

Exomorphology of Abnormally Swollen Roots in Epiphytic Ericaceous Plants in Nepal

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Mitsuo SUZUKI* & Akira TAKAHASHI** : Exomorphology of Abnormally Swollen Roots in Epiphytic Ericaceous Plants in Nepal***

鈴木三男*・高橋 晃** : ネパールのツツジ科の着生植物にみられた
異常肥大生長した根の外部形態

Abstract

Abnormally swollen lignotuber-like organs in *Agapetes serpens*, *A. incurvata* var. *hookeri* and *Vaccinium nummularia* of the Ericaceae are described exomorphologically. They are epiphytic shrubs grown on tree trunks in subtropical or warm-temperate mossy forests in the Nepal Himalayas. Their stem bases become thickened and look like sweet potatoes. Although plant taxonomists know that some Ericaceous plants, *Vaccinium*, *Agapetes* and others, have swollen stem bases, only a few reports describe the swollen organs morphologically. Based on exomorphological observation, it is shown again that the swollen organs are not stem bases but roots. Swollen stems of woody plants are called lignotubers; consequently those organs will be called lignotuberous roots. Based on exomorphological observation, it is considered that the lignotuberous root of *Agapetes* develops as a storage organ which aids the plant in its epiphytic activity, and that of *Vaccinium* is a kind of root tubercle.

Key Words: *Agapetes*—Epiphyte—Lignotuberous root—Nepal—*Vaccinium*

Although swollen stems, roots and leaf bases which serve to store water, starch and other substances are quite common among perennial herbaceous plants, such swollen organs are fairly rare among woody plants. Among woody plants, swollen organs are known in *Manihot utilissima* POHL. (Euphorbiaceae), which is an important food plant cultivated widely in the tropics, *Adenostoma* (Rosaceae), *Eriodictyon* (Hydrophyllaceae, METCALFE and CHALK, 1950), *Adenia* (Passifloraceae), *Arctostaphylos* (JEPSON, 1916) and *Rhododendron* (CANT, 1937) of the Ericaceae, and some others. Most of them are regarded as a metamorphosis of the stem, except for *Manihot*, whose swollen organs are evidently roots which look like the tuberous roots of the Dahlia.

During the 1985 and 1988 cooperative botanical expeditions between Japan and Nepal in the Nepal Himalayas, the senior author collected some shrubby epiphytic plants with abnormally swollen organs. These epiphytes are usually on tall tree trunks in subtropical or warm temperate

evergreen forests, and their swollen stem bases are usually covered by dense mosses. They are identified as *Agapetes serpens* and *A. incurvata* var. *hookeri*, and *Vaccinium nummularia*. The occurrence of such swollen organs in *Agapetes*, *Vaccinium* and some other genera of the Vaccinoideae has been noticed by some collectors and taxonomists (CLARKE, 1882; AIRY SHAW, 1935; SLEUMER, 1966 and others), but no one has observed and described them morphologically or anatomically so far as we know. The abnormally swollen parts have been recognized in various ways: "stems greatly thickened at the base" (CLARKE, 1882); "the stem-bases and upper parts of the roots of *Vaccinium* are often swollen and superficially resembles lignotubers" (SLEUMER, 1966). Descriptions from field notes of collectors are cited in a series of comprehensive taxonomic studies on *Agapetes* by AIRY SHAW as follows: "with swollen spindle-shaped stems, epiphyte with very swollen roots", "roots tuberous, small carrot-like water-storing tubers occur at the base"

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Fig.1. Photographs of abnormally swollen organs of *Agapetes* and *Vaccinium* in Nepal. 1: a mass of lignotuberous roots of *Agapetes incurvata* var. *hookeri* fallen from a tree trunk, near Chichila, July 9, 1989. 2—3: *Vaccinium nummularia*, No.8840174, July 13, 1988. 4: *Agapetes serpens*, No.8540276, near Bhandar, September 10, 1985. 5—6: *Agapetes incurvata* var. *hookeri*, near Chichila. 5: No.8842001, July 9, 1988. 6: No.8840095, July 8, 1988. 7: Flowers of *Agapetes incurvata* var. *hookeri*, near Tashigaon, July 13, 1988.

