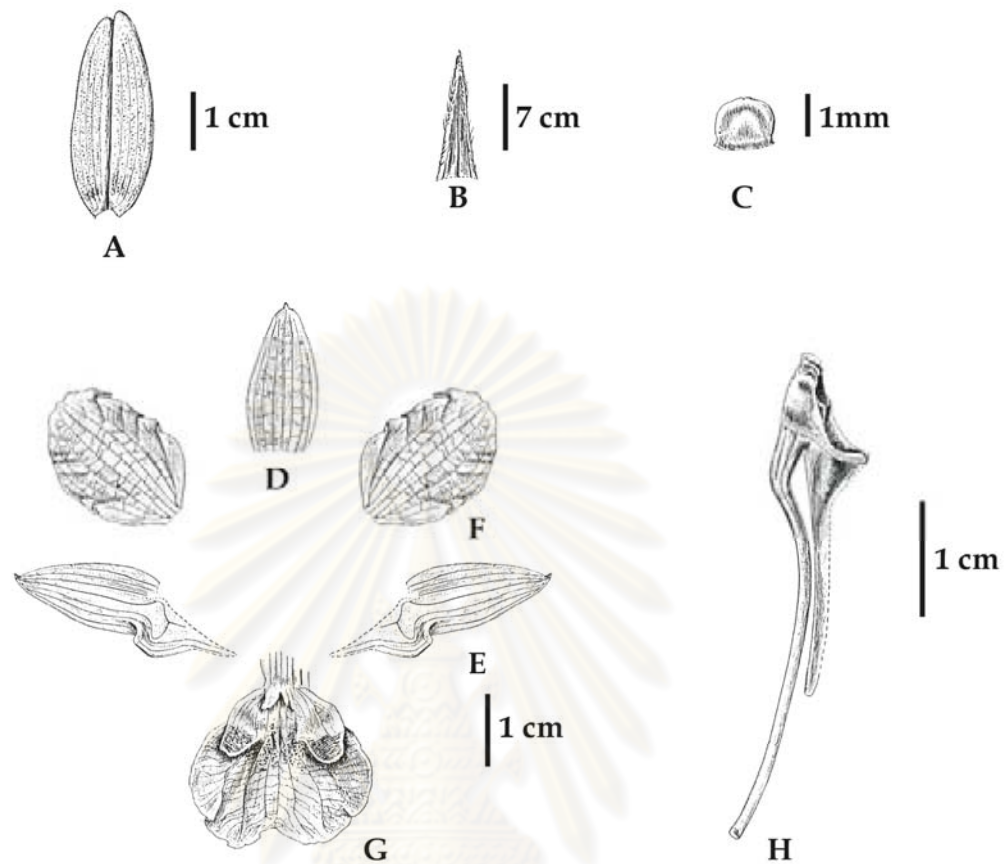


FIGURE 5.12. *Dendrobium igneoniveum* J.J. Sm. **A.** Leaf; **B.** Floral bract; **C.** Anther cap; **D.** Dorsal sepal; **E.** Lateral sepal; **F.** Petal; **G.** Labellum; **H.** Column and column foot, side view. After an unpublished illustration drawn by J.J. Smith (lectotype).

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13. *Dendrobium infundibulum* Lindl., J. Proc. Linn. Soc. Bot. 3: 16. 1859; Thaithong, Thai Orchid: 208. 2000. Type: *Lobb s.n.* (holotype K!; isotype K!, in Lindley Herbarium), Myanmar, Moulmein (nowadays Mawlamyaing City). Fig. 5.13; Pl. 4: M&N; Pl. 5: A-B.

Dendrobium moulmeinense Low ex Baker, Bot. Mag. 90: t. 5446. 1864.

Dendrobium infundibulum var. *ornatissimum* Rchb. f., Gard. Chorn. 19: 656. 1883.

Type: *Sander s.n.* (holotype W!), Myanmar, Moulmein, 1883.

Dendrobium infundibulum var. *carneopictum* Rchb. f., Gard. Chorn. 19: 1885. Type:

Williams s.n. (holotype W!), Myanmar.

Callista infundibulum (Lindl.) Kuntze, Revis. Gen. Pl. 2: 655. 1891.

Flowering shoots erect, cylindrical, brown or ferruginous, 18-37 cm tall, internodes 3.4-5.7 cm long, 1.2-1.5 cm in diameter, leafy along the upper part of stem. **Leaves** distichous, spreading or slightly recurved, thinly coriaceous, green, oblong-elliptic or lanceolate, apex unequally bi-lobed, each lobe acute, mid-vein grooved above and ribbed below, adaxial surfaces sparsely covered with black hirsute hairs, becoming glabrate with aged, abaxial surfaces covered with black hirsute hairs, 3.8-5.7 cm long, 1.6-2.1 cm wide; leaf-sheaths covered with short black hirsute hairs, 2.5-5.3 cm long. **Inflorescences** abbreviated, 1- to 3-flowered, borne along the upper to middle part of both leafy and leafless stems, emerging from base of leaf sheaths opposite the blade; peduncle and rachis glabrous, light green, 0.2-0.3 cm long; floral bracts concave, abaxial surface covered with black hirsute hairs, adaxial surface glabrous, pale brown or brown, oblong, apex acute, base truncate, 2- to 4-veined, 0.8-1.3 cm long, 0.4-0.6 cm wide. **Flowers** papyraceous, resupinate, somewhat waxy, unscented, veins obscured, visible when aged, up to 4.7-5.5 cm in diameter; sepals and petals white; mentum white or yellowish white from outside; labellum white, claw yellow or yellowish orange, side lobes white with yellowish orange lines or blotches on adaxial surface, somewhat waxy; disc yellowish orange; mid-lobe white with more or

less yellowish orange lines; column white, foot yellow or yellowish orange, stigmatic cavity white, anther-cap white, pollinia yellow, pedicellate ovary green or light green. *Sepals* spreading, distally recurved, margin entire, abaxial surface with keel, conspicuous at apical part,; dorsal sepal ovate or elliptic-ovate, apex acuminate, base truncate, 3- to 5-veined, mid-vein grooved on adaxial surface, 2.8-3.6 cm long, 1.1-1.4 cm wide; lateral sepals obliquely triangular-oblong, apex acute or acuminate, base obliquely truncate, 3- to 5-veined, posterior margin 2.7-3.8 cm long, anterior margin 4.8-5.2 cm long, 1-1.4 cm wide at base, ca. 0.5 cm wide at apex. *Mentum* narrowly conical, apex obtuse, 2.5-3.2 cm long, 0.4-0.6 cm in diameter at base, ca. 0.5 cm in diameter at apical part. *Petals* spreading, slightly recurved, widely obovate, apex round or obtuse, base truncate, upper half margin crenulate, lower half margin entire, 9- to 12-veined, 3.4-3.9 cm long, 2.6-3 cm wide. *Labellum* 3-lobed, 5.3-6.6 cm long, 3.3-3.8 cm wide across side lobes; claw linear or narrowly triangular, 17-22 mm long; side lobes obliquely ovate, adaxial surface with 6- to 7-slightly elevated veins along each side lobe, each vein bearing sparse wart-like callus, apex round, lateral margin entire, front margin crenate; disc narrowly oblong, prominent, surface smooth, somewhat waxy, becoming 3-5 keeled at the apical part, continuing to mid-lobe; mid-lobe obovate or widely obovate or obovate-oblong, various in shape and size, with 3-5 keels at basal part, apex deeply emarginated, V-shaped, apiculate between sinus, margin irregular undulate or crenate, sometimes crisped, 1.3-2.3 cm long, 1.8-2.5 cm wide. *Column* surface smooth, without waxy, 6-9 mm long, ca. 5 mm wide at base; foot slightly concave, tapering downwards, surface smooth, 24-26 mm long, 5-6 mm wide at entrance of mentum; stigmatic cavity ovate or elliptic; stielidia triangular; connective linear or narrowly triangular; anther cap obovate, surface very minutely papillose, apex emarginate, basal margin ciliate, adaxial surface sulcate, 3.5-3.7 mm long, 3.2-3.5 mm wide; pollinia 4, in 2 pairs, each pollinium narrowly elliptic, without caudicle and visidium. *Ovary* (including pedicel) narrowly clavate, slender, glabrous, 6-grooved, 3.8-4.3 cm long. *Capsule*

dehiscent, green or dull green, elliptic, apex with persistent dried perianth, 3.6-4.3 cm long, 1.9-2.3 cm wide.

DISTRIBUTION. – India, Myanmar and Thailand.

HABITAT AND ECOLOGY. – Epiphytes in evergreen forests or dry evergreen forests, at 1,000-2,00 m alt. Flowering period: August to March.

VERNACULAR. – Ueang ngoen luang (เอื้องเงินหลวง), Ueang ta hoen (เอื้องตาหิน)

SPECIMENS EXAMINED. – INDIA: *Walter N. Koelz 32841* (L), Lushai Hills, 7,000 m alt., 31 March 1953.

MYANMAR: *Sine coll. s.n. Reichb.f. Orchids Herb. no. 6607* (W); *Foerstermann.s.n.* (W); *Foerstermann.s.n.* (W); *Sine coll. s.n. Reichb.f. Orchids Herb. no. 6192* (W); *Foerstermann. s.n.* (W).

THAILAND: *C. Niyomdham & J.E.Vidal 504* (AAU), Loei, Phu Luang 1,500 m alt., 3 Feb 1983; *C.F. van Beusekom & C. Phengklai 3102* (AAU), Loei, Phu Luang, 1,250 m alt., 19 Jan 1970; *B. Hansen & T. Smitinand 12,759* (AAU), Mae Hong Son, Doi Khun Huai Pong, 1,800 m alt., 2 March 1968; *Bernt Lojtnant & Chawalit Niyomdham 102* (AAU), Doi Inthanond 1,800 m alt., 2 Jan 1978; *C.F. van Beusekom & C. Phengklai 229* (AAU), Kanchanaburi, Khao Yai, 1,450 m alt., 30 March 1968; *B. Hansen & T. Smitinand 12,759* (L), Mae Hong Son, Doi Khun Huai Pong, 1,800 m alt., 2 March 1968; *C.F. van Beusekom & C. Phengklai 229* (L), Kanchanaburi, Kho Yai, E. of Sangkhla, 1,450 m alt., 30 March 1968; *R. Geesink, P. Hiepko & C. Phengklai 8,018* (L), Chiang Mai, Doi Inthanond, 2,600 m alt., 31 December 1974; *C.F. van Beusekom & C. Phengklai 3102* (L), Loei, Phu Luang, 1,250 m alt., 1 January 1970; *K. Bunchuai 1492* (L), Loei, Phu Luang, 5 February 1965; *J.F. Maxwell 89-258* (L), 24 February 1989; *J.F. Maxwell 90-274* (L), 1 March 1990.

LOCALITY UNKNOWN: *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 35696 (W); *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 32451 (W); *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 32477 (W); *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 853 (W); *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 853 (W); *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 14837 (W); *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 32478 (W); *William Bull & F.L.S.* 614 (W); *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 14813 (W); *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 29597 (W); *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 31997 (W); *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 31910 (W).



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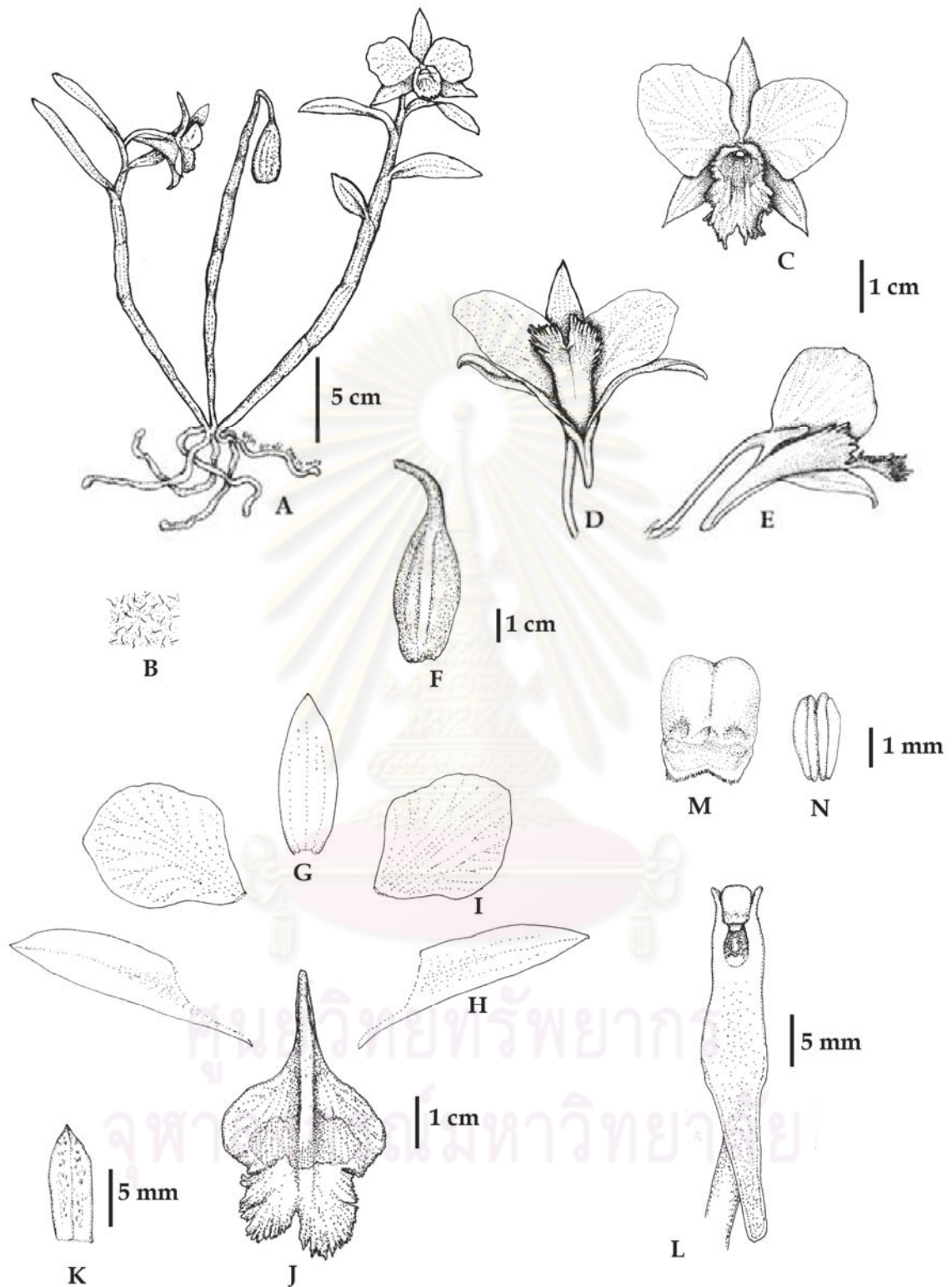


FIGURE 5.13. *Dendrobium infundibulum* Lindl. **A.** Habit; **B.** Hairs, on leaf; **C.** Flower, front view; **D.** Flower, from below; **E.** Flower, side view; **F.** Fruit; **G.** Dorsal sepal; **H.** Lateral sepal; **I.** Petal; **J.** Labellum; **K.** Floral bract; **L.** Column and column foot, from below; **M.** Anther cap; **N.** Pollinia. Drawn from A. Sathapattayanon 417 by Mr. Tanucha Boonjaras.

14. *Dendrobium jamesianum* Rchb. f., Gard. Chorn. 1869: 554. 1869. Type: *Benson s.n.* (holotype W!), Myanmar, Moulmein (Mawlamyaing City). Fig. 5.14; Pl. 5: C.

Dendrobium infundibulum var. *jamesianum* (Rchb. f.) Veitch, Manual of Orchid. Pl. 1: 50. 1887.

Flowering shoots erect, stout, cylindrical, brown or ferruginous, 32-49 cm tall, internodes 2.5-3.4 cm long, 0.6-0.9 cm in diameter, leafy along the upper part of stem. **Leaves** distichous, spreading or slightly recurved, coriaceous, green or dull green, oblong-elliptic or ovate, apex unequally bi-lobed, each lobe acute, mid-vein grooved above and ribbed below, both surfaces densely covered with black hirsute hairs, 4-5.8 cm long, 1.9-2.4 cm wide; leaf-sheaths densely covered with short black hirsute hairs, 2.5-3.4 cm long. **Inflorescences** abbreviated, 1- to 2-flowered, borne at the apical part or uppermost node of leafy stems, emerging from base of leaf sheaths opposite the blade; peduncle and rachis glabrous, light green, 0.2-0.3 cm long; floral bracts concave, abaxial surface covered with dense black hirsute hairs, adaxial surface glabrous, pale brown or brown, oblong or oblong-lanceolate, apex acuminate, base truncate, 2- to 4-veined, 1.3-1.5 cm long, 0.4-0.6 cm wide. **Flowers** papyraceous, resupinate, somewhat waxy, unscented, veins visible; sepals and petals white, up to 7.5-9.5 cm in diameter; mentum yellowish white or orangish white from outside; labellum white, claw yellow or yellowish orange, side lobes white with yellowish orange lines or blotches on adaxial surface, somewhat waxy; disc yellowish orange; mid-lobe white with more or less yellowish orange lines; column white, foot yellow or yellowish orange, stigmatic cavity white, anther-cap white, pollinia yellow, pedicellate ovary green or light green. **Sepals** spreading, distally recurved, margin entire, mid-vein grooved on adaxial surface, abaxial surface keeled, conspicuous at apical part; dorsal sepal ovate or elliptic-ovate, apex acuminate, base truncate, 5- to 7-veined, 4.3-4.6 cm long, 1.2-1.7 cm wide; lateral sepals obliquely triangular-

oblong, apex acuminate, base obliquely truncate, 5- to 7-veined, posterior margin 4.4-4.8 cm long, anterior margin 6.1-6.9 cm long, 1.3-1.8 cm wide at base, ca. 0.3 cm wide at apex. *Mentum* narrowly conical, apex obtuse, 2.5-2.7 cm long, 0.6-0.8 cm in diameter at base, ca. 0.6 cm in diameter at apical part. *Petals* spreading, slightly recurved, widely obovate, apex acuminate, sometimes obtuse, base truncate, upper half margin subentire or crenulate, lower half margin entire, 9- to 12-veined, 4.8-5.2 cm long, 3.1-3.5 cm wide. *Labellum* 3-lobed, 6.3-6.9 cm long, 3.6-4 cm wide across side lobes; claw linear or narrowly triangular, 25-28 mm long; side lobes obliquely ovate or obliquely rhombic, adaxial surface scabrous, with 7- to 9-elevated veins along each side lobe, each vein bearing dense wart-like and short hair-like callus, apex round or sometimes truncate, lateral margin entire, front margin crenate; disc narrowly oblong, prominent, surface smooth, waxy, becoming roughly 3-5 keeled at the apical part, continuing to mid-lobe; mid-lobe oblong or widely oblong, often bigger than each side lobe, with 3-5 keels at basal part, apex truncate or shallow emarginated, apiculate, margin irregular undulate or crenate, 2-2.8 cm long, 1.9-2.4 cm wide. *Column* surface smooth, without waxy, 6-10 mm long, 6-7 mm wide at base; foot slightly concave, tapering downwards, surface smooth, 29-35 mm long, 6-9 mm wide at entrance of mentum; stigmatic cavity ovate or elliptic; stelidia triangular; connective linear or narrowly triangular; anther cap obovate, surface very minutely papillose, apex emarginate, basal margin ciliate, adaxial surface sulcate, 3.1-3.5 mm long, 3-3.2 mm wide; pollinia 4, in 2 pairs, each pollinium narrowly elliptic, without caudicle and visidium. *Ovary* (including pedicel) narrowly clavate, glabrous, 6-grooved, 4.2-4.5 cm long. *Capsule* not seen.

DISTRIBUTION. — India and Myanmar.

HABITAT AND ECOLOGY. — Epiphytes in evergreen forests, at high altitude 1,200-2,000 m.

SPECIMENS EXAMINED. — INDIA: *Sine coll. s.n.* (TNS), 15 Dec. 2006.

MYANMAR: *Sine coll. s.n.* TBG 128905 (TNS).

LOCALITY UNKNOWN: *Cult. Hort. Kew. Entry No. 188-1932* (K), 14 March. 1932; *Cult. Hort. Kew. Entry No. 139-1954* (K), 11 May 1955.



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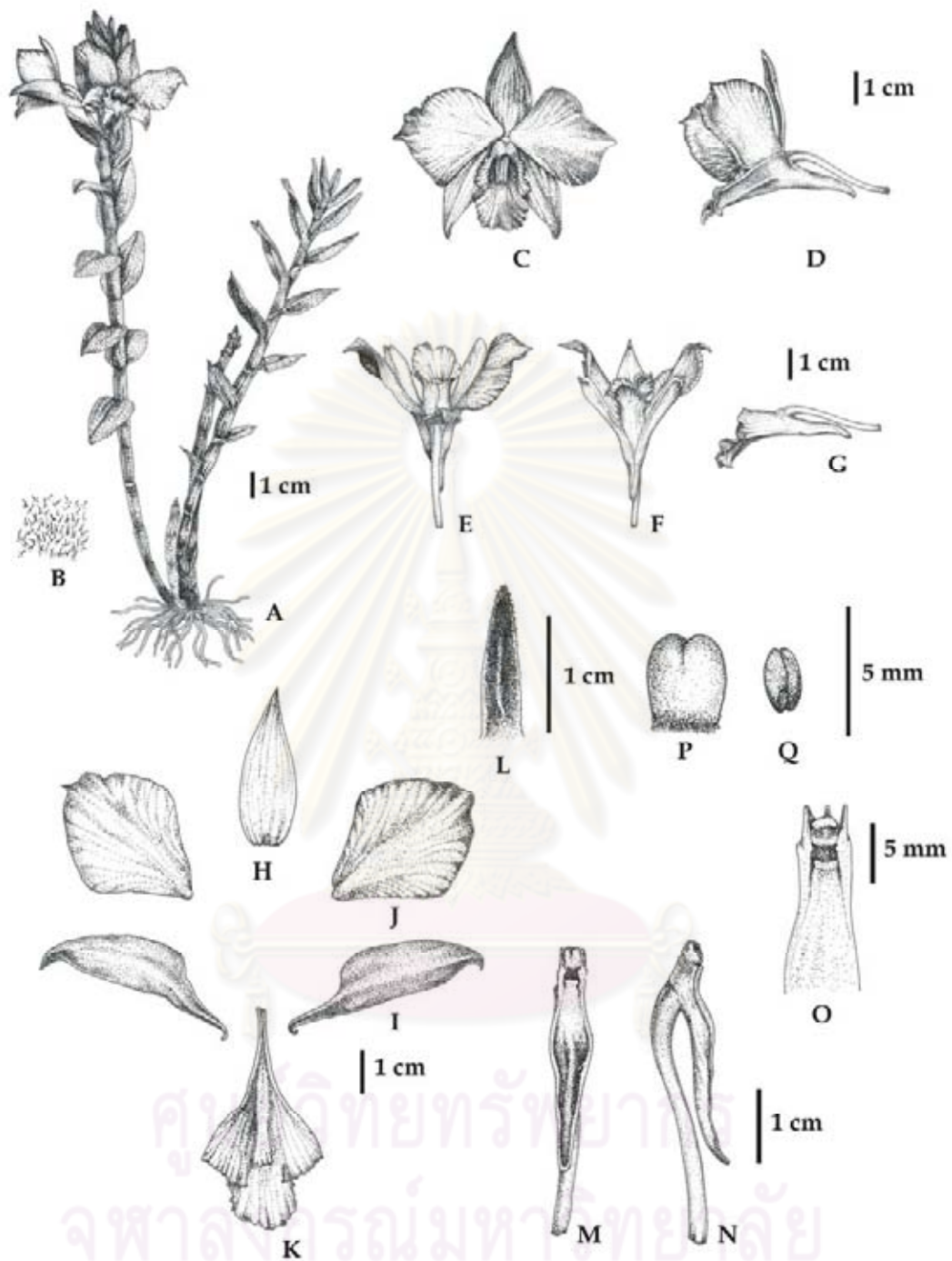


FIGURE 5.14. *Dendrobium jamesianum* Rchb.f. **A.** Habit; **B.** Hairs, on leaf; **C.** Flower, front view; **D.** Flower, side view; **E.** Flower, from above; **F.** Flower, from below; **G.** Labellum and mentum, side view, sepals and petals removed; **H.** Dorsal sepal; **I.** Lateral sepal; **J.** Petal; **K.** Labellum; **L.** Floral bract; **M.** Column and column foot, from below; **N.** Column and column foot, side view; **O.** Column, from below, anther cap removed; **P.** Anther cap; **Q.** Pollinia. Drawn from *Hort. Tsukuba Botanical Garden* accession number 128905 by Ms. Sirilax Tapdechachan.

15. *Dendrobium kontumense* Gagnep., Bull. Soc. Bot. France 79: 165. 1932; In: Flore Générale de l' Indo-Chine 6: 239. 1934; Seidenf., Con. Rev. Orchid Cambodia, Laos and Vietnam: 46. 1975. Type: *Poilane 18280* (holotype P!; isotype C!), Vietnam, Kon Tum Province, Giang Lo to Dac To, 500 m alt., 8 September 1930. Fig. 5.15; Pl. 5: D.

Dendrobium sculptum auct. non Rchb. f.; A.D. Kerr, Nat. Hist. Bull. Siam Soc. 23: 193. 1969; Seidenf., Bull. Mus. Nat. Hist. Paris, 5: 123. 1973; Con. Rev. Orchid Cambodia, Laos and Vietnam: 51. 1975.

Dendrobium virgineum auct. non Rchb. f.; Seidenf. Opera Bot. 83: 112, f. 68. 1985; Opera Bot. 114: 211, f. 134. 1992; Aver., In: Vasc. Pl. Synopsis Vietnam. Fl. 1: 83. 1990; Iden. Guide. Vietnam. Orchids: 182. 1994; S. Rakpaibulsombat, Thai Orchid Sp. pl. 30. 1992; M.L. Baker & C.O. Barker, Orchid Sp. Cult.: 758. 1996; Thaithong, Orchid. of Thail.: 127. 1999; Thai Orchid: 231. 2000; N.X.B.V.H. Dân Tộc, Phong Lan Việt Nam: 102. 2000; Lavarack, Austral. Orchid Rev. 66(3): 13. 2001; S.Y. Alsagoff & W.S. Hong, Malayan Orchid Rev. 35: 73, include photo 5 on p. 70. 2001; H. Schildhauer, J. Orchideenfr. 9: photo on p. 371. 2002; Aver. & A. Averyanova, Updated Checklist Orchids Vietnam: 31. 2003; Turrczaninowia 8(1): 60. 2005; N. Vaddhanaphuti, Field Guide Wild Orchid Thail.: 131. 2005.

Dendrobium schildhaueri Ormerod & H.A. Pedersen, Orchid Rev. 111: 341. 2003; J. Orchideenfr. 11: 35. 2004; H.P. Wood, In: The Dendrobiums: 691, pl. 140. 2006. **syn. nov.** Type: Sine Coll. *GT 9301* (holotype C!), Thailand, Nong Khai Province, Seka, October 1983.

Flowering shoots erect, tufted, cylindrical, gradually reduce toward both ends, rigid, sulcate, slightly constricted at nodes, green or greenish brown, 15.3-29.7 cm tall, internodes 1.7 -2.5 cm long, 1.2-1.5 cm in diameter, leafy along upper to middle half of stem. **Leaves** distichous, coriaceous, spreading, sometimes slightly

recurved, adaxial surfaces glabrescent, glossy, abaxial surface covered with dense short black hirsute hairs, mid-vein grooved above and ribbed below, green or dull green, ovate or narrowly elliptic or elliptic-ovate, apex unequally bilobed, each lobe obtuse, 4.2-5.8 cm long, 1.6-2.2 cm wide; leaf-sheaths covered with short black hairs, densely near apex, 1.8 -2.5 cm long. *Inflorescences* lax raceme, erect, abbreviated, 2- to 4-flowered, borne along the upper portion of both leafy and leafless stems, emerging from base of leaf sheaths opposite the blade; peduncle and rachis glabrous, green, 0.2-0.5 cm long; floral bracts brown or ferruginous, abaxial surface covered with dense black hairs, adaxial surface glabrous, triangular-ovate, slightly concave, apex acuminate, base truncate, 2- to 4-veined, 0.7-1 cm long, ca. 5 cm wide. *Flowers* resupinate, hard, waxy and polished, faintly fragrant or unscented, long-lasting, up to c. 6 cm in diameter; sepals and petals white; mentum white or reddish white from outside; labellum white, side lobes and disc white, waxy, mid-lobe white with cream to reddish orange blotch at basal portion; column white, column white or white with somewhat pale red, foot white or pale red, stigmatic cavity white or ivory white, anther-cap white, pollinia yellow, pedicellate ovary white, becoming light green at the base of pedicel. *Sepals* spreading or recurved, margin entire or slightly undulate, abaxial surface distinctly keeled; dorsal sepal lanceolate-oblong or oblong, apex acuminate, base truncate, veins hardly visible, 2.7-3.4 cm long, 0.8-1.2 cm wide; lateral sepals obliquely triangular-lanceolate, sometime slightly falcate, apex acuminate, base obliquely truncate, 3- to 5-veined, hardly visible, posterior margin 1.5-2.8 cm long, anterior margin 3.7-4.5 cm long, 0.8-1.1 cm wide at base, c. 0.3 cm wide at apex. *Mentum* very narrowly conical, ovipositor-shaped, straight or incurved distally, apex obtuse, 1.7-2.3 cm long, 0.2-0.3 cm in diameter. *Petals* slightly or strongly recurved, obovate or elliptic, gently reduced at base, apex rounded, base truncate, margin entire or slightly undulate, 5- to 7-veined, 2.7-3.2 cm long, 1.1-1.5 cm wide at base. *Labellum* porrect, veins and veinlets visible, un-thickened, without callus, 4.7-5.2 cm long, 2-2.5 cm wide across side lobes; claw linear or narrowly triangular, 15-19 mm long; side lobes

shallowly deltoid or obliquely widely obovate or obliquely widely elliptic, apex obtuse, margin entire; disc oblong or narrowly oblong; mid-lobe transversely elliptic, apex emarginate, margin irregular erose and crisped or wavy, 0.9-1.3 cm long, 0.8-1.4 cm wide. *Column* dilated at base, 5-7 mm long, 4-6 mm wide at base; foot slightly concave, margin raised at base, surface papillose, 22-28 mm long, 5-7 mm wide at base; stigmatic cavity elliptic or ovate; stelidia broadly triangular; connective linear or narrowly triangular; anther cap widely obovate or obovate-oblong, surface minutely papillose, apex rounded, basal margin minutely ciliate, adaxial surface sulcate, 3.4-3.7 mm long, 2.9-3.2 mm wide; pollinia 4, in 2 pairs, each pollinium narrowly elliptic, without caudicle and visidium. *Ovary* (including pedicel) slender, narrowly clavate, glabrous, 6-grooved, 2.4-2.9 cm long. *Capsule* dehiscent, green or dull green, elliptic or elliptic-oblong, with 3 obtuse keels, apex bunt with persistent dried perianth, 2.2-2.7 cm long, 1.3-1.6 cm wide.

DISTRIBUTION. — Thailand, Laos and Vietnam.

HABITAT AND ECOLOGY. — Epiphytes in dry evergreen forests, at altitude 500-1,000 m. Flowering period: August to October.

SPECIMENS EXAMINED. — THAILAND: *Sukhakul* GT 8993 (C), Nakorn Phanom; *Sakdi* 4500 (C), Nong Khai, Phu Wua; *Sakdi* GT 8952 (C), Nong Khai, Phu Wua; *A. Sathapattayanon* 408 (BCU), Nong Khai, Phu Wua; *A. Sathapattayanon* 435 (BCU), Nong Khai, Phu Wua; sine coll. GT 9301 (C), Nong Khai, Seka; sine coll. GT 9307 (C), Ubon Ratchathani; *Saki* GT 8967 (C), sine loc.; *O. Thaithong* 737 (BCU), sine loc.; *O. Thaithong* s.n. (BCU), sine loc.

LAOS: *A.D. Kerr* 988 (C), Vientiane, Phou Khaokhoay; *A.D. Kerr* s.n. (K), Vientiane, Phou Khaokhoay; *Vidal* 5585 (P), Vientiane; *A.D. Kerr* 984 (K), sine loc.; *Delacaeur* 177 (P), sine loc.

VIETNAM: *Oct.a.* 2005/12418, *HAL* 8632/13249, Lâm Dong (Photographs seen, kindly sent by Prof. L. Averyanov); *Vadherst s.n.* (P), sine loc.

NOTE. — The flower is white with a small central blotch on the lip, which varies in colour from very pale to reddish orange.



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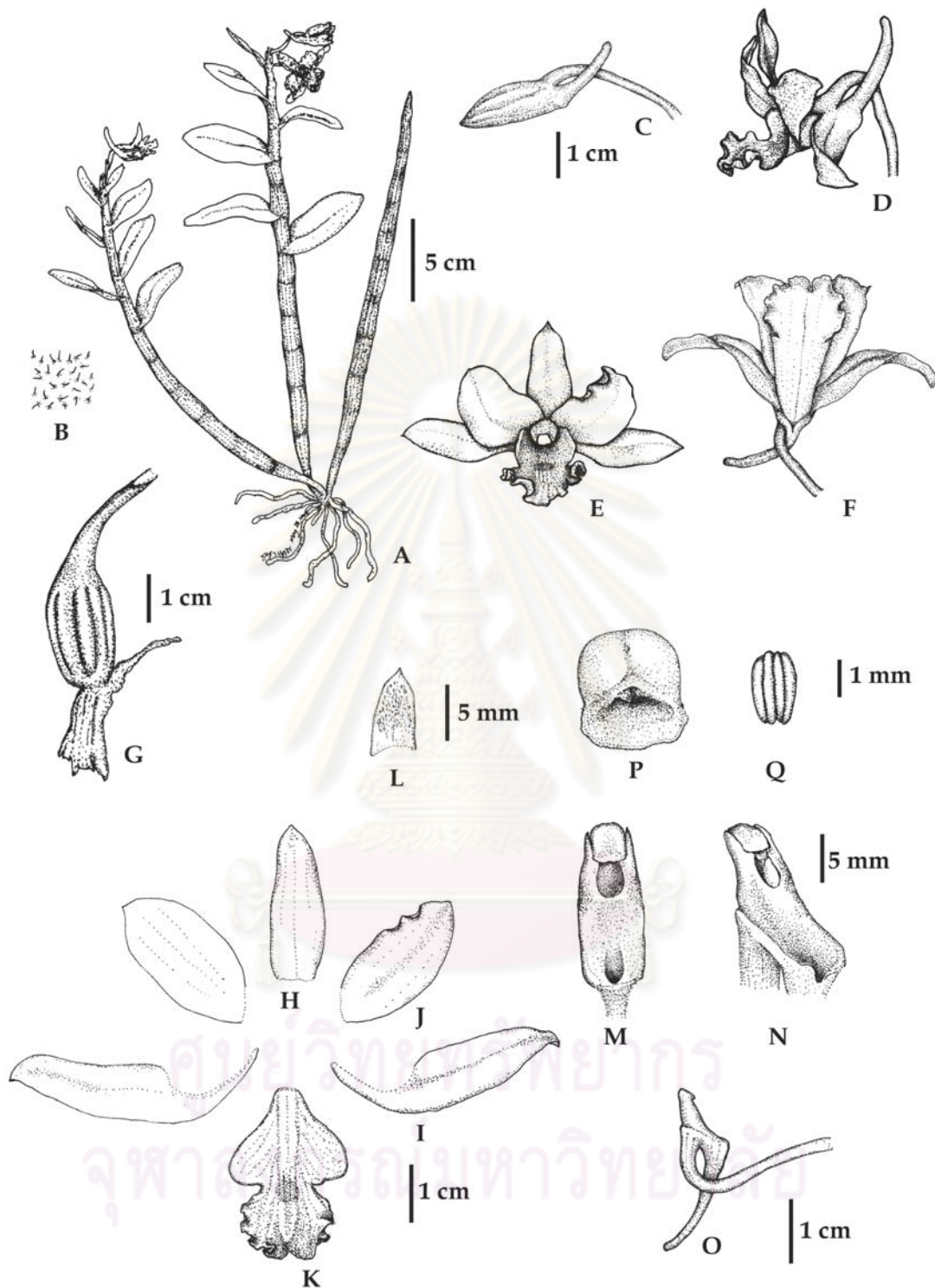


FIGURE 5.15. *Dendrobium kontumense* Gagnep. A. Habit; B. Hairs, on leaf; C. Flower bud, side view; D. Flower, side view; E. Flower, front view; F. Flower, from above; G. Fruit; H. Dorsal sepal; I. Lateral sepal; J. Petal; K. Labellum; L. Floral bract; M. Column and column foot, from below; N. Column, side view; O. Column and column foot, side view; P. Anther cap; Q. Pollinia. Drawn from A. Sathapattayanon 408 by Mr. Tanucha Boonjaras.

16. *Dendrobium longicornu* Lindl., In: Edward's Bot. Reg. 16: t. 1315, exclude an illustration. 1830a; Gen. Sp. Orchid. Pl.: 80. 1830b; Veitch, Manual of Orchid. Pl. 1: 56. 1887; Hooker. f., In: Fl. Brit. Ind. 5: 720. 1890; M.L. Banerji & B.B. Thapa, J. Bombay Nat. Hist. Soc. 67(2): 145. 1970; Pradhan, India. Orchid. 2: 328. 1979; T.K. Bose & S.K. Bhattacharjee, Ochid. India.: 220. 1980; Banerji, Orchid. Nepal.: 63, fig. 27. 1982; M.L. Baker & C.O. Barker, Orchid. Sp. Cul.: 413. 1996; H.J. Chowdhery, Orchid. Flora. Arunachal Pradesh.: 310, fig. 183. 1998; K. White & B. Sharma, Wild Orchids in Nepal.: 227, pl. 92. 2000; N.X.B.V.H. Dân Tôc, Phong Lan Việt Nam.: 94, Ảnh 131, exclude Hình 167. 2000; Rajbh. & S. Bhattarai, Beautiful Orchids of Nepal: 109. 2001; N.R. Pearce & P.J. Cribb, Orchids of Bhutan: 417. 2002; R.D. Milleville & Shrestha, Nepal Orchid. Pic.: 72, pl. 130. 2004; D.B. Gurung, Illus. Guide Orchid. Bhutan: 121. 2006; H.P. Wood, The Dendrobiums. 656, PA 161. 2006. Type: *N. Wallich s.n.* (syntype K!, in Wallich Catalogue no. 1997.1; isosyntype K!, P! and C!), Nepal, Thoka and *F. De Silva s.n.* (syntype K!, Wallich catalogue no. 1997.2), Bangladesh, Shlhet Mountain. Fig. 5.16; Pl. 5: E.

Froscula hispida Raf., Fl. Tellur. 4: 44. 1838.

Callista longicornis (Lindl.) Kuntze, Revis. Gen. Pl. 2: 655. 1891.

Flowering shoots erect, slender, cylindrical, somewhat flexuous, more or less sulcate, light green or yellowish green or brownish green, 12-27 cm tall, internodes 2-2.7 cm long, 0.3-0.6 cm in diameter, leafy at the upper part of stem, sometimes non flowering shoot bulbiferous at distal nodes. **Leaves** distichous, spreading or slightly recurved, thinly coriaceous, young leaves covered with dense black hirsute hairs on both sides, adaxial surface of mature leaf becoming glabrous, more or less waxy, abaxial surface sparsely with short, black, hirsute hairs, becoming glabrous with age, mid-vein grooved above and ribbed below, green or dull green, lanceolate or narrowly elliptic, apex unequally bi-lobed, each lobe acute or obtuse, 2.5-3.7 cm long, 0.4-0.6 cm wide; leaf-sheaths covered with

caducous black hairs, 1.2-2.3 cm long. *Inflorescences* abbreviated, often 2-flowered or solitary or rarely 3-flowered, subterminal on both leafy and leafless stem, raising from the base of leaf-sheaths opposite the blades; peduncle and rachis, glabrous, light green, 0.2-0.3 cm long, covered with bracts; floral bracts concave, abaxial surface covered with scattered black hairs, adaxial surface glabrous, brown or tawny, oblong or elliptic-oblong, apex acuminate, base truncate, 4- to 6-veined, 1.2-1.8 cm long, 0.3-0.4 cm wide. *Flowers* papyraceous, resupinate, unscented, veins obscured, visible when aged, 3.2 -3.7 cm in diameter; sepals and petals white; mentum white or pale orangish white from outside; labellum white, claw orange or pale orange, side lobes white with slightly elevated yellowish orange veins running along each lobe, disc orange, mid-lobe white with 2 to 4 yellowish orange or orange veins and 3 yellowish orange or orange keels; column white or pale orange, foot white or pale orange, stigmatic cavity white or ivory white, anther-cap white, pollinia yellow, pedicellate ovary light green or greenish white. *Sepals* spreading, recurved backward, margin entire, abaxial surface waxy with distinct keel, more or less continuing to pedicellate ovary, veins hardly visible; dorsal sepal oblong or ovate-oblong, apex acuminate or attenuate, base truncate, mid-vein grooved on adaxial surface, 6- to 7-veined, 1.7-2.4 cm long, 0.5-0.9 cm wide; lateral sepals obliquely triangular-ovate, apex acuminate or attenuate, base obliquely truncate, 7- to 8-veined, posterior margin 1.7-2.6 cm long, anterior margin 4.2-4.8 cm long, 0.9-1.4 cm wide at base, c. 0.2 cm wide at apex. *Mentum* narrowly conical, apex obtuse, straight, 2.8-3.3 cm long, 0.4-0.6 cm in diameter. *Petals* spreading, recurved at apex, linear or lanceolate or narrowly oblong, apex acuminate or attenuate, base truncate, margin entire, sometimes slightly undulate at upper half, 3- to 5-veined, 2.2-2.7 long, 0.5-0.6 cm wide. *Labellum* 3-lobed, 4.9-5.7 cm long, 2.5-2.9 cm wide across side lobes; claw linear or narrowly triangular, 2-2.2 cm long; side lobes obliquely ovate or obliquely elliptic, 6- to 7-slightly elevated veins running along each side lobe, each vein branched at terminal and covered with wart-like callus along distal half, apex obtuse, margin crenate and slightly

undulate; disc narrowly oblong, thickening, smooth, becoming 3-keeled with wart-like callus at middle part, continuing to mid-lobe; mid-lobe ovate or elliptic or oblate, various in shape and size, with 2 to 4 slightly elevated veins and 3 keels bearing wart-like callus, continuing from side lobes and disc, apex attenuate, margin fimbriate, 1.3-2.2 cm long, 1-2.1 cm wide. **Column** surface more or less very minutely papillose, without waxy, 4-5 mm long, 3-4 mm wide at base; foot slightly concave, tapering downwards, 19-25 mm long, 4.5-5 mm wide at entrance of mentum; stigmatic cavity elliptic; stelidia triangular; connective narrowly triangular; anther cap obovate, surface very minutely papillose, apex rounded, basal margin minutely ciliate, adaxial surface sulcate, 2.4-2.8mm long, 2-2.3 mm wide; pollinia 4, in 2 pairs, each pollinium narrowly elliptic, without caudicle and visidium. **Ovary** (including pedicel) narrowly clavate, curved, somewhat waxy, glabrous, 6-grooved, 3.5-4 cm long. **Capsule** dehiscent, green or dull green, ovate or ovate-elliptic with 3 obtuse keels, apex bunt with persistent dried perianth, 2.5-2.9 cm long, 1.2-1.7 cm wide.

DISTRIBUTION. – India, Bhutan, Nepal, Bangladesh, China and Myanmar.

HABITAT AND ECOLOGY. – Epiphytic orchids grow in evergreen forest, altitude 1,200-2,700 m. Flowering period: August to December.

SPECIMENS EXAMINED. – INDIA: C.B. Clake 25,339 (BM); C.B. Clake 25,375 (BM,W); C.B. Clake 36,347 A (BM); C.B. Clake 36,47 (W); C.B. Clake s.n. (W); *Cult. Hort. Kew.* 3-1956 K, spirit collection Vial no. 19,848); G. Kirkpatrick 202 (E); G. Mann s.n.(L, P); G.A. Gammie 1,250 (BM); J.D. Hooker & T. Thomson s.n. (P); J.D. Hooker s.n. (P, W); J.M. Cowan s.n. (E); J.S. Gamble 25,230 (K); J.S. Gamble 25,311(K); J.S. Gamble 25,339 B (K); J.S. Gamble 7,280 (K); N.L. Bor 6,416 (K); Prain 56a (K); R. Pantling 15 (BR, E, K, L, P, W); *sine coll.* s.n. TBG122802 (TNS); W. Griffith 1,844 (P); W.G. Craib 615-98 (K).

BHUTAN: *F. Ludlow & G. Sherriff* 932 (BM); *F. Ludlow, G. Sherriff & G. Taylor* 6,755 (BM, E); *F. Ludlow, G. Sherriff & G. Taylor* 7,220 (BM, E); *I. Broad* s.n. (E); *I.W.J. Sinclair & D.G. Long* 5,66. (E); *R.E. Cooper* 2,381 (E); *R.E. Cooper* 3,611 (E).

NEPAL: *C. Grey-Wilson & B. Phillips* 105 (K); *D.H. Nicolson* 2,736 (BM); *Dept. of Medicinal Plants, Katmandu, Nepal herbarium* no. 7,495 (BM); *Edinburgh Makalu Expedition (1991)* 180 (E); *J.D.A. Staintan & William* 8,647 (BM); *J.D.A. Stainton* 1,768 (BM); *J.H. de Haas* 2,846 (L); *K.L. Sharma* s.n. (BM); *N. Wallich* s.n. (C, K, P); *N. Wallich* s.n. Wallich catalogue no. 1997.1, (K-syntype of *D. longicornu*); *S.S.W.* 8,988 (BM); *TB* 949 (C); *Trudel* 949 (K).

BANGLADESH: *F. De Silva* s.n. Wallich catalogue no. 1997.2 (K-syntype of *D. longicornu*).

MYANMAR: *F. Kingdon-Ward* 22,742 (BM).

LOCALITY UNKNOWN: *Cult. Hort. Kew.* 617-1933 (K, spirit collection Vial no. 20801); *Cult. L.M. Mason* s.n. (K, spirit collection Vial no.19346); *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 18,637 (W); *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 32,356 (W); *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 32,357 (W).

NOTE. — 1. *Dendrobium longicornu* is closely related to *D. infundibulum* Lindl. and *D. wattii* (Hook.f.) Rchb.f. Floral morphology of these species is similar in appearance: the flowers are white with yellowish orange or yellow veins on the labellum and the narrowly conical mentum. However, *D. longicornu* is characterized by its longer and slender mentum, more distinct keels at back of sepals, and much shorter and narrower mid-lobe of labellum than the other two species. Moreover, *D. longicornu* has approximately the same size of petals and median sepal, while *D. infundibulum* and *D. wattii* have broader petals than the median sepal.

2. The illustration t. 1315, associated with the original description of *Dendrobium longicornu* (Lindley 1830a), represent a broad and short mid-lobe of the labellum, when compared with type materials. It also depicts hair-like trichomes on the labellum, which disagree with the original description. This finding approve with Reichenbach's comment on *D. longicornu* (Reichenbach 1884). Actually, the syntypes of this species were collected from Nepal and Bangladesh but this illustration was drawn after the plant cultivated in the Horticultural Society (Lindley 1830a). Actually, its characters agreed very well with the concept of *D. hirsutum*. We concluded that the illustration represent *D. hirsutum*.

3. The isosytype specimen of *Dendrobium longicornu*, deposited at Lindley Herbarium of the Royal Botanic Gardens, Kew, was collected from Nepal by Nathaniel Wallich (Wallich Catalogue no. 1997.1). It is mounted on the same herbarium sheet with *D. hirsutum* and *D. flexuosum*.

4. *F. Kingdon-Ward* 22,742 (BM) was collected from Northwestern Myanmar, Chin State, Mountain Victoria at 6,000–7,000 ft by Frank Kingdon-Ward. The floral characters can be recognized within the concept of *Dendrobium longicornu*. However, the oversize flowers and some characters associated with *D. infundibulum*. Another possibility is an introgression from the latter species, which abundant at the same altitude at Mountain Victoria. Unfortunately, we don't have the fresh leaf material in hand for molecular analysis. The further study with more samples is needed in order to clarify this suspense.

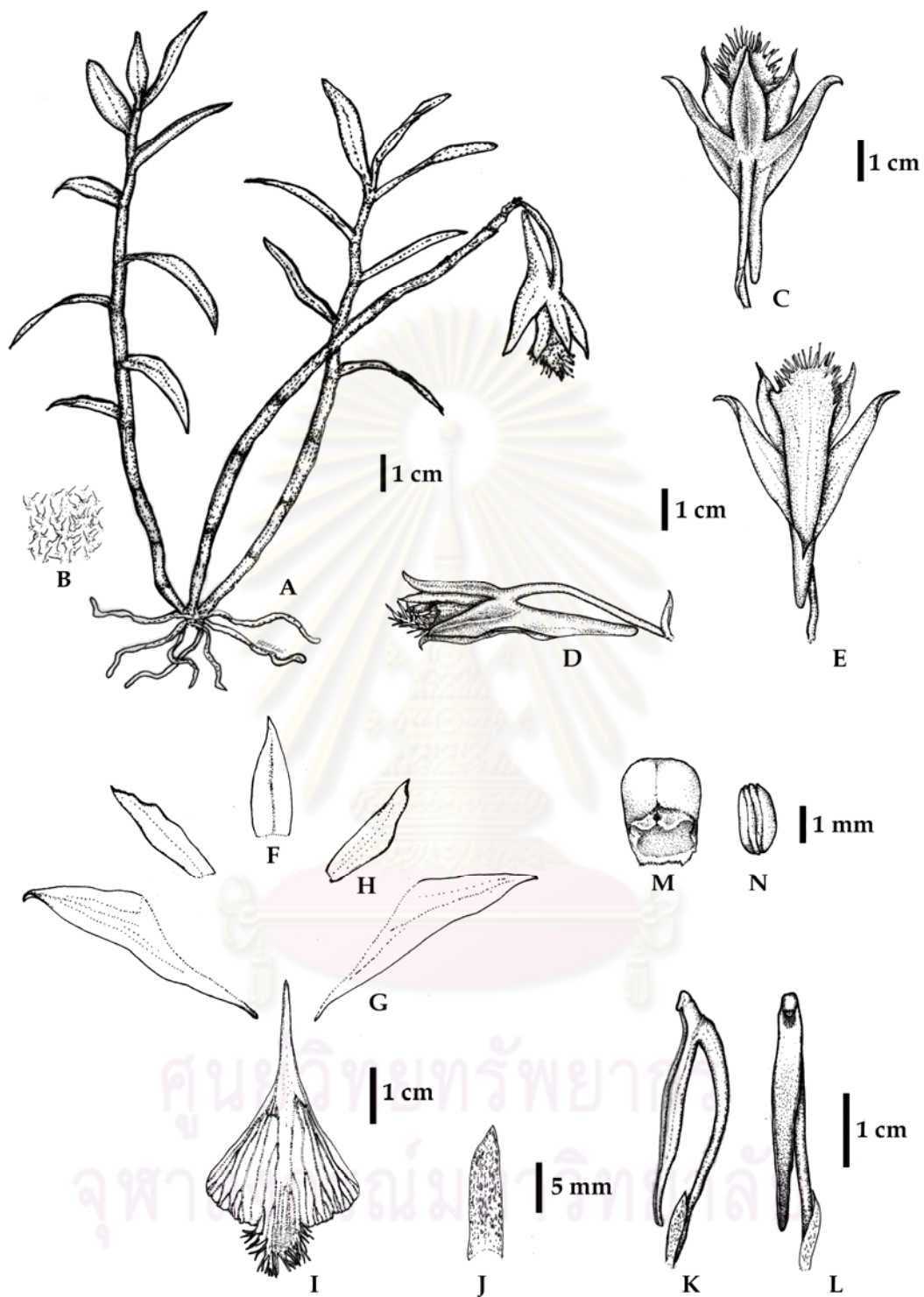


FIGURE 5.16. *Dendrobium longicornu* Lindl. **A.** Habit; **B.** Hairs, on leaf; **C.** Flower, from above; **D.** Flower, side view; **E.** Flower, from below; **F.** Dorsal sepal; **G.** Lateral sepal; **H.** Petal; **I.** Labellum; **J.** Floral bract; **K.** Column and column foot, side view; **L.** Column and column foot, from below; **M.** anther cap; **N.** Pollinia. Drawn from *Hort. Tsukuba Botanical Garden* accession number 122802 by Mr. Tanucha Boonjaras.

