

ECOLOGY AND CONSERVATION BIOLOGY OF *POMATOCALPA NAEVATA* J.J. Sm. (ORCHIDACEAE)

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ABSTRACT

A population of the epiphyte *Pomatocalpa naevata* J.J. Sm. (Orchidaceae) was studied in the nature reserve Ban Pe Arboretum, Rayong Province, Southeast Thailand, during April–July, 2002. Phorophyte preference, distribution within phorophytes, flowering, fruit set, population structure and reproduction were assessed. *Pomatocalpa naevata* was not restricted to a specific phorophyte (host plant) but it exhibited a preference for growth on *Scleropyrum pentandrum* (Dennst.) Mabblerley (Santalaceae), *Diospyros malabarica* (Desr.) Kostel. var. *siamensis* (Hochr.) Phengkklai (Ebenaceae) and *Carallia brachiata* (Lour.) Merr. (Rhizophoraceae). It was found to be a shade-tolerant species distributed in the lower canopy zone of evergreen forest, and it was mainly found on vertical branch and trunk substrates. Distribution within the phorophyte seems to be limited primarily by light. The ability of soft or roughened bark to retain water seemed favorable to germination and growth. *Pomatocalpa naevata* was often associated with other epiphytes because of the influence of the physical substrate. A high proportion of small individuals was found, indicating successful reproduction in the population, while the number of large individuals was low. The frequency of flowering increased with increasing plant size. The distribution of fruits among individuals and the shape of the Lorenz curve suggest that the species is allogamous. Only 6.4% of all individuals produced flowers, and also the fruit set was low (2.1%). Inflorescence size did not influence the relative fruit set, but plants with a larger inflorescence did tend to have a higher probability to set at least one fruit. Vegetative reproduction was found to occur by the production of new subbasal shoots that subsequently detached from the mother plant. Successful germination was observed on substrates providing suitable shelter and moisture. To maintain genetic diversity in this population, special care should be taken to protect large individuals and their phorophytes.

Key words: orchids, ecology, conservation, demography, host preference, reproduction, fruit set

INTRODUCTION

The orchid genus *Pomatocalpa* Breda encompasses 35–40 epiphytic species distributed from Sri Lanka to Fiji, south to northern Australia and north to southern China and Taiwan. The genus is well represented in Thailand, where at least 9 species occur (SEIDENFADEN, 1988; SEIDENFADEN & WOOD, 1992). The highest number of endemic species is found in New Guinea.

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Pomatocalpa usually occurs on trees or limestone rocks in lowland forest in rather open areas from sea level to 650 m (e.g., HOLTTUM, 1957; SEIDENFADEN, 1988; COMBER, 1990; SEIDENFADEN & WOOD, 1992). There are two main groups of species characterized by their habit: (1) small fan-shaped plants with short internodes producing pendent inflorescences, and (2) large rambling plants with long internodes producing long pedunculate-branching inflorescences (KERR, 1985). Published information on the ecology of this genus is sparse. An exception, however, is a study of *Pomatocalpa spicata* Breda which has been examined with regard to phorophyte preference and distribution within its phorophytes (MURSIDAWATI *ET AL.*, 1999).

Pomatocalpa naevata J.J. Sm. (Figs. 1, 2), first described in 1912, is distributed in Thailand and Java. In Thailand it has only been recorded close to sea level in the southeastern part of the country (SEIDENFADEN, 1988). In Java it occurs from sea level to 600 m elevation (COMBER, 1990).

According to previous studies (e.g., WENT, 1940), orchids are usually non-specific for their phorophytes although a few species do show phorophyte specificity. Some trees are better orchid phorophytes than others (i.e., ACKERMAN *ET AL.* 1989; ALLEN, 1959; DRESSLER, 1981; MURSIDAWATI *ET AL.* 1999; SANTOS, 2000), with light, moisture and substrate as the main environmental factors governing the epiphyte/phorophyte relationship (JOHANSSON, 1975).

Most orchids are allogamous but some are autogamous (ARDITTI, 1992). Fruit set in many allogamous orchid species is low, due to phenomena such as low pollination level, resource limitation, and genetic self-incompatibility (e.g., ACKERMAN & MONTERO OLIVER., 1985; MONTALVO & ACKERMAN, 1987; GILL, 1989; ZIMMERMAN & AIDE, 1989; PEDERSEN, 1995; CHUNG & CHUNG, 2003).

