Morphological, Anatomical Characteristics and Uses of Three Myanmar Species of the Genus *Rhododendron* from Natma-taung National Park, Southern Chin State

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မြန်မာနိုင်ငံချင်းပည်နယ်နတ်မေတာင်အမျိုးသားဥယျာဉ်မှ ဗားဇလပ်မျိုးစိတ်သုံးမျိုးတို့၏ ပင်ပရုပ်သွင်၊ ခန္ဓာလက္ခဏာနှင့်အသုံးပြုပုံများကို ကည်ကည်ခိုင်၊ သုေတသနလက်ထား (၂) ကျော်ဝင်မှ လက်ထားသုေတသနအရာရှိမင့်မင့်စန်း၊ လက်ထားသုေတသနအရာရှိစိုးမင့်၊ ပါမာခချုပ်(အတငိမ်းစား) ပခုက္ကူတက္ကသိုလ် စာတမ်းအကျဉ်း

ဆိုးလွမ်းအကျဉ်း:

မြန်မာနိုင်ငံချင်းပည်နယ်နတ်မေတာင်အမျိုးသားဥယျာဉ်မှ ဗားဇလပ်မျိုးစိတ်သုံးမျိုးတို့ကို စုံဆောင်၍မျိုးမည်ဖြစ်ပါသည်။ ဗားဇလပ်မျိုးစိတ်များကိုမျိုးမည်ဖြစ်ရာ၌ အသုံးဝင်ပါသည်။ အပင်ခန္ဓာလက္ခဏာများလည်းမျိုးမည်ဖြစ်ရာတွင်အေထာက်အကူပါသည်။
Morphological, Anatomical Characteristics and Uses of Three Myanmar Species of the Genus *Rhododendron* from Nat Ma Taung National Park, Chin State

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Abstract

Specimens of three species of the genus *Rhododendron* were collected from NaTt Ma Taung National Park, Chin State, identified and studied. The morphological characteristics of their vegetative and reproductive parts and anatomical characteristics of stems and leaves were described, compared, discussed, and presented with their photographs and photomicrographs. Their uses were also mentioned. The morphological characteristics of the species are useful in identifying the *Rhododendron* species of Myanmar. Anatomical characteristics of stems and leaves also help in identification.
Acknowledgement

We acknowledged the Ministry of Environmental Conservation and Forestry for giving research grant to carry out this research work. We are grateful to the Director General of Department of Forestry, Ministry of Environmental Conservation and Forestry for allowing us to carry out this research work. We also thank the Director of Forest Research Institute, Yezin for his support in doing this work. Thanks are also due to the staff of Wood Anatomy section, Library, and Herbarium, Forest Research Institute, Yezin for their various kinds of help.
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Chapter I

1. Introduction

Nowadays, forests are under the spotlight as never before and emphasized together with its ecosystems from point of view of conservation biology. They are globally important in regulating climatic condition and locally important in sustaining communities and supporting biodiversity. But due to unsustainable logging, changing land use pattern, and biofuel producing, the forests are continuously decreased or deteriorating.

Forests cover 48 percent of the whole Myanmar (Hill 1952) and the dense tropical forests contain extensive stands of timber and oil-bearing trees, including commercially valuable teak forests. Other trees include chiefly in the northern highlands, oak, pine, and much species of rhododendron.

Myanmar is being deforested at a rate of 1.19 percent (1990–2005) every year (Crosby 2008) due to over exploitation of wood and fuel.

Rhododendron is a common name for flowering plants of a genus of the heath family. The genus *Rhododendron* contains some 850 species, the majority of which are cultivated and it is native to the temperate areas of the Northern Hemisphere. The species of the genus *Rhododendron* are most abundant in the Himalayas, Southeast Asia, and Malaysia. Cultivated species of *Rhododendron* are also found in all continents. Rhododendrons exhibit great variety in size, habit, and flower colour. They range from small, ground-hugging shrubs to small trees, from white to pink, dark-purple, or yellow flowers. Most species are evergreen but some are deciduous (Crosby 2008).

Some members of the genus *Rhododendron* contain large ornamental evergreen trees and the flowers are brightly colored.

*Rhododendron*, meaning red trees, one of the genera of family Ericaceae, is widely distributed in northern part of Myanmar and well known for its showy flowers and being representative flowers of Chin State. They are economically important for their showy flowers and their stems are used as poles, posts and fence. In Chin hill, the flowers of red Rhododendron species are now becoming interested by local people in using wine making and enormously extracted from the wild plants and they might become scarce without systematic management.
The timbers of *Rhododendron* were used for plates, dishes, handles, and possibly for gun-stocks and fuel and the only possible extensive use for the timber might be as a ply-board (Pearson and Brown 1932). Red *Rhododendron* flowers are used in folk medicine such as cough and diarrhoea, and used in making wine by local people. Root bark of white-flowered *Rhododendron* is used in treatment of acnes by local people in Chin State.

The utility value of a species depends very much on their availability in terms of abundance and, as a food and fodder resource, seasonal availability, as well as the relative merits of other alternatives (Wickens 1995).

It might be stressed that the most important role of *Rhododendron* and other tree and shrub species is to stabilize the environment and thus prevent desertification, a role that safeguards both the national and rural economy. Any future afforestation schemes should be designed for maximum protection against desertification (Wickens 1995). *Rhododendron* species are one of the main resource plants for forest conservation in Myanmar through systematic management. *Rhododendron* communities have probably well established in northern part of Myanmar. These trees are naturally abundant and widely distributed in hill regions of Kachin and Chin States and a few found in Shan and Mon States. Kress et al. (2003) recorded 185 Myanmar species of the genus *Rhododendron*.

Nat MaTaung National Park of Chin States seems to be one of very few regions maintaining the condition of primary forest in Myanmar and its dominant trees contain many species of *Pinus*, *Quercus*, *Lithocarpus* and *Rhododendrons*. Its mountain ranges reach its maximum height of about 3200 meters known as Mount Victoria next to the highest peak of Hkakaboraziand second highest Sarametiin Myanmar. It was established as National Park in 2010 which was initiated as Baw Li Moe Reserved Forest in 1936. It was upgraded to ASEAN Heritage Park in 2012. This national park is being restricted region since very early time in Myanmar forestry history and resulted in an attractive mountain resort especially welcoming potentially increasing ecotourists. It has naturally become remarkable and beautiful area of 71346 hectares for ecotorism and biodiversity of both plants and animals.