17. *Dendrobium lowii* Lindl., Gard. Chron. 1861: 1046. 1861; Hook.f., Curtis's Botanical Magazine 88: t. 5303. 1862; J.J. Wood, Orchid of Borneo 3: 73. 1997; T.E. Beaman *et al.*, Orchids of Sarawak: 48, 253. 2001; H.P. Wood, The Dendrobiums: 656. 2006. Type: cult. *Low s.n.* (holotype K!), Borneo, without precise locality. Fig. 5.17; Pl. 5: F.

Dendrobium lowii Lindl. var. *pleiotrichum* Rchb. f., Gard. Chron. 1885: 424. 1885; John Day, Scrapbook 47: 13. 1885. Type: *E. Low s.n.* (holotype W!), Borneo, without precise locality.

Flowering shoots clustered, erect, cylindrical, flexuose, sulcate, brownish green or brown, 15-66 cm tall, internodes 2-3.5 cm long, 0.5-1 cm in diameter, leafy. **Leaves** distichous, spreading, coriaceous, both surfaces densely covered with black hirsute hairs, mid-vein grooved above and ribbed below, green, oblong-elliptic or oblong-ovate, apex unequally bi-lobed, each lobe obtuse, 6.4-8.8 cm long, 2.3-3.5 cm wide; leaf-sheaths covered with dense black hirsute hairs, 2.5-3.2 cm long. **Inflorescences** abbreviated, 2- to 7-flowered, emerging from the base of the leaf-sheaths along the upper portion of the stem; peduncle and rachis glabrous, light green, 0.8-1 cm long, entirely covered by bracts; floral bracts concave, abaxial surface covered with black hirsute hairs, adaxial surface glabrous, brown, ovate-elliptic, apex acute to acuminate, base truncate, 5- to 7-veined, 1.1-2 cm long, 0.5-0.8 cm wide. **Flowers** thinly coriaceous, resupinate, yellow or creamy yellow, somewhat glaucous, veins obscured, 4.5-5 cm in diameter, claw and side lobes creamy yellow or pale yellow, side lobes with obscure orange or pale pinkish orange veins, disc somewhat waxy, with pale orange to pinkish orange longitudinal lines; mid-lobe yellow, central keel yellow, usually with outer 4-6 orange-red keels, each bearing orange-red laciniae; column orange-yellow, foot orange-yellow, flushed red, anther-cap yellow or orange-yellow, pollinia yellow, pedicellate ovary yellowish green, pale green below. **Sepals** concave at apex, margin entire, lateral margins rolled backward toward

the abaxial surface, veins obscured; dorsal sepal oblong-elliptic, apex acute or mucronate, base truncate, abaxial surface distinctly keeled, 5- to 6-veined, 2.3-3.2 cm long, 1.1-1.2 cm wide; lateral sepals obliquely triangular-ovate, apex acute or mucronate, base obliquely truncate, abaxial surface with distinct keel, wing-like at apex, 7-veined, posterior margin 2.5-3.4 cm long, anterior margin 4.1-4.3 cm long, 1.2-1.5 cm wide at base, c. 0.8 cm wide at apex. *Mentum* very narrowly conical, ovipositor-shaped, gently decurved, apex obtuse, 2.3-3 cm long, ca. 0.2 cm in diameter. *Petals* slightly recurved, oblong-elliptic, apex obtuse, base obliquely truncate, margin undulate, 9-veined, 2.5-3.2 cm long, 1.4-1.6 cm wide at base. *Labellum* distinctly 3-lobed, 5.3-6.2 cm long, 1.5-1.8 cm wide across side lobes; claw linear, ca. 1.3-1.5 cm long; side lobes obliquely triangular obovate, central portion of veins on upper surface with or without hairs, apex of side lobes acute, margin entire; disc oblong, somewhat waxy; mid-lobe with long claw, spatulate-flabellate, with 5 to 7 low keels bearing numerous finely branched hairs, apex emarginate, decurved, front margin undulate, lateral margin entire, 1.5-1.9 cm long, 1.1-1.4 cm wide. *Column* surface smooth, 4-6 mm long, 4-5 mm wide at base; foot concave, surface smooth, 23-30 mm long, 2-4 mm wide at base; stigmatic cavity widely ovate; stelia triangular; connective narrowly triangular; anther cap ovate or elliptic, surface minutely papillose, apex round, basal minutely margin ciliate, adaxial surface sulcate, 3-3.5 mm long, 3-3.1 mm wide; pollinia 4, in 2 pairs, each pollinium narrowly elliptic, without caudicle and visidium. *Ovary* (including pedicel) narrowly clavate, gently curved, glabrous, 6-grooved, 3-4.5 cm long. *Capsule* not seen.

DISTRIBUTION. – Malaysia and Indonesia.

HABITAT AND ECOLOGY – Epiphytes in lower montane forest, grow in exposed situation at 600-900 m alt.

SPECIMENS EXAMINED. – MALAYSIA: A. Lamb s.n. (K), Sabah, Tawau, on east

coast, July 1979; *A. Lamb and Tham s.n.* (K), Sabah, Tawau, 1981.

INDONESIA: Cult. *Low s.n.* (K), Borneo; *Motley 201* (K), Borneo, Bangarmassing; *J. H. Wibbe 13.259* (BR), Borneo, 3,000 ft alt., *Foerstermann.s.n.* (W); *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 1394 (W).

LOCALITY UNKNOWN: *A. Cogniaux s.n.* (BR), 10 Apr. 1903; K: *H. K. 406*, May 1884; *sine coll.* TBG 134848 (TNS), 03 June 2007.

NOTE — *Dendrobium lowii* is the only one in section *Formosae*, which has golden-yellow flowers rather than predominantly white flowers.

A variant with a pale yellow labellum bearing yellow keels, short yellow laciniae and hairs, but without red pigmentation.



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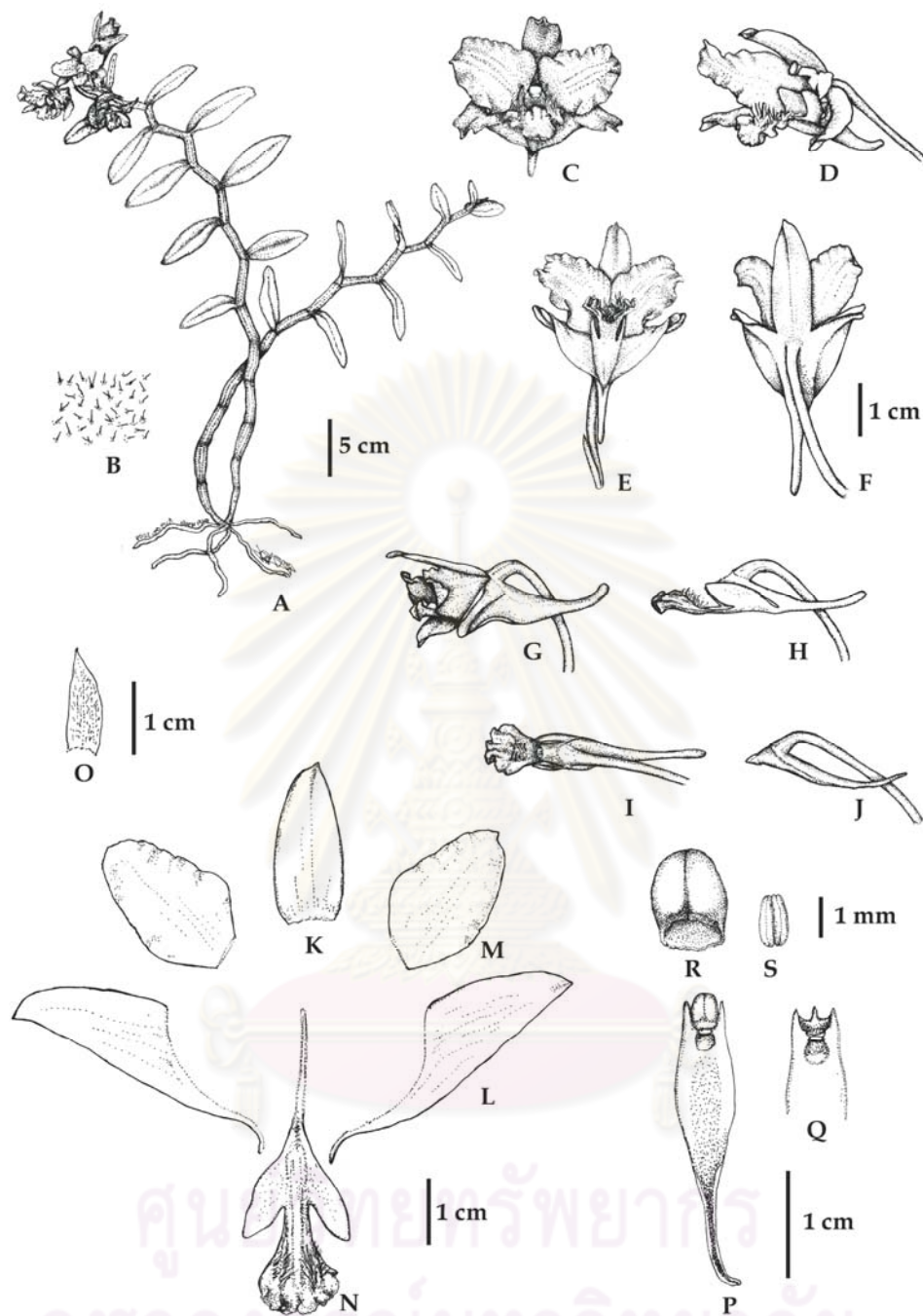


FIGURE 5.17. *Dendrobium lowii* Lindl. **A.** Habit; **B.** Hairs, on leaf; **C.** Flower, front view; **D.** Flower, oblique view; **E.** Flower, from below; **F.** Flower, from above; **G.** Flower, side view; **H.** Labellum and mentum, side view, sepals and petals removed; **I.** Labellum and mentum, from above, sepals and petals removed; **J.** Column and column foot, side view; **K.** Dorsal sepal; **L.** Lateral sepal; **M.** Petal; **N.** Labellum; **O.** Floral bract; **P.** Column and column foot, from below; **Q.** Column, from below, anther cap removed; **R.** Anther cap; **S.** Pollinia. Drawn from *Hort. Tsukuba Botanical Garden accession number 134848* by Mr. Tanucha Boonjaras.

18. *Dendrobium multilineatum* Kerr, J. Siam Soc., Nat. Hist. Suppl. 9: 230. 1933.

Type: *Kerr 972* (holotype K!; isotype P!), Laos, Phu Bia, 1,900 m alt., 12 April 1932.

Fig. 5.18; Pl. 5: G.

Flowering shoots erect, cylindrical, salcate, 35-47 cm tall, internodes 4.2-5.3 cm long, 0.4-0.6 cm in diameter, leafy along the upper part of stem. *Leaves* distichous, spreading, thinly coriaceous, oblong-ovate or lanceolate, apex unequally bi-lobed, each lobe acute, mid-vein grooved above and ribbed below, adaxial surfaces sparsely covered with black hirsute hairs, becoming glabrate with aged, abaxial surfaces covered with dense black hirsute hairs, 7.2-8.5 cm long, 1.7-2.6 cm wide; leaf-sheaths covered with black hirsute hairs, 4.1-5.2 cm long. *Inflorescences* abbreviated, 1- to 2-flowered, borne at the upper part of leafy stems, emerging from base of leaf sheaths opposite the blade; peduncle and rachis glabrous, 0.2-0.4 cm long; floral bracts concave, abaxial surface covered with black hirsute hairs, adaxial surface glabrous, ovate or ovate-oblong, apex acute, base truncate, 2- to 5-veined, 1.5-1.8 cm long, 0.6-0.9 cm wide. *Flowers* papyraceous, resupinate, ca. 5.4 cm in diameter; sepals and petals white; labellum white, brownish red at basal part; disc with red or brownish red elevated veins. *Sepals* spreading, distally recurved, margin entire, abaxial surface with indistinct keel; dorsal sepal oblong-lanceolate or elliptic, apex acuminate, base truncate, 7- to 9-veined, 2.8-3.4 cm long, 0.8-1 cm wide; lateral sepals obliquely triangular-oblong, apex acuminate, base obliquely truncate, 5- to 7-veined, posterior margin 3.1-3.5 cm long, anterior margin 4.5-4.9 cm long, 1-1.4 cm wide at base, ca. 0.4 cm wide at apex. *Mentum* narrowly conical, apex obtuse, 2-2.6 cm long, ca. 0.4 cm in diameter. *Petals* widely ovate, apex round or obtuse, with apiculate, base truncate, margin entire, 9- to 13-veined, 2.8-3.3 cm long, 1.8-2.3 cm wide at base. *Labellum* 3-lobed, 3.7-4.4 cm long, 2.5-2.7 cm wide across side lobes; claw linear or narrowly triangular, ca. 20 mm long; side lobes obliquely triangular, adaxial surface with obvious 5-slightly elevated veins along each side lobe, apex truncate, lateral margin entire, front margin subentire or

crenulate; disc narrowly oblong, with obvious 5 keels along the length, continuing to mid-lobe; mid-lobe transversely oblong, with 5 keels at basal part, apex emarginated, apiculate between sinus, margin crenulate, 0.7-1 cm long, 1.2-1.5 cm wide. *Column* surface smooth, 6-9 mm long, ca. 4 mm wide at base; foot slightly concave, tapering downwards, surface smooth, 15-19 mm long, 4-5 mm wide at entrance of mentum; stigmatic cavity ovate or elliptic; stelidia triangular; connective linear or narrowly triangular; anther cap obovate, surface very minutely papillose, apex emarginate, basal margin ciliate, adaxial surface sulcate; pollinia 4, in 2 pairs, each pollinium narrowly elliptic, without caudicle and visidium. *Ovary* (including pedicel) narrowly clavate, slender, glabrous, 6-grooved, 2.8-2.3 cm long. *Capsule* not seen.

DISTRIBUTION. – Laos (endemic).

HABITAT AND ECOLOGY. – Epiphytes in montane forests, at 1,900 m alt. Flowering period: April.

SPECIMENS EXAMINED. – LAOS: A. F. G. Kerr 972 (K, P), Pu Bia, 1,900 m alt., 12 Apr. 1932.

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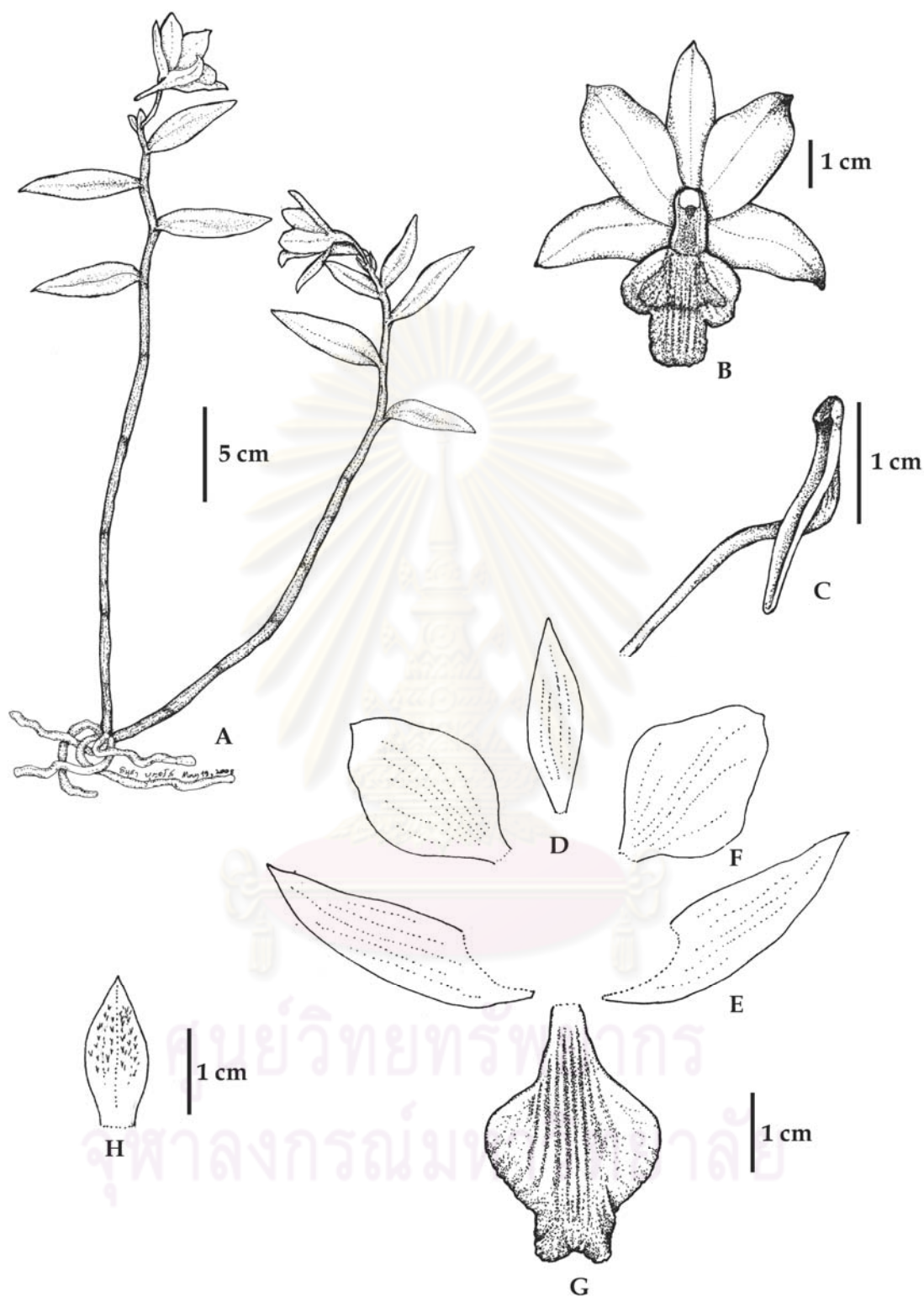


FIGURE 5.18. *Dendrobium multilineatum* Kerr **A.** Habit; **B.** Flower, front view; **C.** Column and column foot, side view; **D.** Dorsal sepal; **E.** Lateral sepal; **F.** Petal; **G.** Labellum; **H.** Floral bract. Drawn from *Kerr 972* (holotype) by Mr. Tanucha Boonjaras.

19. *Dendrobium ochraceum* De Wild., Tribune Hort. 1: 41. 1906. Type: *Bronckart s.n.* (holotype Br!; isotype Br!, C!), Vietnam, Tonkin, 1905, 500 m alt. Fig. 5.19; Pl. 5: H.

Dendrobium ochraceum var. *albiflorum* H. Schildhauer & W. Schrauts, J. Orchideenfr. 12(2): 118. 2005.; 13(2): 170. 2006. Type: ex. Cult. in *Hort Orchids & more* Nr. 1/2003 (holotype: M!), North Vietnam, locality unknown.

Flowering shoots erect, tufted, slightly constricted at nodes, sulcate, green or brownish green, 58-70 cm tall, with 10 to 21 internodes, internodes 4.3-6.4 cm long, 1.3-2 cm in diameter, leafy throughout or along the upper half of stem. **Leaves** distichous, spreading, coriaceous, both surfaces covered with short black hirsute hairs, mid-vein grooved above and ribbed below, green or dull green, lanceolate-oblong or elliptic-oblong, apex unequally bi-lobed, each lobe obtuse, 5.5-9.1 cm long, 1.9-2.6 cm wide; leaf-sheaths brownish green, covered with blackish hairs, 5.3-6.2 cm long. **Inflorescences** abbreviated, 2- to 4-flowered, borne along the upper to middle portion of both leafy and leafless stems, emerging from base of leaf sheaths opposite the blade; peduncle and rachis glabrous, green, 0.3-0.5 cm long, covered with bracts; floral bracts slightly concave, abaxial surface covered with dense black hairs, adaxial surface glabrous, brown, ovate-oblong, apex acuminate, base truncate, 2- to 4-veined, 1-1.5 cm long, 0.4-0.6 cm wide. **Flowers** coriaceous, resupinate, faintly fragrant or unscented, long-lasting, up to 4.3-5.5 cm in diameter; sepals and petals creamy yellow; mentum creamy yellow or orange yellow from outside; labellum creamy yellow with scarlet red veins throughout, disc pale red with scarlet red lines; column white, foot creamy yellow with 3-5 red lines, margin of foot white, stigmatic cavity white and operculum golden yellow to orange; column foot reddish orange, anther-cap white, pollinia yellow, pedicellate ovary light green, becoming green at the base of pedicel. **Sepals** strongly recurved backward, margin entire or slightly

undulate, abaxial surface with distinct keel, veins visible; dorsal sepal lanceolate-oblong or oblong, apex acuminate, base truncate, 4- to 7-veined, 2.3-2.8 cm long, 0.8-1.3 cm wide; lateral sepals obliquely triangular-lanceolate, slightly falcate, apex acuminate, base obliquely truncate, 4- to 7-veined, posterior margin 3-3.5 cm long, anterior margin 5.7-6.5 cm long, 0.8-1.2 cm wide at base, ca. 0.2 cm wide at apex. *Mentum* very narrowly conical, ovipositor-shaped, straight, apex obtuse, 2.8-3.3 cm long, ca. 0.2 cm in diameter. *Petals* strongly recurved backward, slightly twisted, obovate or elliptic, gently reduced at base, apex acute, base obliquely truncate, margin entire or slightly undulate, 3- to 5-veined, 2.7-3.5 long, 1-1.3 cm wide. *Labellum* 3-lobed, 4.1-4.7 cm long, 1.8-2.2 cm wide across side lobes; claw linear 1.4-1.8 cm long; side lobes obliquely semi-circular, adaxial surface with reticulated and slightly elevated veins running along each side, each vein sparsely verrucose, apex rounded, margin entire; disc narrowly oblong, smooth, waxy; mid-lobe oblate, adaxial surface with 4-5 slightly elevated veins, each vein sparsely verrucose, apex obtuse with mucro when flattened, recurved backwards, margin rather thick, crenate and slightly crisped, 0.7-1.1 cm long, 1.2-1.7 cm wide. *Column* surface papillose, 5-7 mm long, 4-5 mm wide at base; foot concave, grooved, surface papillose, somewhat waxy, base truncate, margin raised at base, 27-39 mm long, 4.1-4.7 mm wide at entrance of mentum; stigmatic cavity elliptic or ovate; stelidia triangular; connective narrowly triangular; anther cap widely obovate, surface papillose, apex emarginate, basal margin minutely ciliate, adaxial surface sulcate, 3.0-3.2 mm long, 2.7-3 mm wide; pollinia 4, in 2 pairs, each pollinium narrowly elliptic, without caudicle and visidium. *Ovary* (including pedicel) slender, narrowly clavate, glabrous, 6-grooved, 4-4.4 cm long. *Capsule* dehiscent, elliptic, with 3 obtuse keels, apex with persistent dried perianth, 2.1-2.7 cm long, 1-1.4 cm wide.

DISTRIBUTION.— Vietnam (endemic).

HABITAT AND ECOLOGY.— Epiphytes grow at altitude ca. 900 m. Flowering period: May-July.

SPECIMENS EXAMINED.— VIETNAM: *Georges Bronckart s.n.* BR 6278243 (BR), Tonkin, 500 m alt., 1905 A.D.; *Georges Bronckart s.n.* BR 9887190 (BR), Tonkin, 500 m alt., 1905 A.D.; *Georges Bronckart s.n.* BR 9887527 (BR), Tonkin, 500 m alt., 1905 A.D.; *Bronckart s.n.* (C), Tonkin, 500 m alt., 1905 A.D.; *J. & M. S. Clemens 3905* (BM, P), Annam, Mt. Bani, 25 km from Tourane, May-July 1927; Ex Cult. in *Hort Orchids & more Nr. 1/2003* (M - holotype of *D. ochraceum* var. *albiflorum*), North Vietnam, sine loc. 2003; *Poilane 27663* (P), Norei, Bach Ma Station d' altitude un peu au Sud de Hue, 1,500 m alt., 08 Sep. 1938; *Poilane 29942* (C), Hue, Hui Bach Ma, 1,500 m alt., 22 Apr. 1939.

LOCALITY UNKNOWN: *sine coll.* TBG 122822 (TNS), 11 May 2007.



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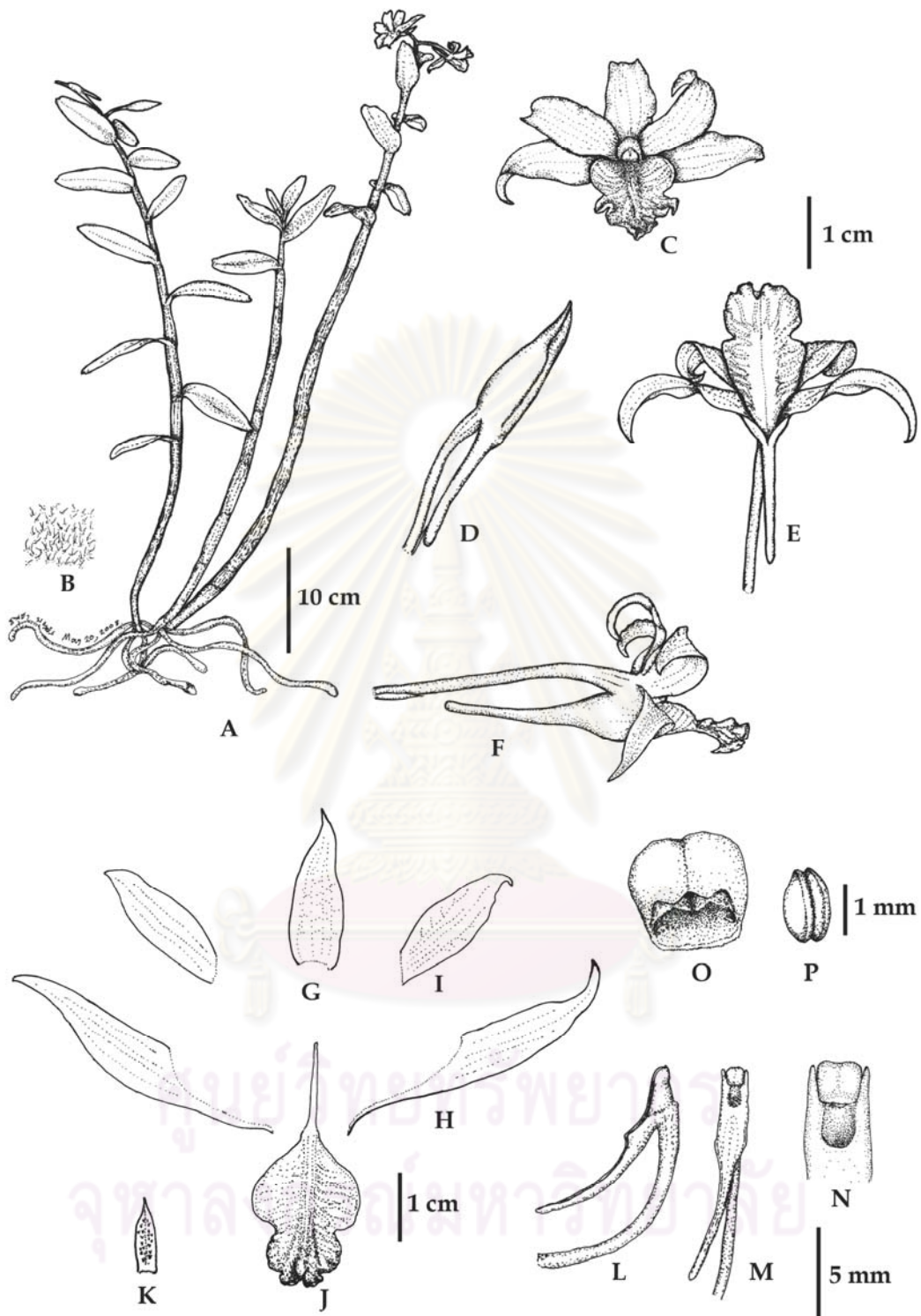


FIGURE 5.19. *Dendrobium ochraceum* De Wild. **A.** Habit; **B.** Hairs, on leaf; **C.** Flower, front view; **D.** Flower bud, side view; **E.** Flower, from below; **F.** Flower, side view; **G.** Dorsal sepal; **H.** Lateral sepal; **I.** Petal; **J.** Labellum; **K.** Floral bract; **L.** Column and column foot, side view; **M.** Column and column foot, from below; **N.** Column, from below; **O.** Anther cap; **P.** Pollinia. Drawn from *Hort. Tsukuba Botanical Garden accession number 122822* by Mr. Tanucha Boonjaras.

20. *Dendrobium ovipostoriferum* J.J. Sm., Bot. Jahrb. Syst. 48: 100. 1912. Type: *Winkler 3,062* (holotype BO), Indonesia, Kalimantan, between Sungei Tarik and Kwaru, July 1908. Fig. 5.20; Pl. 5: I.

Dendrobium takahashii Carr, Orchid Rev. 42: 14. 1934. Type: *Takahashi s.n.* (holotype SING!), Indonesia, Kalimantan Selatan, Martapura near Banjarmasin, 100 m alt.

Dendrobium dearei auct. non Rchb. f.; Wood & Cribb, A Checklist of the *Orchids* of Borneo: plate 9A. 1994.

Flowering shoots erect, cylindrical, flexuose, sulcate, dark brown or greyish brown, 22-59 cm tall, internodes 1.5 – 3.6 cm long, 0.9-1.2 cm in diameter. *Leaves* distichous, spreading, slightly recurved, coriaceous, both surfaces covered with black hirsute hairs, especially when young, mid-vein grooved above and ribbed below, dull green, ovate-oblong or ovate-ellipt, apex unequally bi-lobed, each lobe obtuse, 3.7-7.5 cm long, 1.3-2.75 cm wide; leaf-sheaths covered with short black hirsute hairs, 1.9-2.3 cm long. *Inflorescences* abbreviated, 1- to 4-flowered, up to 6 inflorescences borne from the nodes along the upper part of the stem; peduncle and rachis glabrous, green, ca. 0.3 cm long, entirely covered by bracts; floral bracts concave, abaxial surface covered with dense black hirsute hairs, adaxial surface glabrous, brown, ovate-triangular, apex acuminate, base truncate, 4- to 6-veined, ca. 1 cm long, ca. 0.4 cm wide. *Flowers* coriaceous, resupinate, veins obscured, 4-5.5 cm in diameter; sepals and petals white; mentum white or pale orange white from outside; labellum white and orange, claw pale red, with darker veins, side lobes yellowish white or pale yellow, with red lines along each side of disc, disc white or pale reddish white, with red lines; mid-lobe bright golden-yellow, with broad white margins; column pale green, foot red or pale red with three broad, deeper streaks, anther-cap pale green, pollinia yellow, pedicellate ovary white and pale green. *Sepals* spreading, recurved, margin entire; dorsal sepal oblong to oblong-elliptic, apex acuminate, base truncate,

abaxial surface with inconspicuous keel, 5-veined, 2.7-2.9 cm long, 0.9-1.2 cm wide; lateral sepals obliquely triangular-ovate, apex acuminate, base obliquely truncate, slightly falcate, abaxial surface with distinct keel, 7-veined, posterior margin 2.7-2.9 cm long, anterior margin 4-4.2 cm long, 1-1.5 cm wide at base, *c.* 0.3 cm wide at apex. *Mentum* very narrowly conical, ovipositor-shaped, gently incurved, apex obtuse, 1.6-1.9 cm long, 0.5-0.6 cm in diameter at base, ca. 0.2 cm in diameter near the apex. *Petals* spreading, slightly recurved, obliquely ovate, apex acute to obtuse, base cuneate, margin entire, cuneate, 5-veined, 3.1-3.3 cm long, 1.8-2.4 cm wide at base. *Labellum* 3-lobed, pandurate in outline, 2.7-4.2 cm long, 1.5-1.7 cm wide across side lobes; claw narrowly triangular, ca. 1.5 cm long; side lobes semi-rotund, verrucose on adaxial surface, margin minutely crenulate-denticulate; disc oblong, adaxial surface slightly verrucose, with 3-7 longitudinal slightly elevated veins; mid-lobe fleshy, ovate or suborbicular, with a densely verrucose area in the middle, broad at the base, apex retuse with a mucro in the sinus, margin crenulate, crisped, 1.3-1.4 cm long, 1-1.3 cm wide. *Column* surface papillose, 4-5 mm long, 3.5-4 mm wide at base; foot concave, tapering downwards, surface papillose, 12-15 mm long, 4-5 mm wide at base; stigmatic cavity ovate-elliptic; stelidia triangular; connective narrowly triangular; anther cap obovate, surface papillose, apex round or retuse, basal margin minutely ciliate, adaxial surface sulcate, 3-4 mm long, 2.5-3 mm wide; pollinia 4, in 2 pairs, each pollinium narrowly elliptic, without caudicle and visidium. *Ovary* (including pedicel) narrowly clavate, curved, glabrous, 6-grooved, ca. 3 cm long. *Capsule* not seen.

DISTRIBUTION. – Indonesia and the Philippines.

HABITAT AND ECOLOGY – Exposed ridges, growing on thinly spaced, stunted trees, at ca. 100 m alt.

SPECIMENS EXAMINED. – INDONESIA: *Mottley s.n.* (K), Borneo, Kalimantan; C.

E. Carr A751 (SING - holotype of *D. takahashii*), Borneo, Oct. 1933.

PHILIPPINES: *E. A. Schelpe s.n.* (K), Nov. 1981.

LOCALITY UNKNOWN: *Cult. Hort. Kew. Entry No. 360-1934* (K), Recieved from Singapore Botanic Garden 31 July 1936; *Cult. Hort. Kew. Entry No. 594-1936* (K), Recieved from Singapore Botanic Garden 16 Aug. 1937.



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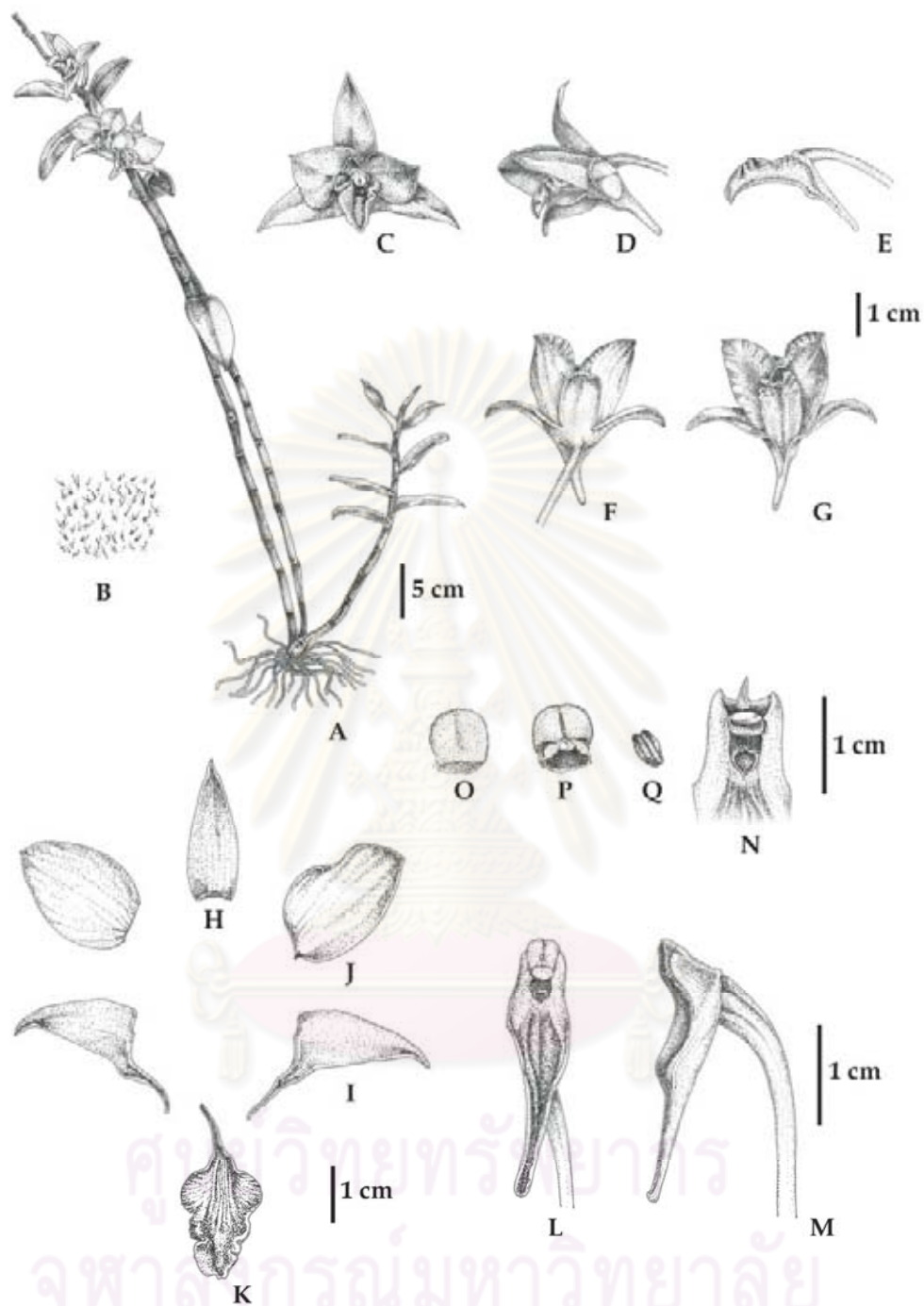


FIGURE 5.20. *Dendrobium ovipostoriferum* J.J. Sm. **A.** Habit; **B.** Hairs, on leaf; **C.** Flower, front view; **D.** Flower, side view; **E.** Labellum and mentum, side view, sepals and petals removed; **F.** Flower, from above; **G.** Flower, from below; **H.** Dorsal sepal; **I.** Lateral sepal; **J.** Petal; **K.** Labellum; **L.** Column and column foot, from below; **M.** Column and column foot, side view; **N.** Column, from below, anther cap removed; **O.** Anther cap, back view; **P.** Anther cap, front view; **Q.** Pollinia. Drawn from *Hort. Tsukuba Botanical Garden* accession number *s.n.* by Mr. Tanucha Boonjaras.

21. *Dendrobium radians* Rchb. f., *Xenia Orchid.* 2: 130, t. 146, figs. 1&2. 1867; T.E. Beaman *et al.*, *Orchids of Sarawak*: 49, 260. 2001; J.J. Wood, *Orchid of Borneo* 4: 105. 2003. Type: cult. *Low s.n.* (holotype W!), Indonesia, Borneo, without precise locality. Fig. 5.21; Pl. 5: J&K.

Flowering shoots erect, cylindrical, somewhat fractiflex distally, ca. 60 cm tall, internodes 2–3.5 cm long, 0.5–1 cm in diameter, leafy. *Leaves* distichous, spreading, coriaceous, both surfaces densely covered with black hirsute hairs, especially on abaxial surface, mid-vein grooved above and ribbed below, oblong-elliptic, apex unequally bi-lobed, each lobe obtuse, 2.8–6.1 cm long, 1.2–2.7 cm wide; leaf-sheaths covered with dense black hirsute hairs, 3–3.5 cm long. *Inflorescences* abbreviated, usually 4- to 5-flowered, often with only 3 flower open at a time, emerging from the base of the leaf-sheaths along the upper portion of the stem; peduncle and rachis glabrous, 0.8–1 cm long, entirely covered by bracts; floral bracts concave, abaxial surface covered with dense black hirsute hairs, adaxial surface glabrous, ovate-elliptic, apex acute to acuminate, base truncate, 1–2 cm long. *Flowers* resupinate, white, unscented, up to 6 cm in diameter, claw greenish, base of labellum with an orange flush, sometimes with brownish cinnabar-red on the disc and sometimes ochre spots at the base of the side lobes; column apex brownish, sometimes with a brownish cinnabar-red flush below the stigmatic cavity. *Sepals* spreading; dorsal sepal oblong-ovate, apex acute, base truncate, abaxial surface distinctly keeled, wing-liked along the distal half, 7-veined, 2.3–2.8 cm long, 1.1–1.3 cm wide; lateral sepals obliquely triangular-ovate, apex acute or mucronate, base obliquely truncate, abaxial surface with distinct keel, wing-liked at apex, 7- to 9-veined, posterior margin 2.5–3.2 cm long, anterior margin 5.5–5.9 cm long, 1–1.3 cm wide at base, c. 0.5 cm wide at apex. *Mentum* very narrowly conical, ovipositor-shaped, straight or slightly curved, apex obtuse, 2.5–3 cm long, ca. 0.3 cm in diameter. *Petals* broadly oblong-elliptic or ovate-elliptic, apex obtuse, base obliquely truncate, margin rather uneven, 7- to 9-veined, 2.3–3.5 cm long, 1.4–1.6 cm wide. *Labellum*

shallowly 3-lobed, 2.9-3.1 cm long, 1.5-1.6 cm wide across side lobes, pandurate, with short isthmus between the side lobes and mid-lobe; claw linear, ca. 1.3 cm long; side lobes obliquely rounded, margin entire; disc oblong; mid-lobe transversely ovate to reniform, apex retuse to emarginate, becoming shallowly bilobulate, margin crenulate, slightly convex at the centre, surface rough, rugulose, 1.3-1.7 cm long, 2.6-2.8 cm wide. *Column* ca. 6 mm long, 4-5 mm wide at base; foot 20-25 mm long, 6 mm wide at entrance of mentum; stelidia triangular; connective narrowly triangular; anther cap ovate, surface minutely papillose, apex round, basal minutely margin ciliate, adaxial surface sulcate, ca. 3.5 mm long, ca. 3.1 mm wide. *Ovary* (including pedicel) narrowly clavate, gently curved, glabrous, 6-grooved, 4.5-5 cm long. *Capsule* not seen.

DISTRIBUTION – Malaysia.

HABITAT AND ECOLOGY – Epiphytes in lower montane mossy forest, at 1,200 m alt.

SPECIMENS EXAMINED. – MALAYSIA: *P. W. Richard & P. M. Synge* 421 (K), Sarawak, Mountain Dulit ridge, 4,000 ft alt., 06 Sep. 1932.

NOTE – Vegetatively *Dendrobium radians* is virtually indistinguishable from the closely allied *D. sculptum*. However, *D. radians* appears to have a more distinctly three-lobed labellum with a broader, shallowly bilobulate reniform mid-lobe. The mid-lobe also lacks the central dark orange blotch characteristic of *D. sculptum*. Both species have only been collected on a couple of occasions since they were described in the 1860's, and consequently the range of variability in the wild is unknown. The intermediates may occur suggesting, that the two species should be united, in which case *D. sculptum* would have the priority.

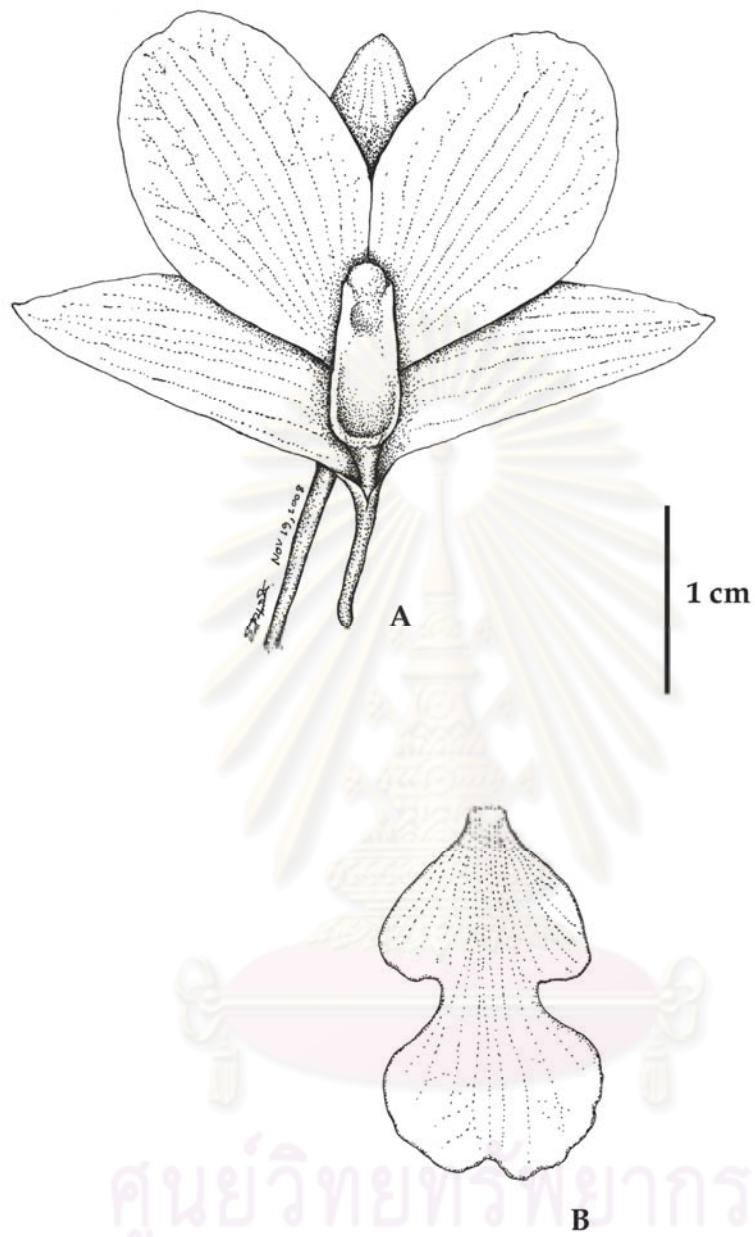


FIGURE 5.21. *Dendrobium radians* Rchb.f. **A.** Flower, front view, labellum removed; **B.** Labellum. Drawn from cult. *Low s.n.* (holotype) by Mr. Tanucha Boonjaras.

22. *Dendrobium roseiodorum* A. Sathapattayanon, T. Yukawa and T. Seelanan, *Blumea* (*ined.*). **spec. nov.** Type: *Hort. Tsukuba Botanical Garden accession number 144309* (holotype TNS!; isotype BCU!), Vietnam, sine loc., 26 July 2007. Fig. 5.22; Pl. 5: L.

Dendrobium kontumense auct. non Gagnep.: H. Schildhauer, *J. Orchideenfr.* 9: 369. 2002; P. Ormerod and H.A. Pedersen, *J. Orchideenfr.* 11: 38. 2004; T. Yukawa, *Ann. Tsukkuba Bot. Gard.* 23: 23, f. 3-4. 2004.

Latin Description: *Dendrobium ochraceum* de Wild. affine, sed petalis ellipticis-rhombicis, labello aureo-aurantiaco, et disco labelli verrucoso diversum.

Flowering shoots erect, clustered, slightly flexuose, weakly sulcate in age, green or brownish green, 30-43 cm tall, with 7 to 18 internodes, internodes 2.9-4.4 cm long, 1.1-1.4 cm in diameter, leafy throughout, almost entirely covered by persistent leaf sheaths. **Leaves** distichous, spreading or slightly recurved, coriaceous, both surfaces covered with dense hirsute hairs rubbing off with age, mid-vein grooved above and ribbed below, dark green, lanceolate, apex unequally bi-lobed, each lobe acute or obtuse, 4.7-5.4 cm long, 0.9-1.9 cm wide; leaf-sheaths brownish green, covered with blackish hairs and rubbed off with age, 3.0-3.4 cm long. **Inflorescences** abbreviated, 2- to 5-flowered, subterminal or axillary on apical part of flowering shoot; peduncle and rachis glabrous, light green, 0.8-1.1 cm long, covered with bracts; floral bracts concave, abaxial surface with brown hairs, adxial surface glabrous, brownish, ovate-triangular or lanceolate-triangular, apex acuminate, base truncate, 5- to 9-veined, 1.3-1.5 cm long, 0.4-0.7 cm wide. **Flowers** coriaceous, resupinate, glossy, sweetly scented, veins obscured, 4.3-4.8 cm in diameter; sepals and petals white; mentum orange from outside; labellum golden yellow, apical part white, veins on side lobes and disc orange; column and operculum golden yellow to orange; column foot reddish orange; pollinia bright yellow; pedicellate ovary white. **Sepals** margin

entire, abaxial surface waxy with keel; dorsal sepal spreading, recurved at apical part, ovate-lanceolate, apex abruptly acute, base truncate, 5- to 7-veined, 2.4-3.2 cm long, 0.9-1.3 cm wide; lateral sepals twisted and recurved, obliquely lanceolate-triangular, apex abruptly acute to mucronate, base obliquely truncate, 5- to 7-veined, posterior margin 2.6-3.5 cm long, anterior margin 5.5-6.7 cm long, 1-1.3 cm wide at base, ca. 0.2 cm wide at apex. *Mentum* very narrowly conical, ovipositor-shaped, apex obtuse, straight or upcurved, 2.5-2.8 cm long, 0.2-0.4 cm in diameter. *Petals* slightly twisted and recurved at apex, elliptical-rhombic, apex obtuse, base truncate, margin undulate, 7- to 9-veined, 2.6-3.2 long, 1.4-1.6 cm wide at base. *Labellum* 3-lobed, 4.7-5.1 cm long, 1.7-1.8 cm wide across side lobes; claw linear or narrowly triangular, 1.5-2 cm long; side lobes obliquely ovate, puberulent at base, adaxial surface with 4--5 veins running along each side and sparsely verrucose, apex rounded, margin entire; disc narrowly oblong, smooth, waxy, densely verrucose at both side; mid-lobe thick, adaxial surface densely verrucose at median ridge, widely obovate, conduplicated and recurved at apical part, apex obtuse when flattened, margin undulate, 1.0-1.2 cm long, 1.1-1.5 cm wide. *Column* surface papillose, dilate at base, somewhat waxy, 7-8 mm long, 6-7 mm wide at base; foot grooved, surface papillose, somewhat waxy, base truncate, margin raised at base, 45-51 mm long, 5-6 mm wide at entrance of mentum; stigmatic cavity elliptic or ovate; stelia short, triangular-falcate, obtuse; connective narrowly triangular; anther cap cucullate, very widely obovate, surface papillose, apex obtuse, basal margin ciliate, adaxial surface sulcate, 3-3.2 mm long, 3-3.1 mm wide; pollinia 4, in 2 pairs, each pollinium narrowly elliptic, without caudicle and visidium. *Ovary* (including pedicel) clavate, curved, slightly sulcate, glabrous, 6-grooved, 3.2-4.1 cm long. *Capsule* not seen.

