The Natural History Journal of Chulalongkorn University 8(2): 135-142, October 2008

Phorophyte Diversity, Substrate Requirements and Fruit Set in *Dendrobium scabrilingue* Lindl. (Asparagales: Orchidaceae): Basic Observations for Re-introduction Experiments

SANTI WATTHANA[1*] AND HENRIK ÆRENLUND PEDERSEN[2]

[1]*Queen Sirikit Botanic Garden, P.O. Box 7, Mae Rim, Chiang Mai 50180, Thailand.*
[2]*Botanical Garden & Museum, Natural History Museum of Denmark, University of Copenhagen, Gothersgade 130, DK-1123 Copenhagen K, Denmark.*

ABSTRACT.– In February-March 2007 a population of the epiphytic orchid, *Dendrobium scabrilingue*, from Salawin Wildlife Sanctuary (province of Mae Hong Son, northern Thailand), was studied with regard to substrate diversity, demography and fruit set. Among the 10 tree species that occurred in the 50 × 50 m study plot, all but *Aporosa villosa* served as phorophytes for *D. scabrilingue*. The orchid was found growing at (1-)2-4(-7) m above the ground, usually on bark densely covered with lichens (*Aporosa villosa* was the only tree species with bark consistently devoid of lichens). The orchid population was dominated by small individuals, thus demonstrating successful reproduction by seed. As indicated by a positive correlation between plant size and frequency of flowering, larger individuals appear to be of major importance for the sexual reproduction. A low relative fruit set in the population (18.5 %), and the shape of a Lorenz curve plotted from fruit set data, suggest a mainly allogamous breeding system operated by insects (probably bees, judging from the floral morphology). Based on our observations of this natural population, specific recommendations are given that may increase the success rates in re-introduction experiments with the rare *D. scabrilingue*.

KEY WORDS: Orchids, Conservation, Flora of Thailand, Epiphytes, Ecology.

INTRODUCTION

The Orchidaceae are one of the largest angiosperm families with an estimated 20,000 epiphytic species from 500 genera (Dressler, 1981, 1993), often with species showing small scattered or hyperdispersed populations (Ackerman, 1986; Kress, 1986). Although the global distribution patterns of orchids are fairly well known, the patterns within forests are complex and poorly understood. Moreover, although some species are common, many are rare and exhibit large variations in life forms, habitat distributions and trophic patterns within genera. This limits the reliable cross-species

* Corresponding author:
Tel: (6653)-298-171
Fax: (6653)- 298 177
E-mail: S_watthana@yahoo.com

FIGURE 1. A flowering plant of *D. scabrilingue* growing on a tree trunk densely covered with lichens. (Photo by S. Watthana).

generalizations of statistically well-supported information attained from common species to the rare, where information on the roles of dispersal, germination and disturbance regimes for controlling population dynamics are desperately needed, for example for in situ conservation and for re-introduction programmes.

The ongoing general decrease in the number and size of orchid populations is mainly due to the loss and degradation of their habitats (e.g. Koopowitz, 2001; Koopowitz et al. 2003). Collecting for cultivation and medicinal purposes is in general a lesser threat, but it can be significantly devastating and the main threat for particularly sought after species (e.g. Schuiteman and de Vogel, 2000; Cribb et al. 2003). Particularly in such cases, transloca-tion of *ex situ* propagated indivi-duals to the wild through re-introduction projects can be a useful supplement to the protection of habitats (Ramsay and Dixon, 2003; Yam and Thame, 2005).

Dendrobium scabrilingue Lindl. (Asparagales: Orchidaceae), known as Ueang Sae Luang, or in English as the rough-lipped dendrobium (Fig. 1), is an epiphytic autotrophic orchid that occurs at 600–1400 m altitude–partly in hill evergreen forests and partly in the transition zone to dry deciduous dipterocarp forests. Flower-ing is seasonal and takes place from December until February (-March). The species is distributed in Myanmar, Thailand and Laos, and has its stronghold in the lower Salawin valley, on both sides of the border between Thailand and Myanmar (Wanandon, 1968; Seidenfaden, 1985). Within this region the local Thais, Shans, Lawas and Karens all have vernacular names for this attractive species (Wanandon, 1968).