Nowadays, local people in Myanmar encounter a shortage of fuel-wood because of over extraction of fuel-wood trees for their daily use. The population in rural area as well as in urban one is still growing and fuel consumption is also greater than ever. It is required that the trees including *Rhododendron* community which are utilized in fuel, medicinal, fodder, and other purposes have to be sustainable to meet local needs.
This research on three species of the genus *Rhododendron* from Nat MaTaung National Park of Chin State is conducted with the aims and objectives of providing information on morphological, anatomical characteristics and uses of the species, supporting in specific identification in *Rhododendron*, and motivating the local people and responsible persons in conserving forest of Myanmar by systematic management of maintaining together with other species.
Chapter 2

2. Literature Review

Encyclopædia Britannica (2013) stated that rhododendron (genus *Rhododendron*), any of a genus of woody plants in the heath family (Ericaceae), was notable for their attractive flowers and handsome foliage. The genus was large and extremely diverse, comprising about 850 species. Rhododendrons were native chiefly in the North Temperate Zone, especially in the moist acid soil of the Himalayas and into Southeast Asia to the mountains of New Guinea. The genus Rhododendron included the azalea and Labrador tea, which were sometimes considered distinct.

*Rhododendron arboreum* was classified under the subgenus *Vireya*, the genus *Rhododendron*, the family Ericaceae of the order Ericales among the flowering plants (Wikipedia 2013).

Rendle (1938) classified *Rhododendron* under the family Ericaceae of the order Ericales, that was placed under the group Pentacyclicae. Pentacyclicae was one of the two groups under the grade Sympetalae of Angiosperms.

Wikipedia (2013) described that *Rhododendron arboreum* (Tree Rhododendron), also known as burans or gurans, was an evergreen shrub or small tree with a showy display of bright red flowers. It was found in Bhutan, China, India, Myanmar, Nepal, Sri Lanka and Thailand. *Rhododendron arboreum* was the national flower of Nepal and the state tree of Uttarakhand in India. It had been recorded as reaching heights of up to 20 m, although more usually it had a height and spread up to 12 m x 12 m. In early- and mid-spring, trusses of 15 – 20 bell-shaped flowers which were 5 cm wide and 3 – 5 cm long, were produced in red, pink or white. They had black nectar pouches and black spots inside. This plant was suitable for woodland gardens.

Many variants of *R. arboretum* were found. *R. arboreum* subsp. *cinnamomeum* had leaves with cinnamon-brown hairs beneath. *R. arboreum* subsp. *zeylanicum* was a rare subspecies from the highlands of Sri Lanka, named after Zeilan. *R. arboreum* subsp. *cinnamomeum* var. *album* had white flowers with small blood red spots on the inner surface of the petals. *R. arboreum* subsp. *delavayi* had red flowers. *R. arboreum* Sm. subsp. *nilagiricum* (Zenker) Tagg was found in Tamil Nadu, India (Wikipedia 2013).

Osborn (1984) described that Kingdon-Ward last went back to Myanmar in 1956 and he went on his twenty-second expedition. He found and recorded many *Rhododendron* species
including *R. arboretum*, *R. burmanicum*, and *R. cuffeanum* in his expeditions in Mt. Victoria in the southern Chin Hills and the slopes of Mt. Sarameti.

Rhododendron was common name for flowering plants of a genus of the heath family. The genus contained some 850 species, the majority of which were cultivated. Most species were evergreen. The deciduous species of rhododendron, those that lose all of their foliage each year, were known in horticulture as azaleas. It was native to the temperate areas of the Northern Hemisphere, and the genus *Rhododendron* was most abundant in the Himalayas, Southeast Asia, and the mountains of Malaysia. Cultivated species could now be found on all continents. Rhododendrons exhibited great variety in size, habit, and flower colour. They ranged from small, ground-hugging shrubs to small trees; and from white to pink, dark-purple, or yellow flowers (Crosby 2008).

Hundley (1987) listed a total of 188 species of the genus *Rhododendron* in Myanmar. Kress et al. (2003) described that the genus *Rhododendron* widely distributed in Myanmar containing 205 species.

Pearson and Brown (1932) stated that *Rhododendron arboretum* was a small tree, much branched and wide-crowned. It sometimes attained to a large girth. Parker stated that it reached a height of 9.1 – 12.2 m, with a girth of 2.1 – 2.4 m, but was more commonly found 0.9 – 1.2 m in girth, while it was difficult to get straight logs of over 1.5 m found in Kashmir and from the Ravi, at 1500 – 3600 m, eastwards to Bhutan; in the Khasia Hills at 1200 – 1800 m; in the hills of Upper Myanmar running as far south as the hills north-east of Toungoo; Western Ghats, Nilgiris, Pulneys, and hills of Travancore, above 1500 m. It was Zalatni in vernacular names in Myanmar and Ngaysheek in Chin.

Shu (2005) described in Flora of China that *R. arboretum* were trees, usually evergreen, (1–) 5 – 20 (–30) m tall; trunk well-defined; bark gray-brownish, exfoliating into thin and small irregular flakes; young shoots stout, with distinct leaf traces, densely grayish tomentose, glabrescent. Winter buds were ovoid, 10 – 12 × 5 – 6 mm, puberulent. Petiole was 10 – 25 mm with dense fawn indumentum intermixed with glands, sometimes glabrescent; leaf blade leathery, oblong-lanceolate or oblong-oblancoiate, 6 – 15 × 2 – 4.5 cm; base cuneate or more or less rounded; margin revolute; apex acuminate or acute; abaxial surface with indumentum 1- or 2-layered, densely compacted, white to fawn tomentose, sometimes with loosely floccose brown upper layer, hairs dendroid, glabrescent; adaxial surface reticulate to bullate, glabrous; midrib deeply impressed adaxially; lateral veins 15- to
26-paired. Inflorescence was dense, about 20-flowered, rachis 10 – 15 mm, tomentose. Pedicel was about 0.9 cm, pilose, glandular; calyx lobes 5, 1 – 2 mm, small, triangular, sparsely glandular and hairy; corolla tubular-campanulate, pink to deeply crimson, rarely white, 3.5 – 4 cm, with 5 black-blotched basal nectar pouches and dark flecks; lobes 5, 1.2 – 1.7 cm, apex emarginate; stamens 10, unequal, 1.7 – 2.7 cm, filaments glabrous; ovary conoid, 4 – 6 mm, white-tomentose, sometimes also glandular; style ca. 3.3 cm, glabrous. Capsule was cylindric, about 30 × 6 mm. Flower appeared in May, fruits in August. Three varieties occurred in China. The name used in Xizang, “da ma”, referred to the medicinal use of the flowers in treating coughs.
CHAPTER 3

3. Materials and Methods

The samples of reproductive and vegetative parts of *Rhododendron* species were collected from Na Ma Taung National Park of Chin State during April 2012 to December 2014. Nama Taung National Park lies between 21° 05′ to 21° 21′ North Latitude and 93° 48′ to 93° 57′ East Longitude in the West Mountain Ridges of Myanmar.