DISTRIBUTION – Vietnam (endemic).

HABITAT AND ECOLOGY – Recorded on boulders or tree branches at altitude 1,000-1,200 m. Flowering: September-November (in natural habitat), July-December (in cultivation).

ETYMOLOGY – The specific epithet refers to rose-like floral scent of the new species.

SPECIMENS EXAMINED – VIETNAM: *Poilane* 46633 (P), Khanh Hoa, Nha Trang; *S. Khrukerd* KV-0012 (TNS), Lâm Dong, Lang Bian Mountain; *Oct.a.2005/12385* (Photograph seen, kindly sent by Prof. L. Averyanov); *sine coll.* TBG 118269 (TNS), *sine loc.*; *sine coll.* TBG 144422 (TNS), *sine loc.*



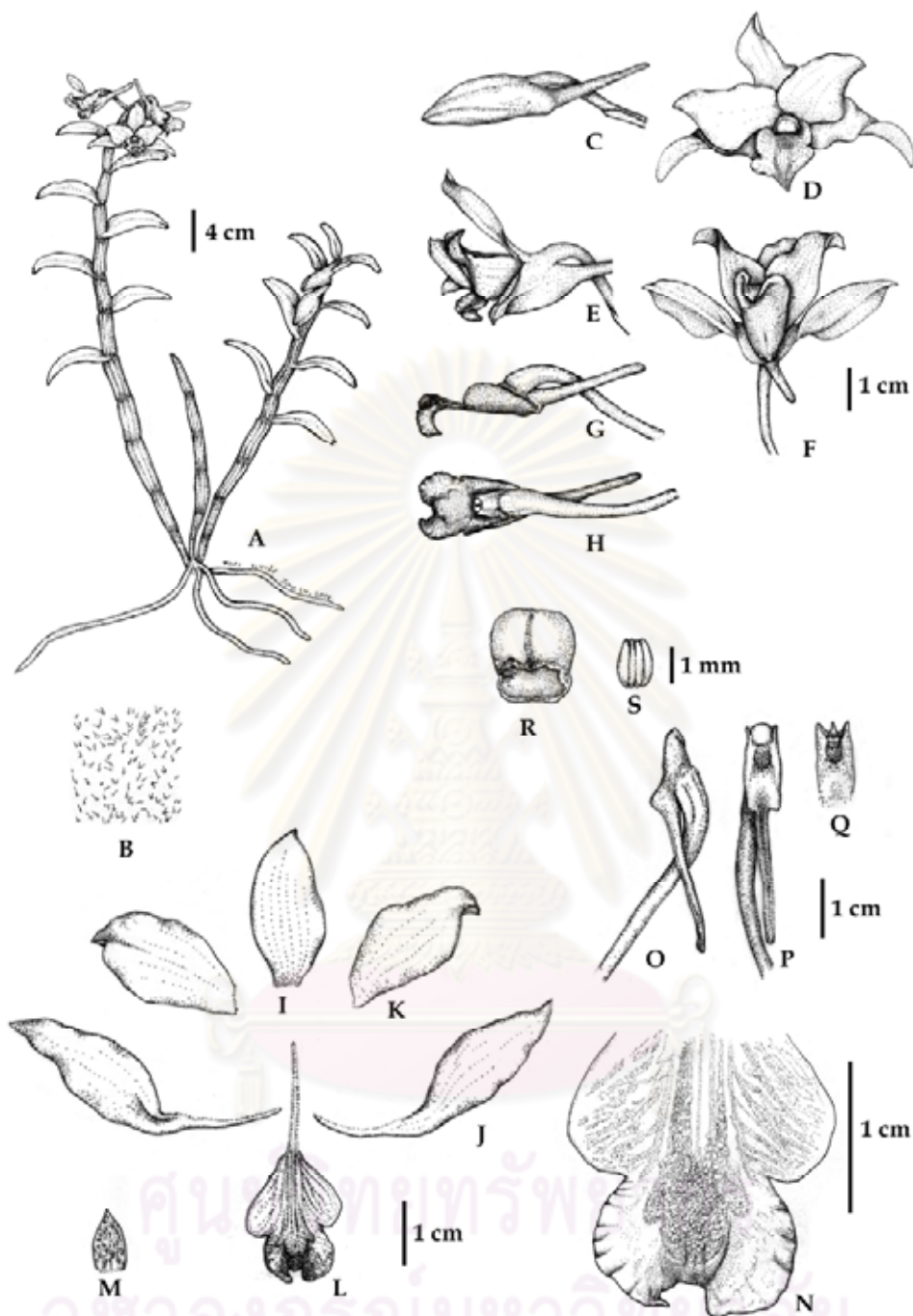


FIGURE 5.22. *Dendrobium roseiodorum* A. Sathapattayanon, T. Yukawa & T. Seelanan A. Habit; B. Hairs, on leaf; C. Flower bud, side view; D. Flower, front view; E. Flower, side view; F. Flower, from below; G. Labellum and mentum, side view, sepals and petals removed; H. Labellum and mentum, from above, sepals and petals removed; I. Dorsal sepal; J. Lateral sepal; K. Petal; L. Labellum; M. Floral bract; N. Mid-lobe of labellum; O. Column and column foot, side view; P. Column and column foot, from below; Q. Column, from below, anther cap removed; R. Anther cap; S. Pollinia. Drawn from *Hort. Tsukuba Botanical Garden accession number 188,269* (holotype) by Mr. Tanucha Boonjaras.

23. *Dendrobium scabrilingue* Lindl., J. Proc. Linn. Soc., Bot. 3: 15. 1859; Hook. f., Fl. Brit. Ind. 5: 735. 1890; Seidenf. and Smitinand, Orch. Thail. 2: 227, f. 172. 1960; Seidenf., Opera Bot. 83: 107, f. 63, Pl. XIVa. 1985; Seidenf. Opera Bot. 114: 210. 1992; Thaithong, Thai Orchid: 220. 2000; Pridgeon, Illust. Ency. Orch.: 99. 2003. Type: *Lobb s.n.* (holotype K!, in Lindley Herbarium), Borneo, but actually from Myanmar, Tenasserim. Fig. 5.23; Pl. 5: M.

Dendrobium hedyosmum Bateman ex Hook.f., Bot. Mag. 91: t. 5515. 1865. Type: *Parish s.n.* (holotype, unknown), Myanmar, Moulmein (nowadays Mawlamyaing City).

Callista scabrilinguis (Lindl.) Kuntze, Revis. Gen. Pl. 2: 655. 1891.

Dendrobium galactanthum Schltr., Orchis 9: 93. 1915. Type: *Hosseus s.n.* (holotype, unknown), Thailand, precise locality unknown, March 1913.

Flowering shoots erect, cylindrical or fusiform, sulcate, constricted at nodes, brown or ferruginous, 10-27 cm tall, internodes 1.4-2.5 cm long, 0.5-1.1 cm in diameter, leafy along the upper part of stem. **Leaves** distichous, spreading or slightly recurved, thinly coriaceous, adaxial surface sparsely covered with black hirsute hairs, becoming glabrate with aged, abaxial surface densely covered with black hirsute hairs, mid-vein grooved above and ribbed below, green, oblong-elliptic or lanceolate, apex unequally bi-lobed, each lobe acute or subacute, 4.3 - 7.4 cm long, 0.6-1.1 cm wide; leaf-sheaths covered with short black hirsute hairs, 1.5-2.7 cm long. **Inflorescences** abbreviated, 1- to 4-flowered, borne along the upper to middle part of both leafy and leafless stems, emerging from base of leaf sheaths opposite the blade; peduncle and rachis glabrous, light green, 0.2-0.5 cm long; floral bracts concave, abaxial surface covered with dense black hirsute hairs, adaxial surface glabrous, pale brown or brown, oblong, apex acute, base truncate, 2- to 4-veined, 0.5-1 cm long, 0.5-0.7 cm wide. **Flowers** resupinate, waxy, veins obscured, visible when aged, long lasting up to 5 weeks, sweetly scented, 3.4-3.9 cm in diameter; sepals and petals white or greenish white;

mentum white or orange white from outside; labellum greenish white or white, claw greenish white, side lobes greenish white with light green transverse lines along on adaxial surface; disc light green; mid-lobe light green, turning yellowish orange or orange with aged; column and foot light green, stigmatic cavity green, anther-cap greenish white or creamy white, pollinia yellow, pedicellate ovary yellowish green to light green. *Sepals* spreading, distally recurved, margin entire, abaxial surface with inconspicuous keel, conspicuous at apical part; dorsal sepal elliptic or elliptic-oblong, apex acute, base truncate, 3- to 5-veined, 1.4-1.7 cm long, 0.7-0.9 cm wide; lateral sepals obliquely triangular-oblong, apex acute or acuminate, base obliquely truncate, 5- to 7-veined, posterior margin 1.5-1.8 cm long, anterior margin 1.9-2.6 cm long, 0.7-1 cm wide at base, 0.3-0.4 cm wide at apex. *Mentum* shortly conical, apex obtuse, 0.8-1.2 cm long, 0.4-0.6 cm in diameter. *Petals* spreading, slightly recurved, elliptic or obovate-elliptic, apex acute, base truncate, margin entire, 3- to 5-veined, 1.4-1.8 cm long, 0.4-0.7 cm wide at base. *Labellum* 3-lobed, 2-2.3 cm long, 1.6-2.0 cm wide across side lobes; claw shallowly triangular, 5-7 mm long; side lobes with slightly elevated and rough veins along the length on adaxial surface, obliquely triangular-obovate, apex acute, margin entire; disc narrowly oblong, prominent, with roughly 3- to 5-keeled, continuing to mid-lobe; mid-lobe thickening, hard, recurved backward at apical part, with 3-5 roughly keels along the length, adaxial surface rough, obovate, apex acute, margin irregular undulate, 0.9-1.3 cm long, 0.6-0.8 cm wide. *Column* surface smooth, 4-5 mm long, 3-4 mm wide at base; foot slightly concave, surface smooth, 7-12 mm long, 3-4 mm wide at entrance of mentum; stigmatic cavity ovate or elliptic; stamens triangular; connective linear or narrowly triangular; anther cap orbicular or widely ovate, surface minutely papillose, apex obtuse or acute, basal margin minutely ciliate, adaxial surface sulcate, 2.5-3 mm long, 2.1-2.6 mm wide; pollinia 4, in 2 pairs, each pollinium narrowly elliptic, without caudicle and viscidium. *Ovary* (including pedicel) narrowly clavate, slender, glabrous, 6-grooved, 1-1.8 cm long. *Capsule* dehiscent, green or dull

green, elliptic with 3 distinct keels, apex with persistent dried perianth, 1.7-2.4 cm long, 0.9-1.3 cm wide.

DISTRIBUTION. — Myanmar, Laos and Thailand.

HABITAT AND ECOLOGY. — Epiphytes in dry evergreen forest or pine forest at the altitude higher than 1,000 m above sea level. Flowering period: November-February.

VERNACULAR. — pho-do-ya (พอดอญ่า), Pho-mue-kha (พอมือคา), Pho-muen-kha (พอหมื่นคา), Pho-mue-lae (พอหม่มและ), Ueang sae (เอื้องแซะ), Ueang ngeon luang (เอื้องแซะหลวง), Ueang ngeon hom (เอื้องแซะหอม)

SPECIMENS EXAMINED. — MYANMAR: *Lobb s.n.* (K), Tenasserim; *Chin 6440* (K), Katum Lay Tha Kon, 3,000 ft alt., 13 Feb. 1928; *Cult. Hort. Kew. s.n.* (K), Mandalay, 16 Feb. 1926; *W. Micholitz s.n.* (K), Ywathit Saliveen Valley, 2,500 ft alt., 30 Dec. 1912; *Parish 134* (K), Moulmein; *R. H. Rule 5396* (K-SPIRIT), 18 Dec. 1961; *R. H. Rule 5429* (K-SPIRIT), 11 Dec. 1961; *Sander cult. 265* (K), Moulmein, 01 Mar. 1897.

LAOS: *A. D. Kerr 1820* (C); *A. D. Kerr 2771* (C), Ritaville 750 m alt.

THAILAND: *sine coll. s.n.* (BKF), Mae Hong Son, Mae Sarieng, 20 Jan. 1965; *A. Buakhlai 112* (BCU), Khao Yai National Park, Khao Khiew, 1,200 m alt., 26 Dec. 2004; *B. Hansen and T. Smitinand 12606* (BKF, C, K), Mae Hong Son (19°25' N, 98°18' E), 250 m alt., 15 Feb. 1968; *J. B. Comber 1614* (K), Chiang Mai Province, 07 Jan. 1985; *Cumberlege 690* (C, K-SPIRIT), Khao Yai, 1,400 m alt.; *A. F. G. Kerr 225* (K), Meh Chem Watershed (60 miles, S.W. of Chieng Mai), 2,000-3,000 ft alt., 31 Jan. 1909; *A. F. G. Kerr 763* (BK, K), Kao Kuap, Korat, c. 300 m alt., 22 Dec. 1929; *A. F. G. Kerr s.n.* (K), Kao Kuap, Korat, 600 m alt., 25 Dec. 1929; *A. F. G. Kerr s.n.* (K); *GT 4376* (C), Khao Khieo, Oct. 1962; *GT 4451* (C), Khao Khieo, Khao Yai, 1,250 m

alt., Nov. 1962; *GT 5198* (C), Baw Luang, km 45-47, 1,140 m alt., 29 Jan. 1964; *GT 5289* (C), Mae Sarieng, 02 Feb. 1964; *GT 5442* (C), Phu Mieng, 1,200 m alt., 14 Feb. 1964; *GT 5838* (C), Khao Khieo, Khao Yai, 1,300-1,400 m alt., 08 Mar. 1964; *GT 7001* (C), Mae Hong Son, 16 Feb. 1968; *GT 7844* (C), I. Umphang Road km 25-31, 11 July 1972; *GT 7929* (C), I. Umphang Road km 31, S of Mae Sot, 14 July 1972; *GT 8436* (C), I. N of Khun Mae Surin, 1,225 m alt., 13 Mar. 1978; *GT s.n.* (C), Presumably Mae Hong Song area, 1,000-1,400 m alt., Jan.-Feb. 1968; *Mason et al. 5* (K-SPIRIT), 21 Apr. 1953; *A. Morrison 1039* (K-SPIRIT), 20 km from Mae Tho, 05 Feb. 1978; *W. Nanakorn et al. 10437* (QBG), From local forest unit, Mae Hong Son, 07 Jan. 1998; *A. Sathapattayanon 375* (BCU), Prachinburi, Khao Yai National Park, 1,200 m alt., 21 Jan. 2005; *T. Smitinand 8621* (BKF), E. Khao Khieo, Khao Yai National Park, 1,400 m alt., 02 Jan. 1965; *T. Smitinand s.n.* (BKF), Mae Sarieng; *Tem Smitinand 10432* (C), Mae Sarieng, en route to Ban Pa Pae, 600-800 m alt., 12 Jan. 1968; *P. Triboun 748* (BK), Mae Hong Son, Doi Pui, Huay Hei, 1,300 m alt., 31 Jan. 1999; *S. Watthana 2284* (QBG), Mae Hong Son, Mae Sariang, Miew Mae Han, Salawin Wildlife Sanctuary, 900 m alt., 20 Feb. 2007; *A. Wongmul s.n.* (BKF), Mae Sarieng, 15 Jan. 1960.

LOCALITY UNKNOWN: *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 26713 (W); *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 792 (W); *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 7008 (W); *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 32359 (W); *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 32373 (W).

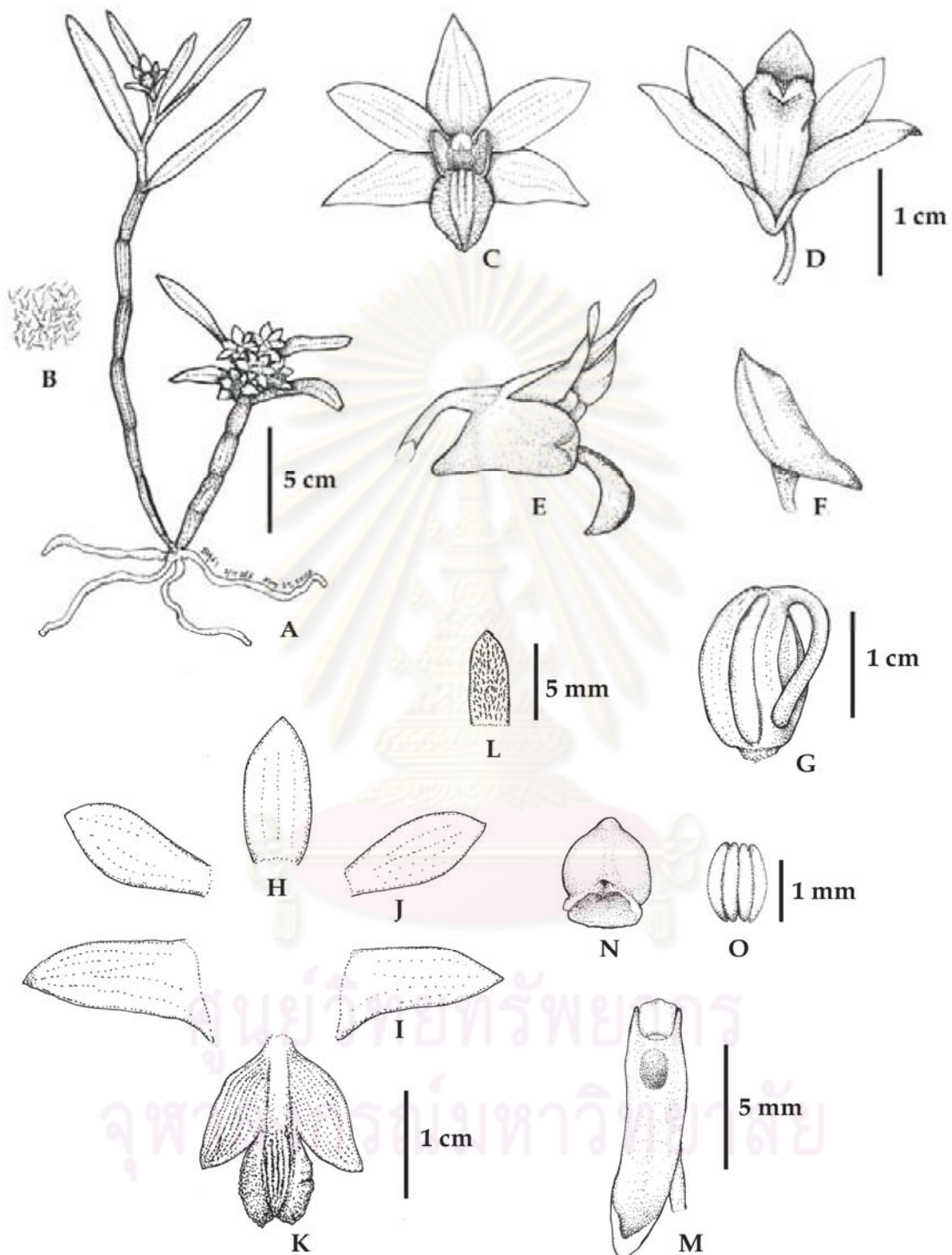


FIGURE 5.23. *Dendrobium scabrilingue* Lindl. **A.** Habit; **B.** Hairs, on leaf; **C.** Flower, front view; **D.** Flower, from below; **E.** Flower, side view; **F.** Flower bud, side view; **G.** Fruit; **H.** Dorsal sepal; **I.** Lateral sepal; **J.** Petal; **K.** Labellum; **L.** Floral bract; **M.** Column and column foot, from below; **N.** Anther cap; **O.** Pollinia. Drawn from A. Sathapattayanon 415 by Mr. Tanucha Boonjaras.

24. *Dendrobium schrautii* H. Schildhauer, J. Orchideenfr. 13 (2): 164. 2006. Type: *Sine Coll. E 0038/03* (holotype M!), Vietnam, Lam Dong Province, Dalat Lambiang. Fig. 5.24; Pl. 5: N.

Dendrobium williamsonii auct. non Day & Rchb.f.; Thaithong, Thai Orchid: 232. 2000.

Dendrobium phi Christenson ex Aver., Turczaninowia 9: 61. 2006, nom. nud.

Flowering shoots caespitose, erect, zigzag, constricted at nodes, cylindrical, tapering downward base, sulcate, green or greenish brown, yellowish green or yellowish brown, old stems yellow, sometime glossy, 7-16 cm tall, internodes 1.5-2.7 cm long, 0.7-1 cm in diameter, leafy along the upper part of stem. **Leaves** distichous, spreading, slightly recurved, often twisted at middle or basal part, coriaceous, green or dull green, elliptic-oblong or or ovate-oblong, apex unequally bi-lobed, each lobe obtuse, both surfaces covered with black hirsute hairs, densely hairy on abaxial surface and young leaves, glabrate on adaxial surface, somewhat waxy, mid-vein grooved above and ribbed below, 4.6-5.8 cm long, 1-1.5 cm wide; leaf-sheaths covered with dense black-hirsute hairs, 1.7-2.2 cm long. **Inflorescences** abbreviated, 1- to 5-flowered, often 2-flowered, borne at the apical part or uppermost node of stems; peduncle and rachis glabrous, sometime glaucous, green or light green, 0.2-0.4 cm long; floral bracts persistent, concave, abaxial surface densely covered with black hairs, adaxial surface glabrous, pale brown or tawny, narrowly ovate or ovate-oblong, apex acuminate, base truncate, 3- to 5-veined, 0.7-1 cm long, 0.3-0.6 cm wide; bracteoles adpressed, abaxial surface covered with particularly black hairs or glabrous, pale brownish yellow, shallowly deltoid, ovate-oblong, apex acuminate or attenuate, base truncate, 3- to 4-veined, 0.4-0.7 cm long, 0.2-0.4 cm wide. **Flowers** not resupinate, causing retrorse flowered, thick, veins hardly visible, scent resemble to scent of *Dendrobium cariniferum*, 3.5-4.3 cm in diameter; sepals yellowish white or pale yellow, abaxial surface darker than adaxial surface, becoming orange

yellow when aged; mentum yellowish white or pale orange yellow from out side; petals creamy white becoming creamy orange when aged; labellum creamy white and bright orange with orange veins and reddish orange hair-like callus on each vein, claw orange or light orange, side lobes yellowish white or creamy white;; disc bright orange or reddish orange; mid-lobe creamy white or yellowish white; column pale red or light orange, foot red or reddish orange, stigmatic cavity white or ivory white, anther-cap white or vary pale orange, pollinia yellow, pedicellate ovary light green or greenish white. *Sepals* spreading, adaxial surface waxy, abaxial surface distinctly keeled, margin entire, veins hardly visible; dorsal sepal narrowly elliptic or elliptic-oblong, apex acute or attenuate, base truncate, mid-vein grooved on adaxial surface, 5- to 7-veined, 2.4-2.8 cm long, 0.7-1.3 cm wide; lateral sepals obliquely triangular-lanceolate, apex acuminate or attenuate, base obliquely truncate, 4- to 6-veined , posterior margin 1.7-2.8 cm long, anterior margin 3.1-3.8 cm long, 0.8-1.1 cm wide at base, ca. 0.2 cm wide at apex. *Mentum* narrowly conical, apex obtuse, straight, 1-1.4 cm long, 0.4-0.6 cm in diameter at base, 0.2-0.4 cm in diameter. *Petals* spreading, recurved at apex, adaxial surface waxy, veins hardly visible, oblanceolate or narrowly obovate-oblong, apex acuminate, base truncate, margin entire, 5- to 7-veined, 1.9-2.4 cm long, 0.5-0.9 cm wide at base. *Labellum* 3-lobed, with sinus between side lobes and mid-lobe, somewhat waxy, 3.2-3.7 cm long, 1.4-1.9 cm wide across side lobes; claw linear or narrowly triangular, 1-1.3 cm long; side lobes obliquely ovate or obliquely elliptic, each lobe with 7 or 8 slightly elevated veins, bearing hair-like callus at the apical part, apex obtuse, lateral margin entire, front margin crenate and undulate; disc oblong, waxy, swollen at the middle part and 3- to 5-obscurely ridged at the end, each ridge bearing dense hair-like callus and continuing to mid-lobe; mid-lobe recurved backward, orbicular or widely ovate, with 2 or 4 elevated veins continued from side lobes and 3-5 ridges continued from disc, densely hair-like callous on each vein and ridge, apex rounded, tipped with mucro, margin thickened, erose and crisped, 1.1-1.6 cm long, 1.2-1.4 cm wide. *Column* surface smooth, without waxy, 5-8 mm long, 4-5 mm wide at base;

foot slightly concave, tapering downwards, surface smooth, without waxy, 15-18 mm long, 3-5 mm wide at entrance of mentum; stigmatic cavity elliptic or oblong-elliptic; stelidia varied in shaped, sometime deltoid with erose margin, sometime 2-triangular lobed, sometime 2-serrated lobed; connective linear or narrowly triangular; anther cap surface minutely papillose, obovate or sub-orbicular, apex emarginated, basal margin ciliate, adaxial surface obscurely sulcate, 2.8-3.2 mm long, 2.7-2.9 mm wide; pollinia 4, in 2 pairs, each pollinium narrowly elliptic, without caudicle and visidium. *Ovary* (including pedicel) clavate, glabrous, 3-obtusely keeled, 2.4-2.9 cm long. *Capsule* not seen.

DISTRIBUTION. – Laos and Vietnam.

HABITAT AND ECOLOGY. – Epiphytes in dry evergreen forests, at 1,400-1,800 m alt.

SPECIMENS EXAMINED. – VIETNAM: *L. Averyanov & N.Q. Binh VH 4016* (AAU), Lam Dong, Lac Duong, DaChay, 1,450 m alt., 16 April 1997; *Evrard 906* (P), route de Prenh, Dalat, 17 May 1924; *V. H. 4016* (P), Lam Dong Province, Lac Duoug District, municipalite Da Chay, 16 Apr. 1997, at 1,450 m alt; *Eberhardt 203* (P), Lang Bian, vallie de Da-Pougman, at 1,800 m alt.; *C. R. S. 71* (P), Dalat, 1953; *Eberhardt 50B* (P), sine loc.

LAOS: *A. Sathapattayanon 429* (BCU), sine loc.; *A. Sathapattayanon 445* (BCU), sine loc.

NOTE. – *Dendrobium schrautii* is closely related species to *D. cariniferum* and *D. williamsonii* but the species is noticable by its un-resupinate flowers and the dense hair-like callus on its labellum.

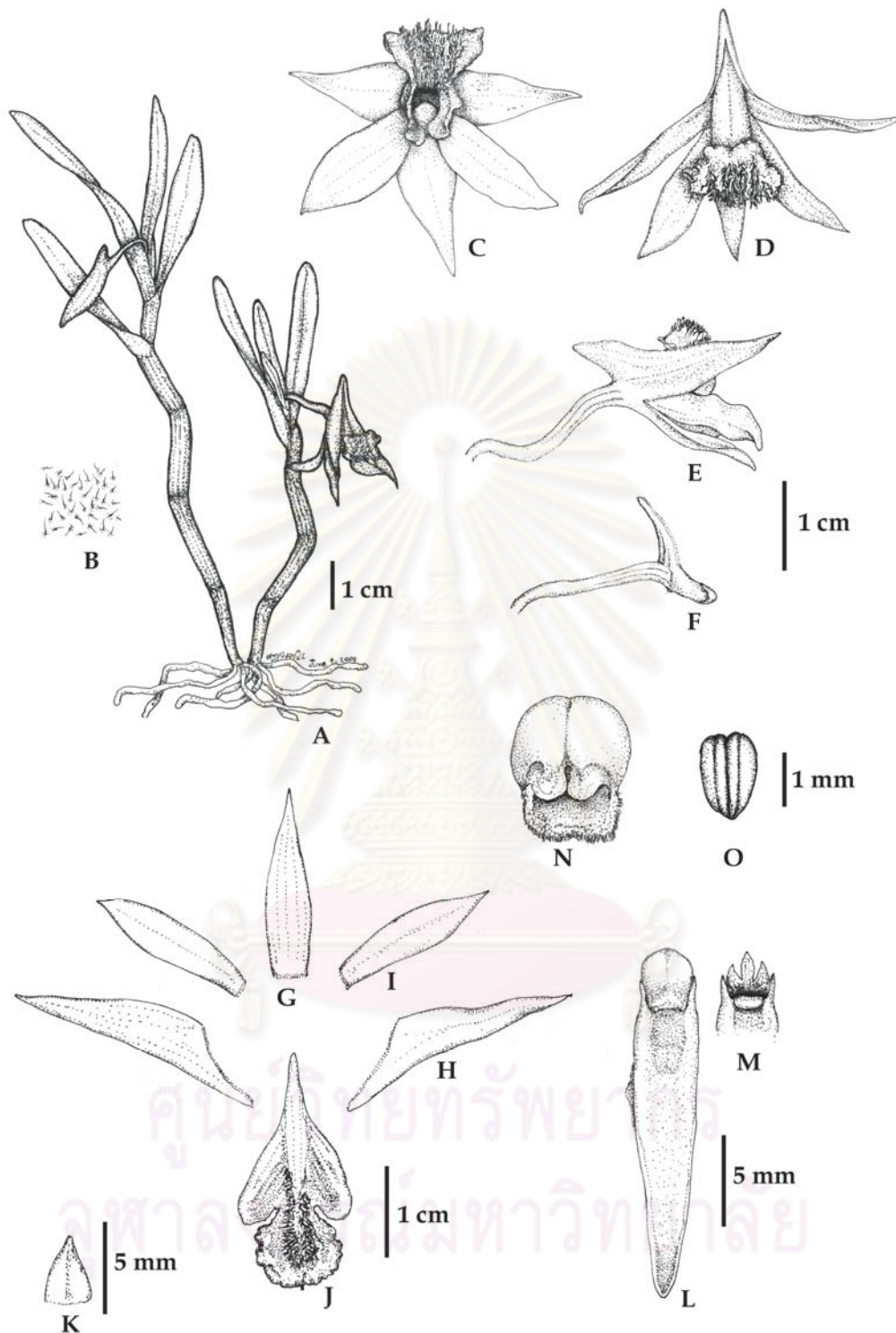


FIGURE 5.24. *Dendrobium schrautii* H. Schildhauer A. Habit; B. Hairs, on leaf; C. Flower, front view; D. Flower, from below; E. Flower, side view; F. Column and column foot, side view; G. Dorsal sepal; H. Lateral sepal; I. Petal; J. Labellum; K. Floral bract; L. Column and column foot, from below; M. Column, from below, anther cap removed; N. Anther cap; O. Pollinia. Drawn from A. Sathapattayanon 429 by Mr. Tanucha Boonjaras.

25. *Dendrobium sculptum* Rchb. f., *Bot. Zeitung (Berlin)* 21: 128. 1863. Type: *Bullen s.n.* (holotype W!), Indonesia, Borneo, without precise locality. Fig. 5.25; Pl. 6: A.

Flowering shoots clustered, erect, fractiflex distally, narrowest above the base, becoming wider distally, 16–75 cm tall, internodes 2.5–4.5 cm long, 0.4–0.8 cm in diameter, leafy along upper half. *Leaves* distichous, both surfaces densely covered with black hirsute hairs, mid-vein grooved above and ribbed below, elliptic to ovate-elliptic, apex unequally bi-lobed, each lobe obtuse, 3–6 cm long, 1.5–3 cm wide; leaf-sheaths covered with dense black hirsute hairs, 3–3.5 cm long. *Inflorescences* abbreviated, 1- to 4-flowered, borne from near the stem apex, emerging from the base of the leaf-sheaths; peduncle and rachis up to 0.5 cm long, entirely covered by bracts; floral bracts concave, abaxial surface covered with black hirsute hairs, adaxial surface glabrous, lanceolate, apex acute, base truncate, 1.2–2 cm long. *Flowers* resupinate, up to 6 cm in diameter, unscented; sepals and petals white; labellum white with an orange to orange-yellow mark at the centre and paler orange-yellow marks either side toward the base, disc sometimes suffused pale yellow; pedicellate ovary white. *Sepals* spreading; dorsal sepal elliptic or ovate-elliptic, subacute or acute, base truncate, abaxial surface distinctly keeled, wing-like at apex, 5- to 7-veined, 2.3–2.8 cm long, 0.9–1.1 cm wide; lateral sepals obliquely triangular-ovate or obliquely triangular-oblong, apex subacute or acute, base obliquely truncate, abaxial surface with distinct keel, wing-like along the distal half, 5- to 7-veined, posterior margin 2–3 cm long, anterior margin 3.5–4 cm long, 1–1.2 cm wide at base, c. 0.4 cm wide at apex. *Mentum* very narrowly conical, ovipositor-shaped, straight or slightly curved, apex obtuse, 1.8–2.5 cm long, ca. 0.2 cm in diameter. *Petals* obovate or broadly ovate, apex obtuse or acute, base truncate, margin entire or uneven, ca. 7-veined, 2.9–4 cm long, 2–2.6 cm wide. *Labellum* slightly 3-lobed, 3–3.5 cm long, 1.5–2 cm wide across side lobes; claw linear, ca. 1.2 cm long; side lobes obscure, very broadly semi-circle, sometime absent, adaxial surface transversely rugulose, apex of side lobes obtuse, margin subentire; disc oblong, slightly thicken at

center; mid-lobe transversely oblong-reniform, porrect to slightly decurved, adaxial surface transversely rugulose at basal part, apex emarginate, margin entire, 1.2-1.5 cm long, 1.7-2.5 cm wide. *Column* ca. 5 mm long, 4-5 mm wide at base; foot ca. 20 mm long, ca. 5 mm wide at entrance of mentum; steldia triangular; connective narrowly triangular ovate; anther cap ovate, surface minutely papillose, apex round, basal minutely margin ciliate, adaxial surface sulcate, ca. 2.7 mm long, ca. 2.5 mm wide. *Ovary* (including pedicel) narrowly clavate, gently curved, glabrous, 6-grooved, 4-5 cm long. *Capsule* not seen.

DISTRIBUTION.— Malaysia.

HABITAT AND ECOLOGY.— Epiphytes in open, rather low, montane forest, at 1,000 - 1,500 m alt. Flowering period: April-June.

SPECIMENS EXAMINED.— MALAYSIA: A. Lamb SAN 93491 (LMC 2305) (K), Sabah, Kinaloatangan District, Qunung Lotong, Malian Basin, c. 4,000-4,500 ft alt., Apr. 1982; J. T. Pereira et al 360 (K), Sabah, Kinabatangan, Maliau Basin, around helipad 5, 3,480 ft alt., 17 Apr. 1996.

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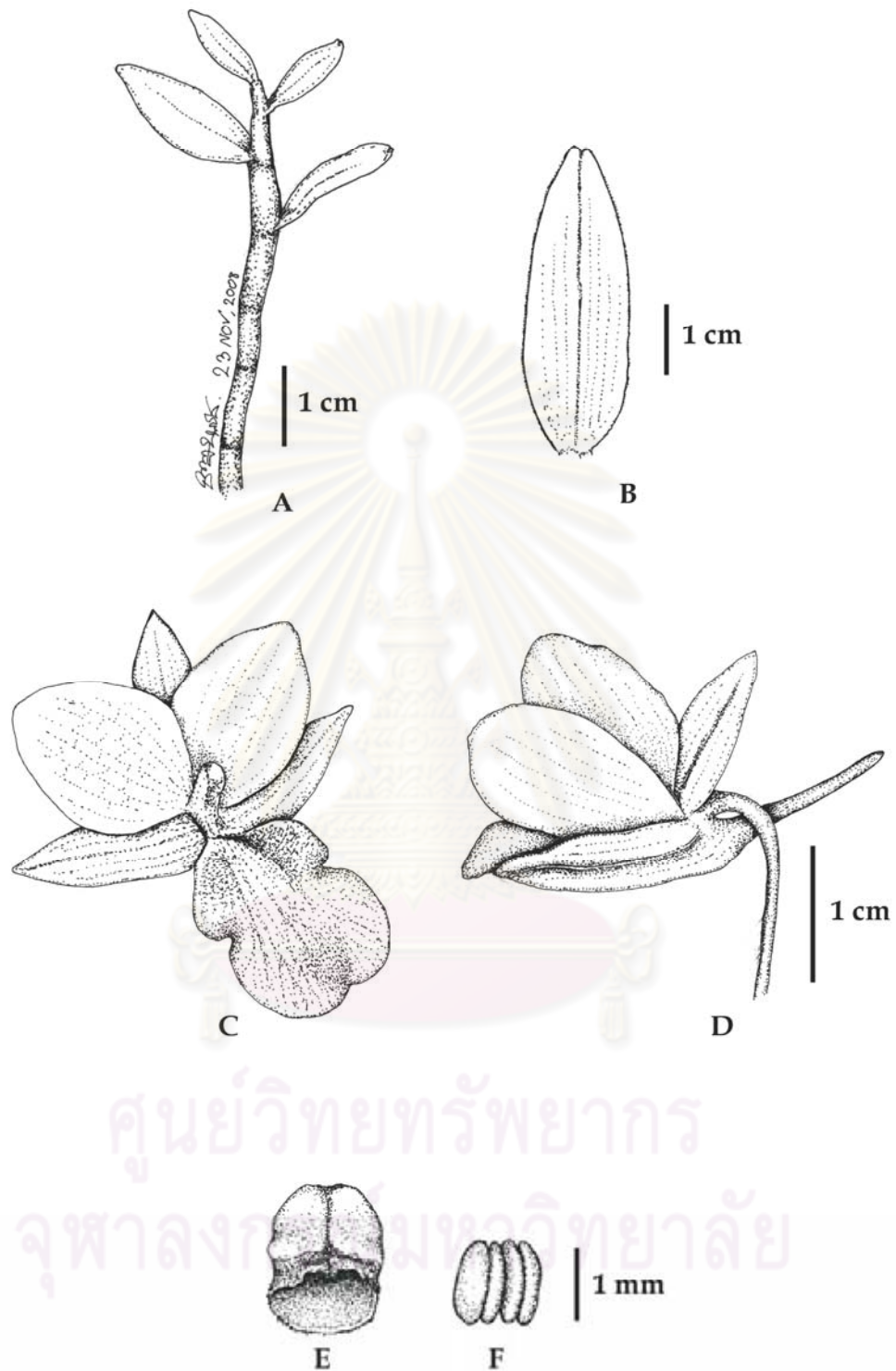


FIGURE 5.25. *Dendrobium sculptum* Rchb.f. A. Habit; B. Leaf; C. Flower; D. Flower, side view; E. Anther cap; F. Pollinia. Drawn from *Bullen s.n.* (holotype) by Mr. Tanucha Boonjaras.

26. *Dendrobium sinense* T. Tang & F.T. Wang, Acta Phytotax. Sin. 12: 41. 1974. Type: C. Wang 35,527 (holotype PE), China, Hainan, Ting-An Hsien, 17 July 1933. Fig. 5.26; Pl. 6: B.

Dendrobium lueckelianum Fessel & M. Wolff, Orchidee 41: 38. 1990. **syn. nov.** Type: Dee Bunpheng 381 (holotype BKF!), Thailand, Loei Province, Phu Kradueng National Park, 4 September 1982; D.O.G. 90, 001 (paratype C!), Thailand, locality unknown.

Flowering shoots erect, fusiform, sulcate, slightly constricted at nodes, greenish brown or grayish brown, 5-10 cm tall, internodes 0.9-1.3 cm long, 0.6-0.9 cm in diameter, leafy at the upper part of stem. **Leaves** distichous, spreading, thinly coriaceous, mid-vein grooved above and ribbed below, both surfaces particularly covered with black hirsute hairs, green or dull green, oblong or elliptic-oblong, apex unequally bi-lobed, each lobe acute or obtuse, 2.7-3.3 cm long, 0.6-1.5 cm wide; leaf-sheaths covered with black hairs, 0.5-1.6 cm long. **Inflorescences** abbreviated, 1- to 2-flowered, often 1-flowered, borne from nodes at the uppermost of leafy stems; peduncle and rachis glabrous, green, 0.1-0.3cm long, covered with bracts; floral bracts abaxial surface covered with sparsely black hairs, becoming glabrous, adaxial surface glabrous, brown, oblong, slight concave, apex acuminate or acute, base truncate, 3- to 4-veined, 0.4-0.7cm long, 0.2-0.3 cm wide. **Flowers** papyraceous, resupinate, unscented, 3- 4 cm in diameter; sepals and petals white; mentum orange white or pale yellow from outside; labellum white, claw reddish orange, side lobes white, pale orange red at basal part, with darker veins, disc crimson or orange red, sometime with yellow, mid-lobe white or creamy white, with crimson keels; column white, foot pale orange or yellowish orange, stigmatic cavity white, anther-cap white, pollinia yellow, pedicellate ovary yellowish green to light green. **Sepals** spreading, slightly recurved distally, margin entire, abaxial surface without keel; dorsal sepal elliptic-oblong, apex acute, base truncate, 5- to 7-veined, 1.4-2.2 cm long, 0.4-0.7

cm wide; lateral sepals obliquely triangular-ovate, apex acuminate or acute, base obliquely truncate, 5- to 7-veined, posterior margin 1.3-1.6 cm long, anterior margin 2.2-2.8 cm long, ca. 1.2 cm wide at base, ca. 0.3 cm wide at apex. *Mentum* saccate, apex obtuse, 0.5-1 cm long, ca. 0.5 cm in diameter at base. *Petals* spreading, oblong or elliptic-oblong, slightly cuneate at base, apex acute or acuminate, base truncate, margin entire, 3- to 5-veined, 1.5-2.2 cm long, 0.5-0.8 cm wide. *Labellum* 3-lobed, 2.4-2.9 cm long, 2.2-3 cm wide across side lobes; claw transversely oblong or shallowly triangular, 2-3 mm long; side lobes obliquely widely elliptic, apex obtuse, margin entire to subentire, 5 to 7 slightly elevated veins running along each side lobe, each vein glabrous; disc narrowly oblong, thickening, with distinctly, smooth 3-keeled, continuing from base of disc to base of mid-lobe, becoming rough at apex; mid-lobe transversely elliptic-oblong, recurved backward, less than 90 degree of angle, apex emarginate to deeply emarginate, margin crenulate or subentire, with rough 3-5 keels at basal part, 0.9-1.1 cm long, 1.2-1.4 cm wide. *Column* 4-5 mm long, 3.7-4.3 mm wide at base; foot concave, cymbiform, broad at middle, waxy, 8-10 mm long, 4-4.7 mm wide at base; stigmatic cavity oblong or ovate-oblong; steldia triangular; connective narrowly triangular; anther cap obovate to widely obovate, surface minutely papillose, adaxial side sulcate, apex emarginated, basal margin minutely ciliate, 2.8-3.1 mm long, 2-2.5 mm wide; pollinia 4, in 2 pairs, each pollinium narrowly elliptic, without caudicle and visidium. *Ovary* (including pedicel) narrowly clavate, curved, glabrous, somewhat waxy with 6-grooves, 2-2.7 cm long. *Capsule* dehiscent, green or dull green, ovate or elliptic with 3 obtuse keels, apex with persistent dried perianth, 1.5-2.2 cm long, 0.6-1.2 cm wide.

DISTRIBUTION. – China and Thailand.

HABITAT AND ECOLOGY. – Epiphytes in dry evergreen forest or pine forest, at 1,000-1,500 m alt. Flowering period: May-September.

SPECIMENS EXAMINED. – CHINA: *Hu Song Hua s.n.* (C), Hainan, sine loc., 1988.

THAILAND: *DB 7519* (C), Loei, Phu Krading 1,300 m alt., 12 Feb. 1959; *DEE 381* (C - isotype of *D. lueckelianum*), Loei, Phu Krading; *Dee 381* (BKF-holotype of *D. lueckelianum*), Loei, Phu Krading, 31 July 1982; *C. Maknoi 165* (QBG), Phitsanulok, Chattrakarn, Lan son, Phu Soi Dao National Park, 1,600 m alt., 24 July 2001; *A. Sathapattayanon 407* (BCU), sine. loc.; *A. Sathapattayanon 439* (BCU), sine. loc., 06 Dec. 2006; *Suphachadiwong D.O.G. 90001* (C), sine loc.; *O. Thaithong 279* (BCU), sine loc., 29 Aug. 1987.

LOCALITY UNKNOWN: *sine coll.* (K), 23 Nov. 1976.



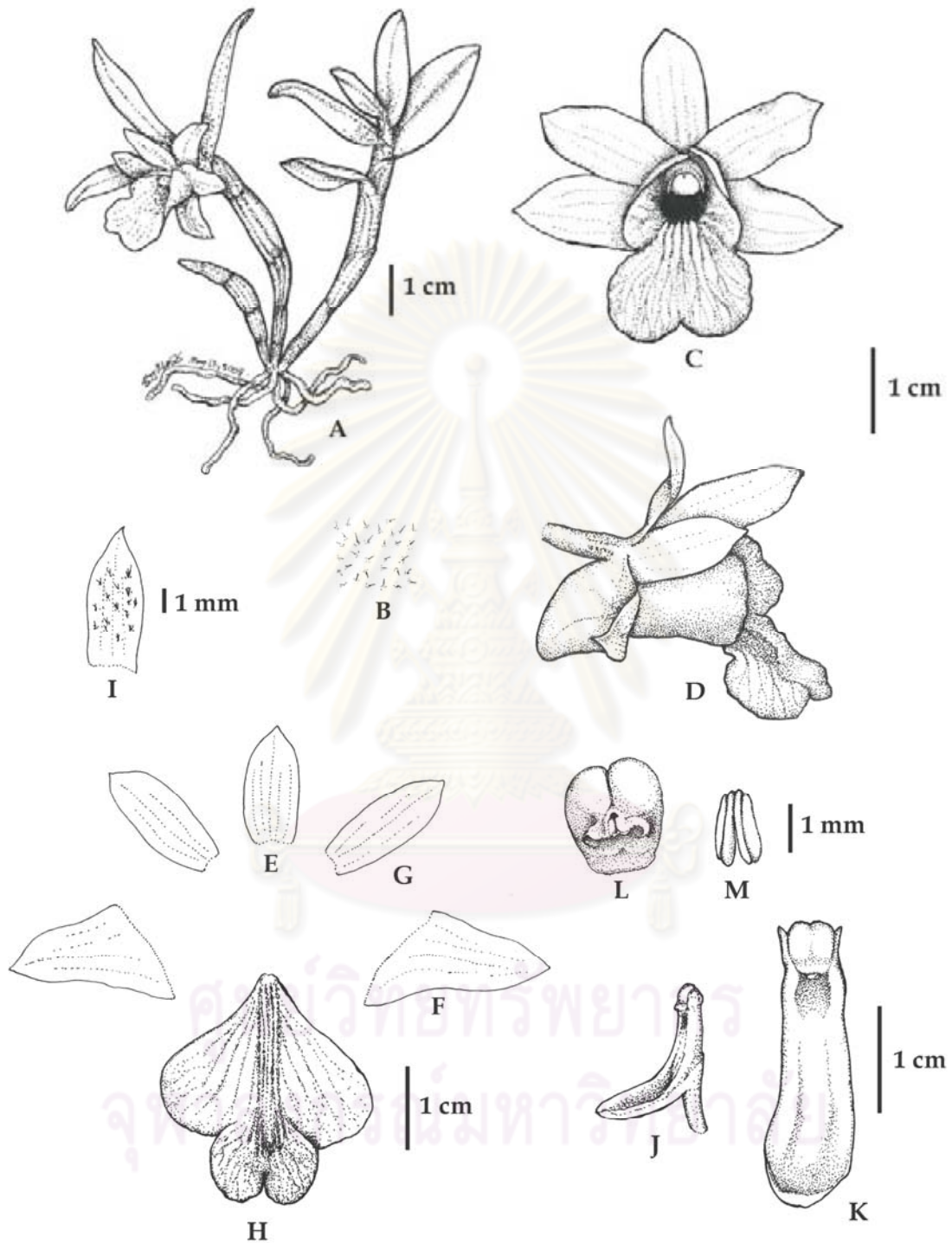


FIGURE 5.26. *Dendrobium sinense* T. Tang & F.T. Wang **A.** Habit; **B.** Hairs, on leaf; **C.** Flower, front view; **D.** Flower, side view; **E.** Dorsal sepal; **F.** Lateral sepal; **G.** Petal; **H.** Labellum; **I.** Floral bract; **J.** Column and column foot, side view; **K.** Column and column foot, from below; **L.** Anther cap; **M.** Pollinia. Drawn from A. Sathapattayanon 407 by Mr. Tanucha Boonjaras.

27. *Dendrobium singkawangense* J.J. Sm., Gard. Bull. Straits Settle. 9: 91. 1935. Type: *Paath s.n.* (holotype L!), Indonesia, Borneo, Kalimantan Barat, Singkawang, 20 October 1934. Fig. 5.27; Pl. 6: C.

Flowering shoots clustered, erect, cylindrical, fractiflex, sulcate, slightly constricted at nodes, central internodes broadest, greenish brown, 20-30 cm tall, internodes 1.5-4 cm long, 0.9-1.2 cm in diameter, leafy along stem. *Leaves* distichous, spreading, recurved distally, coriaceous, both surfaces covered with dense black hirsute hairs, becoming glabrous when mature, mid-vein grooved above and ribbed below, green or brownish green, oblong to ovate, apex unequally bi-lobed, each lobe obtuse or subacute, 4.3-8.2 cm long, 2.2-4 cm wide; leaf-sheaths covered with dense short black hirsute hairs, 1.7-2.5 cm long. *Inflorescences* abbreviated, 1- to 4-flowered, up to 6-flowered, borne from the nodes on the upper portion of the stem opposite the blade; peduncle and rachis glabrous, bilaterally compressed, green, 1-2.2 cm long, covered with bracts; floral bracts deeply concave, abaxial surface covered with dense black hirsute hairs, adaxial surface glabrous, brown, oblong, apex acute, base truncate, 4- to 7-veined, 0.7-1.8 cm long, 0.4-0.5 cm wide. *Flowers* rather coriaceous, resupinate, unscented, veins obscured, visible when aged, up to 2.4-3.2 cm in diameter; sepals and petals pale creamy yellow or cream; mentum cream from outside; labellum orange yellow and reddish orange, claw pale red, side lobes translucent white with papillose reddish orange or pink nerves, disc with a median pink, orange or red keel; mid-lobe cream with a cream central keel and bright orange papillose secondary keels either side; column pale creamy yellow, foot orange or reddish orange, stigmatic cavity pale creamy yellow, anther-cap white, pollinia yellow, pedicellate ovary white or greenish white. *Sepals* spreading, distal half recurved, margin entire; dorsal sepal oblong or subovate, apex acute or acuminate, base truncate, concave at the centre, abaxial surface keeled, hardly visible, 5- to 7-veined, 1.3-2.1 cm long, 0.7-0.9 cm wide; lateral sepals, obliquely triangular-oblong, apex acuminate, base obliquely truncate, abaxial surface with

obtuse keel, 5- to 7-veined, posterior margin 2-2.4 cm long, anterior margin 2.4-2.8 cm long, 0.9-1.3 cm wide at base, c. 0.2 cm wide at apex. *Mentum* shortly conical, straight, apex obtuse, 0.8-1 cm long, 0.2-0.3 cm in diameter. *Petals* spreading, apex recurved, thin-textured, thickened along median line, obliquely ovate or triangular-ovate from a short oblique claw, apex obtuse and apiculate, base truncate, margin entire, distal margin undulate, 3- to 5-veined, 1.7-2 cm long, 0.9-1.5 cm wide near base. *Labellum* 3-lobed, 2.1-2.5 cm long, 1.3-1.5 cm wide across side lobes; claw narrowly oblong, 3-6 mm long; side lobes with 3-5 papillose veins on adaxial surface, elliptic to trapezoid, apex round, margin subentire; disc oblong, slightly prominent, with 3-5 subkeels; mid-lobe convex, decurved, median area with 2-3 papillose median keels, with two pairs of lateral papillose keels either side, elliptic or ovate, apex acuminate or mucronate, margins undulate, especially in the distal half, 0.8-1.1 cm long, 0.5-0.7 cm wide. *Column* surface smooth, 4-5 mm long, 3.5-4 mm wide at base; foot slightly concave, tapering downwards, surface smooth, 8-10 mm long, 3.5-4 mm wide at base; stigmatic cavity elliptic; stelidia triangular; connective linear; anther cap orbicular or widely ovate, surface minutely papillose, apex rounded to slightly retuse,, basal margin minutely ciliate, adaxial surface sulcate, 2.5-2.6 mm long, 2.6-2.7 mm wide; pollinia 4, in 2 pairs, each pollinium narrowly elliptic, without caudicle and visidium. *Ovary* (including pedicel) narrowly clavate, ovary puffed, pedicel slightly curved, glabrous, 6-grooved, 2.1-3.2 cm long. *Capsule* not seen.