Dendrobium scabrilingue is sympodial with up to approximately 10 tufted, erect shoots. Each shoot is up to 17(-30) cm tall and is dominated by a fleshy (up to 1.8 cm thick) clavate stem, the internodes of which are tightly covered with initially black-pubescent (later glabrous) leaf sheaths. Young leaves are produced distally, whilst old leaves are shed from below as the shoot grows. Short, 1- to 2-flowered (rarely 3-flowered) racemes are produced from the distal part of leafy (occasionally leafless) shoots (Fig. 1). The strongly fragrant flowers each measure 1.5-3.5 cm across, they are resupinate and remarkably persistent, lasting for 1-2 months. The sepals and petals are white and relatively broad, the lateral sepals forming a saccate mentum at base. The labellum is 3-lobed with erect, incurved side lobes and a porrect, slightly decurved mid-lobe. Whereas the side lobes are consistently white with numerous green nectar guides on their dorsal surface, the color of the mid-lobe changes from pale greenish yellow over pale yellow to golden yellow (rarely deep orange) during anthesis. The stigma is placed in a cavity on the front of the column, the rostellum produces a fragile sac of adhesive, and the versatile anther contains 4 naked pollinia. The fruit is a unilocular capsule dehiscing by longitudinal slits.

In the early 1900s, 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 Muang Yuam in Mae Hong Son had to pay annually to Chao Vijayanondh, the then ruling chief of Chiang Mai (Wanandon, 1968). Today, Muang Yuam has changed its name to Mae Sariang, but flowering shoots of *D. scabrilingue* are still being collected and used for hair decoration and adornment at private homes, and for paying respect to the images and shrines of Buddha. At a hotel in Mae Sariang District, a bouquet comprised of at least 50 flowering stems of *D. scabrilingue* in a silver bowl could recently be admired, filling the lobby with their strong, pleasantly sweet perfume.

An unfortunate effect of its local popularity as a cut flower is the illegal collecting activities. Most herbarium collections of this species are of older date (Watthana and Pedersen, unpubl.), which suggests a dramatic decline of *D. scabrilingue* in the wild. To counteract this development, Mae Jo University has initiated a conservation project based on the *in vitro* propagation of *D. scabrilingue* from seed. Some of the reared young plants are then used for re-inforcement of natural populations, whereas the others are given to local villagers for cultivation purposes (Kaewkamnoed, pers. comm.).

During orchid studies at Salawin Wildlife Sanctuary, Mae Sariang District, in late February 2007, the first author found a population of *D. scabrilingue* growing at c. 900 m altitude. The forest, standing on a slope of reddish sandy soil, was dominated by dipterocarps and oak species. At the time when flowering ceased, observations were made on the phorophyte (host plant) and microhabitat requirements of *D. scabrilingue* as well as on its fruit set. We anticipate that utilization of such biological data from a natural population may help to increase the success rates in re-introduction experiments with this presently rare species.

MATERIALS AND METHODS

A plot measuring 50 × 50 m was demarcated, and a 6 m tall ladder was used to access the canopy throughout this area (the trees being up to 7-8(-10) m tall). All tree species in the plot were recorded, and for each species it was noted if it served as a phorophyte for one or more individuals of *D. scabrilingue*. Additionally, the maximum and minimum heights of orchids above ground level were estimated as well as the canopy cover.

The length of the longest stem of every individual was measured and used as a general indicator of plant size. The number of flowering stems and the numbers of fruits and scars left after shedding of the flower(s) on each stem were counted in each individual.