Small portions of stem near at the breast height level were also taken. Some of the specimens are dried to make herbarium sheets and some of them are killed and fixed in 50% ethyl alcohol for further study. The collected specimens are identified and checked by the specimen chart made by Fujikawa (2006) that is deposited at Nat Ma Taung National Park Office and checked by the literature made by Pearson and Brown (1932) and Shu (2005).

The barks, stems, leaves, as well as the plants in natural habit in flowering and fruiting seasons, were studied and described, compared, discussed and presented.

The small portions of petioles, leaf blades, stem, previously killed and fixed, were washed in the running water for overnight and the specimens were dehydrated through a series of tertiary butyl alcohol solutions. Then the totally dehydrated specimens were infiltrated in a series of paraffin wax of which melting points were 49° C, 55° C and 60° C respectively. The specimens were then embedded in the 60° C paraffin wax and cut into 16 – 18 μm thick sections by using a rotary microtome, model AO 820.

The thin sections obtained were mounted on a clean glass slide by Mryer's albumen and immersed in xylol solution over night to remove paraffin. Then they were double-stained in the combination of safranin and fast green solutions according to the method of Johansen (1940). After staining, the sections were permanently mounted under a cover slip by using Canada balsam in xylol and kept dried on a slide tray for a week in room temperature. The killing and fixation, dehydration, infiltration, embedding, staining and mounting were made according to Johansen’s (1940) Method.

Some of the stem blocks were boiled in water for 12 hours and cut into 25 – 30 μm thick sections by using a sliding microtome. The sections obtained were stained in haematoxilin and safranin combination according to Johansen (1940). After staining, the
sections were dehydrated and permanently mounted under a cover slip with Canada balsam in xylol and kept dried on a slide tray for a week.

The parts of leaves, stem bark, and stem wood, were macerated separately by warming in a mixture of two parts of 30% hydrogen peroxide solution and one part of glacial acetic acid solution according to Franklin's method (modified) (Berlyn and Mikshe 1976). The macerated elements were studied under research microscope and the vessel elements and fibers were measured and recorded by a digital camera.

Figure 3.1 Location map of Nat Ma Taung National Park as the earth seen by day.
Source: Student Encarta 2009 DVD.

Figure 3.2 Location map of Nat Ma Taung, collection site of *Rhododendron* species.
Source: Student Encarta 2009 DVD.
Figure 3.3 Location map of Nat Ma Taung National Park, viewed from satellite.
Source: Google Earth.
4. Results

4.1 Morphology

4.1.1 Rhododendron arboreum Sm.

*Rhododendron arboreum Sm.* Exot. Bot. i. 9. (IK)

Local name: Zalatni, Taungzalat, Ngaysheek

Family: Ericaceae

Common name: Rhododendron

Locality: Nat Ma Taung National Park, Southern Chin State.

Specimen examined: Kyi Kyi Khaing & Myint Myint San; Nat Ma Taung National Park, 30-4-2012.

**Taxonomic description**

Evergreen small to large trees, much branched and crown sub-umbelliform or sub-globose, 3 – 10 m high. Barks grayish white, outer bark usually easily detached, inner bark pale reddish brown, usually with liken attached on then, outer bark 1 – 4 mm thick, inner bark 1– 1.2 mm thick.

Leaves spiral, dark green above and paler beneath, petioles 0.8 – 2.0 cm long and 0.2 – 0.1 cm wide, canaliculate above, pale green, with scale and warts; leaf blades 6.5 – 11.2 cm long and 2.3 – 3.9 cm wide, elliptical, tip acute, margin entire, base acute, pubescent at lower surface, glabrous at upper surface.

Inflorescence terminal, racemose, fasciculated, 12- to 18-flowered, with involucre of bracts; red, 5.0 – 7.5 cm long and 5.0 – 8.5 cm wide, each flower with a bract. Flowers ebracteolate, 4.0 – 4.9 cm long and 2.5 – 4.5 cm wide; pedicels 0.7 – 1.7 cm long, pale reddish, with warty gland; bracts 2.0 – 2.3 cm long and 0.6 – 1.0 cm wide, pale yellowish brown, pubescent at outer surface; complete, bisporangiate, irregular, zygomorphic, cyclic, pentamerous, hypogynous.
A. A plant fully bloomed in natural habitat top of Mount Victoria. B. A portion of stem showing bark. C. An inflorescence in natural habit showing slightly curved stamens.

D. An inflorescence with fasciculated flowers. E. Flowering branches on a tree.

**Figure 4.1 Habit of *Rhododendron arboreum* Sm.**
A. Inflorescences and young fruits on a tree in natural habit. B. A branch with dehiscent fruits and young inflorescence (Note: Some fruits with persistent style).

C. Inflorescence showing flowers with deciduous corolla. D & E. L. S of a flower showing pistil and stamens. F. L. S of an ovary with basal portion of style showing numerous small ovules in loculus.

G. Close up view of stamens showing apical pores. H. T. S of an ovary showing many ovules in each loculus. I. A seed as seen under microscope. J. Sees as seen.

Figure 4.2 Inflorescences, fruits, floral parts of *Rhododendron arboreum* Sm.
Calyx 5, polyseplous, whitish, triangular, 1 mm long and 2 mm wide at the base, glabrous inside and many warty glands present on the outer surface and at the rim of sepals. Corolla (5), gamopetalous, pinkish red, quincuncial, corolla lobes 1.2 – 1.8 mm long and wide, glabrous; corolla tube tubular-canpanulate, pinkish red, 2.8 – 3.1 cm long and 1.3 – 2.7 cm wide, glabrous.

Androecium  8 – 10, apostamonous, 1.9 – 2.8 cm long; filaments unequal, introrse, inserted, 1.7 – 2.5 cm long, white, glabrous; anther dithecous, anther lobes 2 – 3 cm long, brown, with oblique apical pores, dehiscence apical porous, dorsifixed, pollen grains sticky.

Gynoecium (5), pentacarpellary, ovary with many warty glands, tomentose with white hairs, syncarpus, 10-locular, the placentation axile with many ovules in each loculus, style slender, slightly curved, smooth, deep red, stigma discoid, slightly hexangular.

Pods 10 – 15 mm long and 8 – 15 mm wide, brownish dark green, grayish dark when dry. Seeds numerous, minute, elliptical oblong, yellowish brown, transparent by light.

Floral formula:

\[
\begin{align*}
\text{K}_5 & \quad \text{C}_{(5)} & \quad \text{A}_8 - 10 & \quad \text{G}_{(5)}
\end{align*}
\]

Uses: Corollas are used in making wine in Chin State. Wood is used in building and as fuelwood.