DISTRIBUTION. – Malaysia and Indonesia.

HABITAT AND ECOLOGY. – Hill forest with scattered trees, at 300 – 400 m alt.

SPECIMENS EXAMINED. – MALAYSIA: A. Lamb AL 1,127/2007 (K), Sabah, Paitau area, logging area, 300-400 m alt., 23 May 2007.

INDONESIA: *Paath s.n.* (L), Borneo, Kalimantan Barat, Singkawang, 20 Oct.
1934.

LOCALITY UNKNOWN: *sine coll.* TGB141081 (TNS), 14 May 2007.



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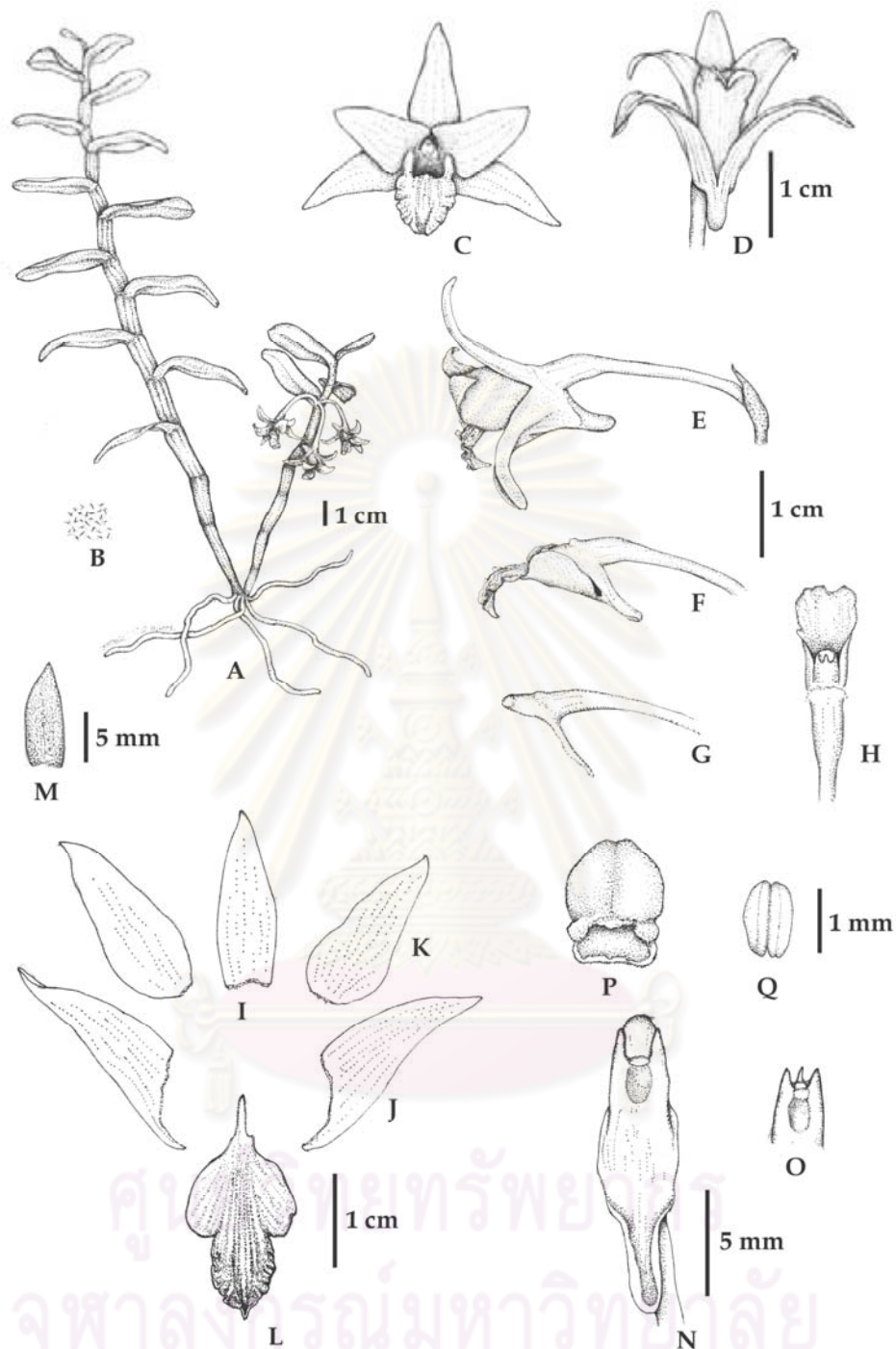


FIGURE 5.27. *Dendrobium singkawangense* J.J. Sm. **A.** Habit; **B.** Hairs, on leaf; **C.** Flower, front view; **D.** Flower, from below; **E.** Flower, side view; **F.** Labellum and mentum, side view, sepals and petals removed; **G.** Column and column foot, side view; **H.** Labellum and mentum, from above, sepals and petals removed; **I.** Dorsal sepal; **J.** Lateral sepal; **K.** Petal; **L.** Labellum; **M.** Floral bract; **N.** Column and column foot, from below; **O.** Column, from below, anther cap removed; **P.** Anther cap; **Q.** Pollinia. Drawn from *Hort. Tsukuba Botanical Garden accession number 141081* by Mr. Tanucha Boonjaras.

28. *Dendrobium sisuronense* J.J. Wood in Wood, Beaman & Beaman, Orchids of Mount Kinabalu (*ined.*). Type: *Lamb AL 250/84* (holotype K!, spirit collection), *Chan drawing no.112* (Iconotype K!), Indonesia, Sabah, Crocker Range, Tambunan District, Sinsuron road, Mountain Alab, 900–1,200 m alt., August 1984. Fig. 5.28.

Dendrobium singkawangense auct. non J.J. Sm.; Chan *et al.*, Orchid of Borneo 1: 132–133, fig. 31. 1994.

Flowering shoots clustered, erect, cylindrical, fractiflex, sulcate, slightly constricted at nodes, lowermost internodes narrowest, ca. 20–32 cm tall, internodes 1–4 cm long, 0.5–1.1 cm in diameter, leafy along stem, bearing 4–15 leaves. **Leaves** distichous, spreading, slightly twisted at middle, coriaceous, both surfaces covered with black hirsute hairs, becoming glabrous with age, mid-vein grooved above and ribbed below, oblong to oblong-elliptic, apex unequally bilobed, each lobe obtuse, 8–11.5 cm long, 1.6–2.7 cm wide; leaf-sheaths covered with short black hirsute hairs, 2.4–3.1 cm long. **Inflorescences** abbreviated, 1- to 10-flowered, borne opposite the leaves at the upper nodes of both leafy and leafless stems; peduncle and rachis glabrous, 1–2 cm long; floral bracts covered with black hirsute hairs on abaxial surface, adaxial surface glabrous, linear-lanceolate, apex acuminate, base truncate, ca. 1 cm long. **Flowers** rather coriaceous, resupinate, waxy, unscented, up to 3–4.5 cm in diameter; sepals and petals pale white; mentum flushed yellowish orange from outside; labellum white and orange, claw and side lobes orange, disc yellow; mid-lobe white with dark orange central area; column dark orange. **Sepals** spreading, margin entire; dorsal sepal lanceolate, apex acute, base truncate, abaxial surface wing-like keeled along distal half, broadest keel at apex, 7-veined, 1.9–2.5 cm long, 0.6–0.7 cm wide; lateral sepals, obliquely oblong-lanceolate, apex acute, base obliquely truncate, abaxial surface with broad wing-like keel, 7-veined, posterior margin 2.2–2.4 cm long, anterior margin 2.6–2.7 cm long, 0.7–1 cm wide at base, c. 0.2 cm wide at apex. **Mentum** shortly conical, straight, apex obtuse, 0.7–1 cm long, ca. 0.2

cm in diameter. *Petals* spreading, recurved at apex, elliptic to lanceolate, apex acute, base truncate, margin entire, 5-veined, 2-2.5 cm long, 0.7-1.1 cm wide. *Labellum* 3-lobed, 2 -2.3 cm long, 1.4-1.5 cm wide across side lobes; claw triangular-oblong, 2-4 mm long; side lobes with many transverse papillose-verrucose callus on adaxial surface, obliquely oblong, apex round, front margin erose, lateral margin subentire; disc oblong, papillose-verrucose on adaxial surface, with 3 rough, obscure keels, veins at either side slightly raised and papillose; mid-lobe clawed, elliptic or obovate, recurved distally, basal half with papillose-verrucose callus, 3-papillose-verrucose keeled at median area, apex rounded or retuse, margins crenulate, not undulate, 1-1.1 cm long, 0.9-1 cm wide. *Column* surface very minutely papillose, 4-6 mm long, 4-4.5 mm wide at base; foot slightly concave, tapering downwards, surface very minutely papillose, 7-10 mm long, 4-5 mm wide at base; stigmatic cavity elliptic; stelia triangular; connective linear or narrowly triangular; anther cap orbicular or widely ovate, surface minutely papillose, apex rounded to slightly retuse,, basal margin minutely ciliate, adaxial surface sulcate, 2.7-3 mm long, 2.4-2.6 mm wide; pollinia 4, in 2 pairs, each pollinium narrowly elliptic, without caudicle and visidium. *Ovary* (including pedicel) narrowly clavate, slightly curved, ovary borne at an obtuse angle to the pedicel, glabrous, 6-grooved, 2.2-3.5 cm long. *Capsule* not seen.

DISTRIBUTION – Malaysia.

HABITAT AND ECOLOGY – Lower montane forest at 900-1,400 m alt. Flowering period: August.

SPECIMENS EXAMINED.— MALAYSIA: C. E. Carr SFN. 26592 (K), Kinabalu, Gurulan Spur, 4,500 ft alt., 17 Mar. 1933; A. Lamb AL 250/84 (K), Sabah, Penampang District, Sinsuron Road, Moyog area, Qunung Alab ridge, 3,000-3,500 ft alt., 14 Aug. 1984; A. Lamb 2004/1221 (K), Sabah; S. Collette 534 (K),

Libang, North of Borneo, 4,000 ft alt., 27 July 1960.

NOTE — *Dendrobium sisuroense* is similar to *D. singkawangense* but differ in having slightly larger flowers than *D. singkawangense*. The mid-lobe of *D. sisuroense* is flat, never undulate, and has three short, obscure papillose-verrucose ridges in the centre. The vein at either side of these is also slightly raised and papillose.



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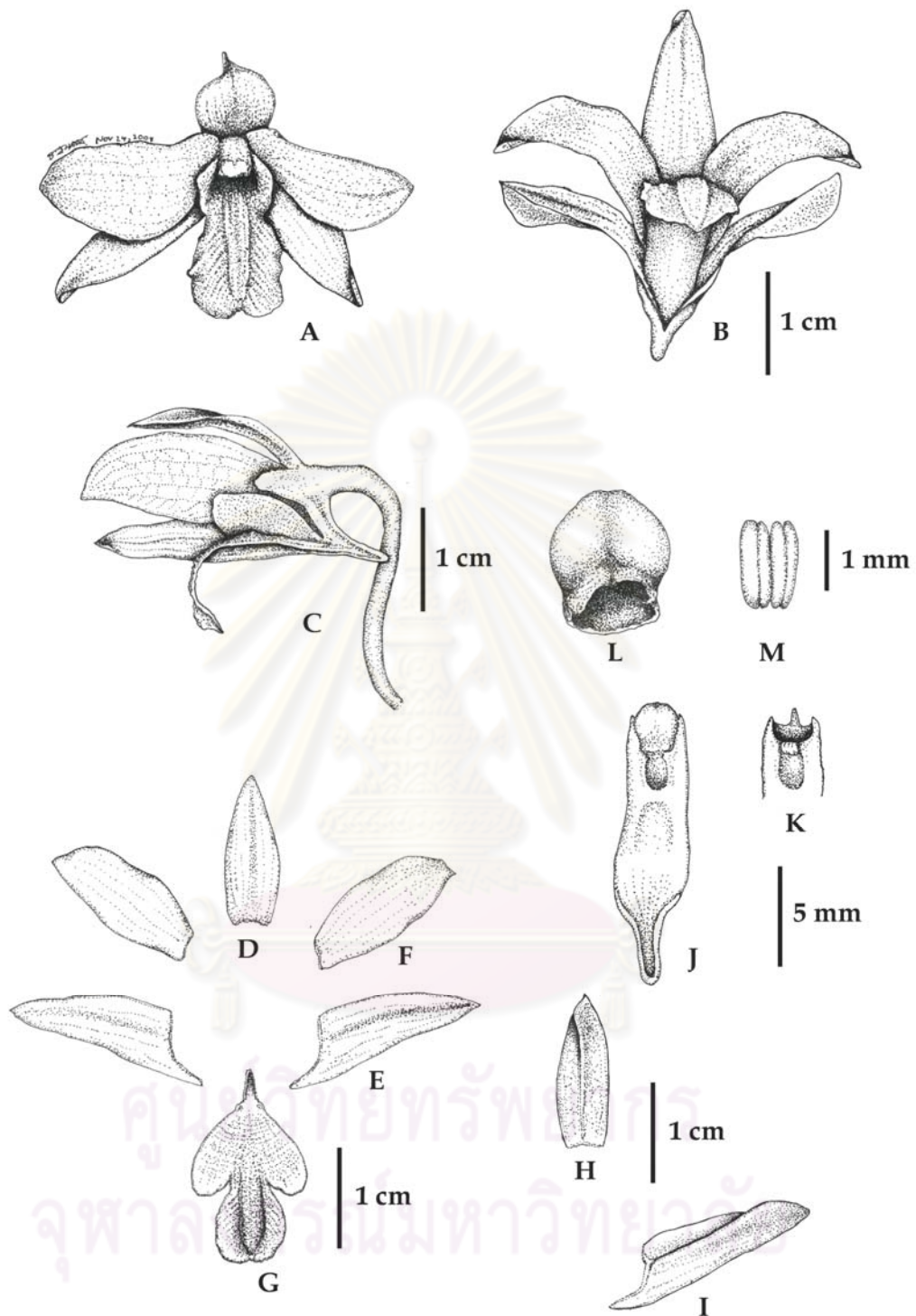


FIGURE 5.28. *Dendrobium sisuronense* J.J. Wood **A.** Flower, front view; **B.** Flower, from below; **C.** Flower, side view; **D.** Dorsal sepal; **E.** Lateral sepal; **F.** Petal; **G.** Labellum; **H.** Dorsal sepal, abaxial surface; **I.** Lateral sepal, abaxial surface; **J.** Column and column foot, from below; **K.** Column, from below, anther cap removed; **L.** Anther cap; **M.** Pollinia. Drawn from *Lamb AL 250/84* (holotype) by Mr. Tanucha Boonjaras.

29. *Dendrobium spectatissimum* Rchb. f., *Linnaea*, 41: 41. 1876. Type: *Lobb s.n.* but actually *Low s.n.* (holotype K!, in Lindley Herbarium; iconotype W!; isotype K!), Indonesia, Sabah, Mountain Kinabalu, 5,000 ft alt., 1856. Fig. 5.29; Pl. 6: D.

Dendrobium speciosissimum Rolfe, *Orchid Rev.* 3: 119. 1895. —Type: *Low s.n.* (holotype K!; isotype K!, in Lindley Herbarium, W!), Indonesia, Sabah, Mountain Kinabalu, 5,000 ft alt., 1856.

Dendrobium reticulatum J.J. Sm., *Bull. Jard. Bot. Buitenzorg, Sér. 2*, 13: 18. 1914. —Type: *Dumas s.n.* (holotype BO), Indonesia, Sabah, Mountain Kinabalu, 200 m alt.

Flowering shoots clustered, erect, cylindrical, fractiflex, sulcate, brown or greenish brown, 30–45 cm tall, internodes 1.5–3 cm long, 0.8–1.2 cm in diameter, leafy along upper part of stem. **Leaves** distichous, spreading, coriaceous, both surfaces covered with dense black hirsute hairs, especially when young, mid-vein grooved above and ribbed below, green, oblong-elliptic or ovate-oblong, apex unequally bi-lobed, each lobe obtuse, 3.3–6.5 cm long, 1.5–2.3 cm wide; leaf-sheaths longer than internodes, covered with dense short black hirsute hairs, ochreous to mustard-yellow, 1.7–2.5 cm long. **Inflorescences** abbreviated, 2- to 4-flowered, up to 6-flowered, borne near the apex of the stem; peduncle and rachis glabrous, green, 1–1.5 cm long; floral bracts concave, abaxial surface covered with dense black hirsute hairs, adaxial surface glabrous, brown or pale brown, triangular-ovate, apex acuminate, base truncate, 7- to 11-veined, 1–2 cm long, 0.5–0.8 cm wide. **Flowers** resupinate, faintly fragrant, veins visible, long-lasting, up to 5.7–10 cm in diameter; sepals and petals pure white; mentum white tinged pink; labellum white with a central band of colour which is mostly reddish or pink, but dark yellow at the apex, claw of mid-lobe deep orange edged scarlet, yellow on reverse; column white, foot white, often flushed pink or scarlet at the base, stigmatic cavity white, anther-cap white, pollinia yellow, pedicellate ovary white. **Sepals** spreading, concave at apex, reticulately-veined, margin entire;

dorsal sepal oblong to oblong-elliptic, apex acuminate, base truncate, abaxial surface with hardly visible keel, 7-veined, 3.9-5 cm long, 1.5-2 cm wide; lateral sepals, obliquely triangular-oblong, apex acuminate, base obliquely truncate, abaxial surface with obtuse keel, 6- to 9-veined, posterior margin 3-3.2 cm long, anterior margin 5.5-7.5 cm long, 1.6-2.3 cm wide at base, c. 0.3 cm wide at apex. *Mentum* shortly conical, straight, apex obtuse, 0.7-1.3 cm long, ca. 0.3 cm in diameter. *Petals* spreading, recurved backwards at middle, reticulately-veined, obliquely ovate or ovate-elliptic, apex obtuse, often slightly retuse or minutely bidentate, base cuneate, margin slightly undulate, repand, 7- to 9-veined, 3.5-5.2 cm long, 2-4.1 cm wide near base. *Labellum* 3-lobed, porrect, 4-6 cm long, 2.5-3.5 cm wide across side lobes, 3-3.7 cm wide across mid-lobe; claw triangular, 5-7.5 mm long; side lobes obliquely semi-circle, adaxial surface minutely rugulose, apex round, margin entire; disc narrowly oblong, with a tumour at central area and obscurely 3-keeled, extending from the base of the labellum and terminating halfway along the mid-lobe; mid-lobe oval, apex retuse, apiculate, margins repand, 1.8-3.2 cm long, 2.2-3.1 cm wide. *Column* surface minutely papillose, 0.6-0.9 mm long, 0.8-1.2 mm wide at base; foot broad at the base, tapering downwards, slightly concave, canaliculate, surface minutely papillose, 8-12 mm long, 11-12 mm wide at base; stigmatic cavity elliptic; stelidia broadly triangular; connective linear; anther cap orbicular or widely depressed ovate, surface minutely papillose, apex rounded to slightly retuse, basal margin minutely ciliate, adaxial surface sulcate, 4 mm long, 4 mm wide; pollinia 4, in 2 pairs, each pollinium narrowly elliptic, without caudicle and visidium. *Ovary* (including pedicel) narrowly clavate, strongly curved, glabrous, 6-grooved, 2.5-5.7 cm long. *Capsule* not seen.

DISTRIBUTION. — Malaysia.

HABITAT AND ECOLOGY. — Epiphytes on bushes and trees in lower montane forest, at 1,500-1,800 m alt.

SPECIMENS EXAMINED.— MALAYSIA: *Andrew Bacon* 239 (E), Sabah, Kinabalu, Marai Parai Plateau/Ridge, 5,500 ft alt.; *C. Bailes & P. Cribb*, 818 (K), Sabah, Mt. Kinabalu National Park, Marai Parai spur, 1,700 m alt., 25 Apr. 1982; *C. L. Chan* 35 (K), Sabah, Mt. Kinabalu, Marai Parai, 5,200 ft alt.; *Sheila Collenette* 14/79 (E), Sabah, Kinabalu, Marai Parai Spur, 5,300 ft alt., 24 Aug. 1970; *S. Collenette s.n.* (K), Mt. Kinabalu National Park, Marai Parai spur, 2,200 ft alt., Sep. 1958; *S. Collenette s.n.* (K), Borneo, probably from Mt. Kinabalu Nat. Park, Marai Parai spur, 2,200 ft alt., 19 Sep. 1959; *A. Lamb* AL 567/2003 (K), Sabah, Kinabalu, 20 July 2003; *A. Lamb* SAN 89686 (K), Mountain Kinabalu, 5,200 ft alt.; *H. Low s.n.* (K), Sep. 1895; *H. Low s.n.* (K), Kinabalu, 5,000 ft alt.; *H. Low s.n.* (K), Kinabalu, 5,000 ft alt.; *Cult. Sander s.n.* (K), July 1895.

LOCALITY UNKNOWN: *sine coll.* TBG133877 (TNS), 30 June 2007.

NOTE.— 1) *Dendrobium spectatissimum* has the largest individual flowers of any Bornean *Dendrobium*, some individuals measuring as much as ten centimetres across. For the first week or ten days after the flower has opened the petals are curled tightly back, completely enclosing the top edges of the lateral sepals. The petals then uncurl until they form right angles to the direction of the lip. During the last two or three days of the flower's life the petals move forward and lie parallel with the lip. The flowers remain open for up to six weeks.

2) Reichenbach (1876) described *Dendrobium spectatissimum* from the specimen collected by Low but he mis-indicated the collector's name as Lobb. The holotype specimen, deposited at Kew in Lindley's Herbarium, indicated that the collector is Low.

3) The isotype of *Dendrobium spectatissimum* also kept at Kew. Rolfe (1895) described *D. speciosissimum* from this specimen.

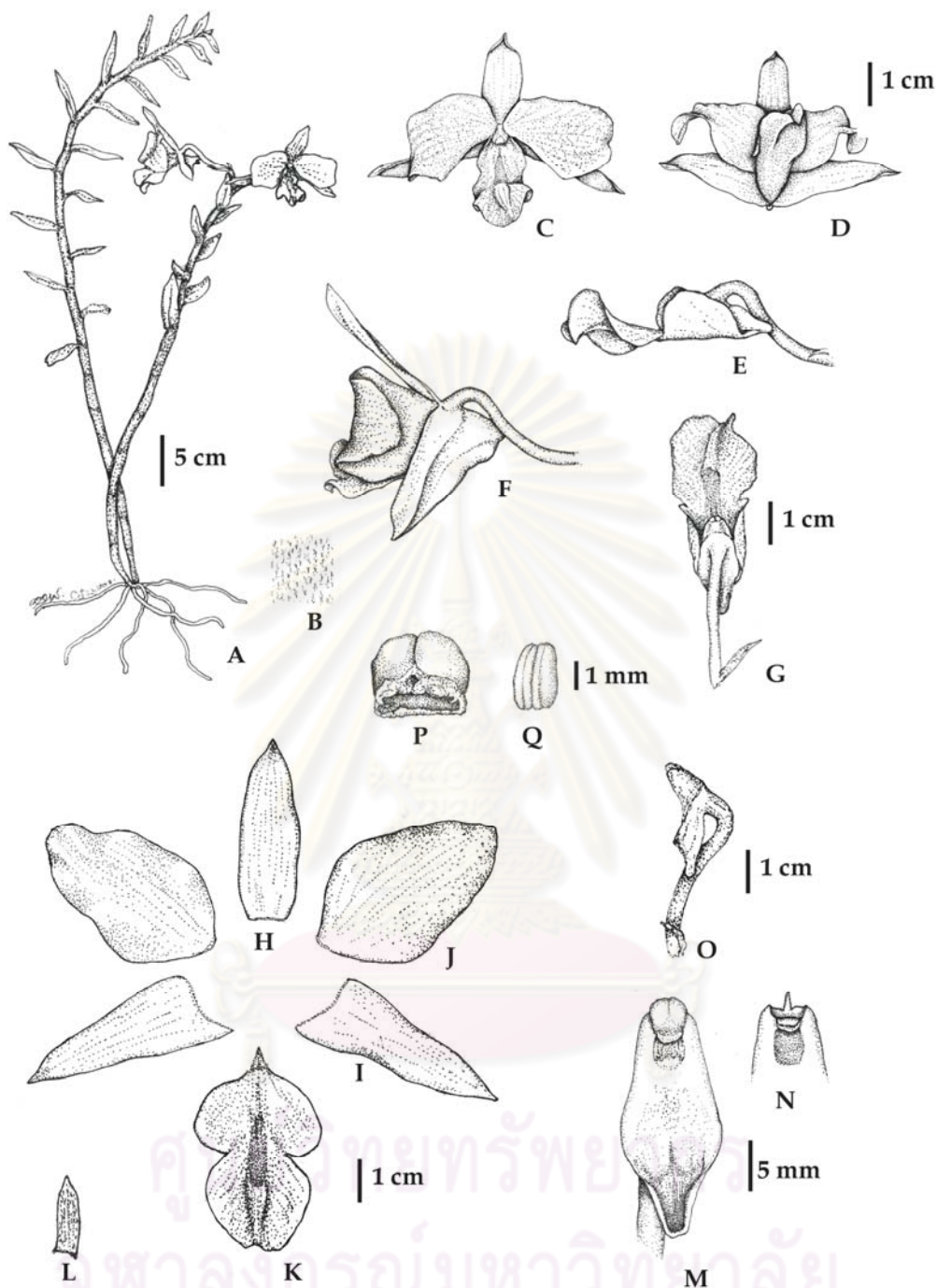


FIGURE 5.29. *Dendrobium spectatissimum* Rchb.f. **A.** Habit; **B.** Hairs, on leaf; **C.** Flower, front view; **D.** Flower, from below; **E.** Labellum and mentum, side view, sepals and petals removed; **F.** Flower, side view; **G.** Labellum and mentum, from above, sepals and petals removed; **H.** Dorsal sepal; **I.** Lateral sepal; **J.** Petal; **K.** Labellum; **L.** Floral bract; **M.** Column and column foot, from below; **N.** Column, from below, anther cap removed; **O.** Column and column foot, side view; **P.** Anther cap; **Q.** Pollinia. Drawn from *Hort. Tsukuba Botanical Garden accession number 133877* by Mr. Tanucha Boonjaras.

30. *Dendrobium sutepense* Rolfe ex Downie, Bull. Misc. Inform. Kew 1925: 374. 1925. Type: *Kerr 91* (holotype K!), Thailand, Chiang Mai, Doi Sutep, at 5,000–5,500 ft alt., 7 April 1909. Fig. 5.30; Pl. 6: E.

Flowering shoots erect, slender, cylindrical, somewhat zig-zag, slightly constricted at nodes, sulcate, green or greenish brown, leafy at the upper part of stem, 12–31 cm tall, internodes 1.7–2.3 cm long, 0.5–0.7 cm in diameter. *Leaves* distichous, spreading, slightly recurved, thinly coriaceous, green or dull green, lanceolate or narrowly elliptic, apex unequally bi-lobed, each lobe obtuse, mature leaves sparsely covered with black hirsute hairs, becoming glabrous with aged, mid-vein grooved above and ribbed below, 5.3–6.8 cm long, 0.5–0.8 cm wide; leaf-sheaths glabrous, 1.3–2.3 cm long. *Inflorescences* abbreviated, 1- to 4-flowered, borne along the upper to middle portion of both leafy and leafless stems; peduncle and rachis short, glabrous, light green, 0.2–0.4 cm long, covered with bracts; floral bracts concave, abaxial surface sparsely covered with black hairs, adaxial surface glabrous, pale brown or tawny, ovate or oblong-ovate, apex acute, base truncate, 3- to 4-veined, 0.4–1 cm long, 0.2–0.4 cm wide. *Flowers* papyraceous, resupinate, waxy, veins hardly visible, sweet scented, 3–3.6 cm in diameter; sepals and petals white or creamy white, becoming creamy orange colored when aged; mentum white or light greenish white from outside; labellum white or creamy white, claw greenish white, side lobes white with pink veins running along each sides, disc pale yellowish orange or creamy orange, becoming yellow or yellowish orange at the end and terminated at halfway of mid-lobe; mid-lobe white; column white or very pale greenish white, foot white or very pale greenish white, becoming yellowish green at the lower portion, stigmatic cavity white or ivory white, anther-cap white, pollinia yellow, pedicellate ovary greenish white, turning green at the end of pedicel. *Sepals* spreading, often recurved distally, margin entire, abaxial surface with inconspicuous keel; dorsal sepal lanceolate or ovate-oblong, apex acute or attenuate, base truncate, mid-vein grooved above, 5- to 7-veined, 1.7–2.1 cm long,

0.5-0.8 cm wide; lateral sepals obliquely oblong-triangular, apex acuminate or attenuate, base obliquely truncate, 5- to 7-veined, posterior margin 1.7-2 cm long, anterior margin 2.1-2.6 cm long, 0.6-0.9 cm wide at base, ca. 0.3 cm wide at apex. *Mentum* shortly conical, apex obtuse, 0.5-0.7 cm long, 0.3-0.4 cm in diameter. *Petals* recurved, obovate, gently reduced at base, apex acute or acuminate, base truncate, margin entire, 3- to 7-veined, 1.3-1.8 cm long, 0.5-0.7 cm wide. *Labellum* 3-lobed, with sinus between side lobes and mid-lobe, 1.9-2.4 cm long, 1.2-1.7 cm wide across side lobes; claw shallowly triangular, 4-6 mm long; side lobes obliquely ovate or obliquely elliptic, with 5 to 9 warty elevated veins running along each side lobe, apex acute, lateral margin entire, front margin shallowly lobed; disc oblong or narrowly oblong, warty 3-keeled at apical portion, continuing to mid-lobe; mid-lobe thick at median area, the lateral area thin, ovate or oblong-ovate, apex acuminate and recurved backward, margin crenate and undulate, 0.8-1.2 cm long, 0.5-0.7 cm wide. *Column* surface minutely papillose, without waxy, 4-6 mm long, 4-5 mm wide at base; foot canaliculate, slightly concave, tapering downwards, surface minutely papillose 9-13 mm long, 4-5 mm wide at entrance of mentum; stigmatic cavity elliptic or ovate; stelia broadly triangular, with two-serrate lobes at the apex; connective linear or narrowly triangular; anther cap obovate or widely obovate, surface minutely papillose, apex rounded, basal margin minutely ciliate, adaxial surface sulcate, 2.1-2.4 mm long, 1.8-2.1 mm wide; pollinia 4, in 2 pairs, each pollinium narrowly elliptic, without caudicle and visidium. *Ovary* (including pedicel) narrowly clavate, gently curved, glabrous, somewhat glaucous, 6-grooved, 1-1.5 cm long. *Capsule* dehiscent, green or dull green, elliptic or oblong-elliptic, with 3 obtuse keels, apex with persistent dried perianth, 1.9-2.4 cm long, 1.1-1.5 cm wide.

DISTRIBUTION.— Thailand.

HABITAT AND ECOLOGY.— Epiphytes in evergreen forests, at 1,000-1,700 m alt.

VERNACULAR. – Ueang sae (เอื้องแซะ), Ueang sae mali (เอื้องแซะมะลิ), Ueang mali (เอื้องมะลิ)

SPECIMENS EXAMINED. – THAILAND: *J.F. Maxwell 91-314* (AAU), Chiang Mai, Jeom Tong, 1,575 m alt., 09 April 1991; *Put 3721* (L), Chiang Mai, Pang Jawn, 21 April 1931; *A.F.G. Kerr.* (L), Chaing Mai, Doi Suthep, 1,450 m alt., 11 April 1915; *J.F. Maxwell 95-330* (L), Mae Hong Song, Doi Meun, 1,500 m alt., 18 April 1995; *J.F. Maxwell 91-314* (L), Chaing Mai, Jaom Tong, Mae Soi Ridge, Mae Soi Subdistrict, 1,450 m alt., 9 April 1991.

LOCALITY UNKNOWN: *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 32360 (W); *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 783 (W); *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 32384 (W); *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 32992 (W); *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 790 (W).

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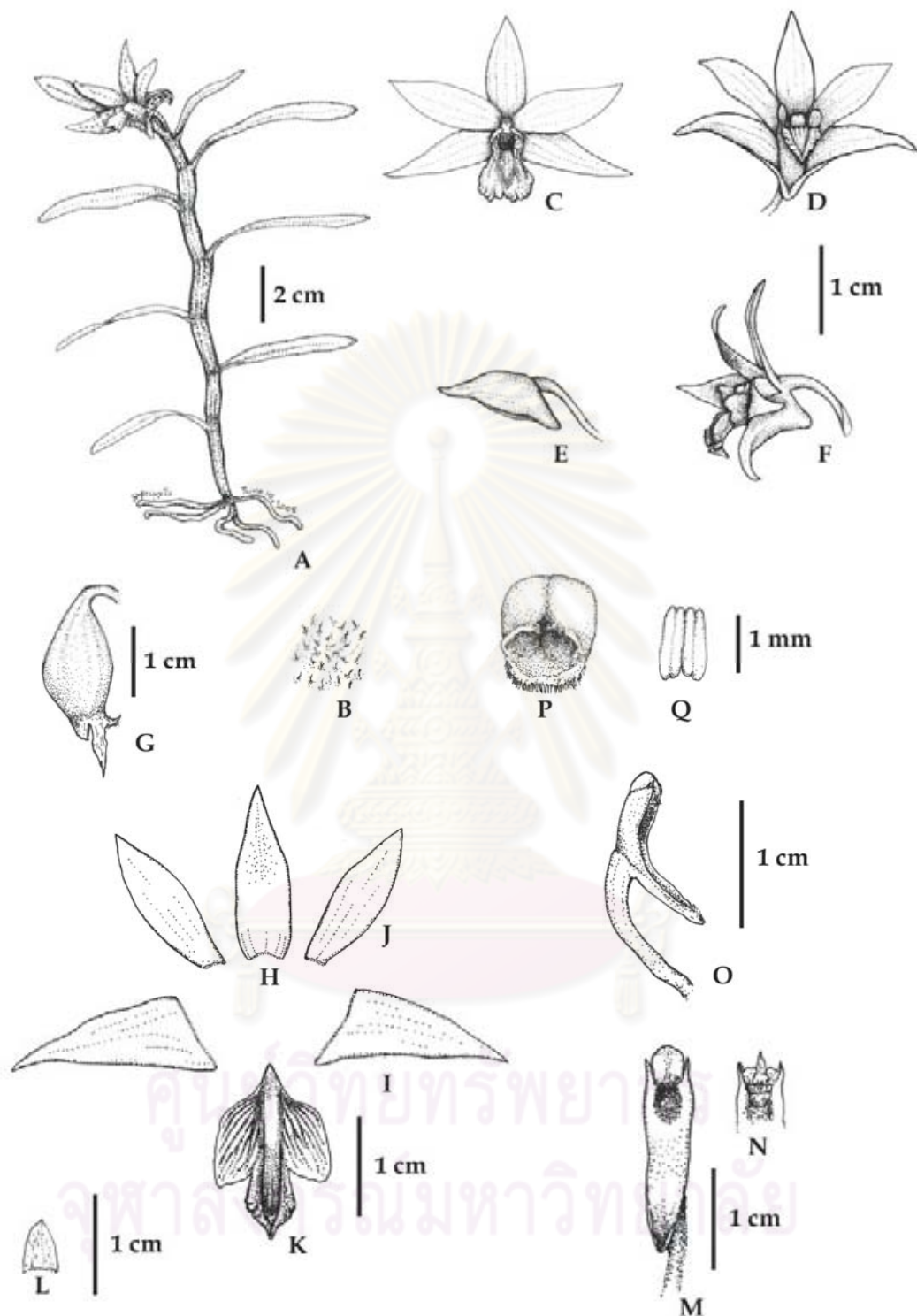


FIGURE 5.30. *Dendrobium sutepense* Rolfe ex Downie A. Habit; B. Hairs, on leaf; C. Flower, front view; D. Flower, from below; E. Flower bud, side view; F. Flower, side view; G. Fruit; H. Dorsal sepal; I. Lateral sepal; J. Petal; K. Labellum; L. Floral bract; M. Column and column foot, from below; N. Column, from below, anther cap removed; O. Column and column foot, side view; P. Anther cap; Q. Pollinia. Drawn from A. Sathapattayanon 444 by Mr. Tanucha Boonjaras.

31. *Dendrobium suzukii* T.Yukawa, Acta Phytotax. Geobot., Tokyo 53 (1): 11. 2002. Type: *Hort. T. Sato s. n.* (holotype TNS!), Vietnam, Ninh Thuan Province, in the vicinity of Ninh Son, flowering in cultivation August 2001. Fig. 5.31; Pl. 6: F.

Flowering shoots cluster, erect, slender, cylindrical, narrowly fusiform, weakly sulcate when aged, brown or brownish green, 26-35 cm tall, internodes 2-3 cm long, 0.5-0.9 cm in diameter, leafy throughout. *Leaves* distichous, spreading, coriaceous, waxy, both surfaces densely covered with short black hirsute hairs, mid-vein grooved above and ribbed below, green or dull green, oblong-lanceolate, apex unequally bi-lobed, each lobe obtuse, 2.1-7.3 cm long, 0.8-2.2 cm wide; leaf-sheaths covered with dense black hirsute hairs, 0.3-3.2 cm long. *Inflorescences* abbreviated, 1- or 2-flowered, borne along apical half of leafy stems, emerging from base of leaf sheaths opposite the blade; peduncle and rachis inconspicuous, glabrous, 0.4-0.7 cm long, entirely enclosed by bracts; floral bracts concave, abaxial surface covered with dense black hirsute hairs, adaxial surface glabrous, brown, lanceolate, apex acuminate, base truncate, 5- to 7-veined, 1-1.5 cm long, 0.3-0.5 cm wide. *Flowers* resupinate, thick, rigid, glaucous, unscented, veins visible; sepals and petals pale yellowish green, veins darker, 4.7-5.8 cm in diameter; mentum pale yellowish green from outside; labellum pale yellowish green and red, claw red, side lobes red; disc red and yellowish green at basal part; mid-lobe red along basal half and yellowish green along distal half; column yellowish green, foot yellowish green with red arrow-shaped blotch at base, stigmatic cavity yellowish green, anther-cap light green, pollinia organish yellow, pedicellate ovary green or light green. *Sepals* spreading, slightly recurved distally, margin entire, abaxial surface with inconspicuous keel; dorsal sepal lanceolate, apex acute, base truncate, 5- or 7-veined, 3.5-4.2 cm long, 1.4-1.6 cm wide; lateral sepals obliquely triangular-lanceolate, apex acute, base truncate, 5-veined, posterior margin 3.2-3.7 cm long, anterior margin 3.9-4.2 cm long, 1.9-2.2 cm wide at base, 0.3-0.4 cm wide at apex. *Mentum* broadly conical, saccate, apex obtuse, 1.5-1.7 cm long, 0.7-2 cm in diameter. *Petals* recurved backwards,

linear or narrowly lanceolate, apex acute, base truncate, margin entire, 3-veined, 3-3.4 cm long, 0.7-0.9 cm wide. *Labellum* 3-lobed, 3.1-3.5 cm long, 3-3.4 cm wide across side lobes; claw shallowly triangular, ca. 5 mm long; side lobes obliquely narrowly triangular, falcate, apex acute, margin entire; disc oblong, basal part thickened, hard, becoming 5-keeled with semiglobose callus at apical part, continuing to mid-lobe; mid-lobe thickened, hard, decurved, obovate, adaxial surface papillose and rugose, with a cristate callus at median area, apex acute, margins thick, undulate, 2.1-2.6 cm long, 1.5-1.8 cm wide. *Column* surface smooth, 4-5 mm long, 6-6.5 mm wide at base; foot surface smooth, slightly curved, dilated at base, basally grooved, 10-11 mm long, 8-10 mm wide at entrance of mentum; stigmatic cavity transversely elliptic; stelia short, triangular; connective linear or narrowly triangular; anther cap very widely ovate or quadrate, surface minutely papillose, apex emarginate, basal margin ciliate, adaxial surface sulcate, 3.3-3.8 mm long, 3.2-3.9 mm wide; pollinia 4, in 2 pairs, each pollinium narrowly elliptic, without caudicle and visidium, 3 mm long. *Ovary* (including pedicel) narrowly clavate, glabrous, glaucous, 6-grooved, 2-2.4 cm long. *Capsule* not seen.

DISTRIBUTION. – Vietnam (endemic).

HABITAT AND ECOLOGY. – Unknown.

SPECIMENS EXAMINED. – VIETNAM: Cult. *DOG Dresden s.n.* (K), 02 Apr. 2001; *sine coll.* TBG132872 (TNS), 01 July 2007.

LOCALITY UNKNOWN: A. *Sathapattayanon* 420, *sine. loc.*, 08 Feb. 2006 (BCU).

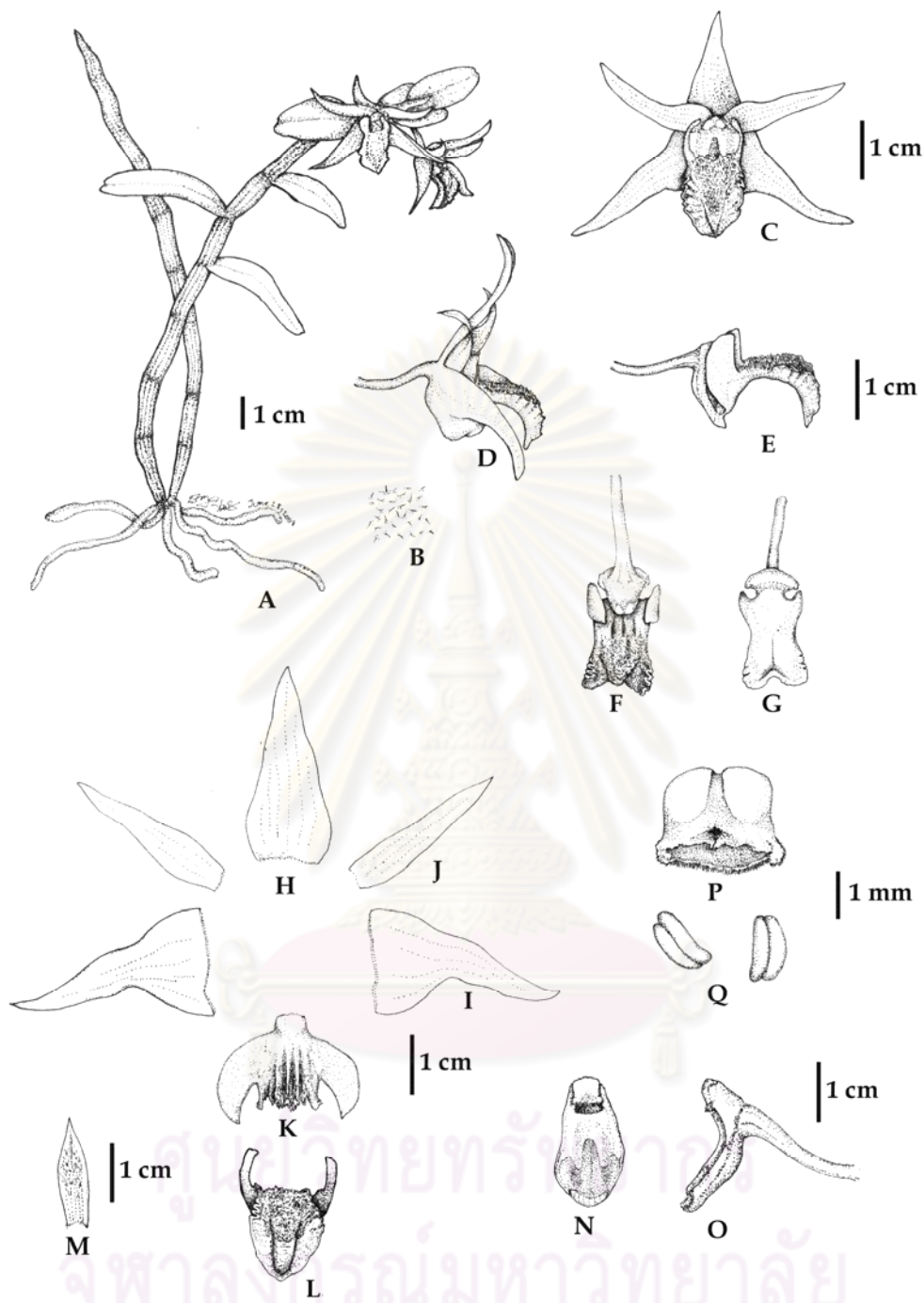


FIGURE 5.31. *Dendrobium suzukii* T. Yukawa **A.** Habit; **B.** Hairs, on leaf; **C.** Flower, front view; **D.** Flower, side view; **E.** Labellum and mentum, side view, sepals and petals removed; **F.** Labellum and mentum, from above, sepals and petals removed; **G.** Labellum and mentum, from below, sepals and petals removed; **H.** Dorsal sepal; **I.** Lateral sepal; **J.** Petal; **K.** Side lobe of Labellum; **L.** Mid-lobe of labellum; **M.** Floral bract; **N.** Column and column foot, from below; **O.** Column and column foot, side view; **P.** Anther cap; **Q.** Pollinia. Drawn from Hort. Tsukuba Botanical Garden accession number 132872 by Mr. Tanucha Boonjaras.

32. *Dendrobium tobaense* J.J.Wood & J.B.Comber, *Lindleyana* 8:115. 1993; J.B. Comber, *Orchids of Sumatra*: 594. 2001; H.P. Wood, *The Dendrobiums*: 709. 2006. Type: *A.H. Schrage s.n.* (holotype K!), Indonesia, North Sumatra, Northeast of Lake Toba, 1,500 m alt., June 1950. Fig. 5.32; Pl. 6: G.

Dendrobium F.B.Dutrieux, *Orchidee (Bandoeng)* 10:27. 1941.

Flowering shoots erect, slender, cylindrical, narrowly fusiform, slightly constrict at nodes, more or less sulcate, brown or brownish green, 19-32 cm tall, internodes 1-3 cm long, 0.7-1 cm in diameter, leafy throughout, bearing 8-9 leaves. **Leaves** distichous, spreading, slightly recurved, coriaceous, adaxial surface densely covered with short black hirsute hairs, abaxial surface sparsely covered with short black hirsute hairs, becoming glabrous with age, mid-vein grooved above and ribbed below, green or dull green, oblong-lanceolate or oblong-elliptic, apex unequally bi-lobed, each lobe obtuse, 3-8.3 cm long, 0.9-2.3 cm wide; leaf-sheaths covered with dense black hirsute hairs, 1.3-2.9 cm long. **Inflorescences** abbreviated, often 1-flowered, successively borne along apical half of leafy stems, emerging from base of leaf sheaths opposite the blade; peduncle and rachis inconspicuous, glabrous, ca. 0.3 cm long; floral bracts slightly concave, abaxial surface covered with black hirsute hairs, adaxial surface glabrous, brown, lanceolate-oblong, apex acuminate, base truncate, 3- to 5-veined, 1-1.5 cm long, 0.2-0.4 cm wide. **Flowers** resupinate, stiff, glaucous, unscented, veins visible, 5.5-6.1 cm in diameter; sepals and petals pale yellow, with green or yellowish green reticulated veins; mentum pale yellow with green lines from outside; labellum pale yellowish green, claw orange red, side lobes pale reddish green with longitudinal orange red veins, disc pale yellowish green, with red prominent callus and keels, base of mid-lobe pale yellowish green with red callus, claw of mid-lobe pale yellowish green, apex of mid-lobe pale yellow or creamy yellow; column pale yellowish green, foot pale yellowish green with longitudinal green lines, red blotched at basal portion, stigmatic cavity white, anther-cap light green,

pollinia yellow, pedicellate ovary green or yellowish green. *Sepals* spreading, recurved distally, margin entire, distal margin involute, abaxial surface with inconspicuous keel; dorsal sepal ovate basally, abruptly and narrowly caudate, apex acute to acuminate, base truncate, 6- or 7-veined, 3-4.2 cm long, 1-1.7 cm wide near base, 0.1 cm near apex; lateral sepals obliquely triangular-ovate basally, abruptly and narrowly caudate, apex acute to acuminate, base truncate, 7- or 9-veined, posterior margin 4.5-4.8 cm long, anterior margin 4.5-4.9 cm long, 1.5-2.5 cm wide at base, 0.1-0.2 wide at apex. *Mentum* broadly conical, saccate, apex obtuse, 1-1.5 cm long, ca. 1 cm in diameter. *Petals* recurved, narrowly ovate-elliptic, apex attenuate, base truncate, margin entire, 3- or 5-veined, 3.4-4.5 cm long, 0.7-1.2 cm wide at base, 0.1-0.2 wide at apex. *Labellum* 3-lobed, 3.9-4.7 cm long, 2.2-2.6 cm wide across side lobes; claw short, shallowly triangular, 2-3 mm long; side lobes obliquely triangular-ovate, falcate, with 4 to 5 slightly elevated veins, each vein bearing minutely wart-like callus, apex acute, margin entire; disc oblong, hard, thickened at basal part, becoming 5-keeled at apical part, the outer two keels taller than the three middle keels, each keel bearing verruculose callus, continuing to mid-lobe; mid-lobe hard, with 5-7 verruculose keels at basal portion, middle part abruptly reduced forming a claw, 1-1.1 cm long, margin of apical part of mid-lobe folded inwards forming a narrow clavate structure, narrower below, obscurely sulcate on upper surface, glabrous, apex acute, 2.1-2.7 cm long, 0.2 cm wide. *Column* surface smooth, dilated at base, 2-4 mm long, 3-4 mm wide at base; foot surface smooth, somewhat waxy, slightly curved, 2-4 grooved basally, 15-17 mm long, 5.9-7 mm wide at base; stigmatic cavity transversely elliptic; stelia short, very shallowly triangular; connective linear or narrowly triangular; anther cap very widely ovate or subquadrate, surface minutely papillose, apex retuse, basal margin ciliate, adaxial surface sulcate, 3.8-4 mm long, 3.9-4 mm wide; pollinia 4, in 2 pairs, each pollinium narrowly elliptic, without caudicle and visidium. *Ovary* (including pedicel) narrowly clavate, glabrous, glaucous, 6-grooved, 3.5-4 cm long. *Capsule* not seen.