Using the program SPSS for Windows 11.5, Spearman's correlation coefficient was used to test for correlations between plant size (as expressed by stem length) and (1) the number of individuals, (2) the number of flowers produced and (3) the frequency of flowering.

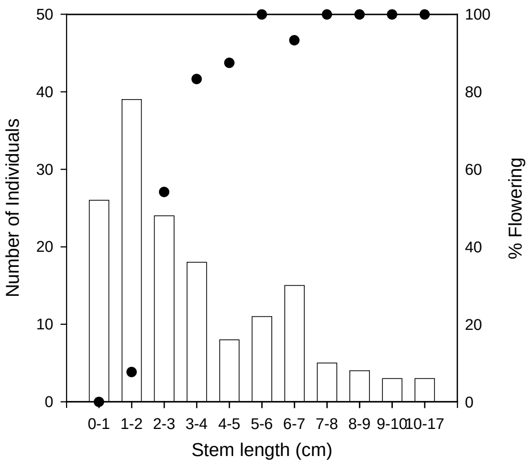

FIGURE 2. Population structure of *D. scabrilingue* according to size classes (columns), and the share of flowering individuals in each size class (dots).

Fruit set and relative fruit set were assessed, based on the numbers of fruits and scars left by shed flowers, on each individual. Additionally, all individuals with inflorescences were sorted in ascending order by the number of fruits they produced, and the cumulative percent of individuals was then plotted against that of the fruits to form a Lorenz curve (Weiner and Solbrig, 1984; Calvo, 1990). A diagonal line from the lower left to the upper right corner of the diagram would indicate equal contributions of individuals to the fruit pool, whereas curves deviating from this diagonal line would indicate inequality.

RESULTS

A total of 156 *D. scabrilingue* individuals were found in the study plot, and 10 tree species were recorded (Table 1). Only one of the tree species, *Aporosa villosa* (Wall. ex. Lindl.) Baill., did not serve as a phorophyte for the orchid. *Dendrobium scabrilingue* was observed to grow on vertical to horizontal trunks and branches at 1-7 m (mostly 2-4 m) above ground level, usually on bark that was densely covered with lichens (Fig. 1). The estimated visual canopy cover over the orchids varied from 10-40%.

In general, the number of individuals was found to decrease with increasing plant size ($P < 0.01$; Fig. 2). The smallest plant in which flowering was observed had a maximum stem length of 1.5 cm. The share of flowering individuals generally increased with increasing plant size ($P < 0.01$; Fig. 2), with ca. 50 and 100% of plants flowering when at 2-3 cm and greater than 7-8 cm stem length, respectively.

Overall, 50.0 % of the total number of orchid accessions were found to have flowered in the study year, and 6.4% produced more than 1 flower per stem. Whereas 5.1% of the individuals had produced flowers from two stems, only one plant had produced flowers from three stems. The longest stem recorded that did not produce any flowers was 6.5 cm long. The maximum stem length was positively correlated with the number of flowers produced ($P < 0.01$). In total, 18.5% (17 out of 92) of the flowers, derived from the 78 different individuals that flowered, set fruit. The relative unequal contribution of flowering individuals to the fruit pool of the population in the study year can be seen from the Lorenz curve (Fig. 3), with most fruits coming from relatively few (< 20%) flowering individuals.

TABLE 1. List of tree species occurring in the study plot. Only *Aporosa villosa* did not serve as a phorophyte for *Dendrobium scabrilingue*.