(1935); "curious balls, like small marbles", "potato-like outgrowths on the stems", "large tuberous stems" (1949); "stems swollen" (1960a); "a tuberous root a foot long and about 5 inches in diameter, and fusiform" (1960b); "rootstock or base of stem formed into a large woody nodule", "woody tubers on the roots", "corky tubers on roots" (1968); etc. From these descriptions, it will be easily recognized that the swollen parts described in various ways indicate morphologically the same organs, although there are many variants which differ in shape and size. Therefore, we here try to describe the swollen organs as exactly as possible, based on the observation of living plants and fixed samples. To follow the way the swollen organs grow with age, we tried to read the number of growth rings on transverse sections of stems just above the swollen parts. The wood of those plants are diffuse porous, and the growth rings are usually quite indistinct, so that the assumed ages might not be correct in some cases. The plants with the specimen numbers are represented by herbarium specimens which are deposited in the University Museum of the University of Tokyo (TI). The wood structure of one species, *Agapetes serpens*, has already been described (SUZUKI and NOSHIRO, 1988).

This study is a part of the results of the cooperative botanical expeditions in the Nepal Himalayas between the Department of Forestry and Plant Research (formerly Department of Medicinal Plants), Ministry of Forest and Soil Conservation, H. M. G. Nepal, and the University of Tokyo in 1985 and Kanazawa University in 1988. We wish to thank Director General Dr. S. B. MALLA and the staff of the Department of Forestry and Plant Research, and National Council for Science and Technology, H. M. G. Nepal, for their help and hospitality during the expeditions. Thanks are also due to Dr. H. OHBA, University Museum, University of Tokyo, for his kind guidance during this study.

Observations

Agapetes serpens (WIGHT) SLEUMER

Specimen: No.8540275 (Fig.1-4 and Fig.2-3), d (diameter of stem)=1.5cm, h (plant height)=1.2m; No.8540276 (Fig.2-2), d=3cm, h=1.8m. Both specimens and another small plant (Fig.2-1)

are small evergreen epiphytic shrubs on the trunk of *Alnus nepalensis*, alt. 1860m, near Bhandar, Ramechhap District, Janakpur Zone (about 86°23' E, 27°34'N); collected by OHBA *et al.*, Sept. 10, 1985.

Description: Specimens usually have 3-6 roots arranged radially. In a young plant (Fig.2-1), whose stem is one year old, one or two of the roots, which originate from the hypocotyl directly, thicken from about 1-3 cm in diameter at the root base to 3-6 cm distally. In a larger plant (Fig. 2-2, about 5 years old), the roots thicken from about 5 cm in diameter at the root bases to about 10 cm distally, and the stem ends of the swollen roots fuse with each other to look like anchors. In an even bigger plant (Figs.1-4 and 2-3), which is 13 or more years old, five or more roots are swollen to a fairly big size, 10 cm or more in diameter and nearly 20 cm long. All of the swollen roots are spindle-shaped or sweet potato-like, with fused stem ends and tapered distal ends to normal roots. The surface of the thickened parts is covered by brown-colored secondary bark which is mainly cracked longitudinally and partially peeling off.

Agapetes incurvata (GRIFF.) SLEUMER var. *hookeri* (GRIFF.) SLEUMER

Specimen: No.8840095 (Fig.1-6 and Fig.4), d=1.5cm, h=2m, alt.1970m, July 8, 1988; No. 8842001 (Fig.1-5 and Fig.3-3), alt.1880m, July 9, 1988. These are small evergreen epiphytes on trunks of *Castanopsis* sp.; collected at Chichila, near Khandbari, Dhankuta District, Koshi Zone (about 87°13'E, 27°30'N), by M. SUZUKI *et al.*

Description: The swollen roots of this species are quite similar to those of *A. serpens*. In a young plant (Fig.3-1), which is one year old, the root below the hypocotyl is about 1.5 cm in diameter and 2.5 cm long. In a little larger plant (Fig.3-2), whose living stem is also one year old, the root is larger, about 2 cm in diameter and 8 cm long. A larger plant (Fig.3-3), whose stem is about four years old, has 6 swollen roots oriented radially from the hypocotyl. An individual root is slender spindle-shaped with tapering ends, 2-3 cm in diameter and 6-10 cm long. Some big plants have only one swollen root as shown in Fig.4, for the plant is about 10 years old or more. The outer bark is quite similar to that of *A. serpens*.