4.1.2 Rhododendron burmanicum Hutch.


Local name: Zalatwar, Taungzalat-ahwar
Family: Ericaceae
Common name: Rhododendron
Locality: Nat Ma Taung National Park, Chin State.
Specimen examined: Kyi Kyi Khaing & Myint Myint San (2012-4-26). Nat Ma Taung National Park, Chin State.
Flowering period: December to May.
Fruiting period: December to June.
**Taxonomic Description**

Everygreen terrestrial shrubs, 1 – 3 m high. Barks reddish brown, outer bark usually detached, inner bark pale reddish brown, usually with lichens attached on the stem. Found growing between at the elevation of 2740 – 2980 m.

Leaves spiral, dark green above and paler beneath, 4.6 – 9.1 cm long and 2.0 – 4.5 cm wide; stipule grayish brown, glabrous, with a few hairs at the margin; petiole 0.4 – 1.2 cm long and 0.2 cm wide, canaliculate above, pubescent, with a few hairs while young; leaf-blade elliptical, tip acute, margin entire, with a few hairs on the margin at the lower potion while young, base acute, with many tiny brown spots at the lower surface.

Inflorescence terminal, racemose, fasciculated, 7 to 10 flowers per inflorescence, with involucre of bracts; bracts yellowish brown, 3.7 – 5.0 cm long and 6.0 – 7.8 cm wide, cup-shaped while young, glabrous inside and outside, pubescent at the margin; each flower with a bract, flower bract yellowish brown, tip acute.

Flowers bracteate, ebracteolate, 3.2 – 4.7 cm long and 1.7 – 3.4 cm wide, whitish yellow; pedicels 0.8 – 1.1 cm long and 0.1 – 0.2 cm wide, hairy; complete, bisporangiate, regular, zygomorphic, cyclic, pentamerous, hypogynous,
A. Plants in natural habit.  

B & C. A portion of stem.  

D. A branch with inflorescence primordia.  

E & F. An inflorescence.  

G. Inflorescences after corolla withered.  

H. L.S of flowers.  

Figure 4.3 Habit of *Rhododendron burmanicum* Hutch.

E. T.S of an ovary. F. A branch with dry dehiscent fruits. G. Dry dehiscent fruits. H. A seed (Bar = 1 mm).

Figure 4.4 Stamens, pistil, fruits and seeds of *Rhododendron burmanicum* Hutch.
Calyx 5, polysepalous, whitish, triangular, 2 mm long and about 1 mm wide at the base, glabrous inside and a few hairs and warts present on the outer surface of sepals.

Corolla (5), gamopetalous, whitish yellow, quincuncial; corolla lobes 1 – 2 cm long and wide, glabrous and a few warts present on the outer surface; corolla tube tubular-campanulate, 2.2 – 2.7 cm long and 0.5 – 1.4 cm wide; whitish yellow, glabrous and a few warts present on the outer surface.

Androecium 7 – 12, apostamonous, 2.0 – 2.6 cm long; filaments unequal, introrse, 1.5 – 2.1 cm long, yellowish white, hairy at the basal potion; anther dithecous, anther lobes 0.4 – 0.5 cm long, white, with oblique apical pores, sometimes rim of pores pale purplish, dehiscence apical porous, dorsifixed, pollen grains sticky.

Gynoecium (6), hexacarpally, ovary whitish green, syncarpus, hexalocular, the placentation axile with many ovules in each loculus, with annular nectary glands, nectary glands with shot hairs; style greenish white, slender, slightly curved, stigma irregularly discoid, greenish.

Pods 10 – 15 mm long and 12 – 13 mm wide, yellowish brown when dry. Seeds many, minute, elliptic-oblong, transparent by light.

**Floral formula:**  
\[ \oplus \quad \hat{\text{♀}} \quad K_5 \quad C_{(5)} \quad A_{7-12} \quad G_{(6)} \]

**Uses:** They are used as ornamental plants.
4.1.3 *Rhododendron cuffeanum* Craib ex Hutch.


Local name: Zalatphyu, Taungzalat-ahphyu

Common name: Rhododendron

Family: Ericaceae

Locality: Nat Ma Taung National Park, Chin State

Specimen examined: Kyi Kyi Khaing & Myint Myint San (2012-4-26), Nat Ma Taung National Park, Chin State

Flowering period: December to May

Fruiting period: January to June

**Taxonomic Description**

Evergreen epiphytic, usually found on pine trees, 1 – 4 m high, stem terete, 2 – 4 cm in diameter; barks grayish brown, with numerous longitudinal and narrow cracks and horizontal small cracks. Found growing between at the elevation of 1800 – 2400 m.

Leaves spiral, deep green above and paler beneath, 7 – 11 cm long and 1.4 – 2.7 cm wide; stipules leafy, brownish green to pale green; petioles 0.9 – 1.5 cm long and 0.1- 0.2 cm wide, canaliculate above, glabrous, whitish green, leaf-blade elliptical, tip acute, margin entire, base acute, glabrous at both surfaces, brownish sports at the lower surface.

Inflorescences terminal, racemose, inflorescence primordia subcylindrical with pointed end, 4- or 5-flowered, with involucres of bracts, 6.0 – 6.5 cm long and 9.0 – 10.5 cm wide, each flower with a bract.

Flower 5.0 – 6.5 cm long and 3.5 – 6.5 cm wide; pedicels 0.7 – 1.7 cm long; glabrous, warty, fragrant, complete, bisexual, irregular, xygomorphic, pentamerous, cyclic, hypogynous. Calyx 5, polysepalus, triangular in shape, minute, valvate, with a few hairs and a few warts. Corolla (5), gamopetalous, corolla 5-lobed, 2.0 – 2.5 long and 1.5 – 2.1 wide, corolla tube 3 – 4 long and 2.0 – 4.4 wide, tubular-campanulate, white, quincuncial, with a few warts at the outer surface.
A. An epiphytic plant on a pine tree. B & C. A plant removed from its habitat.


H. A flower. I. A pistil and stamens on receptacle and a flower exposed to stamens and pistil.

Figure 4.5 Habit of *Rhododendron cuffeanum* Craib ex Hutch.

Figure 4.6 T.S of an ovary, fruits and seeds of *Rhododendron cuffeanum* Craib ex Hutch.
Androecium 9 or 10, apostamonous, 2.7 – 4.0 cm long; filaments unequal, introrse, 2.2 – 3.3 cm long, white while young, pale yellow at maturity, with long and white hairs at the basal potion; anther dithecous, antherlobes 0.5 – 0.7 cm long, brown, with oblique apical pores, dehiscence apical porous, basifixed, pollen grains sticky.