Species	Family
Anneslea fragrans Wall.	Theaceae
Aporosa villosa (Wall. ex. Lindl.) Baill.	Euphorbiaceae
Craibiodendron stellatum (Pierre) W.W. Sm.	Ericaceae
Dillenia L. sp.	Dilleniaceae
Gardenia sootepensis Hutch.	Rubiaceae
Gluta usitata (Wall.) Ding Hou	Anacardiaceae
Quercus L. sp.	Fagaceae
Shorea obtusa Wall. ex Blume	Dipterocarpaceae
Tristaniopsis burmanica (Griff.) Peter G. Wilson & J.T.Waterh. var. *rufescens* (Hence) J.Parn. & Nic Lughadha	Myrtaceae
Vaccinium sprengelii (G.Don) Sleumer	Ericaceae

DISCUSSION

The phenology of *D. scabrilingue* appears closely adapted to the seasonal dynamics of its habitat. In the dry season, from November to April, the canopy cover is less dense than in the rainy season (from May until October). Vegetative growth of the orchid ceases by the beginning of the dry season, and the storage resources are then used for sexual reproduction in the period with the highest abundance and activity of pollinators. New vegetative shoots may be formed in the next rainy season.

According to Wanandon (1968), *D. scabrilingue* is usually found growing "on such trees as" *Dipterocarpus tuberculatus* Roxb., *Melanorrhoea usitata* Wall. (= *Gluta usitata* (Wall.) Ding Hou), *Tristania rufescens* Hance (= *Tristaniopsis burmanica* (Griff.) Peter G. Wilson & J.T.Waterh. var. *rufescens* (Hence) J.Parn. & Nic Lughadha), *Shorea obtusa* Wall. ex Blume, *Wendlandia* Willd. spp., oaks and chestnuts. This is a systematically broad spectrum of phorophytes, and the apparent generalist nature of *D. scabrilingue* is supported by our data (Table 1), albeit at a single surveyed site. Like most other epiphytic orchid species (e.g. Went, 1940), *D. scabrilingue* appears not to be adapted to grow on specific species of phorophytes, although we found it to be specifically absent from *Aporosa villosa*, at least at this one site. This was the only tree species in the plot with a consistently naked bark, i.e. with no coverage of bryophytes or lichens. A dense coverage of lichens and bryophytes on the trunks and branches of other trees in tropical orchid habitats tends to change the substrate characteristics in such a way as to offer better germination conditions for orchid seeds-perhaps by providing shelter, withholding small amounts of humus and reducing evaporation (Dressler, 1981; Arditti, 1992; Watthana, 2005). However, it has also been observed that the thalli of foliose lichens may overgrow and harm seedlings of epiphytic orchids (Zotz and Vollrath, 2003).

The population structure, according to the size classes found in the present study, of *D. scabrilingue* (Fig. 2) is similar to demographic patterns previously reported for the orchids *Dimerandra emarginata* (G.F.W. Mey.) Hoehne (Zotz, 1998), *Jacquiniella leucomelena* Schltr. (Winkler &

Hietz, 2001) and *Pomatocalpa maculosum* (Lindl.) J.J. Sm. subsp. *andamanicum* (Hook.f.) S. Watthana (Watthana, 2005, sub nom. *P. naevata* J.J.Sm.). The dominance of small (probably young) individuals in the population demonstrates that reproduction by seed is successful. The reason for the very low number of large individuals is not clear. Whilst this may reflect different requirements for, or differential mortality between germination and survival of seedlings as opposed to mature orchids, including susceptibility to disturbance, it also seems likely that large individuals, due to their usually rich floral display, are particularly often collected by local orchid hunters. For example, a long bamboo stick, which was found during the field work, might well be an orchid collecting tool left behind by its owner. In order to secure the *D. scabrilingue* population at Mae Sariang on a long-term scale, special care must be taken to preserve large individuals, since large plants appear to be responsible for a much higher proportion of the sexual reproduction than smaller plants (Fig. 2). Incidentally, this pattern is similar to that reported for *Pomatocalpa maculosum* subsp. *andamanicum* in southeastern Thailand (Watthana, 2005, sub nom. *P. naevata*).