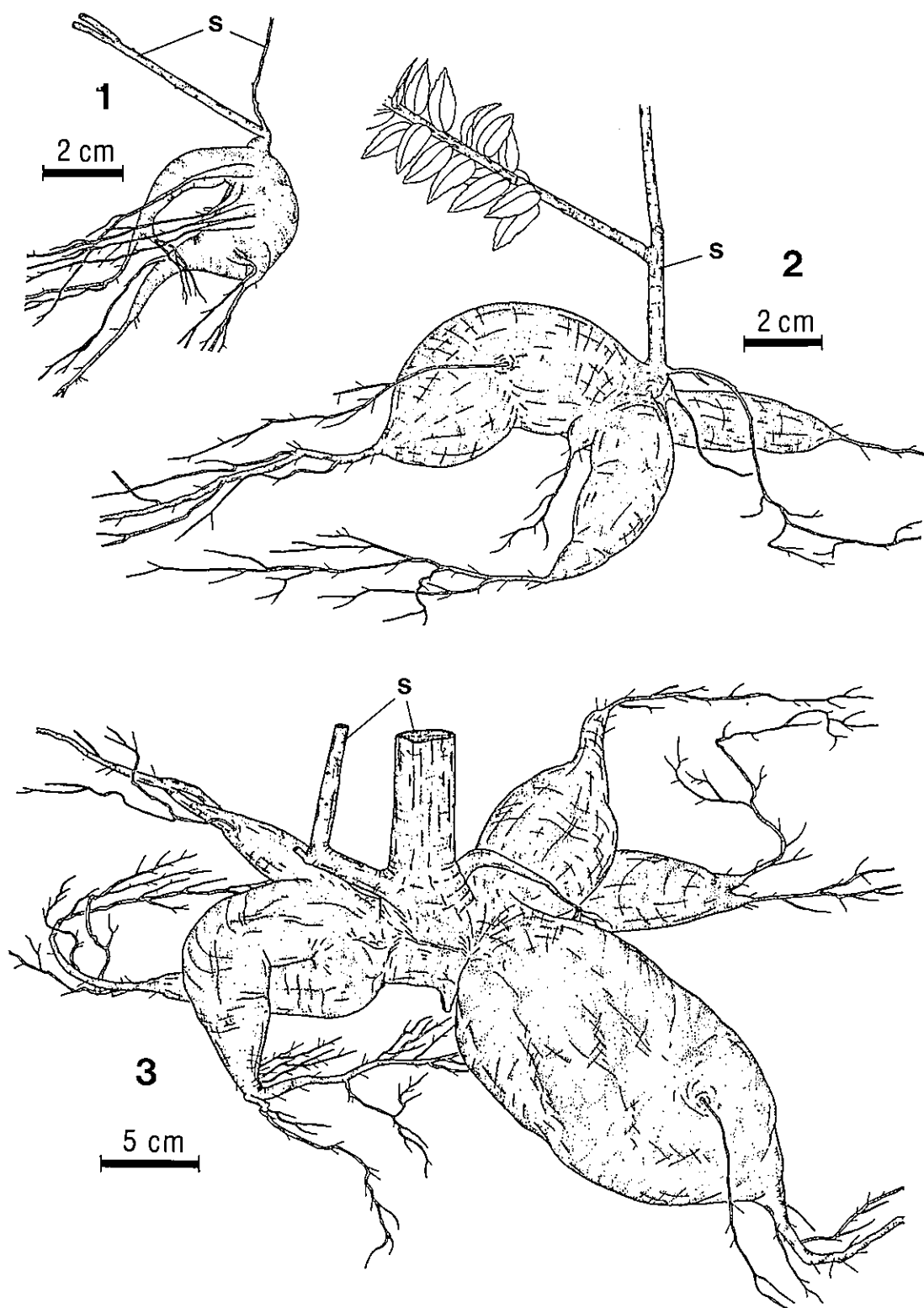


Fig. 2. *Agapetes serpens*. 1: one-year-old plant collected at the same place with Nos.8540275 and 8540276. 2: No.8540276, about 5 years old. 3: No.8540275, 13 years old or more. s: stem.