Gynoecium (6), hexacarpally, syncarpus, warty, haxalocular, the placentation axile with many ovules in each loculus, with nectary glands, nactary glands with shot hairs; style slender, slightly curved, warty at basal potion, stigma discoid, hexangular.

Pods 25 – 32 mm long and 8 – 14 mm wide; grayish brown when dry, seeds numerous; seeds elliptic-oblong, pale brown, transparent under light.

Floral formula: $\begin{array}{c}
\otimes \\
K_5 \\
C_{(5)} \\
A_{9 \text{ or } 10} \\
G_{(6)}
\end{array}$

**Uses:** The plants are used as ornamental, and roots are ground and applied to treat acne, scar and wound.

4.1.4 **Synoptic key to the species of the genus *Rhododendron***.

1. Evergreen small to large trees, terrestrial shrubs; flowers pinkish red or whitish yellow .................................................................

2. Evergreen small to large trees, flowers pinkish red, gynoecium pentacarpellary, 10-locular ..................... *Rhododendron arboreum*

2. Terrestrial shrubs, flowers whitish yellow, gynoecium hexacarpally, hexalocular ...................... *Rhododendron burmanicum*

1. Epiphytic plants, flowers white ..................... *Rhododendron cuffeanum*
Table 4.1 Size of leaf of three species studied.

<table>
<thead>
<tr>
<th>No.</th>
<th>Species</th>
<th>Habit</th>
<th>Leaf-blade length (cm)</th>
<th>Leaf-blade width (cm)</th>
<th>Length of petiole (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><em>Rhododendron arboreum</em></td>
<td>tree</td>
<td>6.5 – 11.2</td>
<td>2.3 – 3.9</td>
<td>0.8 – 2.0</td>
</tr>
<tr>
<td>2</td>
<td><em>Rhododendron burmanicum</em></td>
<td>shrub</td>
<td>4.6 – 9.0</td>
<td>2.0 – 4.5</td>
<td>0.4 – 1.2</td>
</tr>
<tr>
<td>3</td>
<td><em>Rhododendron cuffeanum</em></td>
<td>epiphyte</td>
<td>7 – 11</td>
<td>1.4 – 2.7</td>
<td>0.9 – 1.5</td>
</tr>
</tbody>
</table>

Table 4.2 Size of inflorescences and flower colour of three species studied.

<table>
<thead>
<tr>
<th>No.</th>
<th>Species</th>
<th>Flowers per inflorescence</th>
<th>Inflorescence length</th>
<th>Inflorescence width</th>
<th>Flower colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><em>Rhododendron arboreum</em></td>
<td>12 – 18</td>
<td>3.5 – 5.0</td>
<td>9.0 – 10.5</td>
<td>Red</td>
</tr>
<tr>
<td>2</td>
<td><em>Rhododendron burmanicum</em></td>
<td>7 – 9</td>
<td>3.7 – 5.0</td>
<td>6.0 – 7.8</td>
<td>Yellow</td>
</tr>
<tr>
<td>3</td>
<td><em>Rhododendron cuffeanum</em></td>
<td>4 – 5</td>
<td>6.0 – 6.5</td>
<td>5.0 – 8.5</td>
<td>White</td>
</tr>
</tbody>
</table>

Table 4.3 Characters of stamens and pistils of three species studied.

<table>
<thead>
<tr>
<th>No.</th>
<th>Species</th>
<th>Stamen hairs</th>
<th>Ovary hairs</th>
<th>Style colour</th>
<th>Stigma shape</th>
<th>Nactory gland shape</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><em>Rhododendron arboreum</em></td>
<td>Glabrous</td>
<td>Tomentose and warty</td>
<td>Brownish pale red, smooth</td>
<td>Discoid, circular</td>
<td>Nil</td>
</tr>
<tr>
<td>2</td>
<td><em>Rhododendron burmanicum</em></td>
<td>Pubescent at the basal portion</td>
<td>Ovary warty</td>
<td>Whitish, warty at basal potion</td>
<td>Irregularly discoid</td>
<td>Wavy annular ring , with whitish hairs</td>
</tr>
<tr>
<td>3</td>
<td><em>Rhododendron cuffeanum</em></td>
<td>hairs at the basal potion</td>
<td>Ovary warty</td>
<td>warty at basal potion</td>
<td>Discoid, slightly hexangular</td>
<td>Wavy annular ring with hairs</td>
</tr>
</tbody>
</table>

Table 4.4 Size of flower, number of stamen and size of fruit of three species studied.

<table>
<thead>
<tr>
<th>No.</th>
<th>Species</th>
<th>Length of flower</th>
<th>Diameter of flower</th>
<th>stamen per flower</th>
<th>Fruit length</th>
<th>Fruit width</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><em>Rhododendron arboreum</em></td>
<td>4.0 – 4.9</td>
<td>2.5 – 4.5</td>
<td>8 – 10</td>
<td>1.0 – 1.5</td>
<td>0.8 – 1.5</td>
</tr>
<tr>
<td>2</td>
<td><em>Rhododendron burmanicum</em></td>
<td>3.2 – 2.0</td>
<td>1.7 – 3.4</td>
<td>7 – 12</td>
<td>1.0 – 1.5</td>
<td>1.2 – 1.3</td>
</tr>
<tr>
<td>3</td>
<td><em>Rhododendron cuffeanum</em></td>
<td>5.0 – 6.5</td>
<td>3.5 – 6.5</td>
<td>9 – 10</td>
<td>2.5 – 3.2</td>
<td>1.8 – 2.2</td>
</tr>
</tbody>
</table>
4.2 Anatomy

4.2.1 *Rhododendron arboretum* Sm.

4.2.1.1 Wood of stem

**General characteristics and properties of the wood**

Wood of stem of *Rhododendron arboretum* studied is pale yellow and its odour and taste not distinct. It is hard, straight-grained, and very fine-textured. The wood is semiring-porous and its growth ring is distinct.

**Microscopic characteristics**

**Vessel elements:** Semiring-porous, pores very small to moderately small, tangential diameter 32.5 – 52.5 μm (mean 49.1 μm), very fine-textured; pore solitary, radial multiples of 2 – 4, or clustered, solitary pores 31.8 – 74.1%; pore polygonal; vessel elements simple pitted or bordered pitted, perforation plate reticulate, end walls oblique, tailed at one end, intervessel pits alternate, oval or elongated; vessel elements moderately short to medium-sized; 250 – 670 μm (mean 485.6 μm) long, tyloses absent; gum deposit absent, crystals rarely present, pith flecks usually found in some annular rings.