DISTRIBUTION.— Known only from the type collection and photograph of second collection from North Sumatra, Indonesia (endemic).

HABITAT AND ECOLOGY.— Epiphytes grow in area with heavy rainfall all year all, at 1,000-1,500 m. alt. Flowering period: June.

SPECIMENS EXAMINED.— INDONESIA: A. H. Schrage s.n. (H 186/56) (K), Sumatra, Siantar, 24 Jan. 1956; Cult. J. Wubben s.n. (K), Sumatra, 06 Mar. 2002.

NOTE.— *Dendrobium tobaense* is the allied species of *D. cruentum* from south Thailand. Their flowers are similar but the mid-lobe of the labellum of *D. tobaense* is much longer and club-shaped.



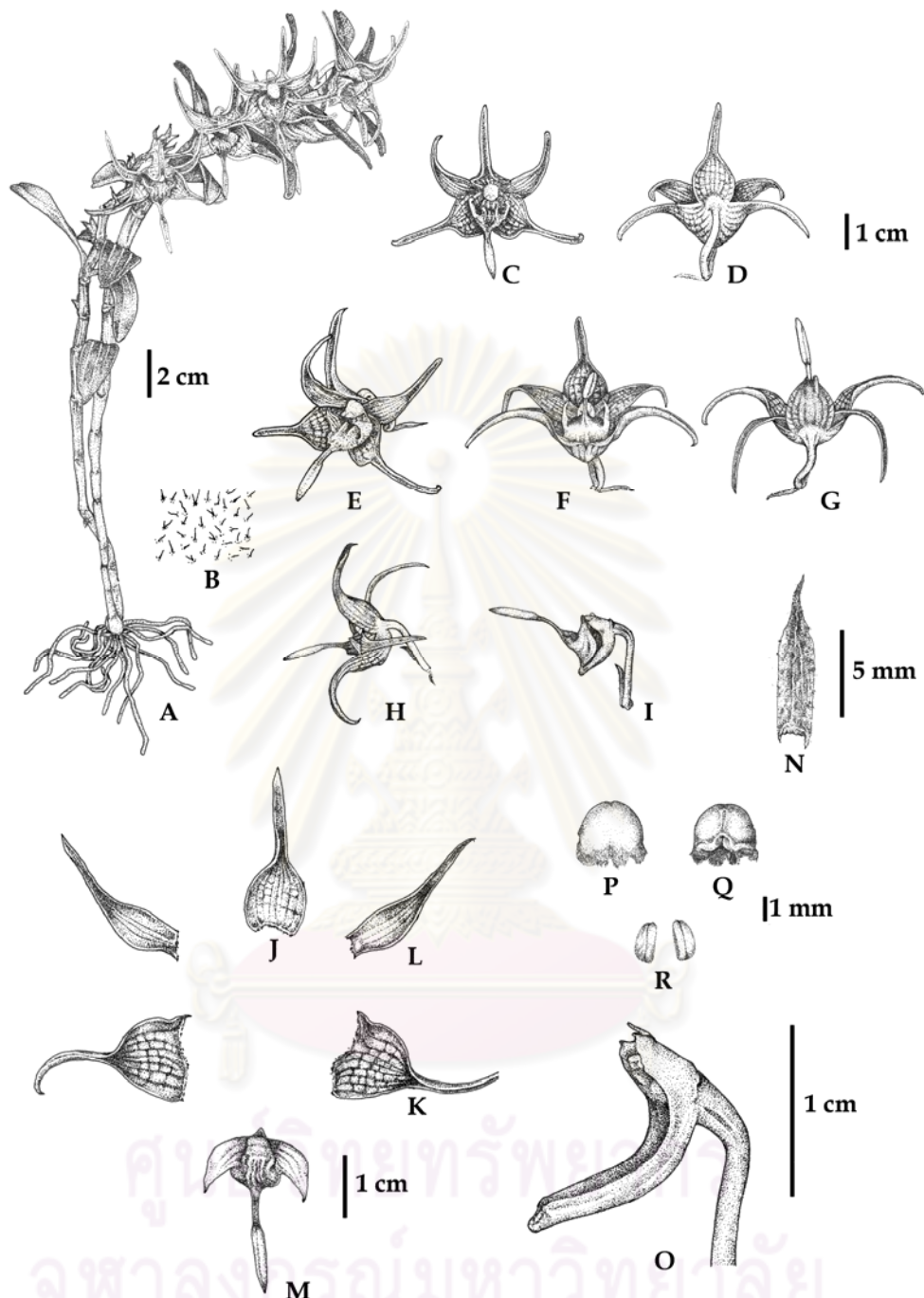


FIGURE 5.32. *Dendrobium tobaense* J.J. Wood & J.B. Comber **A.** Habit; **B.** Hairs, on leaf; **C.** Flower, front view; **D.** Flower, back view; **E.** Flower, oblique view; **F.** lower, from below; **G.** Flower, from above; **H.** Flower, side view; **I.** Labellum and mentum, side view, sepals and petals removed; **J.** Dorsal sepal; **K.** Lateral sepal; **L.** Petal; **M.** Labellum; **N.** Floral bract; **O.** Column and column foot, side view, anther cap removed; **P.** Anther cap, back view; **Q.** Anther cap, front view; **R.** Pollinia. Drawn from *Hort. Tsukuba Botanical Garden* accession number 126681 by Ms. Sirilax Tapdechachan.

33. *Dendrobium toppii* A. Lamb & J.J. Wood, *Malesian Orchid Journ.*, 1: 94, figs. 1-3. 2008. Type: *L. & C. Topp* in *Lamb AL 842/2005* (holotype SNP), Malaysia, Sabah, Sipitang District, lower montane heath forest, trail from Meligan to Long Miau and Long Pa Sia, 1,240 m alt., 8 February 2005. Fig. 5.33; Pl. 6: H.

Flowering shoots clustered, erect, slender, cylindrical, gently fractiflex, constrict at nodes, slightly swollen at the base, more or less sulcate, 30-54 cm tall, internodes 1.2-3 cm long, 0.4-0.8 cm in diameter, lower internodes the narrowest, leafy throughout, old stems glossy yellow. *Leaves* distichous, spreading, coriaceous, adaxial surface glabrous, abaxial surface covered with short black hirsute hairs, mid-vein grooved above and ribbed below, dull green, oblong-elliptic, apex unequally bi-lobed, each lobe obtuse, 2.7-5 cm long, 1.2-2.1 cm wide; leaf-sheaths covered with black hirsute hairs, 1.3-2 cm long. *Inflorescences* abbreviated, 2- to 3-flowered, usually 2 flowers open simultaneously, borne from the nodes opposite a leaf-blade along the mid and upper portion of the stem; peduncle and rachis, glabrous, 0.2-0.4 cm long; floral bracts covered with black hirsute hairs on abaxial surface, adaxial surface glabrous, brown, ovate, apex acuminate, base truncate, ca. 1 cm long, 0.3-0.4 cm wide. *Flowers* resupinate, veins visible, ca. 3 cm in diameter; sepals and petals white with pale green to pale orange veins; labellum yellow, side lobes orange-red, margin of side lobes yellow, disc with orange to orange-red keels, mid-lobe and keels on mid-lobe yellow; column yellow with orange-red basal and ventral patches, stigmatic cavity pale green, anther-cap yellow, pedicellate ovary pale green to white. *Sepals* spreading, recurved distally, margin entire, abaxial surface without keel; dorsal sepal triangular-ovate, apex acuminate, base truncate, 5-veined, 3-4.7 cm long, 1-2 cm wide near base; lateral sepals obliquely triangular-ovate, apex acuminate, base truncate, 5-veined, posterior margin ca. 4 cm long, anterior margin ca. 3 cm long, 1.5 cm wide at base, 0.2-0.3 wide at apex. *Mentum* broadly conical, saccate, apex obtuse, ca. 1 cm long. *Petals* recurved, lanceolate, apex acuminate, base truncate, margin entire, 3-veined, 2.4-2.5 cm long, 0.7-0.9 cm

wide at base. *Labellum* 3-lobed; claw short, shallowly triangular; side lobes semi-ovate, subfalcate, apex acute, margin entire; disc with two 3 mm high keels between the side lobes, with a shorter 1 mm high median keel in between, and 2–3 small keels either side towards the margin of the side lobes; mid-lobe triangular-ovate, with a low median keel, decurved, apex acute, margins involute, 1.2–1.7 cm long. *Column* 12 mm long, 7 mm wide at base; foot 10 mm long; steldia obtuse; anther cap very widely obovate, adaxial surface sulcate, ca. 3 mm long, ca. 3 mm wide; pollinia 4, in 2 pairs, each pollinium narrowly elliptic, without caudicle and visidium. *Ovary* (including pedicel) narrowly clavate, glabrous, 1.5–1.7 cm long, ca. 0.5 cm in diameter. *Capsule* ovoid, pale green, shrivelled remains of sepals and petals persistent, 1.7 cm long, ca. 1 cm in diameter.

DISTRIBUTION.— Malaysia.

HABITAT AND ECOLOGY.— Lower montane forest, at 1,240 m alt.

SPECIMENS EXAMINED.— MALAYSIA: L. & C. Topp in Lamb AL 842/2005 (K), Sabah, Sipitang District (N 04°33'478", E 115°44'744"), 1,240 m alt., 08 Feb. 2005.

NOTE.— *Dendrobium toppii* is most closely allied to *D. ayubii* from which it is distinguished by having only one, instead of three, small keels in between the two large keels on the disc of the lip.

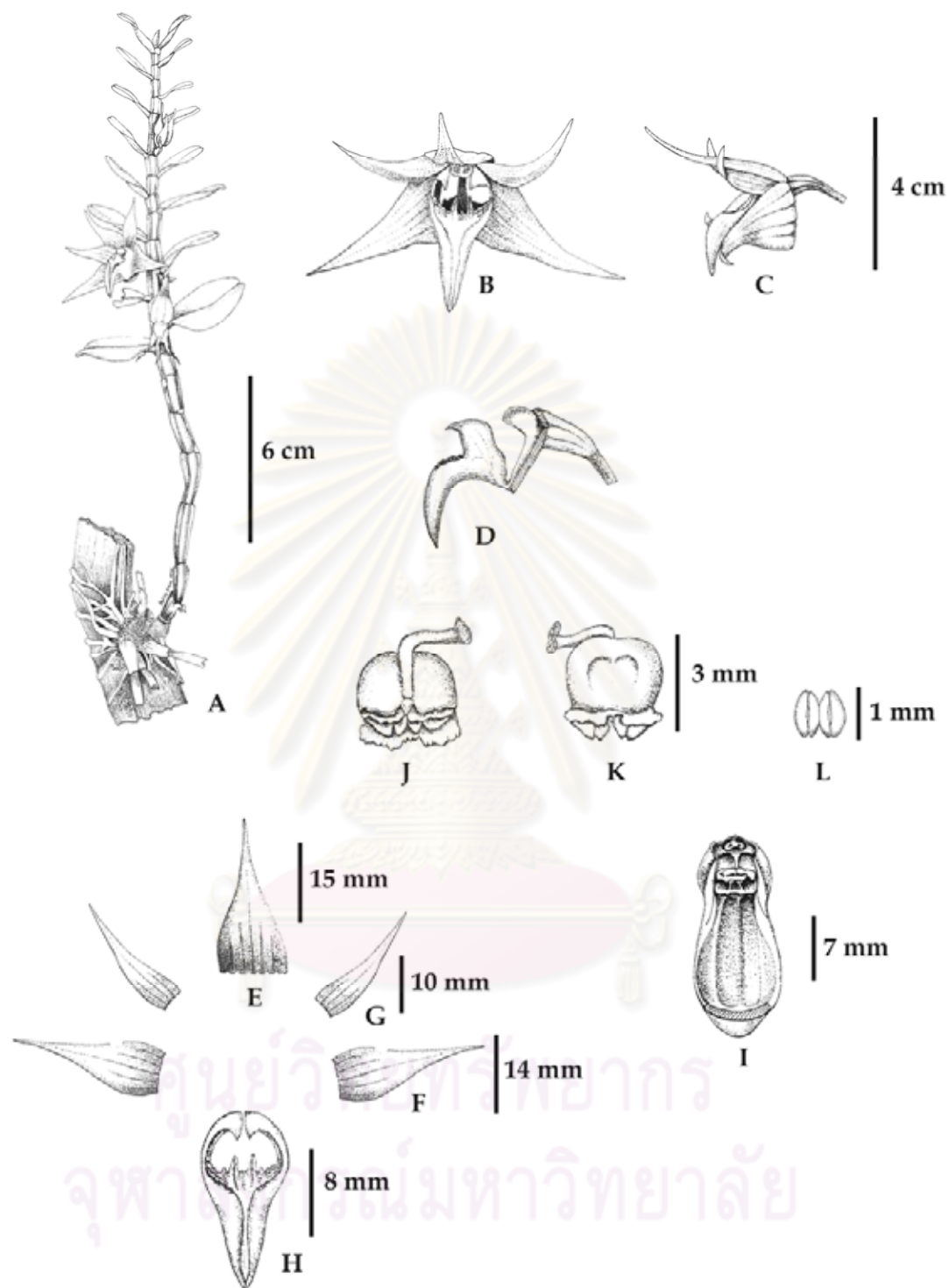


FIGURE 5.33. *Dendrobium toppii* A. Lamb & J.J. Wood A. Habit; B. Flower, front view; C. Flower, side view; D. Pedicel with-ovary, labellum and column, side view; E. Dorsal sepal; F. Lateral sepal; G. Petal; H. Labellum; I. Column and column foot, from below; J. Anther cap, front view; K. Anther cap, back view; L. Pollinia. Drawn from L. & C. Topp in Lamb AL 842/2005 (holotype), After A. Lamb *et al.*, Malesian Orchid Journ. 1: figs. 3. 2008.

34. *Dendrobium trankimianum* T.Yukawa, Ann. Tsukuba Bot. Gard. 23:21. 2004.
 Type: Hort. Tsukuba Botanical Garden accession no. 127511 (holotype TNS!),
 Vietnam, precise locality unknown. Fig. 5.34; Pl. 6: I.

Flowering shoots erect, clustered, slightly constrict at nodes, weakly sulcate in age, brown or brownish green, 35-45 cm tall, with 10 to 18 internodes, internodes 3.3-3.7 cm long, 0.7-1.2 cm in diameter, leafy throughout, bearing 7-15 leaves. *Leaves* distichous, spreading, coriaceous, both surfaces covered with dense hirsute hairs, becoming glabrous with age, mid-vein grooved above and ribbed below, dark green, ovate-lanceolate, apex unequally bi-lobed, each lobe obtuse, 2.1-8.3 cm long, 0.7-2.2 cm wide; leaf-sheaths brownish green, covered with blackish hairs, 3-3.5 cm long. *Inflorescences* abbreviated, 1- or 2-flowered, borne at subterminal or axillary on apical part of both leafy and leafless stems, emerging from base of leaf sheaths opposite the blade; peduncle and rachis inconspicuous, glabrous, light green, 0.4 cm long, entirely enclosed by bracts; floral bracts concave, abaxial surface with brown hairs, adxial surface glabrous, brownish, oblanceolate-elliptic, apex obtuse, base truncate, 3- to 5-veined, 1-1.3 cm long, 0.5-0.7 cm wide. *Flowers* coriaceous, resupinate, glossy, unscented, veins obscured, long-lasting, 4.2-4.8 cm in diameter; sepals and petals white; mentum pale orange white from outside; labellum white and pale orange, claw red, side lobes white, suffused with pale orange, red veins alongside of disc, disc red, mid-lobe white; column pale red, foot red, stigmatic cavity pale red or red, anther-cap pale red, pollinia yellow, pedicellate ovary light green. *Sepal* spreading, margin entire; dorsal sepal obvate-lanceolate, apex acute, base truncate, mid-vein grooved on adaxial surface, indistinctly keeled on abaxial surface, 2.5-3.4 cm long, 0.9-1.2 cm wide; lateral sepals obliquely triangular-lanceolate, apex acuminate, base obliquely truncate, abaxial surface with distinct keel, 5- or 7-veined, posterior margin 3.8-4.4 cm long, anterior margin 4.6-4.9 cm long, 1.3-1.5 cm wide at base, c. 0.2 cm wide at apex. *Mentum* narrowly conical, apex obtuse, straight, 1.5-1.9 cm long, 0.5-0.7 cm in diameter at base, 0.2-0.3 cm in

diameter at apical part. *Petals* spreading, slightly recurved at apex, oblanceolate-obovate, apex acute, base truncate, margin entire, 7- to 9-veined, 2.5-3.3 long, 1.4-1.6 cm wide at base. *Labellum* 3-lobed, 4.3-4.9 cm long, 2.5-2.9 cm wide across side lobes; claw linear or narrowly triangular, 8-11 mm long; side lobes obliquely triangular, with 3 to 5 slightly elevated veins running along each side lobe, apex obtuse, margin entire; disc prominent, somewhat waxy, narrowly oblong, becoming 3 keeled at the apex, continuing to mid-lobe; mid-lobe oblong or elliptic-oblong, adaxial surface with 3-5 verruculose keels, apex obtuse, apiculate, margin weakly undulate, 0.9-1.3 cm long, 0.9-1.1 cm wide. *Column* surface smooth, dilate at base, 4-5 mm long, 4.1-4.6 mm wide at base; foot concave, base truncate, margin raised at base, surface smooth, 9-12 mm long, 4-5 mm wide at base; stigmatic cavity ovate; stelidia triangular; connective linear or narrowly triangular; anther cap widely obovate, surface minutely papillose, apex retuse, basal margin ciliate, adaxial surface sulcate, 3.5-3.9 mm long, 3-3.2 mm wide; pollinia 4, in 2 pairs, each pollinium narrowly elliptic, 2.5 mm long, without caudicle and visidium. *Ovary* (including pedicel) clavate, curved, glabrous, 6-grooved, 2.9-3.5 cm long. *Capsule* not seen.

DISTRIBUTION. – Vietnam (endemic).

HABITAT AND ECOLOGY. – Unknown.

SPECIMENS EXAMINED. – VIETNAM: *Poilane* 3611 (P), Khanh Hoa Province, Nha Trang, Giang Ly, 2,000 m alt., 22 May 1922; *sine coll.* TBG127511 (TNS), 13 May 2007.

NOTE. – *Dendrobium trankimianum* is closely related to *Dendrobium draconis*, it is also from Indochina but can be distinguished by the following characters: 1) Thinner, terete stems; 2) smaller perianth lobes; 3) oblanceolate-obovate petals; 4)

more-developed lateral lobes of the labellum; 5) a shorter mid lobe of the labellum; and 6) different callus of the labellum.



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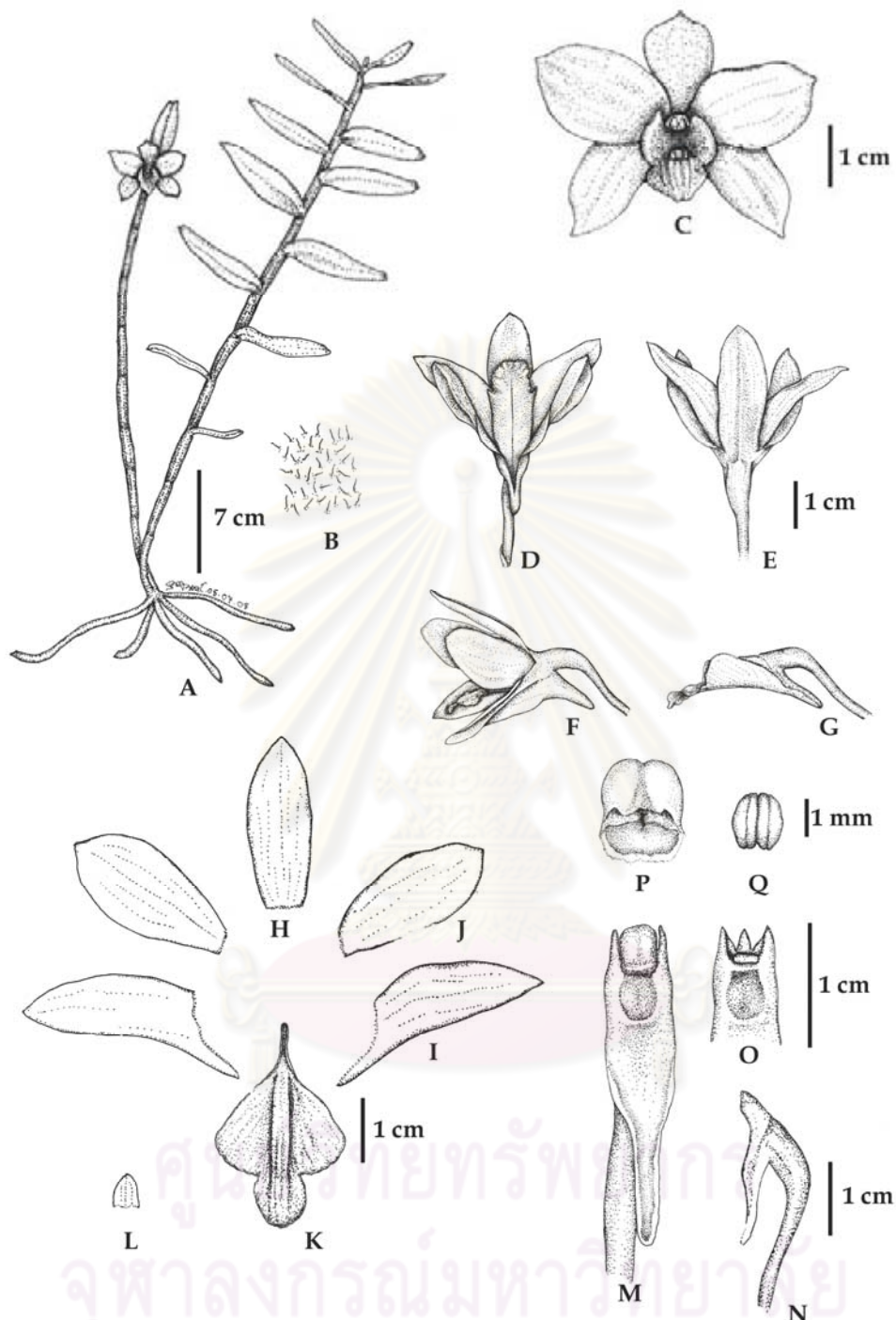


FIGURE 5.34. *Dendrobium trankimianum* T. Yukawa **A.** Habit; **B.** Hairs, on leaf; **C.** Flower, front view; **D.** Flower, from below; **E.** Flower, from above; **F.** Flower, side view; **G.** Labellum and mentum, side view, sepals and petals removed; **H.** Dorsal sepal; **I.** Lateral sepal; **J.** Petal; **K.** Labellum; **L.** Floral bract; **M.** Column and column foot, from below; **N.** Column and column foot, side view; **O.** Column, from below, anther cap removed; **P.** Anther cap; **Q.** Pollinia. Drawn from *Hort. Tsukuba Botanical Garden accession number 127511* (holotype) by Mr. Tanucha Boonjaras.

35. *Dendrobium virgineum* Rchb.f., Gard. Chron. 1884(2): 520. 1884. Type: cult. *Low s.n* (holotype W!), Myanmar, locality unknown, October 1884. Fig. 5.35; Pl. 6: J&K.

Callista virginea (Rchb.f.) Kuntze, Revis. Gen. Pl. 2: 655. 1891.

Flowering shoots erect, cylindrical, ca. 20-25 cm tall, internodes 2.7-3 cm long, 0.5-.8 cm in diameter. **Leaves** narrowly elliptic or lanceolate, apex unequally bilobed, each lobe obtuse, mid-vein grooved above and ribbed below, ca. 5.4 cm long, ca. 1.8 cm wide; leaf-sheaths 1.9-2.9 cm long. **Inflorescences** abbreviated, 1-flowered; floral bracts concave, abaxial surface covered with black hirsute hairs, adaxial surface glabrous, apex acuminate, base truncate, 5- to 7-veined, 0.7-0.9 cm long, 0.4-0.5 cm wide. **Flowers** ca. 4 cm in diameter, see note below. **Sepals** spreading, distally recurved, margin entire, abaxial surface with keel, conspicuous at apical part; dorsal sepal ovate-oblong, apex acuminate, base truncate, 3- to 5-veined, mid-vein grooved on adaxial surface, 1.9-2.1 cm long, 0.6-0.8 cm wide; lateral sepals obliquely triangular-oblong, apex acuminate, base obliquely truncate, 3- to 5-veined, posterior margin 2-2.2 cm long, anterior margin 3.2-3.5 cm long, ca. 0.8 cm wide at base, ca. 0.3 cm wide at apex. **Mentum** narrowly conical, apex obtuse, 1.5-1.8 cm long, 0.3-0.4 cm in diameter. **Petals** widely ovate, apex round or obtuse, base truncate, margin entire, 9- to 12-veined, 2.4-2.7 cm long, 1.7-2 cm wide at base. **Labellum** 3-lobed, 3.5-3.8 cm long, 2.4-2.6 cm wide across side lobes; claw linear or narrowly triangular, ca. 15 mm long; side lobes obliquely ovate, adaxial surface with 6- to 7-slightly elevated veins along each side lobe, each vein bearing sparse wart-like callus along distal half, apex round, lateral margin entire, front margin crenate; disc narrowly oblong, prominent, with indistinct 2-3 keels at the apical part, could not see the "two singular, thickened, ligulate lines" as Reichenbach's mention (1884); mid-lobe widely obovate, with 5 keels at basal part, each keel bearing small wart-like callus, apex emarginated, margin crenate, 1-1.3 cm long, 1.2-1.5 cm wide.

Column surface smooth, 4-5 mm long, ca. 4 mm wide at base; foot slightly concave, tapering downwards, surface smooth, ca. 18 mm long, ca. 4 mm wide at entrance of mentum; stelidia triangular; connective linear or narrowly triangular; anther cap and pollinia not seen. *Ovary* (including pedicel) narrowly clavate, slender, glabrous, 6-grooved, ca. 2.5 cm long. *Capsule* not seen.

DISTRIBUTION.— Myanmar.

HABITAT AND ECOLOGY.— Unkonwn.

SPECIMENS EXAMINED.— MYANMAR: cult. *Low s.n* (W). , locality unknown, October 1884.

NOTE.— Reichenbach mentioned in his first description of *Dendrobium virgineum* that “ ...very near *D. infundibulum* of Dr. Lindley, It is much like the above name species; the leave, however, are nearly twice as board. The flowers are only two-thirds the size of those of the named species, and the lip has, as it best recommendation, two singular light reddish, thickened, ligular lines from the base of the lip to the base of the mid-lacinia. Excepting this and some reddish tint at the base of column the flowers, which have a fine texture, are ivory-white, as well as the stalk ovary, only the back of mentum has a light green hue, and the upper part of ovary is of the gayest green, which looks very graceful.”.

In my opinion, this species is resembled to *Dendrobium infundibulum*. It may be another form of latter species. There are no other herbarium specimens for examination, except only a type specimen. However, I retain *D. virgineum* as a separated species.

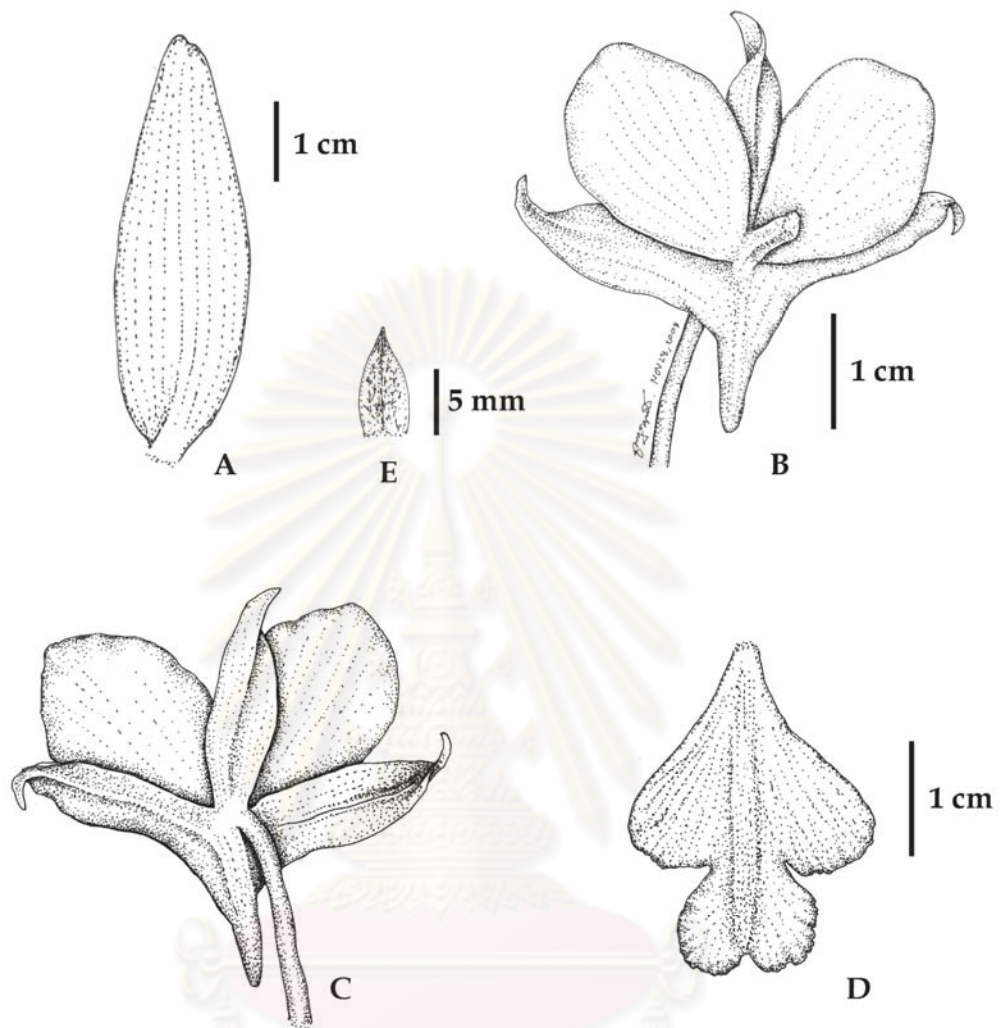


FIGURE 5.35. *Dendrobium virgineum* Rchb.f. **A.** Leaf; **B.** Flower, from below; **C.** Flower, from above; **D.** Labellum; **E.** Floral bract. Drawn from cult. *Low s.n* (holotype) by Mr. Tanucha Boonjaras.

36. *Dendrobium vogelsangii* P. O'Byrne, *Malayan Orchid Rev.* 34: 65. 2000. Type: *O'Byrne SUL 134* (holotype SING!), Indonesia, Sulawesi Selatan, Polmas District, Mamasa Valley, about 1,155 m alt., 3 April 2000. Fig. 5.36; Pl. 6: L.

Flowering shoots erect, cylindrical, tapering towards the apex, fractiflex, sulcate, slightly constricted at nodes, dark brown or greenish brown, 25-31 cm tall, internodes 2.9-4 cm long, 0.9-1.5 cm in diameter, leafy along the upper part of stem. *Leaves* distichous, spreading, slightly recurved distally, coriaceous, both surfaces densely covered with black hirsute hairs, mid-vein grooved above and ribbed below, dull green, lanceolate, apex unequally bi-lobed, each lobe obtuse, 5-5.5 cm long, 1.1-1.5 cm wide; leaf-sheaths covered with short black hirsute hairs, 1.5-1.9 cm long. *Inflorescences* abbreviated, 1- to 3-flowered, borne at the upper part of both leafy and leafless stems, emerging from base of leaf sheaths opposite the blade; peduncle and rachis glabrous, green, 0.2-0.5 cm long, covered with bracts; floral bracts concave, abaxial surface covered with dense black hirsute hairs, adaxial surface glabrous, brown, ovate, apex acute, base truncate, 2- to 4-veined, 0.9-1.2 cm long, 0.3-0.4 cm wide. *Flowers* papyraceous, resupinate, somewhat waxy, unscented, veins obscured, visible when aged, 4.8-5.4 cm in diameter; sepals and petals white; mentum white or orange white from outside; labellum white and orange, claw, side lobes and disc orange, basal half of mid-lobe orange, apical half white; column white, foot reddish orange, stigmatic cavity white or ivory white, anther-cap pale orange, pollinia yellow, pedicellate ovary white or greenish white. *Sepals* spreading, margin entire; dorsal sepal ovate-lanceolate, apex acute or mucronate, base truncate, abaxial surface with keel, 5- to 7-veined, 1.8-2.4 cm long, 0.5-0.9 cm wide; lateral sepals, decurved, obliquely triangular-ovate, apex acuminate, base obliquely truncate, abaxial surface with distinct wing-like keel, 5- to 7-veined, posterior margin 2-2.8 cm long, anterior margin 2.5-3.2 cm long, 0.9-1.2 cm wide at base, *c.* 0.2 cm wide at apex. *Mentum* shortly conical, up-curved, apex obtuse, 0.7-1 cm long, 0.2-0.4 cm in diameter. *Petals* spreading, slightly recurved distally, narrowly elliptic or

lanceolate, apex acuminate, base truncate, margin entire, 5- to 7-veined, 2-2.5 cm long, 0.6-0.8 cm wide at base. *Labellum* 3-lobed, 2-2.5 cm long, 1.4-1.7 cm wide across side lobes; claw shallowly triangular, 2-2.5 mm long; side lobes with many transverse papillose-verrucose callus on adaxial surface, obliquely triangular-obovate, apex acute, margin entire; disc oblong, with roughly 3-keeled at apex and continuing to mid-lobe; mid-lobe clawed, convex, hard, median area with 3 rough keels along the length, obovate, apex acute or acuminate, margin minutely erose, 1.1-1.8 cm long, 0.5-0.9 cm wide. *Column* surface minutely papillose, 4-4.5 mm long, 3.5-4 mm wide at base; foot slightly concave, tapering downwards, surface minutely papillose, 7-10 mm long, 3.2-3.7 mm wide at base; stigmatic cavity ovate; stelia triangular; connective narrowly triangular; anther cap orbicular or widely ovate, surface minutely papillose, apex obtuse or acute, basal margin minutely ciliate, adaxial surface sulcate, 2-2.6 mm long, 1.5-2 mm wide; pollinia 4, in 2 pairs, each pollinium narrowly elliptic, without caudicle and visidium. *Ovary* (including pedicel) narrowly clavate, curved, glabrous, 6-grooved, 3.4-3.8 cm long. *Capsule* not seen.

DISTRIBUTION.— Indonesia.

HABITAT AND ECOLOGY.— Epiphytes in lower montane forest, at about 1,000 m alt.

SPECIMENS EXAMINED.— INDONESIA: *P. O'Byrne* SUL 134 (SING), Sulawesi, Polmas District, Mamasa Valley, Pa'pandan Waterfall, 1,155 m alt., 03 Apr. 2000; *P. O'Byrne* SUL 217 (SING), Sulawesi, Central, "Sulawesi Tengah", top of dividing range on Uwekuli-Malino Road, 07 July 2003; *living specimen* no. 20050908, *spirit specimen* no. 23483 (L), Sulawesi, Salatah, Mangkutane District, Mangkutane District-Pendol District Divide, S. flank near crest, 1,200 -1,400 m alt.

LOCALITY UNKNOWN: *Cult. Leiden no. 20050908 (L); sine coll. s.n. (TNS)*, 11
May 2007.



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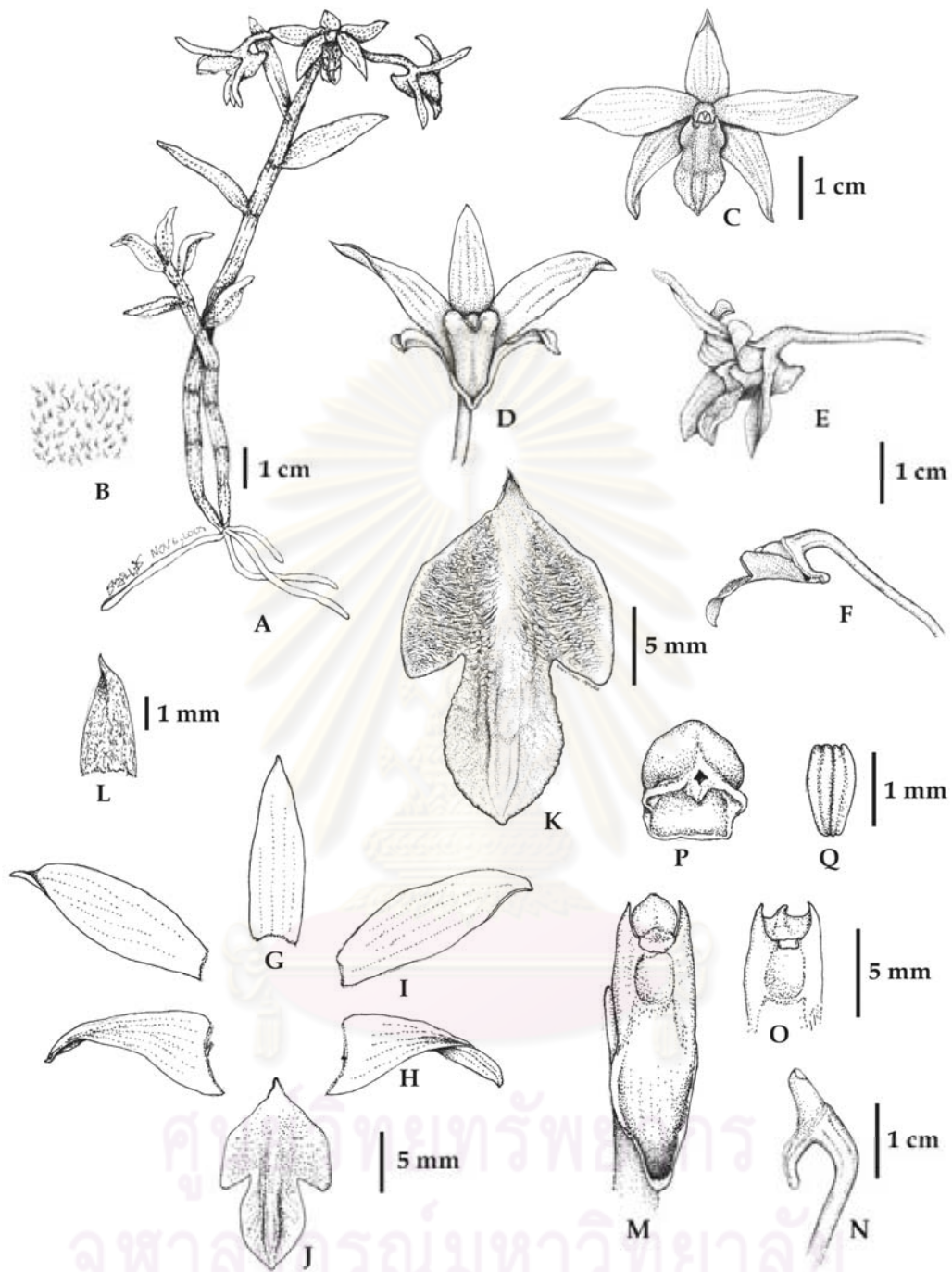


FIGURE 5.36. *Dendrobium vogelsangii* P. O'Byrne **A.** Habit; **B.** Hairs, on leaf; **C.** Flower, front view; **D.** Flower, from below; **E.** Flower, side view; **F.** Labellum and mentum, side view, sepals and petals removed; **G.** Dorsal sepal; **H.** Lateral sepal; **I.** Petal; **J.** Labellum; **K.** labellum, note the transverse papillose-verrucose callus on side lobes; **L.** Floral bract; **M.** Column and column foot, from below; **N.** Column and column foot, side view; **O.** Column, from below, anther cap removed; **P.** Anther cap; **Q.** Pollinia. Drawn from *Hort. Tsukuba Botanical Garden accession number s.n.* by Mr. Tanucha Boonjaras.

37. *Dendrobium wattii* (Hook.f.) Rchb.f., Gard. Chorn. 1888: 725. 1888. Type: *Watt 5,944* (holotype K!, photograph seen), India, Manipur, 9,000 ft alt., 16 June 1882. Fig. 5.37; Pl. 6: M.

Dendrobium cariniferum var. *wattii* Hook.f., Bot. Mag. 109: t. 6715. 1883.

Callista wattii (Hook.f.) Kuntze, Revis. Gen. Pl. 2: 655. 1891.

Flowering shoots erect, slender, cylindrical, brown or greenish brown, 17-43 cm tall, internodes 1.8-3.2 cm long, 1.4-1.9 cm in diameter, leafy along stem. **Leaves** distichous, spreading or slightly recurved, thinly coriaceous, green or dull green, ovate or lanceolate, apex unequally bi-lobed, each lobe acute, mid-vein grooved above and ribbed below, both surfaces sparsely covered with black hirsute hairs, becoming glabrous with aged, 3.5-4.2 cm long, 0.5-1.1 cm wide; leaf-sheaths covered with short black hirsute hairs, 2-2.7 cm long. **Inflorescences** abbreviated, often 2-flowered or solitary, borne at the uppermost part of both leafy and leafless stems, emerging from base of leaf sheaths opposite the blade; peduncle and rachis glabrous, light green, 0.2-0.4 cm long; floral bracts concave, abaxial surface covered with black hirsute hairs, adaxial surface glabrous, pale brown or brown, oblong or oblong-lanceolate, apex acuminate, base truncate, 2- to 4-veined, 1-1.5 cm long, 0.5-0.7 cm wide. **Flowers** papyraceous, resupinate, unscented, veins visible; sepals and petals white, 4.7-5.3 cm in diameter; mentum yellowish white or orangish white from outside; labellum white, claw yellow or yellowish orange, side lobes white with orange or yellowish orange lines on adaxial surface, somewhat waxy; disc orange or yellowish orange; mid-lobe white with more or less orange or yellowish orange lines; column white, foot yellow or yellowish orange, stigmatic cavity white, anther-cap white, pollinia yellow, pedicellate ovary light green. **Sepals** spreading, distally recurved, margin entire, mid-vein grooved on adaxial surface, abaxial surface keeled, conspicuous at apical part; dorsal sepal elliptic-oblong or elliptic-ovate, apex acuminate, base truncate, 5- to 7-veined, 3.2-3.7 cm long, 1.1-1.3 cm wide; lateral sepals obliquely

triangular-oblong, apex acuminate, base obliquely truncate, 5- to 7-veined, posterior margin 3.2-3.5 cm long, anterior margin 4.7-5.1 cm long, 1-1.4 cm wide at base, ca. 0.3 cm wide at apex. *Mentum* narrowly conical, apex obtuse, 1.9-2.2 cm long, 0.4-0.5 cm in diameter. *Petals* spreading, slightly recurved, obovate, apex acuminate or acute, base truncate, upper half margin subentire, lower half margin entire, 9- to 12-veined, 3.1-3.4 cm long, 2.1-2.4 cm wide at base. *Labellum* 3-lobed, 4.8-5.3 cm long, 2.6-2.9 cm wide across side lobes; claw linear or narrowly triangular, 1.5-1.9 cm long; side lobes obliquely ovate, adaxial surface with 6- to 7-slightly elevated veins along each side lobe, each vein bearing minutely wart-like callus, apex round, lateral margin entire, front margin crenate; disc narrowly oblong, prominent, surface smooth, waxy, becoming roughly 3-5 keeled at the apical part, continuing to mid-lobe; mid-lobe ovate, often same size with each side lobe, the length of mid-lobe longer than its width, with 3-5 keels at basal part, apex round or retuse, apiculate, margin irregular undulate or dentate, 1.2-1.7 cm long, 1.3-1.5 cm wide. *Column* surface smooth, without waxy, 6-7 mm long, 4-5 mm wide at base; foot slightly concave, tapering downwards, surface smooth, 24-27 mm long, 5-6 mm wide at entrance of mentum; stigmatic cavity ovate or elliptic; stelidia triangular; connective linear or narrowly triangular; anther cap obovate, surface very minutely papillose, apex emarginate, basal margin ciliate, adaxial surface sulcate, 3.2-3.4 mm long, 2.9-3.1 mm wide; pollinia 4, in 2 pairs, each pollinium narrowly elliptic, without caudicle and visidium. *Ovary* (including pedicel) narrowly clavate, glabrous, 6-grooved, 4.2-4.6 cm long. *Capsule* not seen.

DISTRIBUTION. – India, Myanmar and Vietnam.

HABITAT AND ECOLOGY. – Epiphytes in evergreen forests at ca. 2,700 m alt.

SPECIMENS EXAMINED. – INDIA: *Watt 5,944* (K), Manipur, 9,000 ft alt., 16 June 1882.

MYANMAR: *Micholizt s.n.* (W), Maymyo; *Maymyo Botanic Garden 13532* (K), Maymyo, Painwe Gon Village, 3,500 ft alt.

VIETNAM: *C. H. S. F. 70* (P), Dalat, 1,500 m alt.; *F. Evrard 389* (P), Langbian, 2,100 m alt., 27 Oct. 1920; *Grillec 115* (P), Sangbrace, 2,000 m alt.; Cult. *Marcel Lecoufle, Boissy Sant-Leger, Frame s.n.* (K), 04 Nov. 1986; *Poilane 31050* (P), Manif du Bi-Doug, du Haut Danai Province, 2,000 m alt., 19 Oct. 1940; *sine coll. s.n.* (TNS), 26 July 2007; *H. Donnai 31050* (W), Annam, Bi-doup, 19 December 1940.

LOCALITY UNKNOWN: *Living specimen no. 970779* (L), *spirit specimen no. 22552*, (L), August 2006; *living specimen no. 970778* (L), *spirit specimen no. 23599* (L); *sine coll.* (TNS), 24 May 2007.

NOTE – *Dendrobium wattii* is very similar to *D. infundibulum* in both vegetative and reproductive features. The species can be distinguished from *D. infundibulaum* by using the character of labellum. The length of mid-lobe of *D. wattii* is longer than the width (length of mid-lobe is shorter than the width in *D. infundibulum*). Moreover, the labellum of *D. wattii* has no or less callus.

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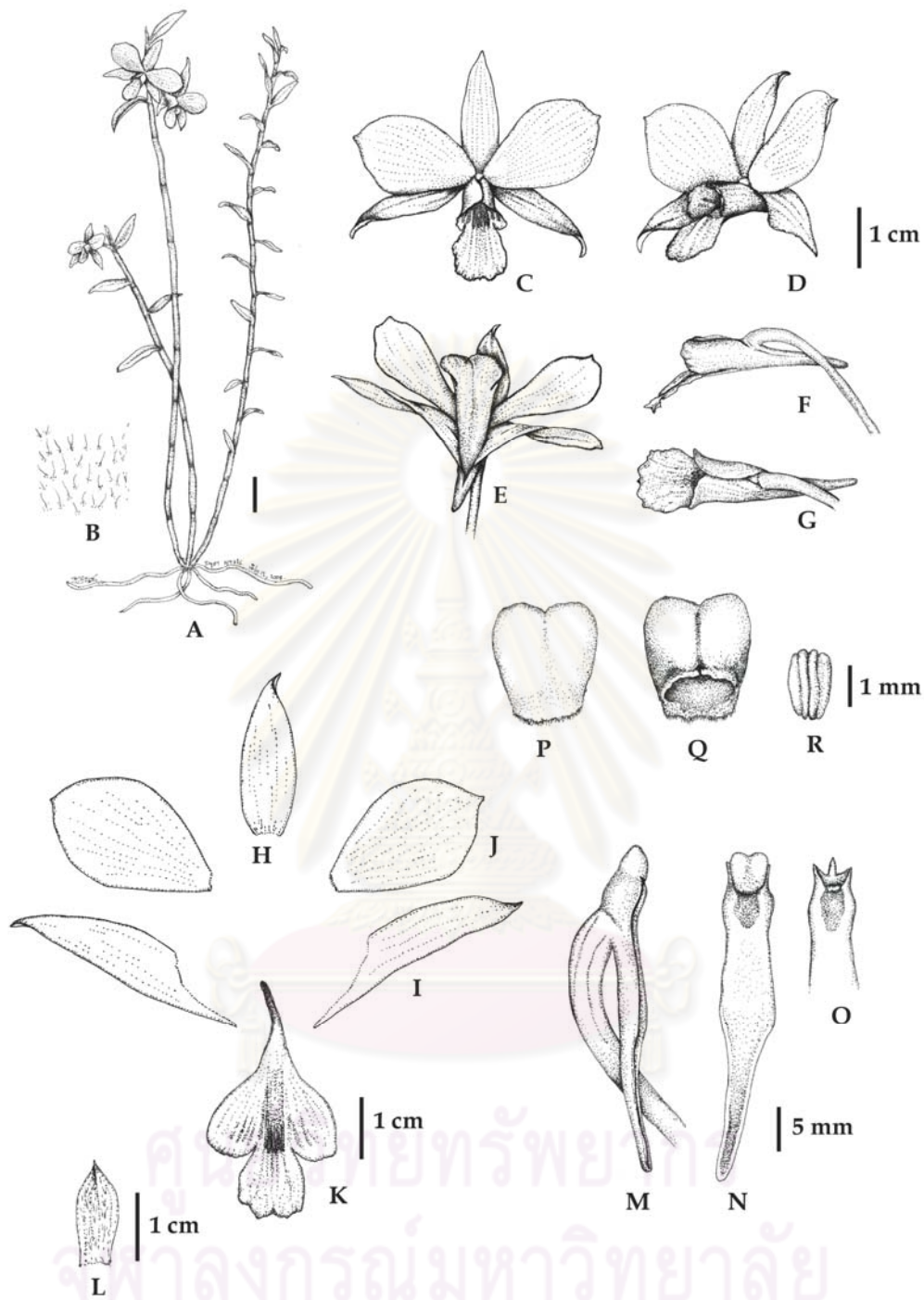


FIGURE 5.37. *Dendrobium wattii* (Hook.f.) Rchb.f. **A.** Habit; **B.** Hairs, on leaf; **C.** Flower, front view; **D.** Flower, oblique view; **E.** Flower, from below; **F.** Labellum and mentum, side view, sepals and petals removed; **G.** Labellum and mentum, from above, sepals and petals removed; **H.** Dorsal sepal; **I.** Lateral sepal; **J.** Petal; **K.** Labellum; **L.** Floral bract; **M.** Column and column foot, side view; **N.** Column and column foot, from below; **O.** Column, from below, anther cap removed; **P.** Anther cap, back view; **Q.** Anther cap, front view; **R.** Pollinia. Drawn from *Hort. Tsukuba Botanical Garden* accession number *s.n.* by Mr. Tanucha Boonjaras.

38. *Dendrobium williamsonii* Day & Rchb. f., Gard. Chron. 1869: 78. 1869. Type: *Williamson s.n.* (holotype W!), India, Assam, March 1868. Fig. 5.38; Pl. 7: A.

Dendrobium lubbersianum Rchb.f., Gard. Chron. 1882(1): 460. 1882. **syn. nov.** Type: cult. *Veitch s.n.* (holotype W!), Myanmar, precise locality unknown.

Callista williamsonii (Day & Rchb.f.) Kuntze, Revis. Gen. Pl. 2: 655. 1891.

Callista lubbersiana (Rchb.f.) Kuntze, Revis. Gen. Pl. 2: 655. 1891.