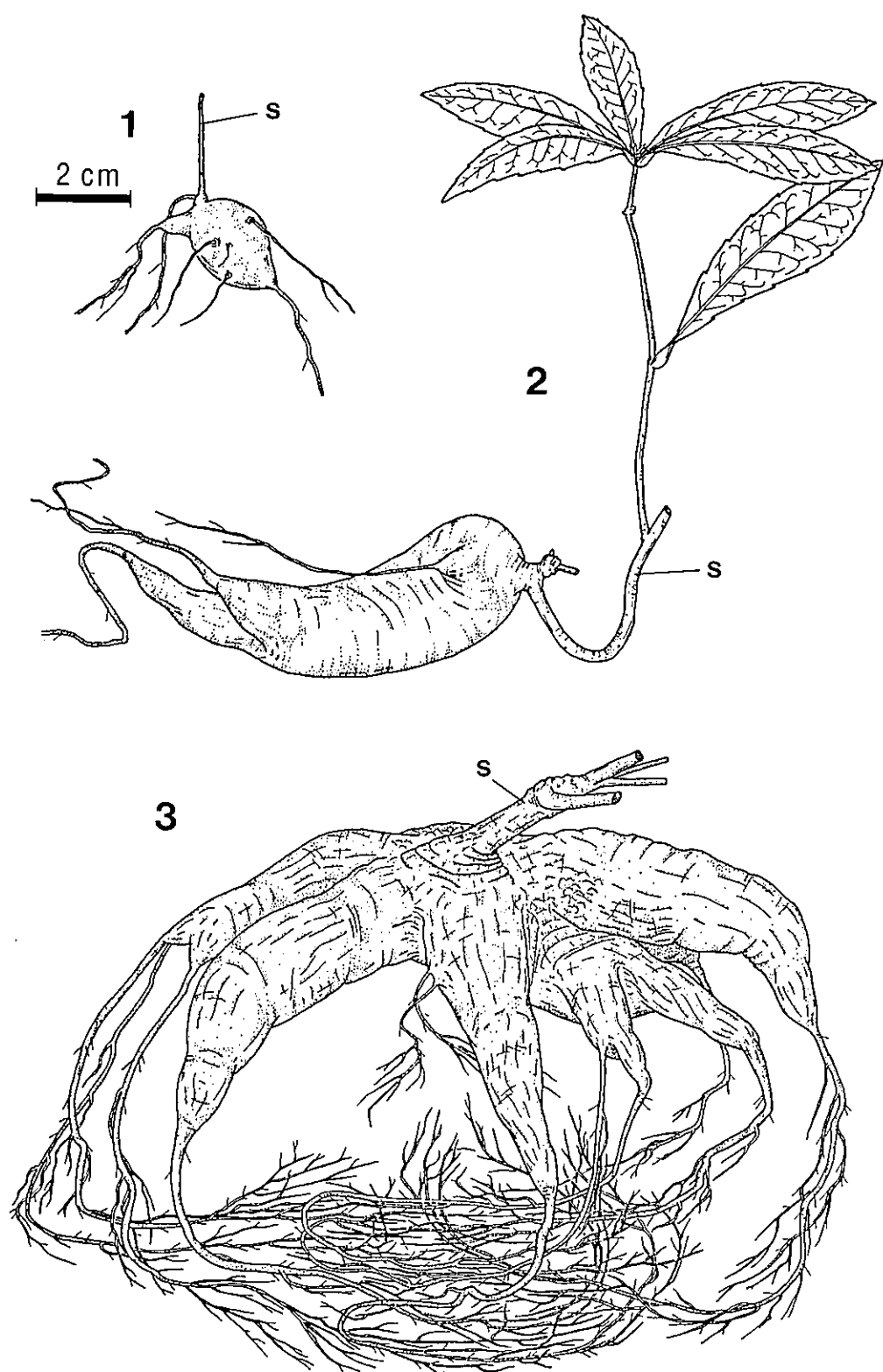


Fig. 3. *Agapetes incurvata* var. *hookeri*. 1,2: one-year-old plants collected at the same place with No.8840095.
3: No.8842001, about 4 years old.