**Fibres:** Fiber tracheid very short to medium-sized, 550 – 980 μm (mean 983.6 μm) long and 20 – 35 μm (mean 32 μm) wide, wall 5.0 – 7.5 μm (mean 6.3 μm) thick, non-septate, with tapering ends; interfibre pits minute, bordered.

**Rays:** Heterogeneous, 1- to 5-seriate, 7 – 20 (mean 13.1) per mm tangentially, moderately numerous to very numerous; uniseriate rays 5 – 18 (mean 11) per mm tangentially, moderately numerous to very numerous; multiseriate rays 0 – 4 (mean 2.1) per mm tangentially, very few to few; uniseriate rays 70 – 680 μm (mean 271.3 μm) in height, 15 – 30 μm (mean 22.6 μm) in diameter, extremely fine to moderately fine, cells 1 – 12 (mean 4.7) layered; multiseriate rays 280 – 780 μm (mean 489.4 μm) in height, 40 – 90 μm (mean 65.9 μm) in diameter, moderately fine to medium-sized, cells 10 – 29 (mean 17) layered; ray vessel pitting alternate, circular or oval in shape; gum deposits dark reddish-brown.

**Axial parenchyma:** Almost absent.
A. Stem wood sections as seen.  B. T. S of a portion of stem showing bark and wood.  C. T. S of a portion of stem showing vascular cambium, bark and wood, phloem ray dilated outward.  D. T. S of a portion of stem showing vascular cambium.

E. T. S of a portion of stem showing secondary xylem or wood.  F. T. L. S of stem wood showing uniseriate and multiserate rays.  G. T. L. S of stem wood showing bordered-pitted vessels.  H. T. L. S of stem wood showing heterogenous ray cells and storied fibers band vessels.

I. T. L. S of stem wood showing ray cells.  J. A vessel element with reticulate perforation plate at one end and scalariform at the other end.  K. A terminal portion of a vessel element with spiral and pitted thickenings.  L. A fiber.  M. A central portion portion of fiber tracheid with bordered pits.

**Figure 4.7 Internal structure and macerated elements of stem of *Rhododendron arboretum* Sm.**
4.2.2 *Rhododendron burmanicum* Hutch.

4.2.2.1 Wood of stem

**General characteristics and properties of the wood**

Wood of stem of *Rhododendron burmanicum* studied is whitish yellow, its odour and taste not distinct. It is hard, straight-grained, and very fine-textured. The wood is ring-porous and its growth ring is distinct.

**Microscopic characteristics**

**Vessel elements:** Ring-porous, pores extremely small to very small, tangential diameter 12.5 – 30.0 μm (mean 20.6 μm), very fine-textured; pore solitary, radial multiples of 2, or clustered; solitary pores 47.3 – 75.0 %; pore polygonal; vessel elements simple pitted or bordered pitted, perforation plate reticulate; end walls of element oblique, tailed at one end; intervessel pits alternate, oval or elongated; vessel element moderately short to medium-sized; 220 – 550 μm (mean 390.86 μm) long, tyloses absent; gum deposit absent, crystals rarely present, pith flecks usually found in some annular rings.

**Fibres:** Fiber tracheid extremely short to medium-sized, 470 – 1000 μm (mean 673.4 μm) long and 12.5 – 25 μm (mean 21 μm) wide, wall 5.0 – 15 μm (mean 9.75 μm) thick, non-septate, with tapering ends; interfibre pits minute, bordered.

**Rays:** Heterogeneous, uniseriate to multiseriate; 15 – 25 (mean 20.3) per mm tangentially, very numerous; uniseriate rays 12 – 23 (mean 24.8) per mm tangentially, very numerous; multiseriate rays 0 – 4 (mean 2) per mm tangentially, very few to few; uniseriate rays 62.5 – 1220.0 μm (mean 450.6 μm) in height, 12.5 – 25 μm (mean 18.2 μm) in diameter, extremely fine to very fine, cells 1 – 30 (mean 9.3) layered; multiseriate rays 330 – 1350 μm (mean 704.7 μm) in height, 50 – 100 μm (mean 73.7 μm) in diameter, moderately fine to medium-sized, cells 15 – 48 (mean 27.6) layered; ray vessel pitting alternate, circular or oval in shape; gum deposits dark reddish-brown.

**Axial parenchyma:** Almost absent.

Figure 4.8 Internal structure and macerated elements of stem of *Rhododendron burmanicum* Hutch.
4.2.3 *Rhododendron cuffeanum* Craib ex Hutch.

### 4.2.3.1 Wood of stem

**General characteristics and properties of the wood**

Wood of stem of *Rhododendron cuffeanum* studied is whitish yellow, its odour and taste not distinct. It is hard, straight-grained, and very fine-textured. The wood is ring-porous and its growth ring is distinct.

**Microscopic characteristics**

**Vessel elements:** Ring-porous, pores very small, tangential diameter 25.0 – 37.5 μm (mean 29.7 μm), very fine-textured; pore solitary, radial multiples of 2 – 6, or clustered; solitary pores 67.7 – 90.1%; pore polygonal; vessel elements simple pitted or bordered pitted, perforation plate reticulate, end walls oblique, tailed at one end or both ends, intervessel pits alternate, oval or elongated; vessel element very short to medium-sized; 217.5 – 512.5 μm (mean 374.0 μm) long, tyloses absent; gum deposit absent. crystals rarely present, prismatic and druses found, pith flecks usually found in some annular rings.

**Fibres:** Fiber tracheid extremely short to very short, 300 – 682 μm (mean 472.7 μm) long and 20.0 – 37.5 μm (mean 24.3 μm) wide, wall 5.0 – 20.0 μm (mean 7.3 μm) thick, non-septate, with tapering ends; interfibre pits minute, bordered.

**Rays:** Heterogeneous, uniseriate to multiseriate; 8 – 19 (mean 14.6) per mm tangentially, numerous to very numerous; uniseriate rays 7 – 18 (mean 13.4) per mm tangentially, moderately numerous to very numerous; multiseriate rays 0 – 2 (mean 1.2) per mm tangentially, very few; uniseriate rays 62.5 – 650 μm (mean 286.7 μm) in height, 12.5 – 22.5 μm (mean 15.9 μm) in diameter, extremely fine to moderately fine, cells 1 – 14 (mean 5.5) layered; multiseriate rays 250 – 1010 μm (mean 480.2 μm) in height, 30 – 75 μm (mean 49.6 μm) in diameter, medium-sized, cells 6 – 43 (mean 19.7) layered; ray vessel pitting alternate, circular or oval in shape; gum deposits dark reddish-brown.