Flowering shoots caespitose, erect, somewhat zigzag, constricted at nodes, cylindrical, tapering downward base, sulcate, green or greenish brown, yellowish green or yellowish brown or ferruginous, old stems yellow, sometime glossy, 18-29 cm tall, internodes 3.1-3.7 cm long, 1.2-1.5 cm in diameter, leafy along the upper part of stem. **Leaves** distichous, spreading, slightly recurved, often twisted at middle or basal part, coriaceous, green or dull green, elliptic-oblong or narrowly elliptic, apex unequally bi-lobed, each lobe obtuse, mid-vein grooved above and ribbed below, both surfaces covered with black hirsute hairs, densely hairy on abaxial surface and young leaves, glabrate on adaxial surface, somewhat waxy, 8.6-10.5 cm long, 0.6-1.1 cm wide; leaf-sheaths covered with dense black-hirsute hairs, 1.5-3.3 cm long. **Inflorescences** abbreviated, often 2-flowered, sometime solitary, borne at the apical part or uppermost node of stems; peduncle and rachis, glabrous, green or light green, 0.3-0.4 cm long; floral bracts persistent, concave, abaxial surface densely covered with black hairs, adaxial surface glabrous, pale brown or tawny, ovate-oblong or ovate-triangular, apex acute, base truncate, 3- to 5-veined, 1.4-1.6 cm long, 0.4-0.6 cm wide; bracteoles adpressed, abaxial surface covered with particularly black hairs or glabrous, pale brownish yellow, ovate-oblong, apex acuminate, base truncate, 2- to 4-veined, 0.3-0.5 cm long, 0.2-0.4 cm wide. **Flowers** resupinate, texture thinner than other allies, veins hardly visible, scent resemble to *Dendrobium cariniferum*, 5.2-5.7 cm in diameter; sepals yellowish white or pale yellow, abaxial surface darker than adaxial surface, becoming orange yellow when aged; mentum pale orange

yellow from out side; petals creamy white becoming creamy orange when aged; labellum creamy white, with pale orange veins and reddish orange hair-like callus on each vein, claw pale orange, side lobes yellowish white or creamy white, with reddish orange blotch at the apical part of each lobe; disc creamy white, reddish orange at the end; mid-lobe creamy white, reddish orange blotch at the basal part; column white, foot white, becoming pale orange at the entrance of mentum, stigmatic cavity white or ivory white, anther-cap white, sometime with a pale orange spot at the center, pollinia yellow, pedicellate ovary light green or greenish white. *Sepals* spreading, adaxial surface waxy, abaxial surface obtusely keeled, veins hardly visible, margin entire; dorsal sepal oblong or narrowly oblong, apex acute or acuminate, base truncate, mid-vein grooved on adaxial surface, 3- to 5-veined, 2.8-3.4 cm long, 0.7-0.9 cm wide; lateral sepals obliquely triangular-oblong or obliquely triangular-lanceolate, apex acuminate or attenuate, base obliquely truncate, 5- to 7-veined, posterior margin 2.8-3.3 cm long, anterior margin 4-4.6 cm long, 1.2-1.5 cm wide at base, ca. 0.5 cm wide at apex. *Mentum* narrowly conical, apex obtuse, straight, 1.1-1.5 cm long, 0.3-0.4 cm in diameter. *Petals* slightly recurved at apex, adaxial surface waxy, narrowly oblong or lanceolate, apex acute or acuminate, base truncate, margin entire, 5- to 7-veined, hardly visible, 2.8-3.2 cm long, 1.4-1.7 cm wide. *Labellum* 3-lobed, without sinus between side lobes and mid-lobe, somewhat waxy, 3.8-4.4 cm long, 2.1-2.5 cm wide across side lobes; claw linear or narrowly triangular, slightly pubescent at apical part, 9-12 mm long; side lobes obliquely obovate, each lobe with 7-8 slightly elevated and rugulose veins, bearing sparsely hair-like callus at the apical part, apex obtuse or subacute, lateral margin entire, front margin subcrenate; disc oblong or narrowly oblong, pubescent at the basal part, slightly swollen at the middle part and 3-obscurely ridged at the end, each ridge bearing sparsely hair-like callus and continuing to mid-lobe; mid-lobe orbicular or very widely ovate, with 2 or 4 elevated veins continued from side lobes and 3 ridges continued from disc, bearing sparsely hair-like callous at basal to middle portion, apex rounded, margin crenate and slightly crisped, 1.2-1.6 cm long, 1.3-1.5 cm

wide. *Column* surface smooth, without waxy, 6-8 mm long, 5-6 mm wide at base; foot concave, tapering downwards, surface smooth, without waxy, 17-22 mm long, 6-7 mm wide at entrance of mentum; stigmatic cavity elliptic or ovate or ovate-oblong; stelia broadly triangular, apex rounded or subacute, margin irregular lobed; connective linear or narrowly triangular; anther cap surface minutely papillose, obovate or sub-orbicular, apex truncate, basal margin ciliate, adaxial surface obscurely sulcate, 2.8-3.2 mm long, 2.4-2.7 mm wide; pollinia 4, in 2 pairs, each pollinium narrowly elliptic, without caudicle and visidium. *Ovary* (including pedicel) clavate, glabrous, sometime glaucous, 3-obtusely keeled, 3.7-4.3cm long. *Capsule* not seen.

DISTRIBUTION. – India, China, Myanmar and Vietnam.

SPECIMENS EXAMINED. – INDIA: *Sine coll. s.n.* (K); *Cult. Hort. Kew. Entry No. 139-1954* (K), Kalimpong, Bagal, 04 Mar. 1954; *Cult. Hort. Kew. Entry No. 255-1954* (K), Kalimpong, Bagal, 01 Apr. 1954; *F. K. W. 6659* (K), Ridge above the Nam Hat, 4,000-6,000 ft alt., 27 Apr. 1926; *R. Panting s.n.* (BM), Khasia Hills, 4,000 ft alt., Apr. 1897; *Prain's collector 166* (BM, BR, E, L, P), Assam, Jharani, Jaintea Hills, Apr. 1899; *sine coll. s.n.* (TNS), 01 July 2007; *Pantling s.n.* (W), Khasia Hills, 4,000 ft alt., April 1897; *Sine.coll.s.n.* (W), Khasia Hills, April 1875; *Sine. coll. s.n.* (W), Passyak Hills, 2,000-3,000 ft alt., May 1890.

CHINA: *G. Forrest 26729* (BM), Shweli-Salevin divide, E. Tibet and S.W. China; *Steward and Cheo 259* (K), Kwangsi Province, 25 Apr. 1933.

MYANMAR: *G. Forrest 26608* (BM, E, P), N.E. upper Burma, hills around Chir-kao, (26°12' N, 98°33' E), May 1925; *C. W. D. Kermode 17330* (K), Myitkyina District, Near Black Rock, 4,000-5,000 ft alt., 06 May 1938; *F. Kingdon-Ward 20771* (BM), North Burma, Kachin State, North Tringle (Hkinlum), 4,000 ft alt., 02 May 1953; *Frank Kingdon-Ward s.n.* (E), Upper Burma; *G. Forrest 26608* (W), 1924.

VIETNAM: N.T. Hiep *et al.* HLF6298 (LE-photo seen), Quang Tri, Huong Hoa, 1,200-1,300 m alt., 29 March 2006.

LOCALITY UNKNOWN: *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 6858 (W);

NOTE.— After reexamination of the protologues and type specimens of *D. williamsonii* and those of *D. lubbersianum*. It was found that the two taxa are depicted all the same characters. This agrees with Kerr's opinion (1882). He studied the type of *D. lubbersianum* and mentioned that it is conspecific with *D. williamsonii*. Therefore, I reduced *D. lubbersianum* to the synonymous name.



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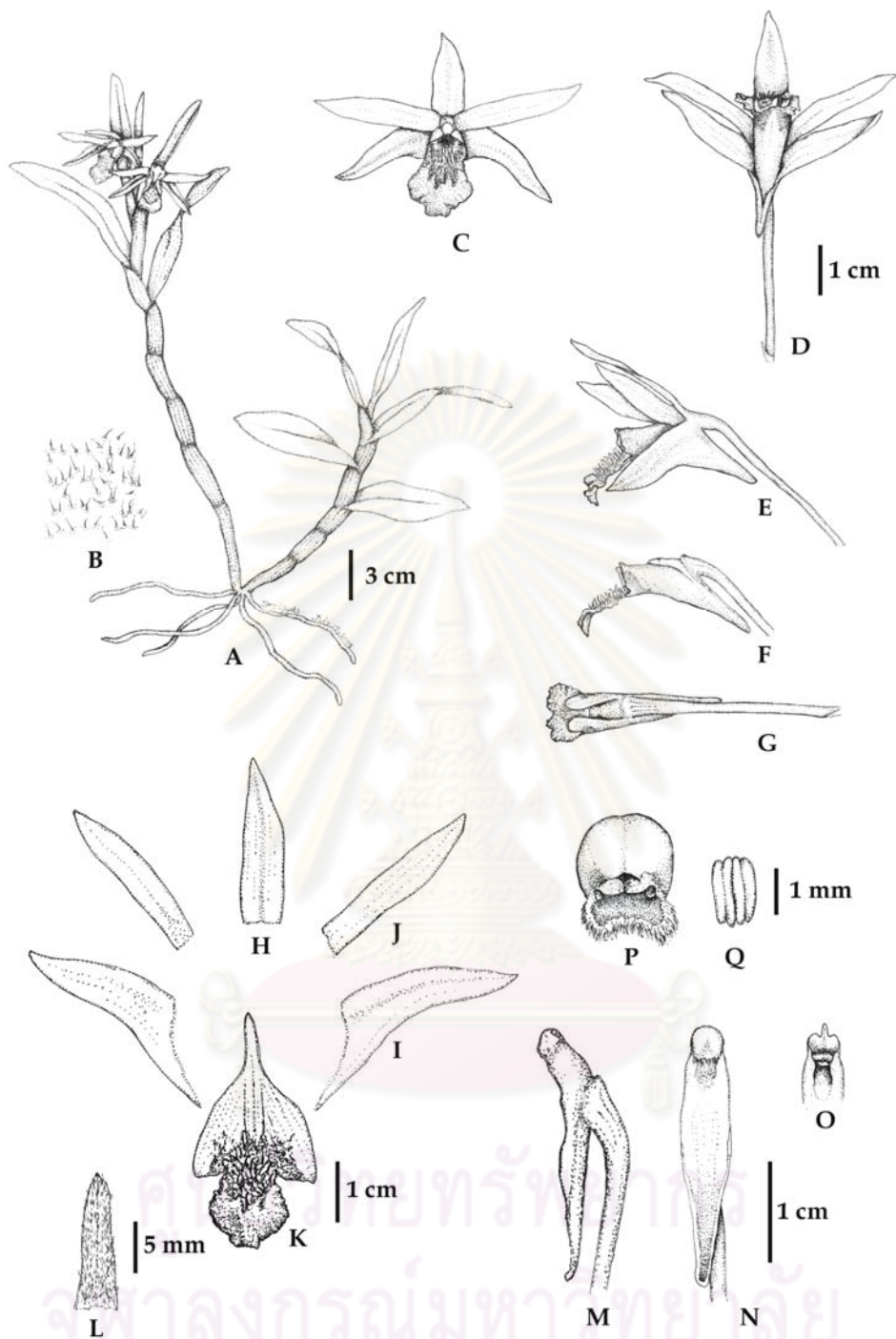


FIGURE 5.38. *Dendrobium williamsonii* J. Day & Rchb. f. **A.** Habit; **B.** Hairs, on leaf; **C.** Flower, front view; **D.** Flower, from below; **E.** Flower, side view; **F.** Labellum and mentum, side view, sepals and petals removed; **G.** Labellum and mentum, from above, sepals and petals removed; **H.** Dorsal sepal; **I.** Lateral sepal; **J.** Petal; **K.** Labellum; **L.** Floral bract; **M.** Column and column foot, side view; **N.** Column and column foot, from below; **O.** Column, from below, anther cap removed; **P.** Anther cap; **Q.** Pollinia. Drawn from *Hort. Tsukuba Botanical Garden accession number 119217* by Mr. Tanucha Boonjaras.

39. *Dendrobium xanthophlebium* Lindl., Gard. Chron. 1857: 268. 1857. Type: *Lobb 176* (holotype K!, in Lindley Herbarium; isotype K!), Myanmar, Moulmein (nowadays Mawlamyaing City), April 1857. Fig. 5.39; Pl. 7: B.

Dendrobium marginatum Bateman ex Hook.f., Bot. Mag. 90: t. 5454. 1864. Type: *Parish s.n.* (holotype, unknown), Myanmar, Moulmein.

Callista xanthophlebia (Lindl.) Kuntze, Revis. Gen. Pl. 2: 655. 1891.

Flowering shoots erect, slender, cylindrical, slightly constricted at nodes, sulcate, grayish green or yellowish brown or ferruginous, 32-47 cm tall, internodes 4.5-5.2 cm long, 1-1.4 cm in diameter. **Leaves** distichous, spreading or slightly recurved, thinly coriaceous, adaxial surfaces of mature leaves becoming glabrous, with aged, more or less waxy, abaxial surface sparsely covered with short black hirsute hairs, mid-vein grooved above and ribbed below, green, narrowly elliptic or lanceolate, apex unequally bi-lobed, each lobe acute, 7-8.4 cm long, 2.1-2.4 cm wide; leaf-sheaths covered with short black hirsute hairs, 3.8-4.9 cm long. **Inflorescences** abbreviated, 1- to 2-flowered, often borne at upper portion of leafless stems, emerging from base of leaf sheaths opposite the blade; peduncle and rachis glabrous, light green, 0.2-0.4 cm long; floral bracts concave, abaxial surface covered with scattered black hirsute hairs, adaxial surface glabrous, pale brown or straw-liked colour, oblong or ovate-oblong, apex acute or acuminate, base truncate, 2- to 4-veined, 0.4-0.6 cm long, 0.2-0.4 cm wide. **Flowers** papyraceous, resupinate, unscented, 2.8-3.6 cm in diameter; sepals and petals white; mentum pale orange or orange white from outside; labellum white and reddish orange, claw pale orange, side lobes orange or reddish orange, white at basal portion, with red wart-liked callus on adaxial surface; disc white at basal half, becoming orange yellow at distal part, with a row of reddish orange callus along both side; mid-lobe orange or reddish orange, margin white, median ridge orange yellow, reddish orange at apical part; column orange or reddish orange, foot orange or yellowish orange, stigmatic cavity white or yellowish white,

anther-cap white, sometime with a reddish orange blotch at center of abaxial surface, pollinia yellow, pedicellate ovary light green or greenish white. *Sepals* spreading, distally recurved, margin entire, abaxial surface with inconspicuous keel, conspicuous at apical part; dorsal sepal elliptic-oblong or obovate-oblong, apex acuminate, 5- to 7-veined, 1.7-2.1 cm long, 0.6-0.9 cm wide; lateral sepals obliquely triangular-ovate, apex acuminate or attenuate, base obliquely truncate, 5- to 7-veined, posterior margin 1.9-2.3 cm long, anterior margin 3.1-3.3 cm long, 0.7-1 cm wide at base, 0.2-0.3 cm wide at apex. *Mentum* shortly conical, apex obtuse, 1.5-1.8 cm long, 0.4-0.6 cm in diameter at base, 0.3-0.4 cm in diameter at apical part. *Petals* spreading, slightly recurved, narrowly elliptic, apex acute, base truncate, margin entire, 3- to 5-veined, hardly visible, 1.8-2.3 cm long, 0.5-0.8 cm wide at base. *Labellum* 3-lobed, 2.5-2.8 cm long, 1.9-2.3 cm wide across side lobes; claw triangular, 0.8-1.1 cm long; side lobes with dense elongate wart-like callus on adaxial surface, obliquely triangular or triangular-elliptic, apex rounded, margin entire; disc narrowly oblong, with 3 keels, somewhat waxy, both side along with a row of sawtooth-like callus; mid-lobe suborbicular, bearing minutely wart-like callus on adaxial surface, median ridge with 3 keels, continuing from disc, apex round, sometime emarginated, slightly recurved backward, margin crisped, 0.7-0.9 cm long, 0.8-1.2 cm wide. *Column* surface smooth, without waxy, 5-7 mm long, 3-4 mm wide at base; foot slightly concave, tapering downwards, 12-14 mm long, 5-6 mm wide at entrance of mentum; stigmatic cavity ovate or elliptic; stelidia triangular; connective linear or narrowly triangular; anther cap obovate, surface minutely papillose, adaxial surface sulcate, apex emarginated, basal margin ciliate, 2-2.4 mm long, 2.1-2.1 mm wide; pollinia 4, in 2 pairs, each pollinium narrowly elliptic, without caudicle and visidium. *Ovary* (including pedicel) narrowly clavate, slender, glabrous, somewhat glaucous, 6-grooved, 2.5-2.7 cm long. *Capsule* not seen.

DISTRIBUTION.— Myanmar (endemic).

HABITAT AND ECOLOGY. – Epiphytes in evergreen forests at ca. 1,300 m alt.

SPECIMENS EXAMINED. – MYANMAR: *Lobb* 176 (K), Mawlamyaing, 4,500 ft alt.; *Parish* 133 (K), Mawlamyaing; *Lobb* 177 (K), Mawlamyaing, 4,500 ft alt., Apr. 1857.

LOCALITY UNKNOWN: *Tipol Rueng-ak-sorn* s.n. (BCU), 08 Jan. 2004; *A. Sathapattayanon* 413 (BCU), sine loc., 28 Dec. 2005; *A. Sathapattayanon* 446 (BCU), 21 Mar. 2007; *C. Glamwaewwong* 1220 (QBG), 06 Feb. 2006; *S. Pumicong* 46 (QBG), 25 Dec. 2005; *sine coll.* s.n. (TNS); *Sine coll.* s.n. Reichb.f. Orchids Herb. no. 32531 (W); *Sine coll.* s.n. Reichb.f. Orchids Herb. no. 26276 (W).



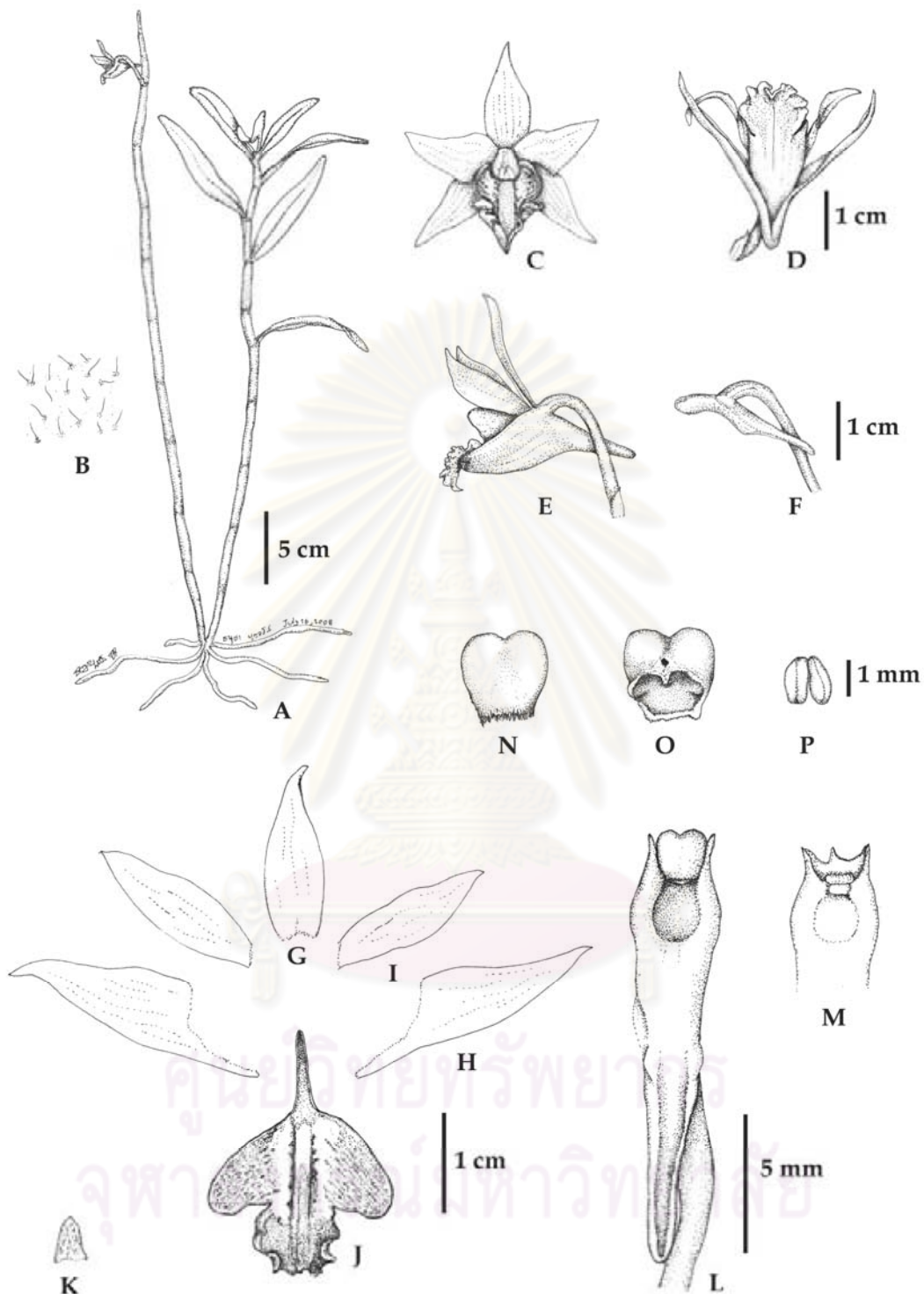


FIGURE 5.39. *Dendrobium xanthophlebium* Lindl. **A.** Habit; **B.** Hairs, on leaf; **C.** Flower, front view; **D.** Flower, from below; **E.** Flower, side view; **F.** Column and column foot, side view; **G.** Dorsal sepal; **H.** Lateral sepal; **I.** Petal; **J.** Labellum; **K.** Floral bract; **L.** Column and column foot, from below; **M.** Column, from below, anther cap removed; **N.** Anther cap, back view; **O.** Anther cap, front view; **P.** Pollinia. Drawn from A. Sathapattayanon 413 by Mr. Tanucha Boonjaras.

NEW SECTION

A. Sathapattayanon, T. Yukawa & T. Seelanan, (*ined.*). Type: *Dendrobium dearei*
Rchb. f.

Flowering shoots erect, tall, thick and leafy. *Leaves* close distichous, the opposite leaves usually imbricate, especially the leaves at upper part of stem, leaves and leaf sheaths glabrous. *Inflorescences* usually with several flowers, up to 26-flowered, borne on distal part of stems, peduncle long. *Flowers* large, usually white. *Mentum* prominent, usually straight, conical. *Labellum* 3-lobed, without callus.

DISTRIBUTION – It seems likely that this new section mainly distributed in the Philippines Islands and also in most western part of Borneo Island.

KEY TO THE SPECIES

- 1-a. Mentum broadly conical. **4. D. schuetzei**
- 1-b. Mentum shortly conical or very narrowly conical.2.
- 2-a. Side lobes of the labellum very small, width across side lobes narrower than width across mid-lobe. **2. D. parthenium**
- 2-b. Width across side lobes boarder than width across mid-lobe.3.
- 3-a. Mid-lobe of the labellum ovate or very widely ovate, apex emarginated.
..... **3. D. sanderae**
- 3-b. Mid-lobe of the labellum oblong, apex truncate, apiculate. **1. D. dearei**

1. *Dendrobium dearei* Rchb. f., Gard. Chron. 1882(2): 361. 1882. Type: *Colonel Deare s.n.* (syntype W!); cult. *Low s.n.* (syntype W!); *Veitch s.n.* (syntype W!), the Philippines, locality unknown. Fig. 5.40; Pl. 7: E.

Dendrobium ovipostoriferum auct. non J.J. Sm.: Wood & Cribb, Checklist Orch. Borneo: pl. 9A. 1994.

Flowering shoots clustered, erect, cylindrical, green or light green, up to 1.5 m tall, internodes 1.5-3 cm long, 1-1.5 cm in diameter, leafy throughout. **Leaves** close distichous, the opposite leaves usually imbricate, especially the leaves at upper part of stem, spreading, thinly coriaceous, both surfaces glabrous, mid-vein grooved above and ribbed below, green, ovate-oblong or oblong, apex unequally bi-lobed, each lobe minutely obtuse or subacute, 6.3-11 cm long, 1.5-3.8 cm wide; leaf-sheaths glabrous, green or light green, 2-3 cm long. **Inflorescences** abbreviated, 5- to 10-flowered (plants from Philippines), 10- to 26-flowered (plants from Borneo), emerging from the base of the leaf-sheaths opposite the blades along the upper portion of the stem, pendulous; peduncle and rachis glabrous, peduncle 2-5 cm long; non-floriferous bracts 2-3 at the base, and 1 in the middle, 1-3 mm long, ovate, apex acute, base truncate; rachis 12-25 cm long; floral bracts 2-4 mm long, triangular-ovate, apex acute to acuminate, base truncate. **Flowers** resupinate, papyraceous, veins visible, long-lasting, with faintly odour, up to 5.5 cm in diameter; sepals and petals white; mentum white or greenish white from outside; labellum white, claw green, side lobes, disc and base of mid-lobe yellowish green to yellowish; column white, with flushed green around stigmatic cavity, foot white, with green central band and green basal margin, stigmatic cavity white, anther-cap light green or greenish white, pollinia yellow, pedicellate ovary white. **Sepals** spreading, somewhat recurved, rather stiff-textured, margin entire, abaxial surface with strongly wing-like keel, keel confluent with pedicellate ovary and twist towards the base; dorsal sepal oblong to ovate-oblong, apex acuminate, base truncate, 5- to 6-veined, 2.4-3.5 cm long,

0.7-1 cm wide; lateral sepals obliquely triangular-ovate, apex acuminate, base obliquely truncate, 6- to 7-veined, posterior margin 2.4-2.7 cm long, anterior margin 4-4.6 cm long, 1.3-1.4 cm wide at base, *c.* 0.3 cm wide at apex. **Mentum** very narrowly conical, ovipositor-shaped, almost straight, apex obtuse, 1.5-2 cm long, *ca.* 0.3-0.5 cm in diameter. **Petals** spreading, somewhat recurved, suborbicular-elliptic, apex obtuse and apiculate, base truncate, upper half margin somewhat undulate, lower half margin entire, 5- to 7-veined, 2.8-3.9 cm long, 2-2.5 cm wide. **Labellum** 3-lobed, without callus, 3-4.1 cm long, 2.2-3 cm wide across side lobes, 1.3-1.8 cm wide across mid-lobe; claw linear, 1.5-2 cm long; side lobes obliquely ovate-oblong, apex obtuse, front margin erose, later margin entire; disc smooth, oblong; mid-lobe oblong to widely oblong, apex truncate or retuse, apiculate, margins irregular, often dentate, 1.3-1.9 cm long. **Column** surface minutely papillose, 0.5-0.7 cm long, *ca.* 0.7 cm wide at base; foot broad at the base, concave, canaliculate, surface minutely papillose, 15-18 mm long, 6-7 mm wide at entrance to mentum; stigmatic cavity elliptic; stelidia triangular; connective narrowly triangular; anther cap obovate, surface minutely papillose, apex rounded or slightly retuse, basal margin minutely ciliate, adaxial surface sulcate, *ca.* 4 mm long, 2.8-3.1 mm wide; pollinia 4, in 2 pairs, each pollinium narrowly elliptic, without caudicle and visidium. **Ovary** (including pedicel) triangulate, wings somewhat undulate, curved, slightly twist, glabrous, 6-grooved, 4.1-5.5 cm long. **Capsule** not seen.

DISTRIBUTION. — Malaysia, Indonesia and the Philippines.

HABITAT AND ECOLOGY. — Coastal forest at the sea level.

SPECIMENS EXAMINED. — MALAYSIA: Cult. *Chan Chew Lun s.n.* (K), Sabah, Nov. 1999; Cult. *Ernst Grell 69A* (K), Sabah; *A. Lamb AL 1375/91* (K), Sabah, S.E. of Sandakan, Tambisan, Dent Peninsula (off-shore island near Sandakan), sea level, 16 Sep. 1991.

INDONESIA: *Sine coll. s.n.* (TNS), Borneo, 25 May 2007 (22 June 2007).

PHILIPPINES: Cult. *Hort. Kew. s.n.* (K), July 1887; Cult. *Hort. Kew. s.n.* (K), Oct. 1885; Cult. *Hort. Kew. s.n.* (K), Aug. 1887; Cult. *Hort. Kew. s.n.* (K), 20 Aug. 1915; L. Kiennst *s.n.* (K), 21 Aug. 1895; A. Loher 5326 (K), Mindanao, 1906; A. Loher *s.n.* (K), Luzon central; Cult. *Sander s.n.* (K), June 1890; *sine coll. s.n.* (TNS); D. Tiu *s.n.* (K), Calayan Islands, Sep. 1994; Cult. *Veitch s.n.* (K), Nov. 1886; *Vidal s.n.* (K), Mar. 1886; J. H. Wibbe 13.246 (BR), Dinagat, 1882.

LOCALITY UNKNOWN: Cult. *Iona Macphie, British s.n.*, Dec. 2006 (K); Cult. *Hort. Kew. Entry No.508-1933* (K), 15 June 1933; Cult. *Hort. Kew* (L), 13 March 1916; *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 32462 (W).

NOTE – *Dendrobium dearei* is one of the members of section *Formosae* lacking the characteristic covering of blackish hairs on the leaf-sheaths and inflorescences. The islands of the Philippines are home to some of the most beautiful species in the section, such as *D. sanderae* and *D. schuetzei*. *Dendrobium scheutzii* appears most closely allied to *D. dearei*, but may be distinguished by the broader petals and lip, and shorter, broader mentum.

The Bornean form of *D. dearei* differs from the typical Philippine plants in having much taller stems up to at least 110 cm long, which are leafy throughout their entire length. The thinner, narrower leaves may attain 18 cm in length. The pendulous inflorescences are typically 15 to 25 cm long and bare up to 26 flowers that are described as smelling of wet socks! Each flower is about 5 cm across and has an almost square to rectangular lip mid-lobe, often with an irregularly toothed margin. O'Byrne (2000) postulated that it may be a polyploid, which would explain the increased size and number of flowers.

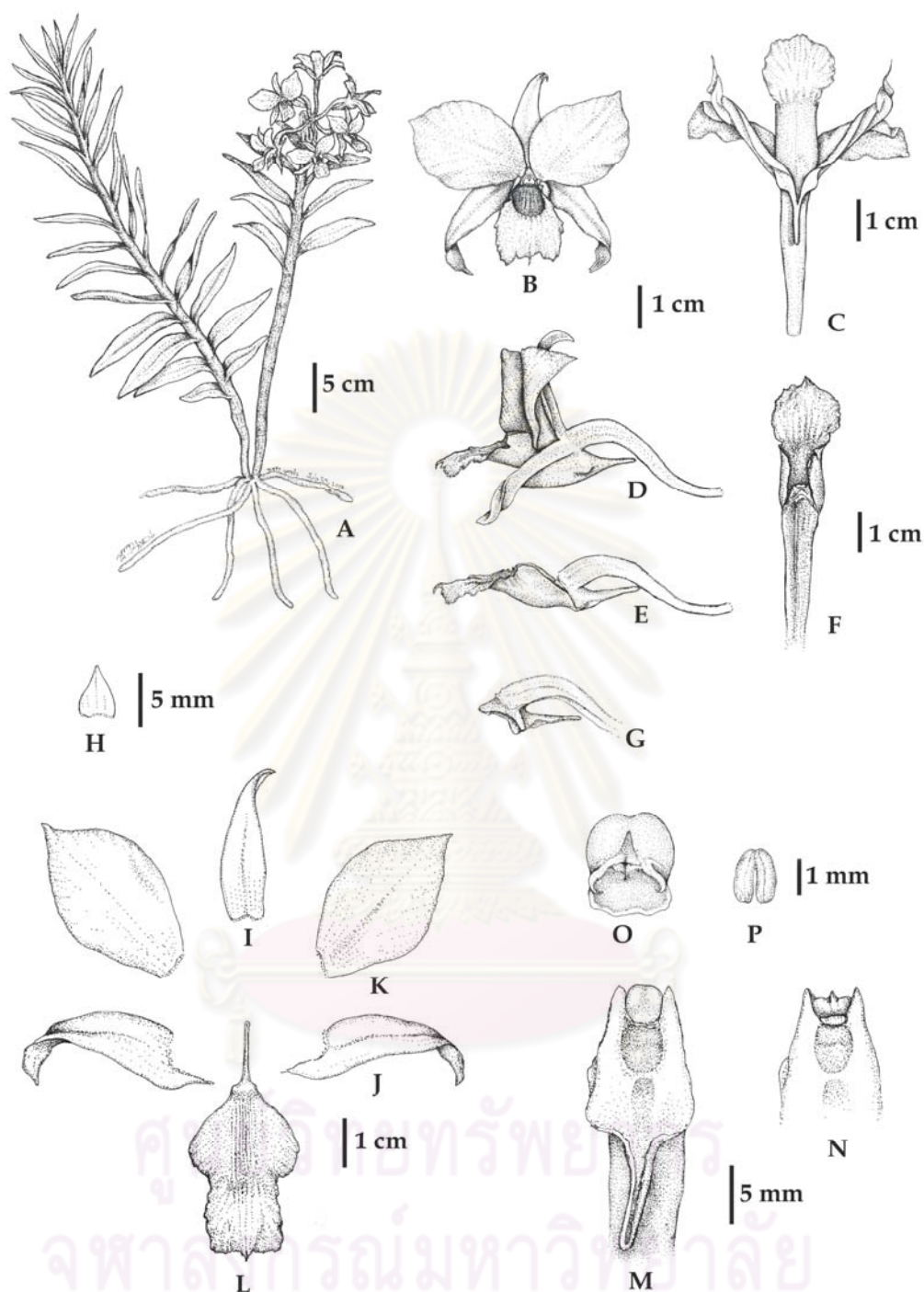


FIGURE 5.40. *Dendrobium dearei* Rchb.f. **A.** Habit; **B.** Flower, front view; **C.** Flower, from below; **D.** Flower, side view; **E.** Labellum and mentum, side view, sepals and petals removed; **F.** Labellum and mentum, from above, sepals and petals removed; **G.** Column and column foot, side view; **H.** Floral bract; **I.** Dorsal sepal; **J.** Lateral sepal; **K.** Petal; **L.** Labellum; **M.** Column and column foot, from below; **N.** Column, from below, anther cap removed; **O.** Anther cap; **P.** Pollinia. Drawn from *Hort. Tsukuba Botanical Garden accession number s.n.* by Mr. Tanucha Boonjaras.

2. *Dendrobium parthenium* Rchb. f., Gard. Chron. 1885(2): 489. 1885. Type: imported by *W. Bull s.n.* (holotype W!), Indonesia, Borneo, precise locality unknown. Fig. 5.41; Pl. 7: F.

Dendrobium sanderianum Rolfe, Bull. Misc. Inform. Kew. 1894: 155. 1894. Type: *Sander s.n.* (holotype K!), Indonesia, Borneo, precise locality unknown,

Dendrobium sanderae Rolfe var. *milleri* Quisumb., Philipp. Orchid Rev. 6: 3, pl. 1-2. 1885, nom. nud. Type: cult. *Miller s.n.* (holotype, unknown), the Philippines, Palawan Island, precise locality unknown.

Flowering shoots clustered, erect, cylindrical, yellowish green or yellow, 27-65 cm tall, internodes 1-3 cm long, 0.4-0.8 cm in diameter, leafy throughout. **Leaves** close distichous, the opposite leaves usually imbricate, especially the leaves at upper part of stem, spreading, stiffly coriaceous, both surfaces glabrous, mid-vein grooved above and ribbed below, green, ovate-oblong or oblong, apex unequally bi-lobed, each lobe minutely obtuse, 1.3-6.7 cm long, 0.6-1.8 cm wide; leaf-sheaths glabrous, yellowish green or yellow, 1-3 cm long. **Inflorescences** abbreviated, 2- to 4-flowered, usually 2-flowered, borne along of the upper part of stem, emerging through base of leaf-sheath opposite blade; peduncle and rachis glabrous, green, 0.5-0.8 cm long; floral bracts glabrous, pale brown, ovate, apex obtuse to acute, base truncate, 0.2-0.4 cm long. **Flowers** resupinate, papery, veins visible, up to 2.5-3 cm in diameter; sepals and petals pure white; mentum white with pale green apex; labellum white with a central purple or reddish purple patch; column white, foot white, often with purple or purplish green band, stigmatic cavity white, anther-cap pale purple or purplish white, sometimes with 3 purple basal blotches, pollinia yellow, pedicellate ovary green. **Sepals** spreading, often recurved distally, margin entire; dorsal sepal oblong to oblong-ovate or oblong-elliptic, apex acuminate, base truncate, abaxial surface with keel, obvious at apex, 5-veined, 2-2.4 cm long, 0.6-0.9 cm wide; lateral sepals obliquely triangular-ovate, apex acuminate, base obliquely truncate, abaxial

surface with keel, obvious at apex, 7- to 9-veined, posterior margin 2.3-2.7 cm long, anterior margin 4.1-4.5 cm long, 0.9-1.1 cm wide at base, c. 0.3 cm wide at apex. *Mentum* very narrowly conical, ovipositor-shaped, broadened at the base, straight or hooked distally, apex obtuse, 1.3-1.9 cm long, ca. 0.3 cm in diameter. *Petals* spreading, suborbicular-elliptic or widely rhombic, apex obtuse and apiculate, base truncate, upper half margin crenulated and undulate, lower half margin entire, 7- to 9-veined, 2.4-2.8 cm long, 2.5-3.2 cm wide. *Labellum* 3-lobed, flabellate in outline, without callus, 2.8-3.5 cm long, 1.7-2 cm wide across side lobes, 2.3-3 cm wide across mid-lobe; claw linear, 1.3-1.7 cm long; side lobes obliquely oblong, apex obtuse, margin entire or few serrate; disc smooth, oblong; mid-lobe broadly obcordate, apex apiculate, margins crenulate, 2-2.9 cm long. *Column* surface minutely papillose, 0.3-0.5 cm long, ca. 0.5 cm wide at base; foot broad at the base, concave, canaliculate, surface minutely papillose, 14-20 mm long, 7-9 mm wide at entrance to mentum; stigmatic cavity elliptic or elliptic-oblong; stelia broadly triangular; connective linear; anther cap ovate to oblong, surface minutely papillose, apex rounded to slightly retuse, basal margin minutely ciliate, adaxial surface sulcate, ca. 3 mm long, 2.8-3 mm wide; pollinia 4, in 2 pairs, each pollinium narrowly elliptic, without caudicle and visidium. *Ovary* (including pedicel) triangulate, curved to somewhat sigmoid, slightly twist, glabrous, 6-grooved, 2.5-4.5 cm long. *Capsule* not seen.

DISTRIBUTION.— Malaysia and Indonesia.

HABITAT AND ECOLOGY.— Epiphytes in hill forest or lowland forest, at altitude ca. 900 m alt.

SPECIMENS EXAMINED.— MALAYSIA: *Cribb* 671 (K-SPIRIT), Sabah, Kinabalu National Park, foothill near Ranau, 2,500 ft alt., 27 Sep. 1983; *J. H. Beaman* 11687 (K), Sabah, Lahad Datu District, Baik Island, 20 m alt., 14 Sep. 1995; *P. Cribb* 89/59 (K-SPIRIT), Sabah, Kinabalu, Ampuan, Bukit, 3,000 ft alt., 16 Nov.

1989; *J. Jumian* 64 (K), Sabah, Telupid District, Bukit Bidu-Bidu, 400 m. a.s.l., 19 Feb. 2004; *A. Lamb* 2004/1223 (K), Sabah; *A. Lamb* AL 311/85 (K), Borneo, Sabah, Bukit Hampuan, Ranau District, Mt. Kinabalu, 2,000-3,000 ft alt., Jan-Feb. 1985; *A. Lamb* K33 (K-SPIRIT), Sabah, Kinabalu, "Secret Place", 2,500 ft alt., 29 Aug. 1984; *A. Lamb* SAN 19514 (LKC No. 3164) (K), Sabah, Ranau District: Bukit Ampuon, Lohan River, 2,500-3,000 ft alt., 11 May 1980; *A. Lamb* SAN 91514 (K-SPIRIT), Sabah, Ranau District: Bukit Ampuon, Lohan River, 2,500-3000 ft alt., 11 May 1980; *A. Lamb* SAN 86946 (K), Sabah, Kinabatangan District, Telupid, Tawai Plateau, 1,300 ft .a.s.l., 09 Sep. 1977; *A. Lamb* s.n. (K-SPIRIT), Sabah, 23 Feb. 1982; *L. M. Mason et al* 619 (K-SPIRIT), Borneo, 29 June 1960; *Cult. Sander* s.n. (K), Nov. 1893; *Cult. Tenom Orchid Centre (Coll. in cult. By J. J. Wood)* 1277 (K-SPIRIT), East Malaysia, Sabah, Ranau District, Bukit Hampuan, 1,500 m alt., 08 June 1988; *J. J. Wood* 837 (K, K-SPIRIT), East Malaysia, Sabah, Ranau District, Bukit Hampuan, 900 m alt., 01 June 1988.

INDONESIA: *W. Bull* s.n. (W), Borneo; *Sander* s.n. (K), Borneo.

LOCALITY UNKNOWN: *sine coll. sn.* TBG142271, 16 May 2007 (TNS).

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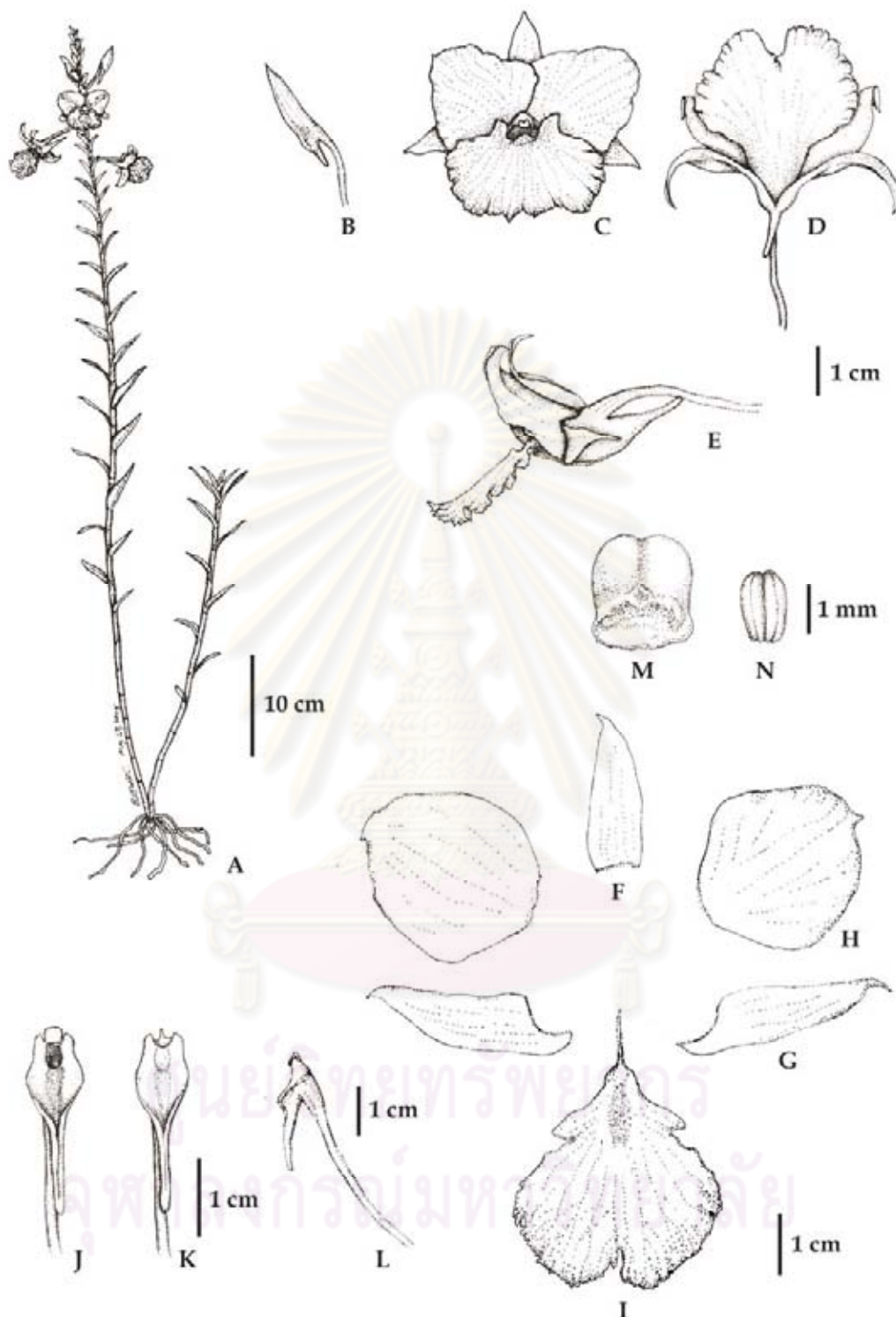


FIGURE 5.41. *Dendrobium parthenium* Rchb.f. **A.** Habit; **B.** Flower bud, side view; **C.** Flower, front view; **D.** Flower, from above; **E.** Flower, side view; **F.** Dorsal sepal; **G.** Lateral sepal; **H.** Petal; **I.** Labellum; **J.** Column and column foot, from below; **K.** Column and column foot, from below, anther cap removed; **L.** Column and column foot, side view; **M.** Anther cap; **N.** Pollinia. Drawn from *Hort. Tsukuba Botanical Garden* accession number 142271 by Mr. Tanucha Boonjaras.

3. *Dendrobium sanderae* Rolfe, Gard. Chron., 45, ser. 3: 374. 1909. Type: cult. *Sanders s.n.* (holotype K!), location unknown, probably the Philippines. Fig. 5.42; Pl. 7: H.

KEY TO THE VARIETIES

- 1-a. Mentum very narrowly conical or ovipositor-shaped mentum.2.
 1-b. Mentum narrowly conical.4.
 2-a. Side lobes of the labellum surround the column.3.
 2-b. Side lobes of the labellum not reach together, not surround the column.
c. **var. luzonicum**
 3-a. Mid-lobe of the labellum without claw.a. **var. sanderae**
 3-b. Mid-lobe of the labellum with claw. b. **var. parviflorum**
 4-a. Margin of petals crisped.d. **var. surigaense**
 4-b. Margin of petals entire, not crisped. e. **var. major**

a. **var. sanderae**

Flowering shoots erect, cylindrical, ca. 50 cm tall, can reach over 1 m tall, internodes 3-3.5 cm long, 1-1.3 mm in diameter, leafy throughout. *Leaves* close distichous, the opposite leaves usually imbricate, especially the leaves at upper part of stem, spreading, stiff, coriaceous, both surfaces glabrous, mid-vein grooved above and ribbed below, oblong-lanceolate, apex unequally bi-lobed, each lobe obtuse, 5.4-7 cm long, 1.4-2 cm wide; leaf-sheaths glabrous, green or light green, ca. 2.5 cm long. *Inflorescences* abbreviated, 2- to 4-flowered, emerging from the base of the leaf-sheaths opposite the blades along the upper portion of the stem; peduncle and rachis ca. 1.6-2 cm long. *Flowers* resupinate, papery, 4.5-5 cm in diameter; sepals and petals white; mentum pale purple from out side; labellum white, claw light green, with a few purple lines, side lobes white or pale green, with dark purple veins along each side lobe, disc light green with dark purple lines, mid-lobe white; pedicellate ovary light green.

Sepals spreading, recurved, with obvious keel on abaxial surface, continuing to the pedicellate ovary, margin entire; dorsal sepal lanceolate or oblong-lanceolate, apex acuminate, base truncate, 5- to 7-veined, 2.8-3.1 cm long, 0.8-1.1 cm wide; lateral sepals obliquely triangular-oblong or obliquely triangular-lanceolate, apex acuminate, base obliquely truncate, 5- to 7-veined, posterior margin 3-3.5 cm long, anterior margin 4.5-4.9 cm long, ca. 1 cm wide at base, c. 0.4 cm wide at apex. *Mentum* very narrowly conical, ovipositor-shaped, straight, apex obtuse, 1.7-2.2 cm long, ca. 0.4 cm in diameter. *Petals* spreading, broadly obovate, apex obtuse, base truncate, margin entire or slightly undulate, 7- to 9-veined, 3.4-3.7 cm long, 2-2.3 cm wide. *Labellum* 3-lobed, without callus, 4.7-5.2 cm long, 2.8-3.1 cm wide across side lobes; claw narrowly triangular, ca. 1.3 cm long; side lobes obliquely triangular-oblong, apex obtuse to truncate, margin entire; disc smooth, oblong; mid-lobe broadly ovate, without claw, apex emarginate, margins crenate, 1.8-2.2 cm long, 2-2.6 cm wide. *Column* surface smooth, 0.5-0.6 cm long, ca. 0.7 cm wide at base; foot concave, surface smooth, 18-21 mm long, 8-10 mm wide at middle; stigmatic cavity circular or widely elliptic; stelia triangular; connective narrowly triangular or linear; anther cap and pollinia not seen. *Ovary* (including pedicel) clavate, curved, triangular in cross-section, with 3 distinctly keels, continued from the abaxial surface of sepal, 3.2-3.8 cm long. *Capsule* not seen.

DISTRIBUTION. — The Philippines.

HABITAT AND ECOLOGY. — Epiphytes, found at 1,000-1,500 m alt.

SPECIMENS EXAMINED. — PHILIPPINES: Cult. Hort. Kew. s.n. (K), Aug. 1909; Cult. Hort. Kew. s.n. (K); Cult. Sanders s.n. (K), May 1909; Father M. V. Vanoverbergh 1263 (BM, K), Luzon, Bontoc Subprovince, 22 June 1911; Father M. V. Vanoverbergh 3112 (BM, K), Luzon, Bontoc Subprovince, 1,600 m alt.; D. Tiu s.n. (K), Manila, 17 Sep. 1997.