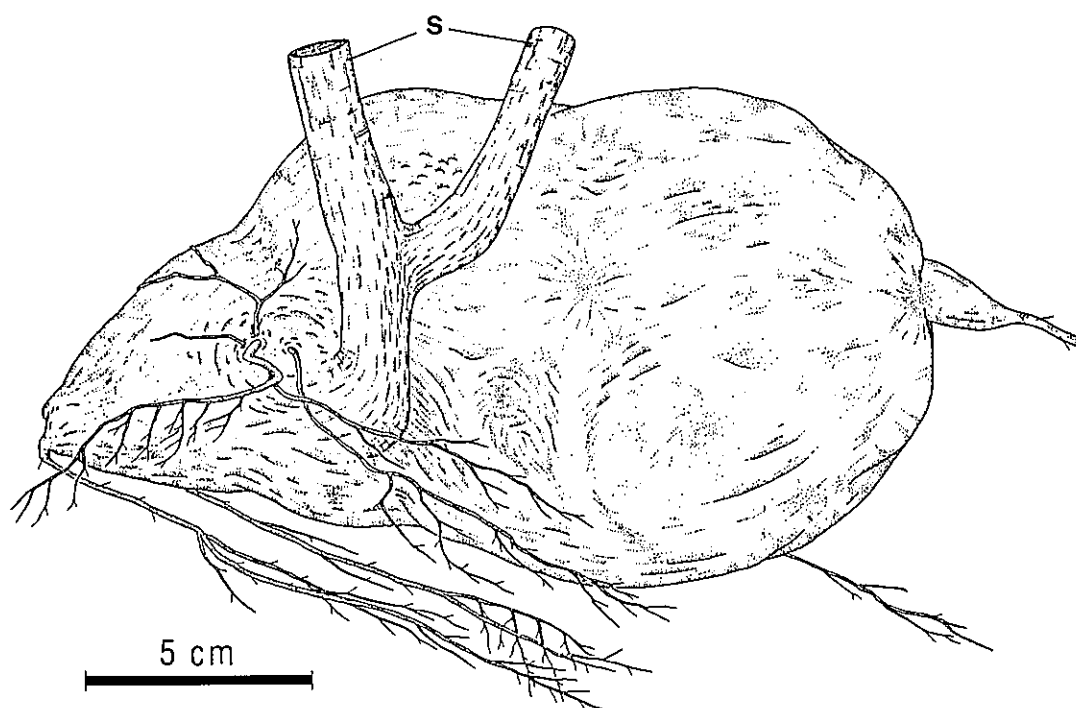


Fig. 4. A large lignotuberous root of *Agapetes incurvata* var. *hookeri*, No.8840095, about 10 years old or more.

***Vaccinium nummularia* HOOK.f. et THOMS.
ex C.B.CLARKE**

Specimen: No.8840174 (Figs.1-2 and 3, Fig.5), d=2cm, h=1.5m, an evergreen epiphytic shrub on a tree trunk, collected at Tashigaon, Dhankuta District, Koshi Zone (about 87°12'E, 27°37'N); collected by M. SUZUKI *et al.*

Description: The swollen roots of this species are quite different from those of *Agapetes*. They are not restricted to primary roots which originate directly from the hypocotyl, nor to the root base. This species has a long main stem which creeps on a tree trunk and branches into aerial stems with leaves and flowers. From the main stem, adventitious roots arise sporadically. Some of the adventitious roots become swollen and ball-like. Each root has one or more swollen parts with or without intervals (Fig.5). The three parts shown in Fig.5 are different parts of the same plant, the specimen No.8840174. Although the main stem of this plant is assumed to be 10 years old or more, the age of each swollen root is obscure. The surface is dark-brownish with many fine cracks in a cross-check pattern.