**Axial parenchyma:** Almost absent.
A. A portion of stem wood section as seen.  
B. T.S of stem wood showing annual rings.  
C. T.S of stem wood showing xylem rays.  
D. T.L.S of a portion of stem wood showing uniseriate and multiseriate rays.

E. T.S of stem wood showing tetraseriate ray and prismatic crystal in vessel.  
F. T.L.S of a portion of stem showing uniseriate and multiseriate rays, and bordered pits.  
G. R.L.S of a portion of stem wood showing uniseriate and multiseriate rays.  
H. R.L.S of stem wood showing ray cells and reticulated perforation plate.

I. A xylem fiber.  
J. A xylem fiber showing slit-like pits.  
K. A vessel element with reticulate perforation plates.  
L. A terminal portion of vessel element with reticulate perforation plates.  
M. A fiber tracheid.  
N. A central portion of fiber tracheid with bordered pits.  
O. A group of ray parenchyma cells.

Figure 4.9 Internal structure and macerated-elements of stem of *Rhododendron cuffeanum* Craib ex Hutch.
4.2.4 Key to the species

1. Stem wood ring porous, mean tangential diameter less than 40 μm, mean length of vessel elements less than 450 μm, mean length of fiber tracheid less than 800 μm, mean diameter of uniseriate ray less than 20 μm

2. Mean tangential diameter 20.6 μm, mean length of fiber tracheid 673.4 μm, mean number of rays per mm (tangential) 20.3, mean height of uniseriate rays 450.6 μm, mean height of multiseriate rays 704.7 μm ……... *Rhododendron burmanicum*

2. Mean tangential diameter 29.7 μm, mean length of fiber tracheid 472.7 μm, mean number of rays per mm (tangential) 14.6, mean height of uniseriate rays 286.7 μm, mean height of multiseriate rays 480.2 μm ………... *Rhododendron cuffeanum*

1. Stem wood semiring-porous, mean tangential diameter more than 40 μm, mean length of vessel elements more than 450 μm, mean length of fiber tracheid more than 800 μm, mean diameter of uniseriate ray more than 20 μm …………….. ……………………………………………………………….. *Rhododendron arboreum*
Table 4.5 Texture of wood, size of pores of stem wood of three species studied.

<table>
<thead>
<tr>
<th>No.</th>
<th>Species</th>
<th>Texture of wood</th>
<th>Pores in annual ring</th>
<th>Vessel diameter class</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><em>Rhododendron arboreum</em></td>
<td>Very fine textured</td>
<td>Semiring porous</td>
<td>Very small to moderately small</td>
</tr>
<tr>
<td>2</td>
<td><em>Rhododendron burmanicum</em></td>
<td>Very fine textured</td>
<td>Ring porous</td>
<td>Extremely small to very small</td>
</tr>
<tr>
<td>3</td>
<td><em>Rhododendron cuffeanum</em></td>
<td>Very fine textured</td>
<td>Ring porous</td>
<td>Very small</td>
</tr>
</tbody>
</table>

Table 4.6 Size of vessel element of stem of three species studied.

<table>
<thead>
<tr>
<th>No.</th>
<th>Species</th>
<th>Vessel element length</th>
<th>Tangential diameter of vessel element</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Range</td>
<td>Mean</td>
</tr>
<tr>
<td>1</td>
<td><em>Rhododendron arboreum</em></td>
<td>280–670</td>
<td>485.6</td>
</tr>
<tr>
<td>2</td>
<td><em>Rhododendron burmanicum</em></td>
<td>220–550</td>
<td>390.86</td>
</tr>
<tr>
<td>3</td>
<td><em>Rhododendron cuffeanum</em></td>
<td>217–512</td>
<td>382.0</td>
</tr>
</tbody>
</table>

Table 4.7 Size of wood fiber of stem of three species studied.

<table>
<thead>
<tr>
<th>No.</th>
<th>Species</th>
<th>Fiber length</th>
<th>Fiber width</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Range</td>
<td>Mean</td>
</tr>
<tr>
<td>1</td>
<td><em>Rhododendron arboreum</em></td>
<td>550–980</td>
<td>831.7</td>
</tr>
<tr>
<td>2</td>
<td><em>Rhododendron burmanicum</em></td>
<td>470–1000</td>
<td>673.4</td>
</tr>
<tr>
<td>3</td>
<td><em>Rhododendron cuffeanum</em></td>
<td>300–682</td>
<td>472.7</td>
</tr>
</tbody>
</table>

Table 4.8 Number of rays per millimeter of the stem wood of three species of *Rhododendron*.

<table>
<thead>
<tr>
<th>No.</th>
<th>Species</th>
<th>Total no. per mm</th>
<th>No. of Uniseriate rays</th>
<th>No. of Multiseriate ray</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Range</td>
<td>Mean</td>
<td>Range</td>
</tr>
<tr>
<td>1</td>
<td><em>Rhododendron arboreum</em></td>
<td>7–20</td>
<td>13.1</td>
<td>5–18</td>
</tr>
<tr>
<td>2</td>
<td><em>Rhododendron burmanicum</em></td>
<td>15–25</td>
<td>20.3</td>
<td>12–25</td>
</tr>
<tr>
<td>3</td>
<td><em>Rhododendron cuffeanum</em></td>
<td>8–19</td>
<td>14.6</td>
<td>7–18</td>
</tr>
</tbody>
</table>

Table 4.9 Size of uniseriate ray of the stem wood of three species of *Rhododendron*.

<table>
<thead>
<tr>
<th>No.</th>
<th>Species</th>
<th>Height (μm)</th>
<th>Diameter (μm)</th>
<th>No. of cells high</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Range</td>
<td>Mean</td>
<td>Range</td>
</tr>
<tr>
<td>1</td>
<td><em>Rhododendron arboreum</em></td>
<td>70–680</td>
<td>271.3</td>
<td>15–30</td>
</tr>
<tr>
<td>2</td>
<td><em>Rhododendron burmanicum</em></td>
<td>62.5–1220</td>
<td>450.6</td>
<td>12.5–25</td>
</tr>
<tr>
<td>3</td>
<td><em>Rhododendron cuffeanum</em></td>
<td>62.5–650</td>
<td>286.7</td>
<td>12.5–22.5</td>
</tr>
</tbody>
</table>
Table 4.10 Size of multiseriate ray of the stem wood of three species of *Rhododendron.*