The present study did not include direct observations on the breeding system of *D. scabrilingue*. However, the low relative fruit set in the population (18.5%) indicates that pollination is dependent on pollen vectors. Correspondingly, the Lorenz curve (Fig. 3) is strongly skewed to the right and thus much more similar to the curves that Calvo (1990) provided for allogamous orchid species than for the autogamous *Oeceoclades maculata* Lindl. (see also Pedersen et al., 2005; Watthana, 2005; Watthana et al.,

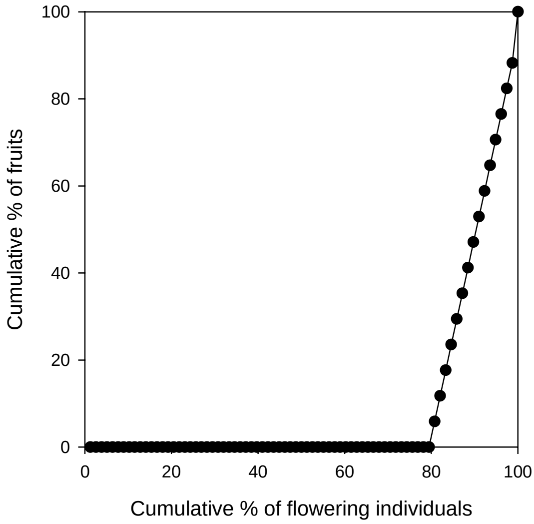

FIGURE 3. Lorenz curve for flowering individuals of *Dendrobium scabrilingue* in the study plot at Salawin Wildlife Sanctuary.

2006). Altogether, our data on fruit set suggests an insect-operated breeding system of relatively low efficiency, but probably with a fairly high rate of outcrossing. To date, no observations of the pollination of *D. scabrilingue* have been reported, but the flowers fit the bee pollination syndrome of van der Pijl and Dodson (1966). In this context it should be noted that pollination by bumblebees has been observed in the closely related *D. infundibulum* Lindl. (Kjellsson et al. 1985).

Our results suggest that the following practices should increase the success rate when trying to (re-)introduce *in vitro* propagated plants of *D. scabrilingue* to other sites in northern Thailand: (1) the localities selected should be situated in hill evergreen forest or in the transition zone to dry deciduous dipterocarp forest (600-1400 m alt.), and formerly known localities for *D. scabrilingue* should be given special priority; (2) the plants for re-introduction should be mounted 2-4 m above ground level and always on branches with a dense cover of bryophytes or lichens; (3) to speed up the establishment of natural reproduction by seed it should be considered not only to set out young individuals, but also a smaller number of well-grown plants.

Due to the scarcity of *D. scabrilingue* it was impossible to include more than one plot in our study. However, it would be desirable to obtain supplementary data from other sites to further assess the ecological amplitude of this species. Thus, findings from just a single plot should always be interpreted with caution–as demonstrated by e.g. Watthana et al. (2006) who found apparent specific habitat requirements of *Pomatocalpa spicatum* at a given locality to reflect local forest structure rather than specific requirements on behalf of the orchid.

ACKNOWLEDGEMENTS

We are grateful to Atipong Kiratikonkol, Pitak Panyachan and Pichai Chantabun for kind assistance during the field work, to the head and staff of Salawin Wildlife Sanctuary for permission to conduct this study and to an anonymous reviewer for constructive criticism of the manuscript.

LITERATURE CITED

Ackerman, J. D. 1986. Coping with the epiphytic existence: Pollination strategies. Selbyana, 9: 52-60.

Arditti, J. 1992. Fundamentals of Orchid Biology. John Wiley & Sons, New York.

Calvo, R. N. 1990. Inflorescence size and fruit distribution among individuals in three orchid species. American Journal of Botanyt, 77: 1378-1381.

Cribb, P. J., Kell, S. P., Dixon, K. W. and Barrett, R. L. 2003. Orchid conservation: A global perspective. In: Dixon, K. W., Kell, S. P., Barrett, R. L. and Cribb, P. J. (eds), Orchid conservation. Natural History Publications (Borneo), Kota Kinabalu, pp. 1–24.