Discussion

Although some taxonomists have noticed abnormally swollen organs in *Vaccinium*, *Agapetes* and some other genera in the Vaccinoideae of the Ericaceae and considered them as stem bases in some cases and roots in other cases (CLARKE, 1882; SLEUMER, 1966; AIRY SHAW, 1936, 1949, 1959, 1960a, 1960b, 1968), they have not given any morphological description.

As described in this paper, the abnormally swollen parts of these Ericaceous plants are not stem, stem-bases or hypocotyls; they are roots. It is known that lignotubers or lignotuber-like organs develop in some other genera of the Ericaceae. JEPSON (1916) reported that *Arctostaphylos glandulosa* and some other species of this genus in California had swollen root bases named root-crowns which lay immediately at or below the surface of the ground. Although he called them root-crowns, the turnip-like swollen parts are surely a transitional zone between stems and roots. Such swollen stem bases are also found in the Maddenii Series of *Rhododendron* (CANT, 1937), which are normally shrubs and may on occasion be epiphytes. It is easily noticeable that

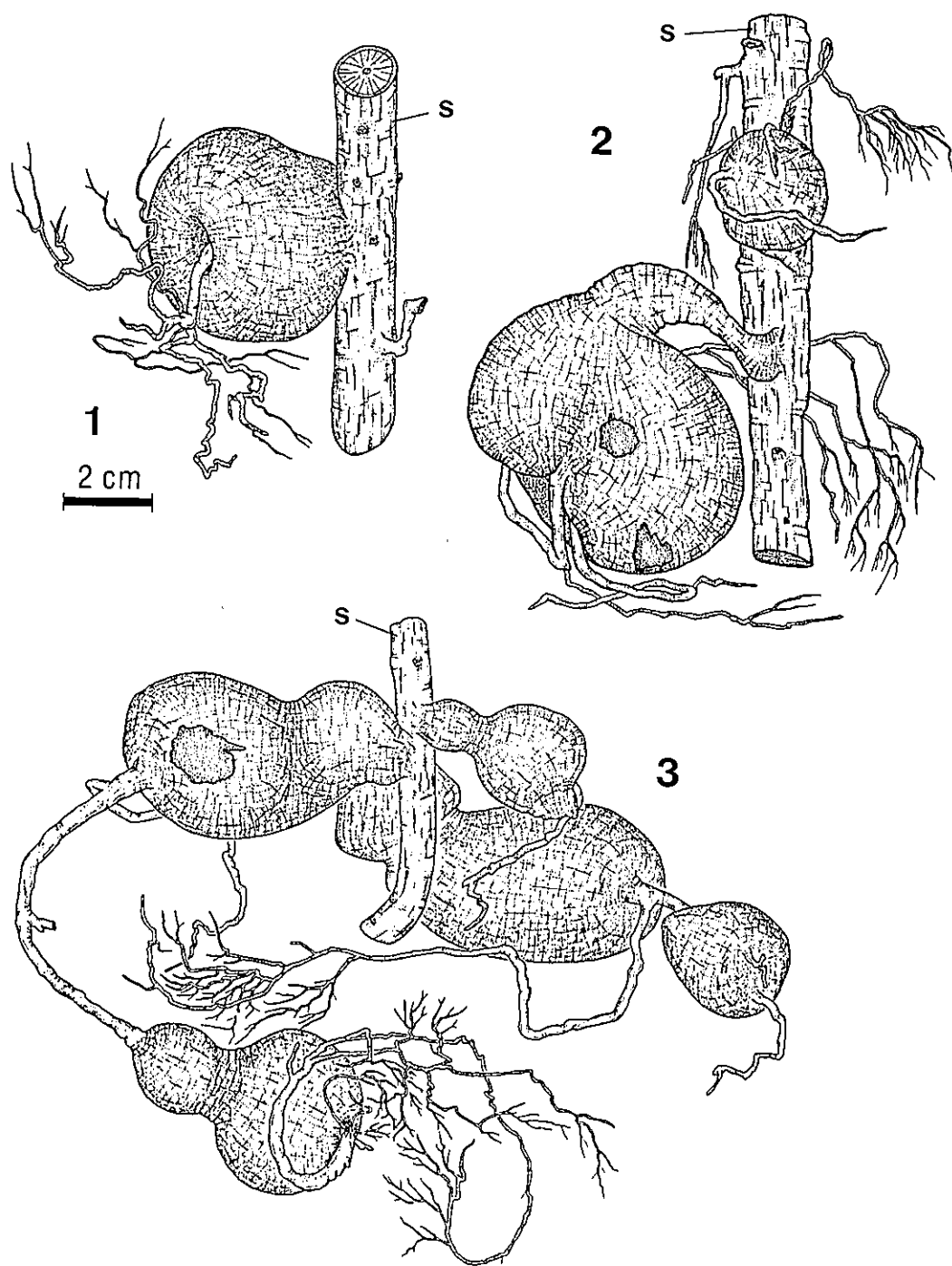


Fig. 5. *Vaccinium nummularia*, No.8840174, about 10 years old or more. 1–3: parts of creeping stem, with many swollen adventitious roots of the same plant.

those “root-crowns” are morphologically quite different from the tuberous roots observed in the present three species.

Furthermore, the shape and occurrence of those

tuberous roots are different in *Agapeles* and *Vaccinium*. Those of the former are usually spindle-like and extend radially from the stem base, while those of the latter are ball-or