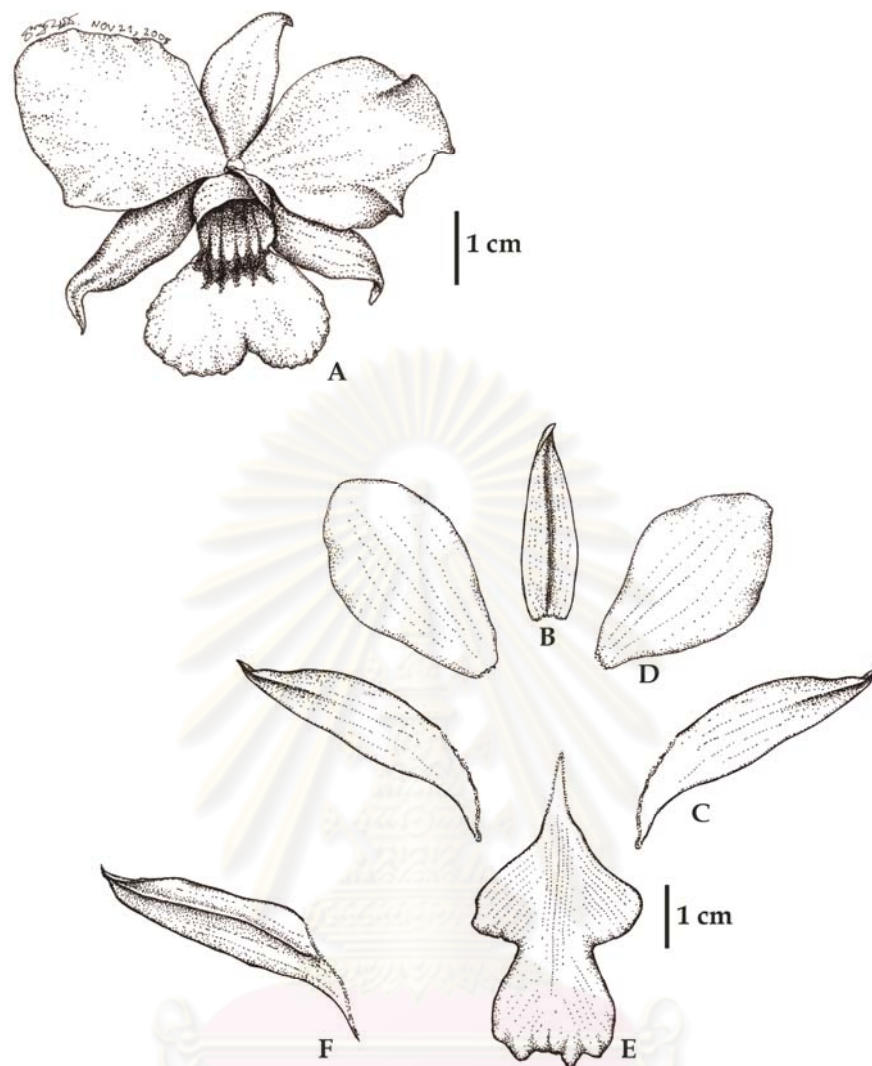


FIGURE 5.42. *Dendrobium sanderae* Rolfe **A.** Flower, front view; **B.** Dorsal sepal, abaxial surface; **C.** Lateral sepal, adaxial surface; **D.** Petal, adaxial surface; **E.** Labellum; **F.** Lateral sepal, abaxial surface. Drawn from cult. *Sanders s.n.* (holotype) by Mr. Tanucha Boonjaras.

b. var. parviflorum Anschutz ex Quisumb., Philipp. Orchid Rev. 2: 3 (1949).
Type: *Celestino* 5,401 (holotype PHN; isotype AMES!), the Philippines, Polis Mountain, Lozon Island, May 1948. Fig. 5.43; Pl. 7: J.

Flowers smaller than *Dendrobium sanderae* var. *sanderae*, up to 4 cm in diameter. Labellum narrower. Mid-lobe of the labellum clawed. Claw ca. 0.5 cm long.

DISTRIBUTION. – The Philippines.

HABITAT AND ECOLOGY – Unknown.

SPECIMENS EXAMINED. – PHILIPPINES: *M. Celestino* 5,410 (AMES), Lozon Island, Mt. Polis, 27 May 1948; *E. Quisumbing* 84,543 (AMES), Banguet.



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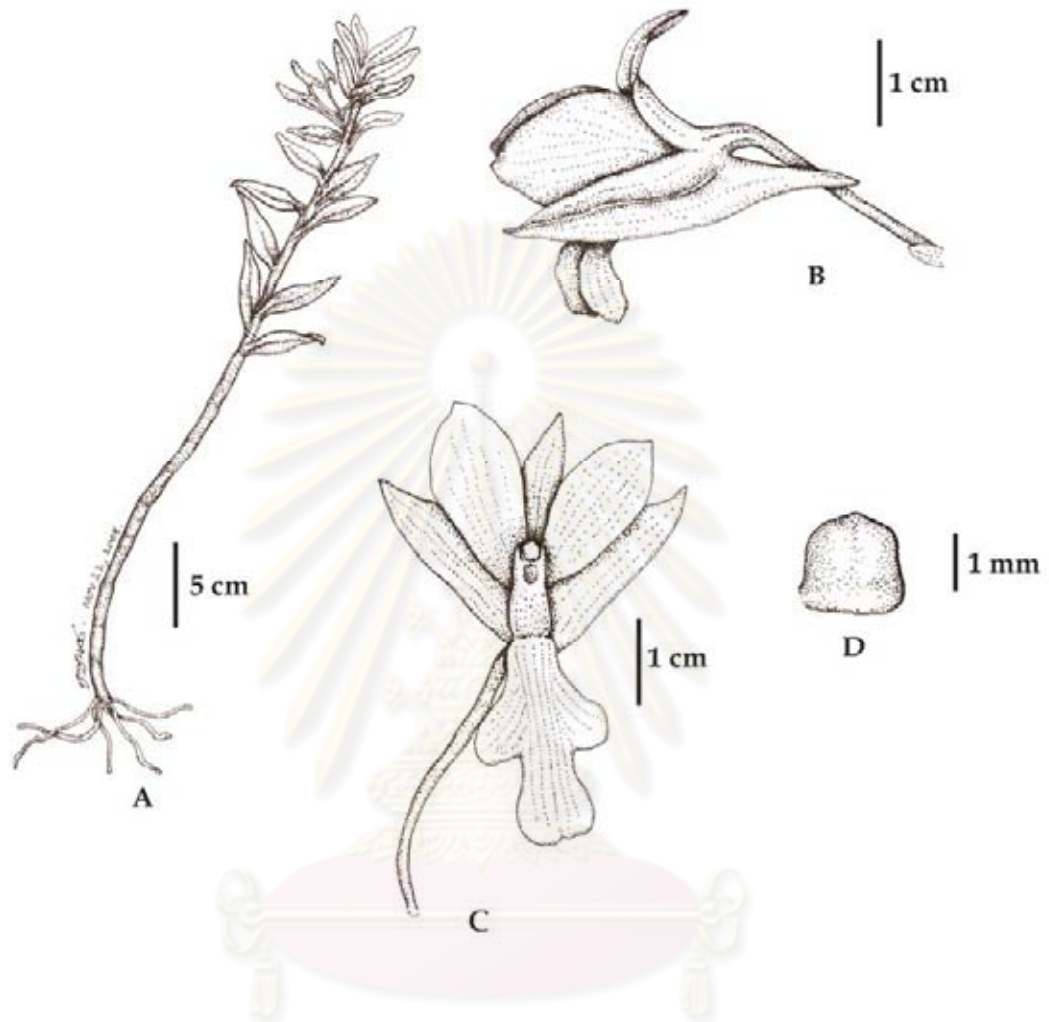


FIGURE 5.43. *Dendrobium sanderae* Rolfe var. *parviflorum* Anshuetz ex Quisumb. **A.** Habit; **B.** Flower, side view; **C.** Flower, front view; **D.** Anther cap. Drawn from *Celestino* 5,401 (isotype) by Mr. Tanucha Boonjaras.

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c. **var. luzonicum** D.A. Tiu ex A. Sathapattayanon, T. Yukawa & T. Seelanan. Type: *Hort. Tsukuba Botanical Garden accession number 120,510* (holotype TNS!; isotype BCU!), the Philippines, sine loc. Fig. 5.44; Pl. 7: G.

Dendrobium sanderae var. *luzonicum* D.A. Tiu, *Waling-Waling Review*. 5(2): 30. 1997. nom. nud.

Latin Description: *Dendrobium sanderae* var. *sanderae* Rolfe affine, sed lateralis lobus labelli plus parvus.

Inflorescence 3-to 5- flowered, up to 10-flowered. Side lobes of the labellum small, erect, not surround the column, each side lobe not reach together. The width across side lobes is narrower than the width across mid-lobe.

DISTRIBUTION. – The Philippines.

HABITAT AND ECOLOGY. – Unknown.

SPECIMENS EXAMINED. – PHILIPPINES: A. Sathapattayanon 438 (BCU), sine. loc., 18 Oct. 2006; sine coll. TBG 120509 (TNS), 26 July 2007; sine coll. TBG 120510 (TNS), 28 May 2007.

NOTE – The first publication of *D. sanderae* var. *luzonicum* is invalid. I'm now validating this name by giving the Latin description and assigning the holotype specimen.

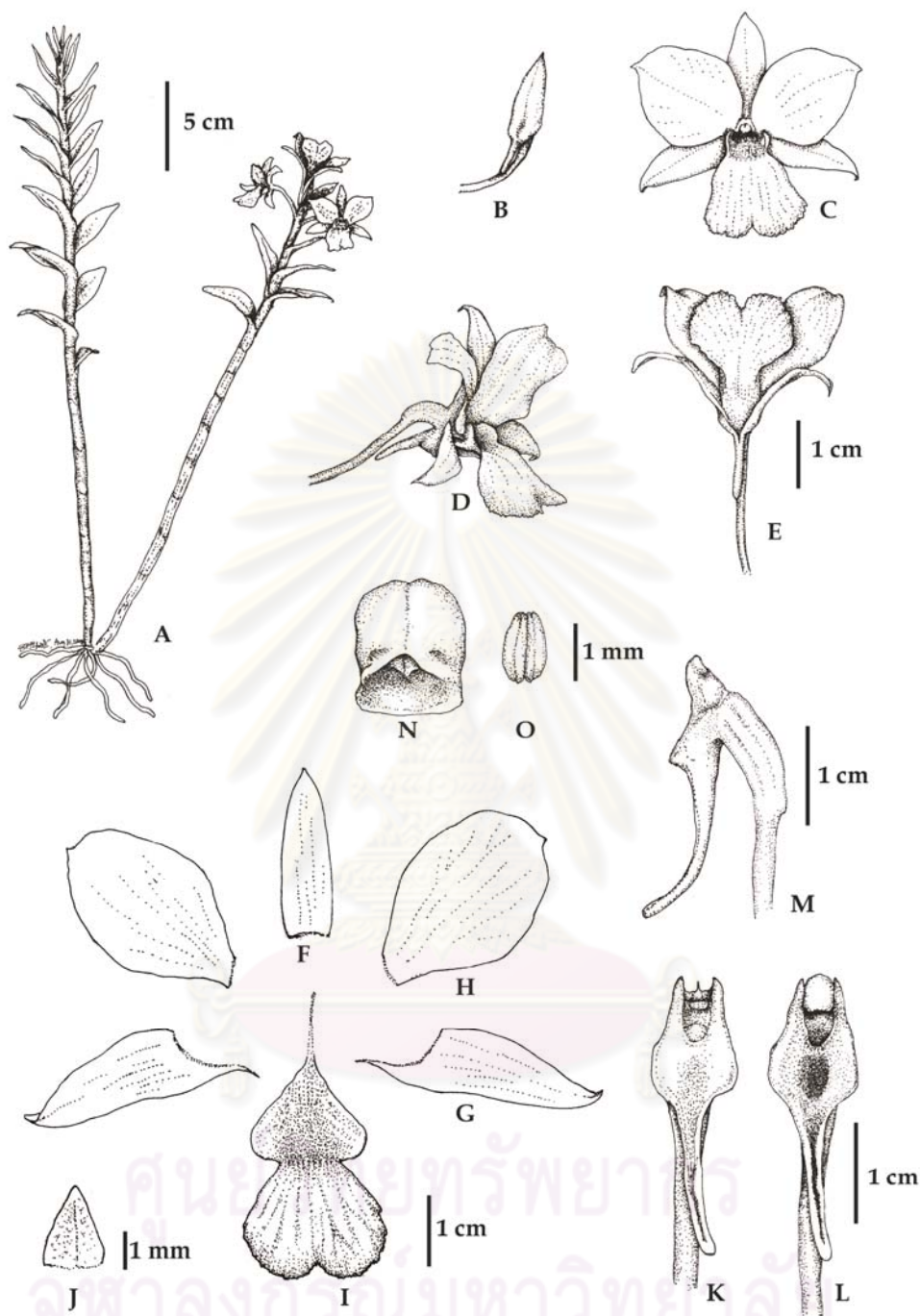


FIGURE 5.44. *Dendrobium sanderae* Rolfe var. *luzonicum* D.A. Tiu ex A. Sathapattayanon, T. Yukawa & T. Seelanan **A.** Habit; **B.** Flower bud, side view; **C.** Flower, front view; **D.** Flower, side view; **E.** Flower, from below; **F.** Dorsal sepal; **G.** Lateral sepal; **H.** Petal; **I.** Labellum; **J.** Floral bract; **K.** Column and column foot, from below, anther cap removed; **L.** Column and column foot, from below; **M.** Column and column foot, side view; **N.** Anther cap; **O.** Pollinia. Drawn from *Hort. Tsukuba Botanical Garden accession number 120,510* (holotype) by Mr. Tanucha Boonjaras.

d. var. surigaense Quisumb., Philipp. Orchid Rev. 4: 2 (1951). Type: cult. *Leon (Lϕjtnant PNH 1,388.) s.n.* (holotype PHN; isotype AMES!), the Philippines, Surigao, 13 February 1951. Fig. 5.45; Pl. 7: K.

Dendrobium suriganese (Quisumb.) H.P. Wood, The Dendrobiums: 704. 2006.

Flowering shoots erect, cylindrical, green or light green, 20-50 cm tall, internodes 3-4.3 cm long, 2.5-3 mm in diameter at the base, 4-6 mm in diameter above, leafy throughout. **Leaves** close distichous, the opposite leaves usually imbricate, especially the leaves at upper part of stem, spreading, coriaceous, both surfaces glabrous, mid-vein grooved above and ribbed below, green or dark green, oblong-lanceolate to linear-lanceolate, apex unequally bi-lobed, each lobe minutely obtuse, 5-9 cm long, 1.4-2.2 cm wide; leaf-sheaths glabrous, green or light green, 2.5-3.5 cm long. **Inflorescences** abbreviated, 1- to 2-flowered, emerging from the base of the leaf-sheaths opposite the blades along the upper portion of the stem; peduncle and rachis up to 5 cm long. **Flowers** resupinate, papyraceous, 4.3-4.9 cm in diameter; sepals and petals white; mentum light green from out side; labellum white, claw light green, with a few purple lines, side lobes white or pale green, with dark purple veins along each side lobe, disc light green with dark purple lines at distal part, mid-lobe white; pedicellate ovary light green. **Sepals** spreading, recurved, with or without obscured keel on abaxial surface, margin entire; dorsal sepal ovate or oblong-ovate, apex acute, apiculate, base truncate, 7- to 9-veined, 2.7-3.2 cm long, 1.5-2 cm wide; lateral sepals obliquely triangular-ovate, apex acute or acuminate, apiculate, base obliquely truncate, 7- to 9-veined, posterior margin 3.2-3.7 cm long, anterior margin 5-5.9 cm long, 1.6-2.1 cm wide at base, *c.* 0.5 cm wide at apex. **Mentum** shortly conical, apex obtuse, 2-2.7 cm long, *ca.* 0.3 cm in diameter. **Petals** spreading, strongly recurved, ovate, apex obtuse and apiculate, base truncate, upper half margin undulate, lower half margin entire, 5- to 7-veined, 3.6-4.3 cm long, 1.7-2.6 cm wide. **Labellum** 3-lobed, without callus, 5.4-6.5 cm long, 3.4-4 cm wide across

side lobes; claw narrowly triangular, 1.5-2 cm long; side lobes erect, surround the column, each side lobe reach together, obliquely oblong, apex obtuse to truncate, front margin erose or crenulate, later margin entire; disc smooth, oblong; mid-lobe very widely ovate, apex emarginate, apiculate, margins serrulate, strongly crisped, 1.9-3.2 cm long, 3.5-4.1 cm wide. **Column** surface smooth, 0.5-0.8 cm long, ca. 0.7 cm wide at base; foot concave, surface smooth, 20-26 mm long, 9-12 mm wide at middle; stigmatic cavity circular or widely elliptic; stelidia triangular; connective narrowly triangular or linear; anther cap subquadrate or widely obovate-oblong, surface minutely papillose, apex rounded or slightly retuse, basal margin minutely ciliate, adaxial surface sulcate, ca. 4 mm long, 3.5-4 mm wide; pollinia 4, in 2 pairs, each pollinium narrowly elliptic, without caudicle and visidium. **Ovary** (including pedicel) triangulate, curved, 6-grooved, 6.1-6.9 cm long. **Capsule** not seen.

DISTRIBUTION. – Indonesia and the Philippines.

HABITAT AND ECOLOGY. – Unknown.

SPECIMENS EXAMINED. – INDONESIA: *P. Smithers* 13150 (K), Borneo, 23 Apr. 1970.

PHILIPPINES: *E. Quisumbing* 13882 AMES 090349 (AMES), From Garden of Mrs. E. de Leon Broadway, Quezon city but actually from Surigao, 13 Feb. 1951; *E. Quisumbing* 13882 AMES 090350 (AMES), Mindanao, Surigao (northeastern of Mindanao), Feb. 1951; *J. & C. Hermans* 1194 (K), sine loc.; *Sine coll. s.n.* (TNS), sine loc.

NOTE – This variety differ from *Dendrobium sanderae* var. *sanderae* in having shortly conical mentum, not ovipositor-shape as in var. *sandederae*, var. *parviflorum* and var. *luzonicum*. H.P. Wood (2006) separated it as *D. surigaense*. However, both

of the morphological characters and the molecular data show that var. *surigaense* is the closely related species to *D. sanderae*. Therefore, I retained it as the variety of *D. sanderae*.

I'm giving the full description here for comparing the differences between *D. sanderae* var. *surigaense* and each variety.

The future study of *Dendrobium sanderae* complex based on morphology and molecular data from more plant materials are needed to resolve this species complex.



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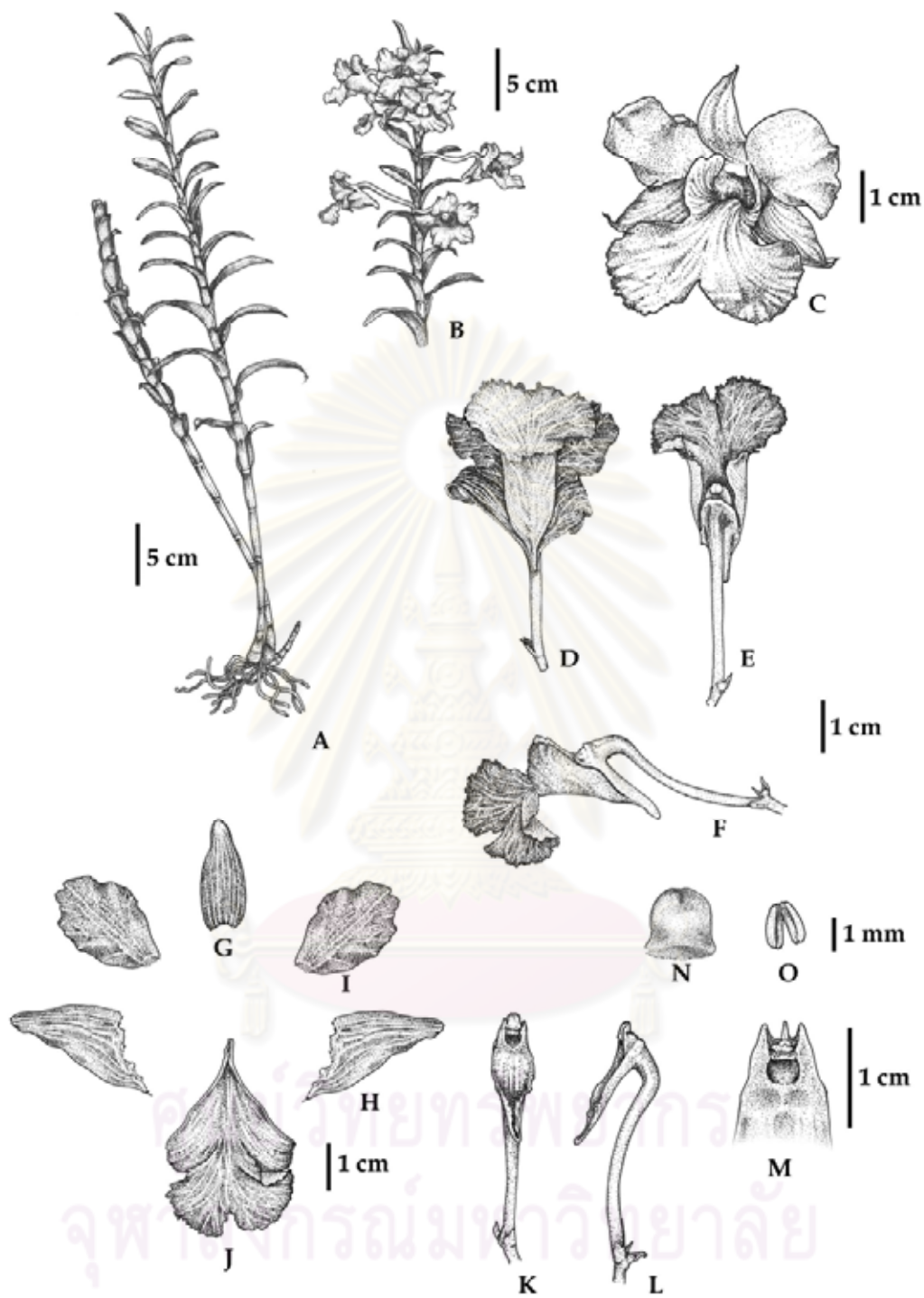


FIGURE 5.45. *Dendrobium sanderae* Rolfe var. *surigaense* Quisumb. **A.** Habit; **B.** Flowering shoot; **C.** Flower, front view; **D.** Flower, from below; **E.** Flower, from above; **F.** Flower, side view; **G.** Dorsal sepal; **H.** Lateral sepal; **I.** Petal; **J.** Labellum; **K.** Column and column foot, from below; **L.** Column and column foot, side view; **M.** Column, from below, anther cap removed; **N.** Anther cap; **O.** Pollinia. Drawn from cult. *Leon* (*Lcjtntant* PNH 1,388.) *s.n.* (isotype) by Ms. Sirilax Tapdechachan.

e. **var. major** J.H. Miller ex A. Sathapattayanon, T. Yukawa & T. Seelanan. Type: Hort. Tsukuba Botanical Garden accession number 120,503 (holotype TNS!; isotype BCU!), the Philippines, sine loc. Fig. 5.46; Pl. 7: I.

Dendrobium sanderae var. *major* J.H. Miller, Orchid J. 3: 113 (1954). nom. nud.; H.P. Wood, The Dendrobiums 690. 2006.

Latin Description: *Dendrobium sanderae* var. *surigaense* Quisumb. affine, sed petalis margo crispus.

The variety most closely related to *D. sanderae* var. *suriganense*. They differ in margin of petals. The var. *major* has entire margin while var. *surigaense* has crisped margin. Moreover, the plant of var. *major* has thicker stem, larger flowers and darker purple lines on the labellum.

DISTRIBUTION. – The Philippines.

HABITAT AND ECOLOGY. – Unkonwn.

SPECIMENS EXAMINED. – PHILIPPINES: Cult. Hort. Kew. Accession No. 2002-2701 (K), 08 Feb. 2007; sine coll. TBG 120504 (TNS), 26 May 2007 (06 June 2007).

NOTE – The first publication of *D. sanderae* var. *major* is invalid. I'm now validating this name by giving the Latin description and assigning the holotype specimen.

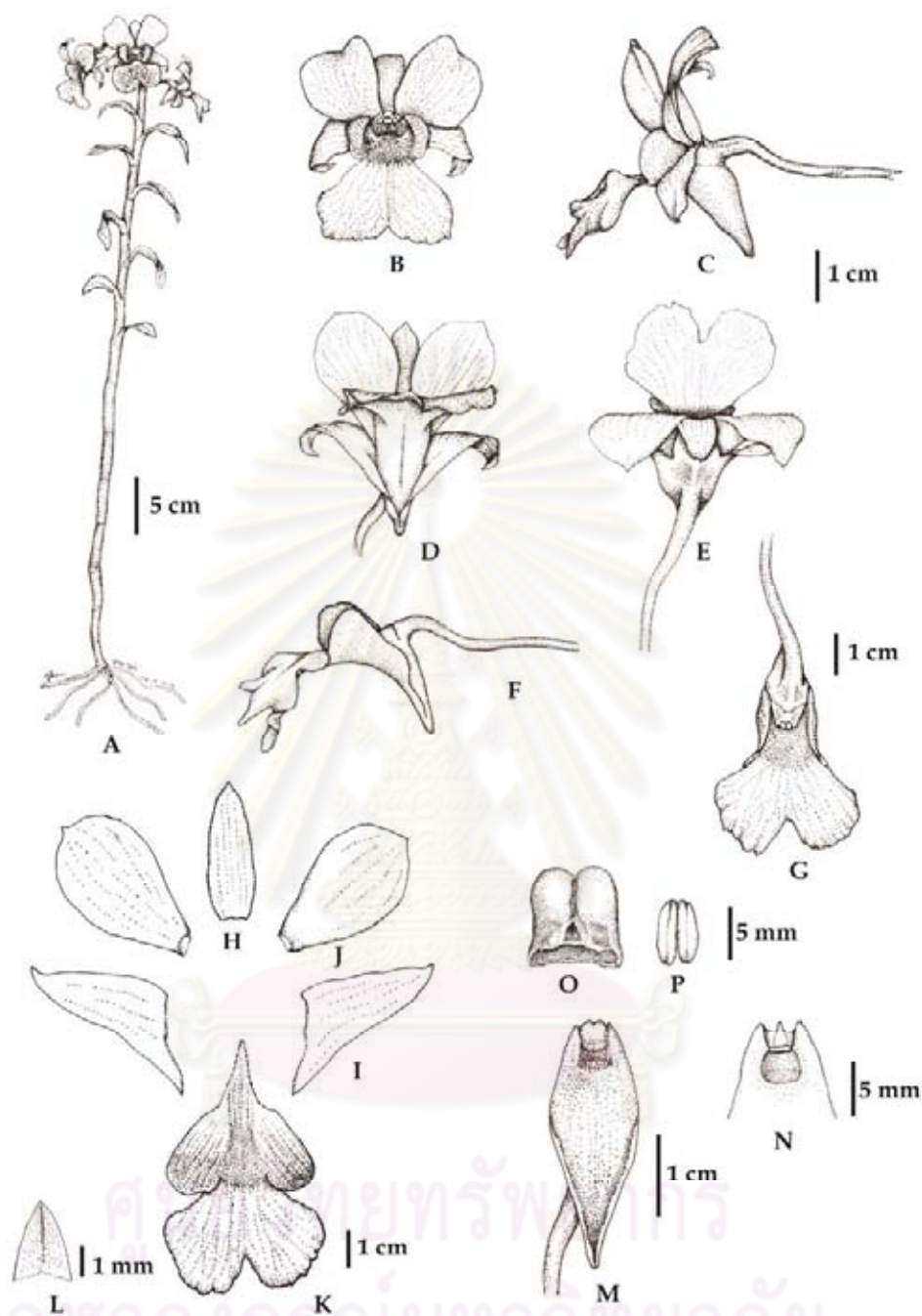


FIGURE 5.46. *Dendrobium sanderae* Rolfe var. *major* J.H. Miller ex A. Sathapattayanon, T. Yukawa & T. Seelanan **A.** Habit; **B.** Flower, front view; **C.** Flower, side view; **D.** Flower, from below; **E.** Flower, from above; **F.** Labellum and mentum, side view, sepals and petals removed; **G.** Labellum and mentum, from above, sepals and petals removed; **H.** Dorsal sepal; **I.** Lateral sepal; **J.** Petal; **K.** Labellum; **L.** Floral bract; **M.** Column and column foot, from below; **N.** Column, from below, anther cap removed; **O.** Anther cap; **P.** Pollinia. Drawn from *Hort. Tsukuba Botanical Garden accession number 120,503* (holotype) by Mr. Tanucha Boonjaras.

4. **Dendrobium schuetzei** Rolfe, Orchid Rev. 19: 224. 1911. Type: *Schütze s.n.* (holotype K!), The Philippines, locality unknown. Fig. 5.47; Pl. 7: L.

Flowering shoots clustered, erect, cylindrical, sulcate, green or brownish green, up to 18-25 cm tall, up to 30 cm tall, internodes 1.8-2.3 cm long, 1-1.5 cm in diameter, leafy along the upper half of stem. *Leaves* close distichous, the opposite leaves usually imbricate, especially the leaves at upper part of stem, spreading, stiff, coriaceous, both surfaces glabrous, mid-vein grooved above and ribbed below, green, ovate-oblong or oblong, apex unequally bi-lobed, each lobe obtuse or subacute, 5.3-6.2 cm long, 1.5-2 cm wide; leaf-sheaths glabrous, green or brownish green, 2-4 cm long. *Inflorescences* abbreviated, 1- to 4-flowered, usually 2-flowered, borne along of the upper part of stem, emerging through base of leaf-sheath opposite blade; peduncle and rachis glabrous, green, 0.5-0.7 cm long; floral bracts glabrous, pale brown, triangular-ovate, apex obtuse to acute, base truncate, 0.2-0.4 cm long. *Flowers* resupinate, papyraceous, veins visible, long-lasting, 7.7-8.3 cm in diameter; sepals and petals white; mentum white or greenish white from outside; sepals and petals white; mentum white or greenish white from outside; labellum white, with light green blotch at central area, claw light green with purple lines, side lobes white, disc white, apical half light green, mid-lobe white; column white, foot white, with flushed green at apical part, stigmatic cavity white, anther-cap white, pollinia yellow, pedicellate ovary white to greenish white. *Sepals* spreading, somewhat recurved distally, margin entire, abaxial surface keeled; dorsal sepal ovate to ovate-oblong, apex acuminate, base truncate, 5- to 7-veined, 3.7-4.4 cm long, 1.1-1.4 cm wide; lateral sepals obliquely triangular-ovate, apex acuminate, base obliquely truncate, 7- to 9-veined, posterior margin 4-4.2 cm long, anterior margin 4.1-4.4 cm long, ca. 2 cm wide at base, c. 0.4 cm wide at apex. *Mentum* broadly conical, saccate, apex obtuse, 1.2-1.5 cm long, ca. 1 cm in diameter. *Petals* spreading, slightly recurved, broadly ovate, apex obtuse, apiculate, base truncate, upper half margin slightly undulate, lower half margin entire, 7- to 12-veined, 4.7-5.5 cm long, 4-4.5 cm

wide. *Labellum* 3-lobed, without callus, 4.7-5.3 cm long, 3.8-4.2 cm wide across side lobes; claw ca. 0.3 cm long; side lobes obliquely triangular-elliptic, apex rounded, front margin subentire or weakly undulate, later margin entire; disc smooth, slightly thickened at middle, oblong; mid-lobe oblate to widely depressed ovate, apex truncate or retuse, apiculate, margins crenulated, 2.3-2.7 cm long, 3.2-3.7 cm wide. *Column* surface smooth, 0.5-0.8 cm long, ca. 0.8 cm wide at base; foot broad, slightly concave, surface smooth, 19-24 mm long, 6-8 mm wide at entrance to mentum; stigmatic cavity circular or oblate; stelia triangular; connective narrowly triangular; anther cap obovate-oblong, surface minutely papillose, apex emarginate, basal margin entire, adaxial surface sulcate, 3-3.4 mm long, 2.9-3.1 mm wide; pollinia 4, in 2 pairs, each pollinium narrowly elliptic, without caudicle and visidium. *Ovary* (including pedicel) curved, glabrous, triangular in cross-section, obtusely 3-keeled, 6-grooved, 6.3-7.5 cm long. *Capsule* not seen.

DISTRIBUTION. — The Philippines.

HABITAT AND ECOLOGY. — Unknown.

SPECIMENS EXAMINED. — PHILIPPINES: Cult. Hort. Kew. Entry No. 129-1964 (K), 25 Mar. 1965; Cult. Hort. Kew. s.n. (K), Oct. 1912; Cult. Sanders s.n. (K), Dec. 1914; Schütze s.n. (K), Manila; sine coll. s.n. (TNS), 13 May 2007.

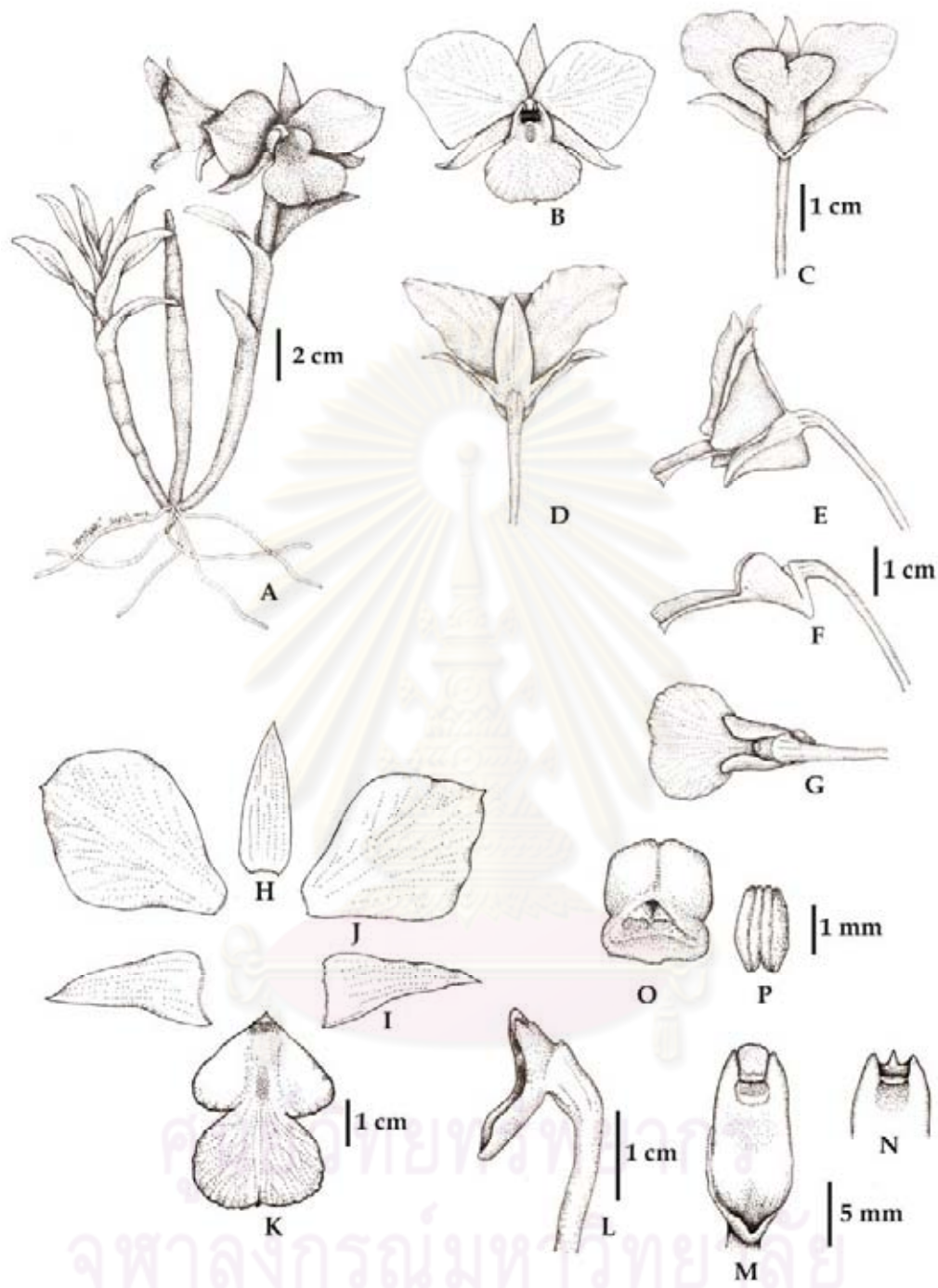


FIGURE 5.47. *Dendrobium schuetzei* Rolfe **A.** Habit; **B.** Flower, front view; **C.** Flower, from below; **D.** Flower, from above; **E.** Flower, side view; **F.** Labellum and mentum, side view, sepals and petals removed; **G.** Labellum and mentum, from above, sepals and petals removed; **H.** Dorsal sepal; **I.** Lateral sepal; **J.** Petal; **K.** Labellum; **L.** Column and column foot, side view; **M.** Column and column foot, from below; **N.** Column, from below, anther cap removed; **O.** Anther cap; **P.** Pollinia. Drawn from *Hort. Tsukuba Botanical Garden accession number 119,088* by Mr. Tanucha Boonjaras.

UNPLACED SPECIES

1. *Dendrobium jerdonianum* Wight, Icon. Pl. Ind. Or. 5: 6, t. 1644. 1851.; Hook.f., Flora British India 5: 734. 1888.; Rchb.f., Gard. Chron. 1868: 866. 1868.; C.S. Kumar & K.S. Manilal, Orchids of Kerala India, in K.S. Manilal & C.S. Kumar (eds.), Orchid Memories: 179. 2004. Type: *Jerdon s.n.* (syntype K!), Southern India, Karnataka State, Coorg (nowadays Kodagu district); *Jerdon s.n.* (syntype K!), South India, Tamil Nadu State, Iyamally Hills. Fig. 5.48; Pl. 7: C.

Dendrobium nutans Lindl., Gen. Sp. Orchid. Pl.: 90. 1830.; Hook.f., Flora British India 5: 734. 1888.; T.K. Bose & S.K. Bhattacharjee, Orchids of India: 224. 1980. Type: *Macrae s.n.* (holotype K! in Lindley collection), Sri Lanka, Peradeniya, 1829.

Dendrobium nutans var. *rubrolabris* Blatter, J. Bombay Nat. Hist. 32:518. 1928. Type: *Blatter&Hallberg 335; Blatter&Hallberg 25,808* (syntype K!), South India, Theni district, Tamil Nadu State, High Wavy Mountains or also called Meghamalai Mountains, May 1917.

Dendrobium villosulum Lindl., Paxton's Fl. Gard. 2: 82. 1851., nom. illeg. Type: cult. *Loddiges 355* (holotype K! in Lindley collection) Kerala, South India, Kerala State, Kannur district, Tellicherry, also known as Thalassery, May 1851.

Dendrobium nutantiflorum A.D. Hawkes & A.H. Heller, Lloydia 20: 122. 1957.; C.S. Kumar and K.S. Manilal, Orchids of Kerala India, in K.S. Manilal and C.S. Kumar (eds.), Orchid Memories: 180. 2004.; H.P. Wood, The Dendrobiums: 668. 2006. nom. illeg.

Callista jerdoniana (Wight) Kuntze, Revis. Gen. Pl. 2: 655. 1891.

Callista nutans (Lindl.) Kuntze, Revis. Gen. Pl. 2: 655. 1891.

Conchidium jerdonianum (Wight) Rauschert, Feddes Repert. 94: 444. 1983.

Flowering shoots erect, slender, fractiflex distally, slightly constricted at nodes, sulcate, 7-28 cm tall, internodes 1.4-1.7 cm long, 0.4-0.8 cm in diameter, leafy along upper part of stem. *Leaves* distichous, spreading, coriaceous, mid-vein grooved above and ribbed below, both surfaces particularly covered with black hirsute hairs, linear-lanceolate or linear-oblong, apex unequally bi-lobed, each lobe acute or obtuse, 2.4-5.1 cm long, 0.5-0.8 cm wide; leaf-sheaths covered with black hairs, 1-1.6 cm long, sometime longer than internodes. *Inflorescences* racemose, 2- to 3-flowered, up to 5-flowered, borne from nodes at the uppermost of both leafy and leafless stems; peduncle ca. 0.2-0.3 cm long, rachis 0.5-0.8 cm long, glabrous; floral bracts ovate, abaxial surface densely covered with dense black hairs, adaxial surface glabrous, apex acute, base truncate; bracteoles thin, both surfaces glabrous, triangular-ovate, apex acute, base truncate, 2- to 3-veined, hardly visible, ca. 0.2 cm long, ca. 0.1-0.2 cm wide. *Flowers* resupinate, 2-3 cm in diameter; sepals and petals yellow or yellowish orange. *Sepals* spreading, recurved distally, margin entire, abaxial surface without keel; dorsal sepal linear-lanceolate, apex acute, base truncate, 3- to 5-veined, 1.1-1.5 cm long, 0.2-0.4 cm wide; lateral sepals obliquely triangular-lanceolate, apex acute, base obliquely truncate, 5- to 7-veined, posterior margin 1.5-1.7 cm long, anterior margin 2-2.3 cm long, ca. 0.3 cm wide at base, ca. 0.2 cm wide at apex. *Mentum* broadly conical, saccate, apex obtuse, ca. 0.5 cm long, ca. 0.3 cm in diameter. *Petals* spreading, linear-oblong or linear-lanceolate, apex acute or obtuse, base truncate, margin entire, 5- to 7-veined, 1.2-1.5 cm long, 0.4 cm wide. *Labellum* 3-lobed, 1.5-1.7 cm long, ca. 0.5 cm wide across side lobes; claw transversely oblong, ca. 3 mm long; side lobes small, surface smooth, obliquely lanceolate, apex obtuse, margin entire; disc narrowly oblong, with 3 lamellae, each lamella continuing and expanding to mid-lobe; mid-lobe ovate to elliptic, with 3 wavy lamellae, apex acute, margin crisped, 0.8-1 cm long, 0.3-0.4 cm wide. *Column* 2-3 mm long, ca. 2 mm wide at base; foot 7-9 mm long, 2-3 mm wide at base; stigmatic cavity widely elliptic or circular; stamens triangular; connective narrowly triangular; anther cap widely obovate, surface smooth, adaxial side sulcate, apex retuse, basal margin

minutely ciliate, 0.8-0.9 mm long, 0.8-0.9 mm wide; pollinia 4, in 2 pairs, each pollinium narrowly elliptic, without caudicle and visidium. *Ovary* (including pedicel) narrowly clavate, 1.4-1.8 cm long. *Capsule* dehiscent, ovate or ovate-elliptic with 3 obtuse keels, apex bunt with persistent dried perianth, 1.2-1.7 cm long, 0.5-0.7 cm wide.

DISTRIBUTION. — South India and Sri Lanka.

HABITAT AND ECOLOGY. — Epiphytic orchids, 800-2,000 m alt.

SPECIMENS EXAMINED. — INDIA: *sine coll. s.n.* (K), Travancor, Sep. 1896; *Anonymous* 569 (K), S. India, Coorg, Feb. 1896; *Barnes* 1231 (K), S. India, Nilgiris; *E. Barnes* 2126 (K), South India, Billigirirangan Hills, Eastern Ridge, 27 Apr. 1939; *E. Barnes* 2267 (K), South India, Slopes above Neouvattan Nilgiris, May 1940; *Blatter & Hallberg* 25808 (K), S. India, Nilgiris, Coorg, High Wavy Mountain, May 1917; *Blatter & Hallberg* 335 (K), S. India, Nilgiris, Coorg, High Wavy Mountain, May 1917; *T. F. Bourdillon* 802 (K), Travancor, 4,500 ft alt., 24 Mar. 1896; C.N. 2357 (BM); *Cult. Hort. Bot. Calcuttensis (Lancaster) s.n.* (BM), Feb. 1896; *J. S. Gamble* 20576 (K), Madras, Nilgiris District, 6,000 ft alt., May 1889; *Lancaster s.n.* (P), Alipur, Garden of Agri-Hort Soc., Feb. 1896; *sine coll. s.n.* (BCU); *Wight s.n.* (BM); *Wight s.n.* (K), Jerdon, Coorg Jungles; *Wynaud* 8127 (BM).

SRI LANGKA: C. N. 2357 P00408056 (P), 1867 A.D.; C. N. 2357 P00408057 (P), 1868 A.D.; *Kostermans* 23089a (L), Elk Plains, 1,600 m alt., 09 Apr. 1969; *Kostermans s.n.* (L), Elk Plains near Ambawela, 1,800 m alt., May 1969; *Macrae s.n.* (K), 1829 A.D.; *Martii* 2357 (BR), 1868 A.D.; *Kostermans* 23089a (L), Elk Plains, 1,600 m alt., 9 April 1969; *Kostermans* (L), Elk Plains near Ambawela, 1,800 m alt., May 1969.

LOCALITY UNKNOWN: *Trevor Lawrence s.n.* (BR), 15 July 1901; *Trevor Lawrence s.n.* (BR), 22 Apr. 1902; *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 32365

(W); *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 32367 (W), January 1847; *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 32366 (W); *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 4447 (W); *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 32349 (W); *Sine coll. s.n.* Reichb.f. Orchids Herb. no. 32351 (W).

NOTE. — Lindley (1830) described the plant, collected by Macrae, from Sri Lanka. He named it as *Dendrobium nutans*. However, this being the homonym of *D. nutans* C. Presl (1827), which is the synonym of *Geodorum densiflorum* (Lam.) Schltr.

In 1851, Wight described *Dendrobium jerdonianum* based on Jerdon's collections from Karnataka State (*Jerdon s.n.*) and Tamil Nadu State (*Jerdon s.n.*) of south India. He mentioned that these syntype specimens of *D. jerdonianum* are different in only size of flowers, but they are same in long narrow form and colour. He considered them as the variation of the plant.

Reichenbach (1868) united *D. nutans* of Lindley and *D. jerdonianum* while Hooker (1888) maintained the two species. Hooker noted that *D. jerdonianum* has more robust and larger flowers, and broader leaves.

I agree with Wight and Reichenbach that *D. nutans* and *D. jerdonianum* represent the same taxon and they be united to one species. The flower's form the shape of sepals and petals and the detail on labellum of both species are identical. Only few differences are the size of plants and flowers.

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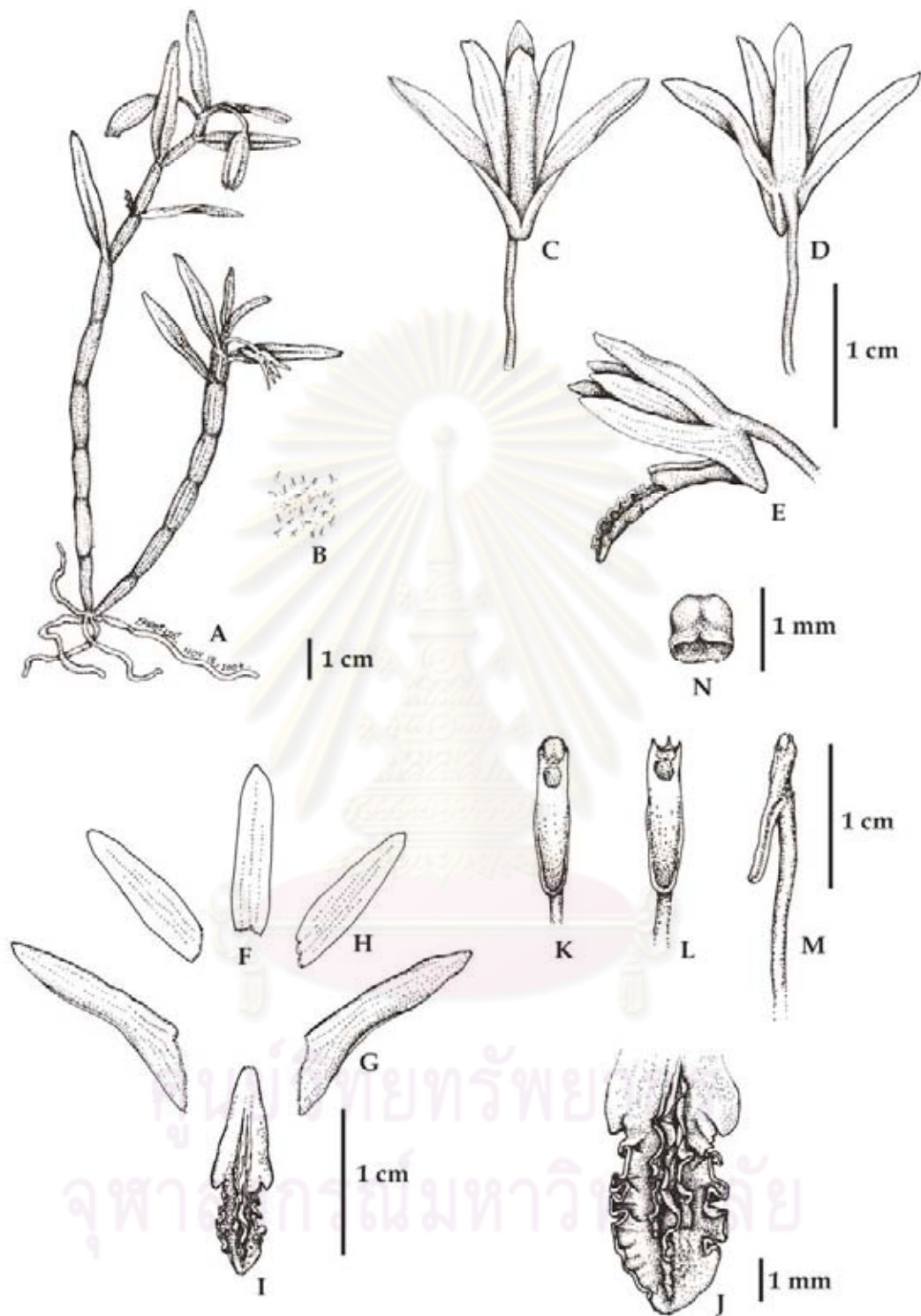


FIGURE 5.48. *Dendrobium jerdonianum* Wight **A.** Habit; **B.** Hairs, on leaf; **C.** Flower, from below; **D.** Flower, from above; **E.** Flower, side view; **F.** Dorsal sepal; **G.** Lateral sepal; **H.** Petal; **I.** Labellum; **J.** Mid-lobe of labellum; **K.** Column and column foot, from below; **L.** Column and column foot, from below, anther cap removed; **M.** Column and column foot, side view; **N.** Anther cap. Drawn from *Lancaster s.n.* by Mr. Tanucha Boonjaras.

2. *Dendrobium trigonopus* Rchb. f. in Gard. Chron. 1887(2): 682. 1887; Thaithong, Thai Orchid: 229. 2000. Type: cult. *Low s.n.* (holotype W!), Myanmar, precise locality unknown. Fig. 5.49; Pl. 7: D.

Callista trigonopus (Rchb.f.) Kuntze, Revis. Gen. Pl. 2: 655. 1891.

Dendrobium velutinum Rolfe, Bull. Misc. Inform. Kew: 33. 1895. Type: cult.

Charlsworth s.n. (holotype K!), Myanmar, Shan State.