<table>
<thead>
<tr>
<th>No.</th>
<th>Species</th>
<th>Hight (μm)</th>
<th>Diameter (μm)</th>
<th>No. of cells high</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Range</td>
<td>Mean</td>
<td>Range</td>
</tr>
<tr>
<td>1</td>
<td><em>Rhododendron arboreum</em></td>
<td>280 – 780</td>
<td>489.4</td>
<td>40 – 90</td>
</tr>
<tr>
<td>2</td>
<td><em>Rhododendron burmanicum</em></td>
<td>330 – 1350</td>
<td>704.7</td>
<td>50 – 100</td>
</tr>
<tr>
<td>3</td>
<td><em>Rhododendron cuffeanum</em></td>
<td>250 – 1010</td>
<td>480.2</td>
<td>30 – 75</td>
</tr>
</tbody>
</table>

Table 4.11 Solitary pore percentage of the stem wood of three species of *Rhododendron.*

<table>
<thead>
<tr>
<th>No.</th>
<th>Species</th>
<th>Solitary pore</th>
<th>Radial multiple pore</th>
<th>Pole cluster</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Number</td>
<td>%</td>
<td>Number</td>
</tr>
<tr>
<td>1</td>
<td><em>Rhododendron arboreum</em></td>
<td>20 – 63</td>
<td>31.75 – 74.12</td>
<td>6 – 29</td>
</tr>
<tr>
<td>2</td>
<td><em>Rhododendron burmanicum</em></td>
<td>43 – 138</td>
<td>47.3 – 75.0</td>
<td>5 – 38</td>
</tr>
<tr>
<td>3</td>
<td><em>Rhododendron cuffeanum</em></td>
<td>42 – 136</td>
<td>67.7 – 90.1</td>
<td>2 – 18</td>
</tr>
</tbody>
</table>
Chapter 5

DISCUSSION AND CONCLUSION

Natma Taung National Park is located in West Ridges of Myanmar that possesses greener vegetation in comparison to that of surrounding area in Southern Asia (Fig. 3.1). It is restricted area of natural forest in Myanmar since years and it is an ideal national park possessing the national pride among the Asian countries.

The existence of Rhododendron in the Myanmar's Himalaya could be dated back to the Mesozoic was of the Cretaceous period and this area was considered to be the birth place of Mountain Rhododendron. These mountain azalea flowers were highly ornamental and of world famous (Kalya Lu 2013). The rhododendron trees of Chin hill are well known worldwide for its beauty and naturally become one of the national symbols of Chin State that can support the area to be used for purposes other than timber, such as recreation or research.

According Osborn (1984), Kingdon-Ward explored in Mt. Victoria in the southern Chin Hills and the slopes of Mt. Sarameti and found and recorded many Rhododendron species including Rhododendron arboretum, R. burmanicum, and R. cuffeeanum. He found many species of Rhododendron which had been existed since the Cretaceous period and they were freely regenerated in Natma Taung area up to date. There were about 205 species of the genus Rhododendron (Kress et al. 2003) in Myanmar hill forests. The detailed work of morphology of the genus Rhododendron was become more important to identify the species among many species, subspecies and varieties of Rhododendron.

The morphology of R. burmanicum and R. cuffeeanum were not found in literature available in Myanmar. These two species seemed to be not studied yet in Myanmar so far except Fujikawa’s (2006) herbarium charts that were deposited at Natma Taung Nationational Park Office. These species were identified by checking their characters with the aids of herbarium charts of Fujikawa (2006). R. arboreum was checked by the literature of Pearson and Brown (1932) and Shu (2005).

Among the three species studied in this paper, Rhododendron arboreum was small or moderately large trees whereas R. burmanicum was a small shrub and the rest R. cuffeeanum was small epiphytic plants. All of them were ever green and the flower colour was mainly
different from each other. Among the three species studied, individual leaf area was found to be highest in *R. arboreum* whereas it was the lowest in *R. cuffeanum*.

The characters of floral parts were quite different from each other and these characters can be used as distinguishing characters among the three species studied. The stamens of *R. arboreum* were glabrous, but those of the rest two species were found to be hairy at the basal portions. All of them had warty ovaries, and those of *R. arboreum* were not only warty but also tomentose with whitish hairs. The stigmas were generally found to be discoid in all of three species studied, but the stigma of *R. cuffeanum* was slightly hexangular whereas that of *R. burmanicum* was irregularly formed. Although the nectary glands were not distinctly formed in the flower of *R. arboreum*, the wavy annular ring of glands were formed at the base of ovary in each of the rest two species. The size of fruits of *R. arboreum* was also found to be quite different among the three species studied. It was longer than those of the rest two species studied.

Among the three species studied in this paper, stem wood of *R. arboreum* was semiring-porous whereas the two other were ring-porous in transverse section. The wood of the stem of all of the three species was found to be very fine textured. Very fine textured wood meant average tangential diameter of the vessels in the wood was found to be less than 100 μm according to Pearson and Brown (1932).

According to IAWA standard of measurement, vessel diameter of stem of *R. arboreum* was very small to moderately small, while that of *R. burmanicum* was extremely small to very small, and the rest *R. cuffeanum* was very small.

The length of vessel elements of the stem of *R. arboreum* was found to be the highest and that of *R. cuffeanum* was the lowest among the three species studied. Tangential diameter of vessel of the stem of *R. arboreum* was found to be the highest and that of *R. burmanicum* was the lowest.

There were somewhat remarkable areas of parenchymatous cells observed in transverse section of the stem wood in all of the three species that were known as pith flecks which might be irregular formation of parenchyma cells in mine made by insect larva or by other means.

The wood fiber length of the stem of *R. arboreum* was found to be the highest and it was followed by *R. burmanicum*. The lowest was observed in that of *R. cuffeanum*. 
The local people of the study area now became having much knowledge of the utility value of *Rhododendron* species. They naturally extremely harvested the stem and flowers of some *Rhododendron* species for their livelihood and some species of *Rhododendron* became being threatened as had been described by Kalya Lu (2013). Systematic management for *Rhododendron* species should be more emphasized not only in the study area but also in the other potentially over harvested area in Myanmar for conservation.

The flowers of *R. arboretum* were continuously used in wine making in study area so that this species was more likely to be over harvested. Subspecies of this species may potentially have use for wine making and many other *Rhododendron* species should also be considered to do research on them. The roots of *R. cuffeanum* were used to apply to treat acne by local people and juice of flowers was also used for menstrual disorder. All of the species studied possessed showy flowers so that all of them were useful to grow in gardens and road sides. The stems could be used as fuel wood and that of *R. arboreum* was used for building by local people.

The morphological characters of the species studied in this research paper might be useful in identification of the *Rhododendron* species and anatomical characteristics might also be useful to support in identification of the flowering plants. These characters might also help in the preparation of the flora of Myanmar. The threatening to the species of *Rhododendron* in Chin State should be environmentally aware and systematic management is highly needed in the study area to meet the local need and for the sustainable extraction of the species.
Reference