nodule-like on adventitious roots. The bark surface of the former is fairly smooth but coarse in the latter, with many minute cracks. Although we could not get any direct evidence from this study, the morphological difference between the tuberous roots of the two genera may suggest that those of the former are storage organs for water and/or other substances, which develop in epiphytic plant in a sub-tropical climate with alternation of dry and rainy seasons, and those in the latter are a kind of root tubercle. To prove the difference, anatomical and histological studies will be required.

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摘要

文部省科学研究費による海外学術調査の際、ネパールの亜熱帯及び暖温帯常緑広葉樹林においてツツジ科の低木性の着生植物3種を見かけた。2種は東南アジアの熱帯から亜熱帯を中心に分布する *Agapeles* 属の *A. serpens* と *A. incurvata* var. *hookeri* で、いずれも樹上着生であり、残り1種は世界に広く分布するスノキ属の *Vaccinium nummularia* で、多くは樹上、時に岩上に着生していた。多湿なネパールの森林においては日本などでは地上生の植物の仲間が着生になることはなんら珍しいことではないが、このツツジ科の3種の著しい特徴はその根が異常に肥大生長し、貯蔵器官となっていることである。草本植物では茎あるいは胚軸が肥大生長して塊茎をなし、あるいはサツマイモのように根が肥大生長して塊根をなすのはごく普通にみられることだが、木本植物ではかなり珍しいことである。また、*Agapeles* や *Vaccinium* 属の分類やフローラの文献を見ても、そのように肥大生長する「茎の基部」を持つことの記載はあっても、それが植物形態学的にどの部分が肥大しているのかについては正確な記載が見あたらない。そこで本報ではその形態を詳しく記載し、それがどの部分であるかを検討した。試料は1985年および1988年の現地調査の際採集したもので、その生育状況を記載した後、大きな個体は標本番号をつけ、枝条は腊葉標本に、幹は木材組織用標本にし、肥大した部分は50%エチルアルコールで固定し、持ち帰った。また、これらの大きな個体と同じところに生えていた小さな個体も一緒に採集し、それも固定して持ち帰り、観察に供した。これらの肥大した部分をスケッチし、観察した結果、*Agapeles* の2種では肥大している部分はすべて根で、その肥大は茎の付け根、すなわち胚軸の下端から始まり、紡錘形になり、先端が通常の根に終わるものが胚軸から放射方向に1~6本くらいでき、植物体をスタンドのように支えているのに対し、*Vaccinium* では多かれ少なかれ樹幹上を這う主軸の不定根が所々で丸くボール状あるいはヒョウタン状に肥大していることが分かった。すなわちいずれもが根の部分が肥大生長していることでは共通だが、その肥大する部分と肥大の仕方にはこの両属で違いがあることが分かった。なお、塊根は tuberous root の訳であり、木化する塊茎には lignotuber という用語があるが、木化する塊根を示す言葉は見あたらないので、ここでは lignotuberous root という言葉を用いた。

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