Flowering shoots erect, fusiform, slightly constricted at nodes, sulcate, greenish brown or purplish brown or grey, 4.3-6.5 cm tall, internodes 0.8-1.4 cm long, 0.8-1.4 cm in diameter, leafy at only apical part of stem. **Leaves** distichous, spreading, coriaceous, both surface of young leaves covered with dense short black hirsute hairs, mature leaves covered with sparse short black hair, becoming glabrous with aged, mid-vein grooved above and ribbed below, dull green, elliptic or oblong-elliptic, apex unequally bi-lobed, each lobe obtuse, 4.3-5.1 cm long, 0.6-1.1 cm wide; leaf-sheaths covered with short black hairs, densely near apex, 1.3-1.9 cm long. **Inflorescences** abbreviated, 1- to 3-flowered, borne on the upper portion of both leafy and leafless stems; peduncle and rachis glabrous, green, 0.3-0.6 cm long; floral bracts adpressed or slightly concave, abaxial surface covered with scattered black hirsute hairs, glabrate, adaxial surface glabrous, pale brown or grayish brown, triangular or triangular-ovate, apex acute, base truncate, 2- to 4-veined, 0.2-0.4 cm long, 0.2-0.4 cm wide. **Flowers** resupinate, hard, waxy and polished, veins obscured, sweetly scented, long-lasting, up to 5-6 weeks, up to ca. 3.5 cm in diameter; sepals, petals and mentum golden yellow; labellum golden yellow, with brownish red transverse lines sprinkle on each side lobes, central portion of mid-lobe yellowish green; column golden yellow, foot golden yellow with scattered brownish red spot, stigmatic cavity golden yellow, anther-cap golden yellow, pollinia yellow, pedicellate ovary light green. **Sepals** spreading, sometimes slightly recurved at distal part, margin entire, mid vein grooved on adaxial surfaces, veins hardly invisible, abaxial surface distinctly

keeled, continuing to pedicellate ovary; dorsal sepal lanceolate-oblong or oblong, apex acuminate, base truncate, 2.2-2.7 cm long, 0.8-1.2 cm wide; lateral sepals obliquely triangular-ovate, apex acute to acuminate, base obliquely truncate, posterior margin 2-2.5 cm long, anterior margin 2.8-3.2 cm long, 0.8-1 cm wide. *Mentum* broadly conical, short, apex obtuse, 0.3-0.6 cm long, 0.4-0.6 cm in diameter. *Petals* spreading, ovate or ovate-elliptic, apex acute, base truncate, margin entire, sometime slightly undulate, veins hardly visible, 1.8-2.4 cm long, 1-1.4 cm wide at base. *Labellum* 3-lobed, thickening, hard, veins invisible, adaxial surface with dense wart-liked callus, causing rough surface, 1.7-2.4 cm long, 1.4-1.8 cm wide across side lobes; claw transversely oblong, 0.6-1 cm long; side lobes widely obliquely oblong, apex truncate, margin erose; disc oblong with 4-5 keels, each keel bearing wart-liked callus, continuing to mid-lobe; mid-lobe depressed obovate or transversely elliptic, 4-5 keeled on median ridge with dense wart-liked callus, apex retuse, slightly conduplicate, margin erose, 0.7-1.2 cm long, 1.1-1.5 cm wide. *Column* surface smooth, 4-5 mm long, 3-4 mm wide at base; foot surface smooth, base truncate, 3-5 mm long, 3-4 mm wide at base; stigmatic cavity quadrangular, nearly same width with column; stelia triangular; connective linear or narrowly triangular; anther cap ovate, slightly bend upward at apical part, surface smooth, apex round or retuse, basal margin entire, adaxial surface sulcate, with papillose callus at base, 3-3.5 mm long, 2.3-2.7 mm wide; pollinia 4, in 2 pairs, each pollinium narrowly elliptic, without caudicle and visidium. *Ovary* (including pedicel) curved to somewhat sigmoid shape, obviously twisted, triangular in cross-section, distinctly 3-keeled along the length, 2 narrow grooves between each keel, glabrous, 2.7-3.5 cm long. *Capsule* dehiscent, green or dull green, elliptic to ovate, distinctly 3-keeled, apex with persistent dried perianth, 4.2-4.9 cm long, 1.2-1.5 cm wide.

DISTRIBUTION.— Myanmar, Thailand and Laos.

HABITAT AND ECOLOGY. — Epiphytes s in dry evergreen forest or deciduous forest, at 600-1,100 m alt. Flowering period: February-March.

VERNACULAR. — Ueang kham pka kai (เอื้องคำปากไก่), Ueang kham phu (เอื้องคำภู), Ueang kham liam (เอื้องคำเหลื่อม)

SPECIMENS EXAMINED. — MYANMAR: cult. *Charlsworth s.n.* (K), Shan State.

LAOS: *A. D. Kerr 2481* (C), Phu Khao Khauai, 1,800 m alt.; *Rondon 118* (C), Boa Khao Kwai (or Phu Khao Khauai).

THAILAND: *Collins s.n.* (K), Doi Sutep, 29 Mar. 1932; *J. B. Comber 1694* (K), 05 Mar. 1987; *Mirs Davis s.n.* (K-SPIRIT), 25 Apr. 1965; *S. Dyson & Chanderville s.n.* (K), N. Thailand, Nan Province; *GT 5900* (C), Chiang Mai, Date fl. 17 Mar. 1965; *GT 7947* (C), II. Phu Krading, Mar. 1971; *GT 8732* (C), II. Namnao National Park, 800-850 m alt., 20 Mar. 1980; *A. F. G. Kerr 89A* (K, L), Chiang Mai Province, Mae Chem District, 14 Apr. 1915; *A. F. G. Kerr 405* (P, K), Payap, Doi Pahom Pok, c. 1,200-1,500 m alt., 01 Apr. 1921; *A. F. G. Kerr 904* (BK, K, P), Loei, Kao Krading (Phu Krading), c. 1,200 m alt., 11 Feb. 1931; *A. F. G. Kerr s.n.* (K), Bangkok, 29 Feb. 1932; *M. C. Lakshnakara s.n.* (BK), Loei, Kao Krading, 4,000 ft alt., 02 Apr. 1933; *Menzies & Du Puy 65* (K-SPIRIT), Mae Hong Son Province, Pai, (ex Bangkok Market), Feb. 1983; *R. Payne s.n.* (K-SPIRIT), 29 Apr. 1981; *A. Sathapattayannon 448* (BCU), Nong Khai, Pone Pi Sai, Talad Lao (Laotian market), 06 Mar. 2007; *T. Smitinand 1084* (BKF), Loei, Phu Krading, 1,300 m alt.; *W. Songkakul 50* (BKF), Chaiyaphum, Phu Khieo, Tung Kamung, 900 m alt., 21 Mar. 1989; *S. Suvarnasuddhi 423* (BKF), Chiang Mai, Pha Mawn, 1,200 m alt., 16 Jan.; *S. Watthana 1219* (QBG), Chiang Mai, Chiang Dao, Doi Chiang Dao, Den Yaakat, ca. 1,400 m alt., 21 Mar. 2001; *S. Watthana & M. Wongnak 1898* (QBG), Mae Hong Son, Muang District, Huai Pu Loei, 1,200 m alt., 26 Mar. 2006; *Micholitz s.n.* (SING), sine loc.

LOCALITY UNKNOWN: *A. Sathapattayanon* 394 (BCU), 30 Mar. 2005; *A. Sathapattayanon* 416 (BCU), 01 Feb. 2006; *O. Thaithong* 393 (BCU), 19 Mar. 1988; *O. Thaithong* 1651 (BCU), 03 Apr. 1996; *Micholitz s.n.* (K); *sine coll.* TBG 119100 (TNS), 01 June 2007.



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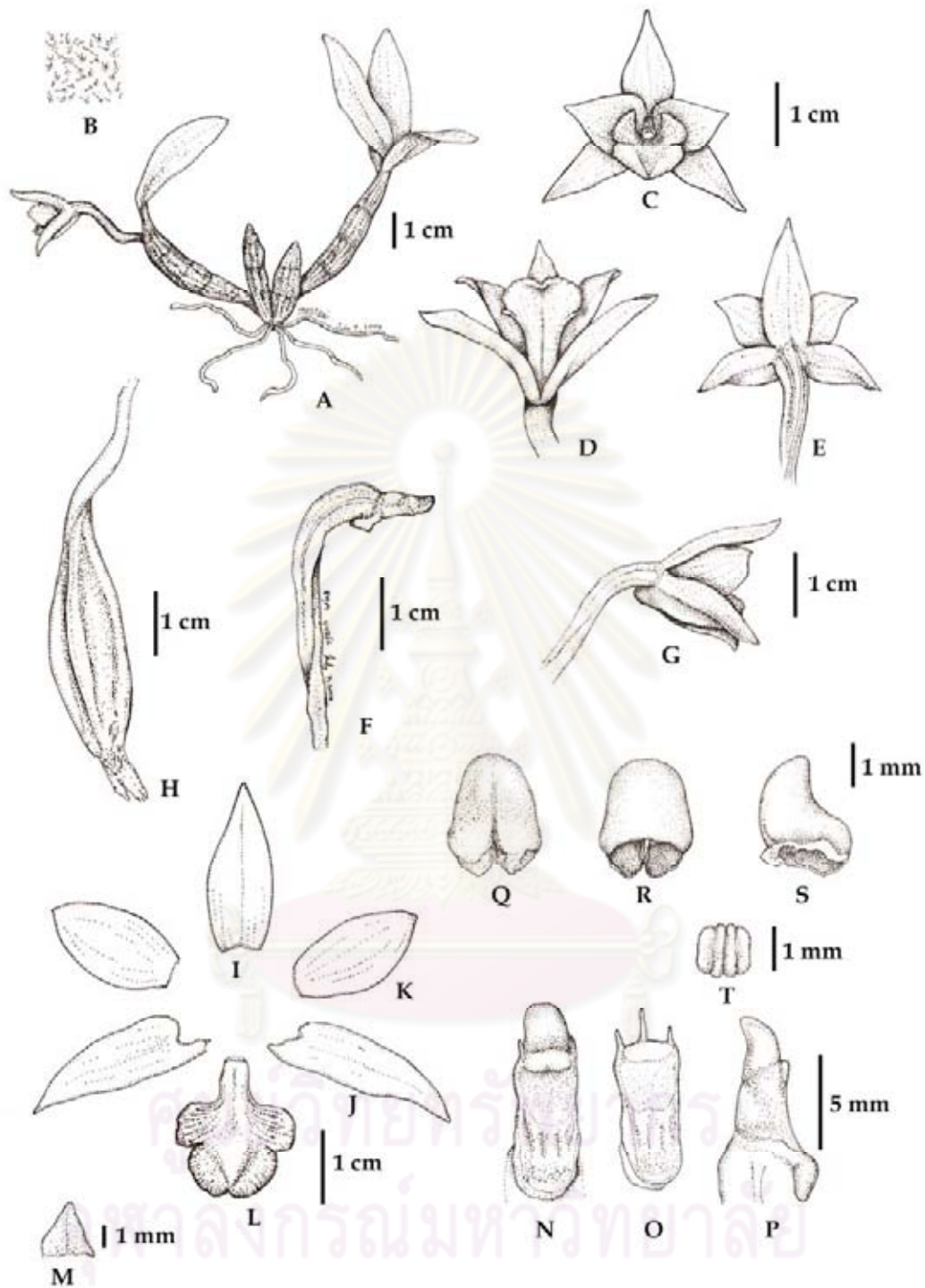


FIGURE 5.49. *Dendrobium trigonopus* Rchb.f. **A.** Habit; **B.** Hairs, on leaf; **C.** Flower, front view; **D.** Flower, from below; **E.** Flower, from above; **F.** Column, column foot and pedicellate ovary; **G.** Flower, side view; **H.** Fruit; **I.** Dorsal sepal; **J.** Lateral sepal; **K.** Petal; **L.** Labellum; **M.** Floral bract; **N.** Column, from below; **O.** Column, from below, anther cap removed; **P.** Column and column foot, side view; **Q.** Anther cap, back view; **R.** Anther cap, front view; **S.** Anther cap, side view; **T.** Pollinia. Drawn from A. Sathapattayanon 394 by Mr. Tanucha Boonjaras.

5.4 Discussions and Conclusion

5.4.1 Enlisted species of section *Formosae* of Thailand

The most important of taxonomic work on Asiatic orchids are the series of Orchid Genera in Thailand, which are still the most usable framework for identification. The section *Formosae* was included over of Seidenfaden (1985) and Seidenfaden (1995). Nineteen *Formosae* species were enlisted with key provided in these works. However, it was estimated that 15 species of section *Formosae* could be found in Thailand (Table 5.1), with 4 additional species appearing to be found in neighboring areas, such *D. multilineatum* (occurred in Laos), *D. ochraceum* (occurred in Vietnam), *D. williamsonii* (occurred in Assam, India) and *D. xanthophlebium* (occurred in Myanmar). Seidenfaden also suggested those species may prove to be present in Thailand as well, although no sample specimens were obtained from area in vicinity of Thailand. According to the results of this study, there are 12 species of section *Formosae* in Thailand. It was also proved that the 4 additional species not occur in Thailand as there is no recorded of those species since 1985 until now. Furthermore, no field collections of those species were found during this study.

The questionable species, *Dendrobium chistyanum* and *D. fuerstenbergianum*, which are resemble in floral feature but distinguished by the length of stem. The morphological and molecular studies in this revision work confirm that both species are conspecific. Therefore, *D. fuerstenbergianum* is reduced to a synonym of *D. chistyanum*. In another case, *Dendrobium lueckelianum* was considered the endemic species of Thailand by Fessel and Wolff (1990) but here it was found that this taxon was conspecific with *D. sinense* from Hainan Island, South China. Thus, *D. lueckelianum* was treated as a synonym of *D. sinense*. Consequently, *D. fuerstenbergianum* and *D. lueckelianum* are removed from the list of *Formosae* species of Thailand.

In contrary, Seidenfaden (1985) reduced *Dendrobium kontumense*, the *Formosae* species occurs in the Northeastern part of Thailand, to the synonym of *D. virgineum*. In this study, however, the Thai plant is clearly referable to

D. kontumense (see 5.3.4 for detail discussion). Therefore, *D. kontumense* is added while *D. virgineum* is removed from the list of *Formosae* species of Thailand.

Seidenfaden (1985; 1995) identified plant from Doi Chiang Dao, Doi Inthanon and Phu Luang of North Thailand as *Dendrobium wattii*. The floral characters of this species are very resembled to *D. infundibulum*. However, I have studied those specimens and determined that all of them are the variation of *D. infundibulum*. The molecular study on several samples from various localities of Thailand, demonstrated that all samples represent the same entity as *Dendrobium infundibulum*. In the molecular study, the strict consensus tree derived from combined *matK* and ITS datasets analysis (Fig. 4.6) shows that plant from Vietnam, which morphologically matches very well with the original description of *D. wattii*, appeared in separated group with the *D. infundibulum* materials from Thailand. Therefore, I concluded that *D. wattii* do not occur in Thailand and removed this species from the list of *Formosae* species of Thailand.

According to the molecular analysis result, *Dendrobium trigonopus* was removed from section *Formosae* although its placement is still in doubt. Therefore, for the time being, this species was excluded from the list of *Formosae* species of Thailand.

Table 5.1 Comparison of *Dendrobium* section *Formosae* species, in Thailand between previous study by Seidenfaden (1985, 1995) and present study.

No.	Taxa	Seidenfaden (1985, 1995)	Present study	Note
1.	<i>D. bellatulum</i>	√	√	
2.	<i>D. cariniferum</i>	√	√	
3.	<i>D. christyanum</i>	√	√	
4.	<i>D. cruentum</i>	√	√	
5.	<i>D. draconis</i>	√	√	
6.	<i>D. formosum</i>	√	√	
7.	<i>D. fuerstenbergianum</i>	√	*	Reduce to the synonym of <i>D. christyanum</i>
8.	<i>D. hirsutum</i>	-	√**	New records

No.	Taxa	Seidenfaden (1985, 1995)	Present study	Note
9.	<i>D. infundibulum</i>	√	√	
10.	<i>D. kontumense</i>	-	√**	
11.	<i>D. lueckelianum</i>	√	*	Reduce to the synonym of <i>D. sinense</i>
12.	<i>D. multilineatum</i>	√	*	Not occur in Thailand
13.	<i>D. ochraceum</i>	√	*	Not occur in Thailand
14.	<i>D. scabrilingue</i>	√	√	
15.	<i>D. sinense</i>	-	√**	
16.	<i>D. sutepense</i>	√	√	
17.	<i>D. trigonopus</i>	√	*	Removed from section <i>Formosae</i> sensu stricto
18.	<i>D. virgineum</i>	√	*	Not occur in Thailand
19.	<i>D. wattii</i>	√	*	Not occur in Thailand
20.	<i>D. williamsonii</i>	√	*	Not occur in Thailand
21.	<i>D. xanthophlebium</i>	√	*	Not occur in Thailand

√ = “enlisted”

- = “not enlisted”

* = “removed from the list of *Formosae* species of Thailand”

** = “added to the list of *Formosae* species of Thailand”

5.4.2 New record

All morphological characters of the *Dendrobium* specimens from Phu Luang Wildlife Sanctuary, Loei Province, Thailand roughly matched with the protologue and type specimens of *D. longicornu*. However, several features are different. It was found that the Thai specimens agreed very well with the original description and the type specimen of *D. hirsutum* Griff. (Griffith, 1851a; 1851b) described from Assam, India. Previously, *D. hirsutum* has been interpreted as a synonym of *D. longicornu* because they have a similar floral morphology. The flowers are white with yellowish orange or yellow veins on the labellums and the mentums are narrowly conical. In fact, *D. hirsutum* is characterized by its widely obovate petals, transversely oblong and serrate mid-lobe of the labellum, whilst *D. longicornu* has lanceolate petals, ovate and fimbriate mid-lobe of the labellum. The molecular analysis also supports the distinction between these two species. I thus confirm that

Dendrobium hirsutum Griff. is newly recorded for Thailand. Consequently, this species is added to the list of *Formosae* species of the country (Sathapatayanon, Seelanan and Yukawa, *ined.*).

5.4.3 New species

After I examined the plants previously identified as *Dendrobium kontumense* by Schildhauer (2002), Vestweber (2004) and Yukawa (2004) and compared it with the holotype of *D. kontumense*. It was found that the flower of this plant had densely verrucose calli on the lip, the golden yellow to orange lateral lobes and central part of a mid-lobe of the lip, a widely obovate mid-lobe narrower than side lobes of the lip, whereas the flower of the holotype of *D. kontumense* showed a glabrous lip, having only 3- to 5-slightly raised veins on the disc, a shape of mid-lobe more or less same size as side lobes of the lip. Moreover, an apical part of the lip of this plant is more recurved and thicker than that of *D. kontumense*. Therefore, I recognized this plant as a new species, *Dendrobium roseiodorum* A. Sathapattayanon, T. Yukawa & T. Seelanan (*ined.*).

5.4.3 Validation of two varieties

Two Philippines taxa, which are the varieties of *Dendrobium sanderae*, namely *D. sanderae* var. *luzonicum* and var. *major*, are invalid because the authors did not provide the Latin description. I'm now validating these two names by giving the Latin description and assigning the holotype specimens.

5.4.4 Clarification of *Dendrobium kontumense* confusion

In 1930, Poilane collected a *Dendrobium* material from Kon Tum Province, Vietnam (Poilane 18280). Gagnepain (1932) recognized its new status and described it as *Dendrobium kontumense*. Kerr (1969) and Seidenfaden (1973, 1975), however, overlooked this species and identified Laotian

materials assignable to *D. kontumense* as *D. sculptum* Rchb.f., a Bornean species, because both species are similar base on the having white flower with an orange blotch on the lip and a narrowly conical mentum. Later, Seidenfaden (1985) recognized the mistake in this earlier works and re-determined the Laotian materials as *D. kontumense*. He considered afterward that *D. kontumense* is conspecific with *D. virgineum*, a species described from Myanmar (Reichenbach, 1884). Therefore, Seidenfaden reduced the name *D. kontumense* as a synonym of *D. virgineum*.

On the other hand, Schildhauer (2002) demonstrated differences between *Dendrobium kontumense* and *D. virgineum* but he misapplied the name *D. kontumense* to another entity, which is described here as a new species namely *D. roseiodorum*. He compared the sketches of the type material and original descriptions of *D. virgineum* with the pictures of *D. roseiodorum* and found the difference between them. He thus concluded that *D. kontumense* was not a synonym of *D. virgineum*. Additionally, Schildhauer (2002) did not recognize the differences between the holotype of *D. virgineum* and the Indochinese material of *D. virgineum* sensu Seidenfaden. He displayed a picture of Indochinese material and named it, *D. virgineum*.

Subsequently, Ormerod and Pedersen (2003) found that the picture of Indochinese material, which Schildhauer (2002) called *D. virgineum*, differed from the holotype of *D. virgineum*. Therefore, they described the Indochinese materials of *D. virgineum* sensu Seidenfaden as a new species, *D. schildhaueri*.

After rechecking of the holotype of *Dendrobium virgineum*, I found that it definitely belongs to *D. infundibulum* Lindl. complex and is not closely related to *D. kontumense*. I also found that the protologue and holotype of *D. kontumense* completely agree with those of *D. schildhaueri* (Ormerod and Pedersen 2003). Vegetative parts of them are identical and they share floral features such as lanceolate-oblong sepals, elliptic petals, a narrowly conical mentum, a red central blotch on the glabrous lip and a transversely elliptic mid-lobe of the lip. From these evidences, I thus conclude that *D. kontumense* and *D. schildhaueri* represent the same taxon. Consequently, I reduced *D.*

schildhaueri to a synonym of *D. kontumense* (A. Sathapattayanon, T. Yukawa & T. Seelanan, *ined.*).

5.4.4 Synonym

After careful study on the type specimens and the original descriptions of each species, together with the molecular analysis, I found that several species of *Dendrobium* section *Formosae* are conspecific. Therefore, I reduced these names to synonymous names. The new synonyms, as listed in Table 5.2.

Table 5.2 Lists of the synonyms, made in this study.

No.	Syn. nov.	Reduced to the synonymous name of
1.	<i>D. chapaense</i>	<i>D. flexuosum</i>
2.	<i>D. fuerstenbergianum</i>	<i>D. christyanum</i>
3.	<i>D. jaintianum</i>	<i>D. hirsutum</i>
4.	<i>D. lubbersianum</i>	<i>D. williamsonii</i>
5.	<i>D. lueckelianum</i>	<i>D. sinense</i>
6.	<i>D. ochraceum</i> var. <i>albiflorum</i>	<i>D. ochraceum</i>
7.	<i>D. schildhaueri</i>	<i>D. kontumense</i>

5.4.5 Lectotypification

The lectotypification of *Dendrobium igneoniveum* are made, selected from the unpublished illustration of the type plant drawn by J.J. Smith, the author of the species. It is the only one specimen of *D. igneoniveum* that I ever examined. Comber (2001) listed this species (incorrectly in section *Distichophyllum*) in his "Orchids of Sumatra" but without mentioning the specimen examined. Presumably, only J.J. Smith ever saw the real plant material.



Plate 1 Habitat of *Dendrobium infundibulum*: A. Terrestrial, B. Epiphyte and C. Lithophyte.

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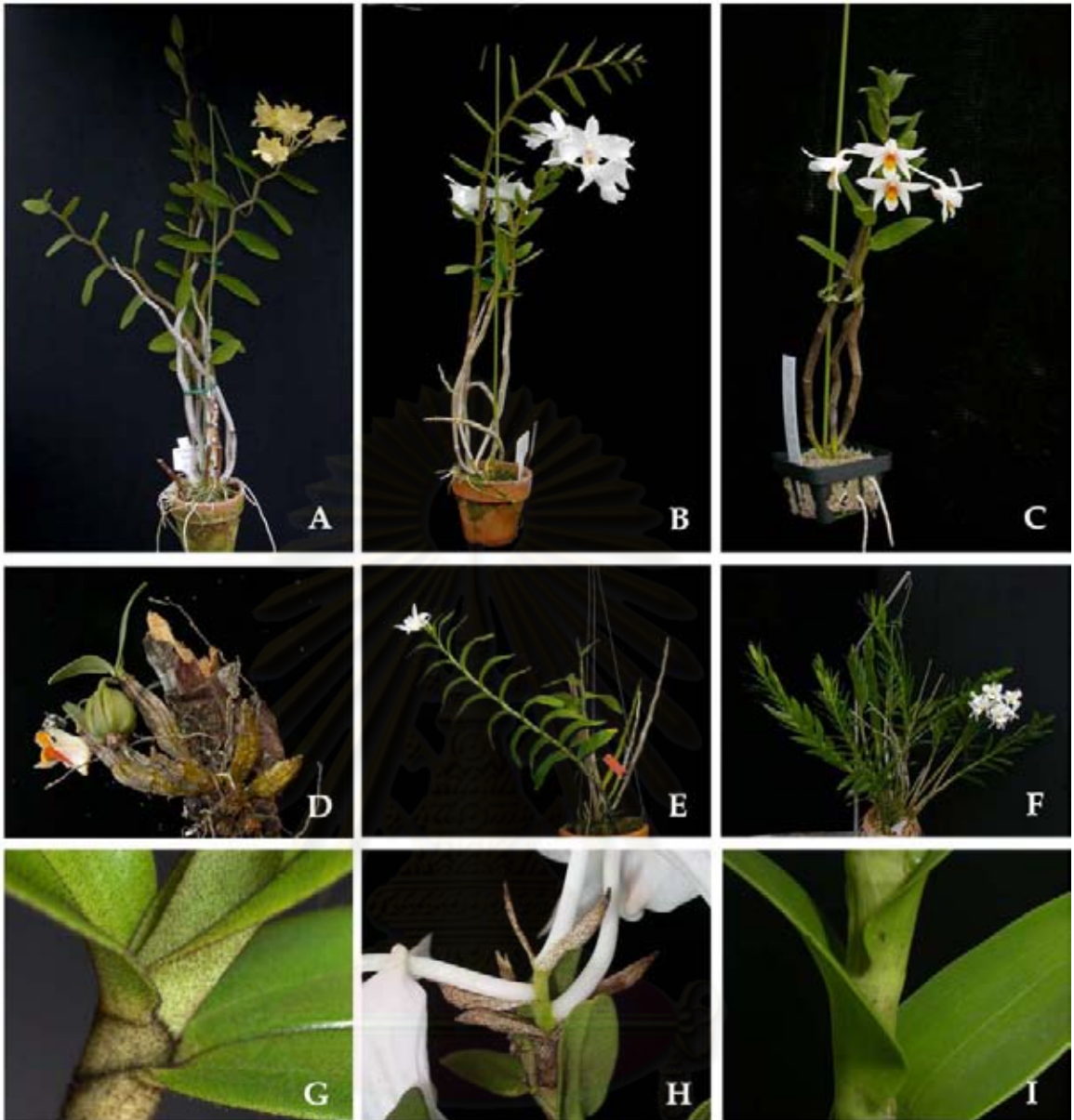


Plate 2 A.-C. Fractiflex pseudobulbs and far distichous leaves arrangement: A. *Dendrobium lowii*, B. *D. spectatissimum* and C. *D. vogelsangii*; D. Fusiform pseudobulbs: *D. bellatulum*; E. Far distichous leaves arrangement: *D. draconis*; F. Close distichous leaves arrangement: *D. dearei*; G. Blackish hairs on leaf-blades and leaf sheaths: *D. bostrychodes*; H. Blackish hairs on bract: *D. spectatissimum*; I. leaf-blades and leaf sheaths: *D. sanderae* var. *luzonicum*, note the absent of blackish hairs.

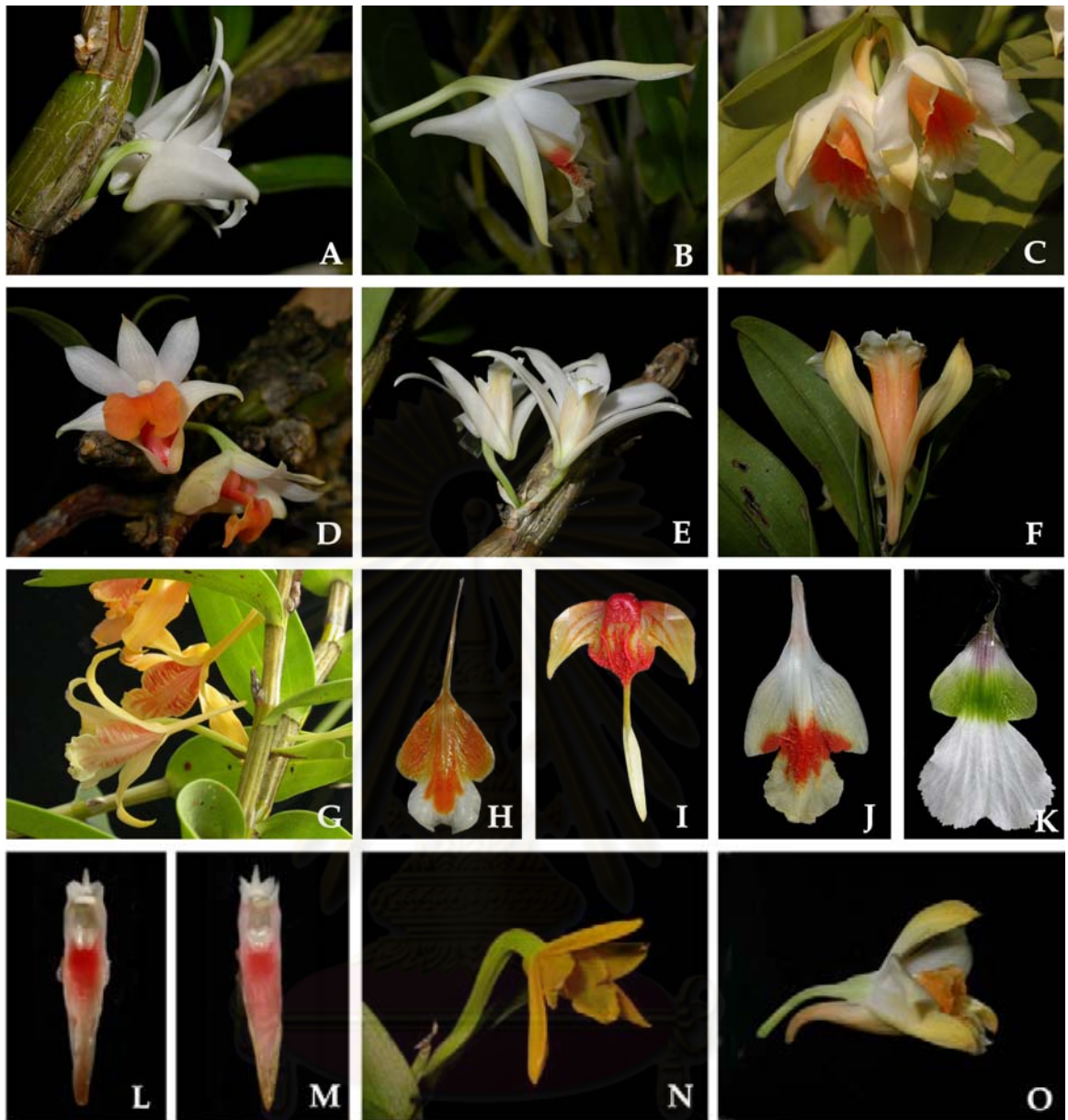


Plate 3 A.-C. Keels on abaxial surface of the dorsal and lateral sepals: A. *Dendrobium sutepense*, B. *D. williamsonii* and C. *D. cariniferum*; D.-G. Types of mentum: D. Broadly conical mentum, *D. bellatulum*, E. Shortly conical mentum, *D. sutepense*, F. Narrowly conical mentum, *D. cariniferum* and G. Very narrowly conical, *D. ochraceum*; H.-K. Callus decoration on labellum: H. *D. roseiodosum*, I. *D. tobaense*, J. *D. williamsonii* and K. *D. sanderae* var. *luzonicum*; L.&M. Variation of stelia of *D. schrautii*; N.&O. Wing-like keels on pedicellate ovary: N. *D. trigonopus* and O. *D. cariniferum*.

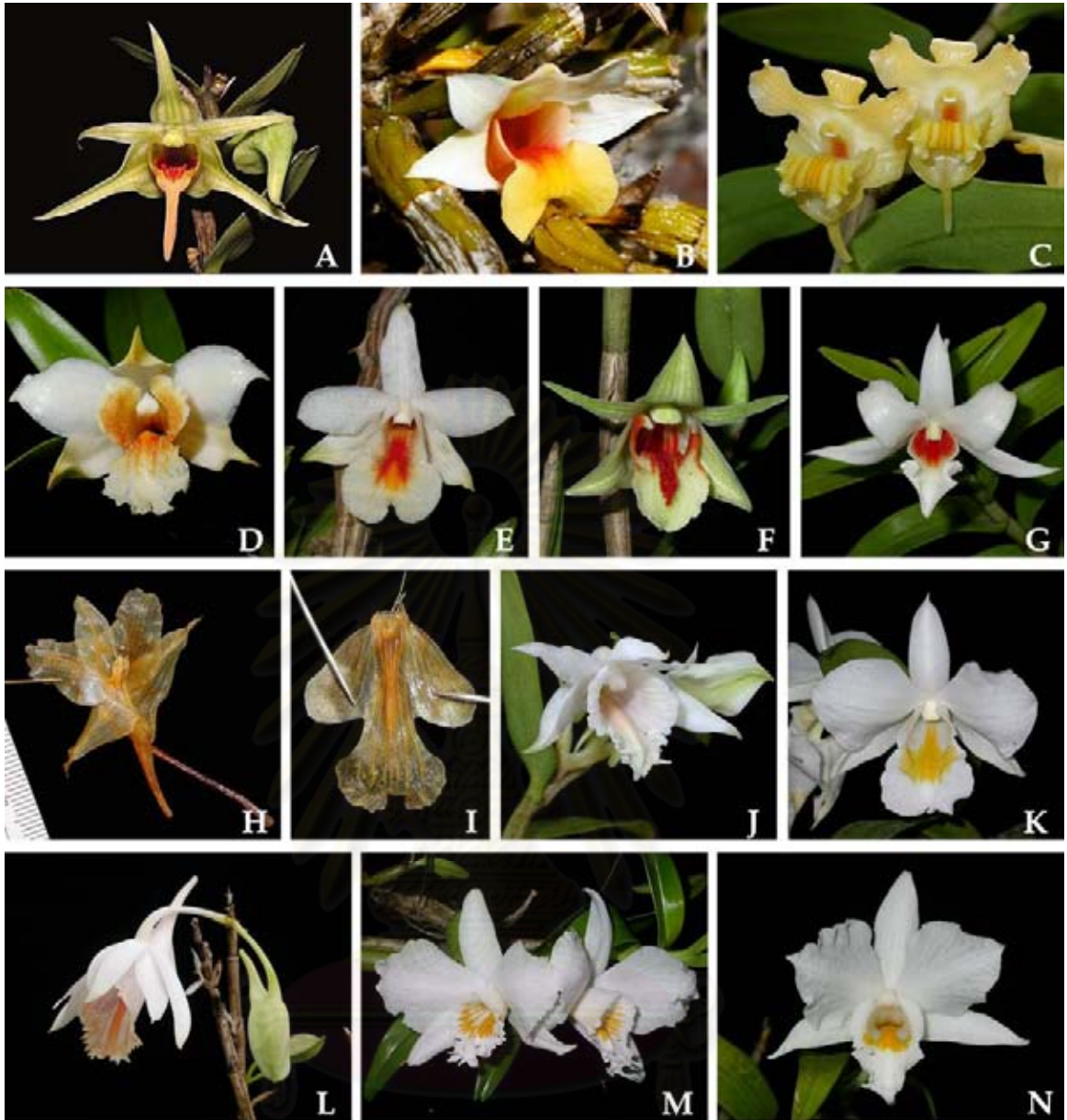


Plate 4 Flowers of each species: A. *Dendrobium ayubii*, B. *D. bellatulum*, C. *D. bostrychodes*, D. *D. cariniferum*, E. *D. christyanum*, F. *D. cruentum*, G. *D. draconis*, H.&I. *D. erythropogon*, H. sepals and petals, I. labellum, J. *D. flexuosum*, K. *D. formosum*, L. *D. hirsutum* and M.&N. *D. infundibulum*.



Plate 5 Flowers of each species (continued): A.&B. *Dendrobium infundibulum*, C. *D. jamesianum*, D. *D. kontumense*, E. *D. longicornu*, F. *D. lowii*, G. *D. multilineatum*, H. *D. ochraceum*, I. *D. ovipostoriferum*, J.&K. *D. radians*, J. sepals and petals, K. labellum, L. *D. roseiodorum*, M. *D. scabrilingue* and N. *D. schrautii*.

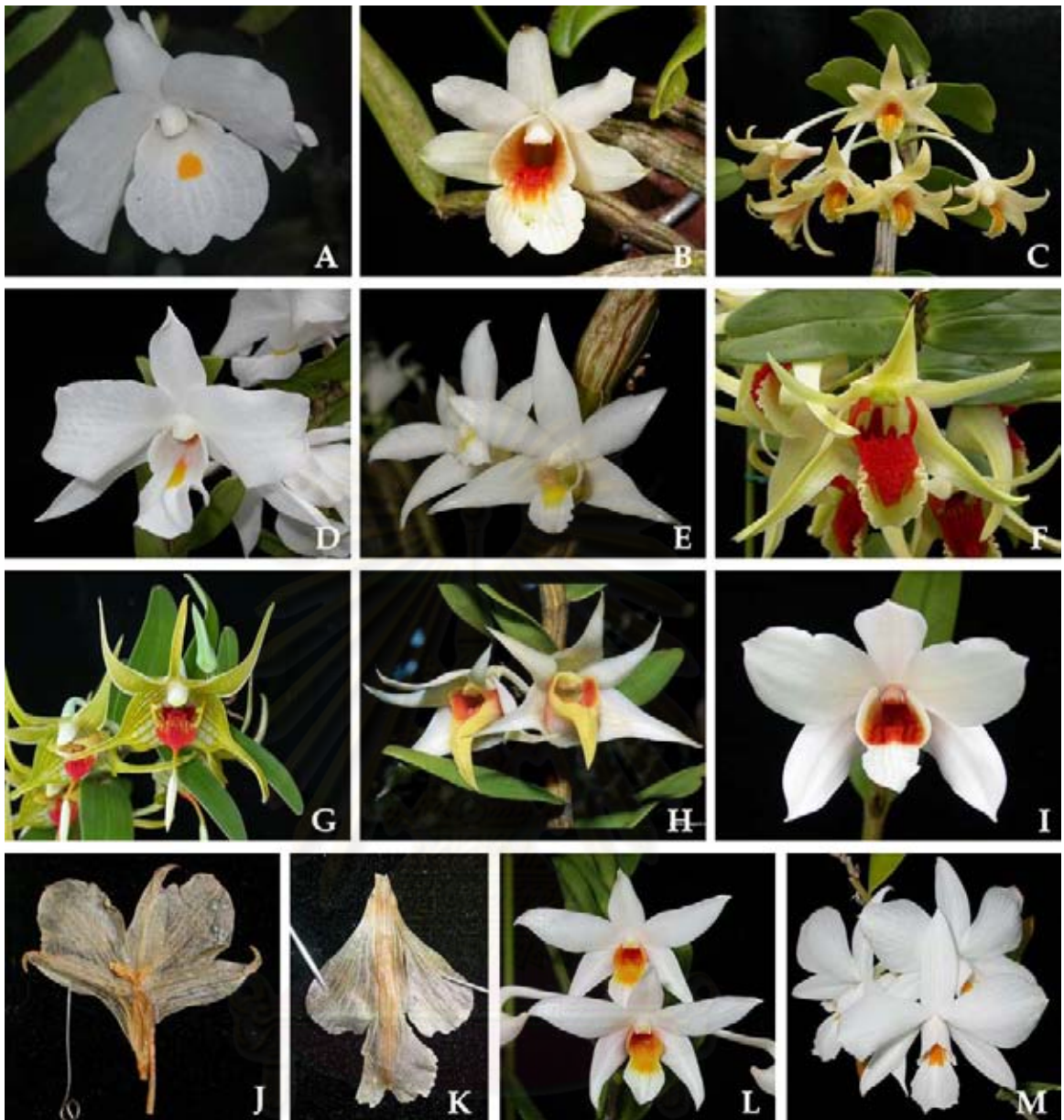


Plate 6 Flowers of each species (continued): A. *Dendrobium sculptum*, B. *D. sinense*, C. *D. singkawangense*, D. *D. spectatissimum*, E. *D. sutepense*, F. *D. suzukii*, G. *D. tobaense*, H. *D. toppii*, I. *D. trankimianum*, J.-K. *D. virgineum*, J. sepals and petals, K. labellum, L. *D. vogelsangii* and M. *D. wattii*.



Plate 7 Flowers of each species (continued): A. *Dendrobium williamsonii*, B. *D. xanthophlebium*, C. *D. jerdonianum*, D. *D. trigonopus*, E. *D. dearei*, F. *D. parthenium*, G. *D. sanderae* var. *luzonicum*, H. *D. sanderae* var. *sanderae*, I. *D. sanderae* var. *major*, J. *D. sanderae* var. *parviflorum*, K. *D. sanderae* var. *surigaense* and L. *D. schuetzei*.

CHAPTER VI

GENERAL CONCLUSION

The complete revision of *Dendrobium* section *Formosae* were provided in this study. Because of the board sectional circumscription by previous taxonomist, the more efficiency limits of this section were also provided based on the morphological, anatomical and molecular data.

In total, 49 taxa of section *Formosae* sensu lato were enumerated and described. Among these, 39 species of the section *Formosae* were recognized, 4 species and 4 varieties were proposed to erect as the new section and 2 species were leaved as the unplaced species.

6.1 Distributions

All species of the *Formosae* sensu stricto have the spectacularly beautiful flowers therefore they are one of the most popular in the cultivated orchids, widely spread to many orchid nurseries. With the exception of the cultivated species, two major of distributions are recognized here: (1) The Indo-Burmese, Sino-Himalaya and Indo-Chinese species and (2) the Malesian species. The list of 39 species of the section based on their distributions is shown in Table 6.1.

Table 6.1 List of species of *Dendrobium* section *Formosae* sensu stricto based on the geographical distribution.

Number	Taxa
The Indo-Burmese, Sino-Himalaya and Indo-Chinese elements	
1	<i>D. bellatulum</i>
2	<i>D. cariniferum</i>
3	<i>D. christyanum</i>
4	<i>D. draconis</i>

Number	Taxa
5	<i>D. flexuosum</i>
6	<i>D. formosum</i>
7	<i>D. hirsutum</i>
8	<i>D. infundibulum</i>
9	<i>D. jamisianum</i>
10	<i>D. kontumense</i>
11	<i>D. longicornu</i>
12	<i>D. multilineatum</i>
13	<i>D. ochraceum</i>
14	<i>D. roseiodorum</i>
15	<i>D. scabrilingue</i>
16	<i>D. schrautii</i>
17	<i>D. sinense</i>
18	<i>D. sutepense</i>
19	<i>D. trankimianum</i>
20	<i>D. virgineum</i>
21	<i>D. wattii</i>
22	<i>D. williamsonii</i>
23	<i>D. xanthophlebium</i>

Malesian element

- 1 *D. ayubii*
- 2 *D. bostrychodes*
- 3 *D. cruentum*
- 4 *D. erythropogon*
- 5 *D. igneoniveum*
- 6 *D. lowii*
- 7 *D. ovipostoriferum*
- 8 *D. radians*
- 9 *D. sculptum*
- 10 *D. singkawangense*
- 11 *D. sisuronense*

Number	Taxa
12	<i>D. spectatissimum</i>
13	<i>D. suzukii</i>
14	<i>D. tobaense</i>
15	<i>D. toppii</i>
16	<i>D. vogelsangii</i>

Indo-Burmese, Sino-Himalaya and Indo-Chinese species

There are 23 species of section *Formosae* sensu stricto, occurred in Indo-Burmese, Sino-Himalaya and Indo-Chinese regions. They are dispersed from Northwest India through Himalaya, South China, Myanmar, Thailand, Laos, Vietnam and Cambodia.

Dendrobium bellatulum, *D. cariniferum*, *D. christyanum*, *D. flexuosum*, *D. hirsutum*, *D. infundibulum*, *D. longicornu*, *D. scarbrilingue*, *D. sutepense* and *D. williamsonii* are widely distributed from Northwestern India through South China, and North of Indo-Chinese regions. They were usually found in the moist evergreen forests at 1,000-2,000 m alt.

Dendrobium sinense, the species that is most similar with *D. christyanum* in floral appearance but distinguished only by its smooth and obvious keels on disc of the labellum, was reported only from 2 localities: Hainan Islands of South China and from Loei Province of the Northeastern Thailand (as *D. lueckelianum*). There were no collections of this species from other areas. This disjunction distribution is probably because of the very similar flower of *D. sinense* and *D. christyanum*. Therefore, many *D. sinense* specimens might be identified as *D. christyanum*.

Dendrobium formosum occurred in lower altitude, at 500-700 m alt. There are the collections from Himalayan foothills, West India, Myanmar and East Thailand (along Tennasserim Mountain Range).

There are 5 species that are restrictedly distributed in Western part of Indo-Chinese element, i.e. *Dendrobium kontumense*, *D. ochraceum*, *D.*

roseiodorum, *D. schrautii* and *D. trankimianum*. They were found in the deciduous forest or dry evergreen forests at 600-1,000 m alt.

Dendrobium draconis were also reported from the deciduous forest or dry evergreen forests at 600-1,000 m alt. too but the species could be found both from West Indo-Burmese element (middle part of Myanmar and eastern part of Thailand) and Western part of Indo-Chinese element but skipping for central part of Thailand. These may due to the deforestation for cultivated and urban proposes. In fact, this area are lacking of almost all natural habitat orchids.

Dendrobium jamesianum, which were proved here that it is the allied species but distinct from *D. infundibulum*, were first discovered in Myanmar. Based on the herbarium specimens study and the survey, *D. jamesianum* were recorded only from North India and Myanmar.

Dendrobium wattii is another *D. infundibulum* allied species. It is looked very near *D. infundubulum* in appearance but the molecular data proved that *D. wattii* is the distinct taxa. The species were recorded only from India and North Vietnam.

Dendrobium multilineatum, allied species of *D. infundibulum*, was first discovered from Phu Bia, Laos and this is the only one report from natural habitat until the most recently study on Orchidaceae of Laos (Schuiteman *et al.*, 2008). The species was found from Xaisomboun. It can be concluded that *D. multilineatum* is the endemic species to Laos.

Another *Dendrobium infundibulum* ally is *D. virgineum*, the doubtful species. Reichenbach (1884) distinguished this species from *D. infundibulum* because its labellum has 2 keels, which I could not see from the dried type specimen. Moreover, there is only one collection of this taxa (the type specimen) from Myanmar. No more material for study the morphological characters. However, I still keep *D. virgineum* as a species in *Formosae* sensu stricto because of its hairy leaf character.

There are various plants and variation of the *D. infundibulum* allied species in the northern and northeastern part of Thailand but they are actually

D. infundibulum based on the morphological character of the labellum and the molecular data analysis.

Dendrobium xanthophlebium is first discoveries from Myanmar. Seidenfaden (1985) expected that the small fragment of Thai collection from Doi Langka, Chiang Mai Province (*Kerr s.n.*, K!) could possibly be this species. In my opinion, that specimen is hardly to identify but it look like *D. sutepense*, not *D. xanthophlebium*. Furthermore since 1985 to nowadays, there is no recorded of *D. xanthophlebium* from Thailand. I conclude that the species is endemic to Myanmar.

Malesian species

There are 16 *Formosae* sensu stricto species, were recorded from the Malesian element. Fourteen species mainly distributed on Sumatra, Borneo and Sulawesi Islands: *Dendrobium ayubii*, *D. bostrychodes*, *D. erythropogon*, *D. igneoniveum*, *D. lowii*, *D. ovipostoriferum*, *D. radians*, *D. sculptum*, *D. singkawangense*, *D. sisuronense*, *D. spectatissimum*, *D. tobaense*, *D. toppii* and *D. vogelsangii*. However, most species occurred in Borneo Island.

The other two species are *Dendrobium cruentum* and *D. suzukii*. The former species is endemic and reported from southern part of Thailand, below isthmus or called Malay-Penninsular. *D. suzukii* occurred in the southern part of Vietnam, approximately at the same latitude with *D. cruentum*. Therefore, I included this species in Malesian species.

There are 5 closely related species of *Dendrobium cruentum*: *D. ayubii*, *D. cruentum*, *D. tobaense*, *D. toppii* and *D. suzukii*, which shared the morphological characters such flower form, shape of side lobes of the labellum and shape of the mentum. It is reasonable that all species were distributed in the same element.

The molecular study suggested that the Bornean species, i.e. *Dendrobium bostrychodes*, *D. lowii*, *D. ovipostoriferum* and *D. singkawangense*, are the related species as well as *D. spectatissimum* and *D. vogelsangii*. The result leaded to hypothesize that those species were evolved from the same

ancestral *Formosae* species, which was distributed from the mainland. After the plate tectonic happening, Sumatra, Borneo and Sulawesi Islands were separated from the mainland Asia. The *Formosae* Bornean species started their own evolution to the present species.

6.2 Sectional circumscription of *Formosae sensu stricto*

The phylogenetic analysis of 50 samples of *Dendrobium* section *Formosae*, 9 related sections and an outgroup section was conducted on combined data of internal transcribed spacer (ITS) region of the 18S-26S nuclear ribosomal DNA and a maturase-coding gene *matK* of chloroplast DNA. The phylogenetic analysis results do not support the monophyly of the currently circumscribed *Formosae* species. This corresponds with the previous studies (Yukawa *et al.*, 1993; Wongsawad *et al.*, 2005). Moreover, the result also shown that the Philippines native species are not the closely related group to species from mainland Asia, Sumatra, Borneo and Sulawesi Islands. Both of these two groups have their own clade with strongly bootstrap support (BP=100).

These molecular interpretations are in agreement with the morphological study. All of the species from mainland Asia, Sumatra, Borneo and Sulawesi Islands share the morphological character in the presence of dark hirsute hairs on their leaf blades and leaf sheaths while the species from Philippines Islands lacked of this character. Both results suggested the removal of the hairless species from this section.

Therefore, it can be concluded that the hairiness character could be used as the diagnostic character of section *Formosae sensu stricto*. In addition, the additional characteristics should be included in the section circumscription: 1) psuedobulbs with far distichous leaf arrangement; 2) inflorescences with 1-4 flowers or up to 6 flowers; 3) labellum with more or less callus (excepting for *Dendrobium kontumense*).

The study on leaf surface of 63 samples of *Dendrobium* section *Formosae* and 3 related sections by using scanning electron microscope, shown that

most of *Dendrobium* species share the leaf surface characters. The stomal shape, stomatal type and epidermal hairs are the most informative characters. However, these characters are taxonomic useful for grouping taxa at sectional level.

The stomatal type and shape of all *Formosae* sensu lato species, section *Distichophyllum* and section *Conostalix* are identical in having tetracytic stomata and stomatal shape type II while section *Dendrobium* has anomocytic stomata and stomatal shape type I. Hairs of *Dendrobium* section *Formosae* sensu stricto (hairs absent in Philippines *Formosae* species) are the twist and aduncate. The hairs characters which present on leaves and leaf sheaths of *D. lamrianum* and *D. nemorale*, section *Distichophyllum* species, are similar to *Formosae*, i.e. twist but not aduncate hairs. However, this hairs character differs from *D. pachyglossum* and *D. senile* of section *Conostalix* and section *Dendrobium*, respectively.

The cuticular sculpturing on leaves of most species of all sections in this study is the same pattern: smooth on adaxial surface and striate on abaxial surface. Only *Dendrobium trigonopus* and *D. bellatulum* have the irregular cuticular sculpturing, which may be useful for species identification.

The varieties of morphological characters have been employed in this revisionary work. All of them are based on the floral feature. The vegetative character, the qualitative characters were avoided.

The shape of mentum is the first character, used for distinguished the section into 4 groups: broadly conical, shortly conical, narrowly conical and very narrowly conical. The mentum's character was also used in previous work (Seidenfaden, 1985) but distinguished *Formosae* into 2 groups (saccate mentum and extensoriform mentum). The other taxonomic important characters used in this study are:

- 1) Shape of the petals
- 2) Keel on abaxial surface of the sepals
- 3) Shape of side lobes and mid-lobe of the labellum
- 4) Details on the labellum, such as keels and callus characters.

Some characters were previously unused but are proved to be useful and important characters in this work, including ratio between length of mentum and length of dorsal sepal, flowers resupination, length and width of side lobes compare with those of mid-lobe.



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