Dressler, R. L. 1981. *The Orchids*: *Natural History and Classification.* Harvard University Press, Cambridge MA & London. pp.

Dressler, R. L. 1993. Phylogeny and classification of the Orchid family. Dioscorides Press, Portland, OR, USA.

Kjellsson, G., Rasmussen, F. N. and Du Puy, D. 1985. Pollination of *Dendrobium infundibulum*, *Cymbidium insigne* (Orchidaceae) and *Rhododendron lyi* (Ericaceae) by *Bombus eximius* (Apidae) in Thailand: a possible case of floral mimicry. Journal of Tropical Ecology, 1: 289-302.

Koopowitz, H. 2001. Orchids and their conservation. B. T. Batsford Ltd., London.

Koopowitz, H., Lavarack, P. S. and Dixon, K. W. 2003. The nature of threats to orchid conservation. In: Dixon, K. W., Kell, S. P., Barrett, R. L. and Cribb, P. J. (eds), Orchid conservation. Natural History Publications (Borneo), Kota Kinabalu, pp. 25–42.

Kress, W. J. 1986. Systematic distribution of vascular epiphytes: An update. Selbyana, 9: 2-22.

Pedersen, H. Æ., Watthana, S., Suddee, S. and Sasirat, S. 2005. Breeding system, post-pollination growth, and seed dispersal in Gastrodia exilis (Orchidaceae). Natural History Bulletin of Siam Society, 52: 9-26.

van der Pijl, L. and Dodson, C. H. 1966. Orchid Flowers: their Pollination and Evolution. The Fairchild Tropical Garden & University of Miami Press, Coral Gables.

Ramsay, M. M. and Dixon, K. W. 2003. Propagation science, recovery and translocation of terrestrial orchids. In: Dixon, K. W., Kell, S. P., Barrett, R. L. and Cribb, P. J. (eds), Orchid conservation. Natural History Publications (Borneo), Kota Kinabalu, pp. 259–288.

Schuiteman, A. and de Vogel, E. 2000. Orchid genera of Thailand, Laos, Cambodia, and Vietnam. Nationaal Herbarium Nederland, Universiteit Leiden branch, Leiden.

Seidenfaden, G. 1985. Orchid genera in Thailand XII. *Dendrobium* Sw. Opera Bottanist, 83: 1-295.

Wanandon, P. W. 1968. The ueang sae orchid (*Dendrobium scabrilingue* Lindl.). Natural History Bulletin of Siam Society, 22: 317-321, Pl. XVIII.

Watthana, S. 2005. Ecology and conservation biology of *Pomatocalpa naevata* J.J. Sm. (Orchidaceae). Natural History Bulletin of Siam Society, 52: 201-215.

Watthana, S., Pedersen, H. Æ. and Suddee, S. 2006. Substrate diversity, demography, and fruit set in two populations of the epiphyte *Pomatocalpa spicatum* (Orchidaceae) in Thailand. Selbyana, 27: 165-174.

Weiner, J. and Solbrig, O. T. 1984. The meaning and measurement of size hierarchies in plant populations. Oecologia, 61: 334-336.

Went, F. W. 1940. Soziologie der Epiphyten eines tropischen Urwaldes. Ann. Jard. Bot. Buitenzorg 50: 1-98.

Winkler, M. and Hietz, P. 2001. Population structure of epiphytic orchids. Selbyana, 22: 27-33.

Yam, T. W. and Thame, A. 2005. Conservation and reintroduction of the native orchids of Singapore. Selbyana, 26: 75–80.

Zotz, G. 1998. Demography of the epiphytic orchid, *Dimerandra emarginata*. Journal of Tropical Ecology, 14: 725-741.

Zotz, G. and Vollrath, B. 2003. The epiphyte vegetation of the palm *Socratea exorrhiza*: correlations with tree size, tree age and bryophyte cover. Journal of Tropical Ecology, 19: 81-90.

Received: 12 June 2008
Accepted: 20 August 2008