Population structure of epiphytic orchids has not been widely studied, but the few existing studies have shown variable strategies of ecological adaptation (e.g., WINKLER & HIETZ, 2001; ZOTZ, 1998).

Ecological studies of orchids in tropical Asia, including Thailand, are rare despite the critical need for more information on many of these species. The rarity and ongoing illegal collection of many orchid species make the need for research particularly urgent (KOOPOWITZ, 2001). Core ecological information is necessary for the sustainable management of these important components of Thailand's biodiversity.

In the present study, I assess the distribution of the epiphytic orchid *Pomatocalpa naevata* within and among its phorophytes as well as its flowering, fruit set, population structure and reproduction.

MATERIAL AND METHODS

Study Site

The study site is situated in the nature reserve Ban Pe Arboretum, Rayong Province, Southeast Thailand. The total area of the reserve is 100 ha located as a narrow strip along the coastline and surrounded by areas of residential tourism. The average annual rainfall is around 1,500 mm, with a relatively dry period during November to March. The yearly range of the mean temperature is 27.9–28.8°C (climatological data from Rayong Station



Figure 1. Habit of *Pomatocalpa naevata* J.J. Sm.



Figure 2. Inflorescence and flowers of *Pomatocalpa naevata* J.J. Sm.

for the period 1991–2000). The vegetation type is evergreen forest on sandy soil, dominated by *Vatica odorata* (Griff.) Symington (Dipterocarpaceae), *Mangifera* sp. (Anacardiaceae), *Carallia brachiata* (Lour.) Merr. (Rhizophoraceae), *Scleropyrum pentandrum* (Dennst.) Mabberley (Santalaceae), and *Diospyros malabarica* (Desr.) Kostel. var. *siamensis* (Hochr.) Phengklai (Ebenaceae), while *Dipterocarpus alatus* Roxb. ex G. Don (Dipterocarpaceae) is the largest and tallest tree in the forest. *Pothos scandens* L. (Araceae) and *Hoya parasitica* (Roxb.) Wall. ex Traill (Asclepiadaceae) are the most frequent epiphytic plants, dominating and occurring densely on tree trunks/branches in this forest. Five species of orchids (*P. naevata*, *Cymbidium finlaysonianum* Lindl., *Grosourdyia appendiculata* Reichb.f., *Aerides falcata* Lindl., and *Dendrobium* sp.) are found in the area.

The forest patch, is rectangular in outline, with its longest dimension extending in a west-east direction. The study was carried out in April–July 2002, in an area 150 m x 200 m in dimensions, in the western end of the forest patch where *P. naevata* occurs abundantly.

General Notes on Data Analysis

The data were recorded and organized in Microsoft Excell. Statistical analyses were performed by the programme PractiStat (ASHCROFT & PEREIRA, 2003). Sigma Plot 8.01 was used for graphic display.

Phorophyte Preference and Distribution within the Phorophytes

In the study area, 10 plots 40 m x 10 m in size were established at random to census the species in the area. All individuals of woody plants measuring more than 10 cm circumference at chest height were counted in these plots. Because of the low frequency of *P. naevata* in the plots, the study was extended to include all phorophytes accommodating this species in the whole study area (150 m x 200 m). All individuals of *P. naevata* were registered, and their phorophytes were identified. For each individual, the following data were collected from its specific site on the phorophyte: branch or trunk circumference (cm), inclination (adaxial angle of the branch or trunk to the vertical plane), height above the ground (cm) and approximate canopy cover (%). The cover of other epiphytes, e.g. *Pothos scandens*, *Hoya parasitica* and *Pyrrosia piloselloides* (L.) M.G. Price (Polypodiaceae), was estimated according to three levels (no cover/ fragmentary cover/ continuous cover). Chi-square tests were used to test for phorophyte specificity and for the importance of a cover of other epiphytes.

Flowering and Fruit Set

The number of flowering plants and current inflorescences of *P. naevata* were counted on each single tree. Total flower production in each inflorescence was estimated by counting the flowers and scars. By the end of flowering, the natural fruit set was determined by the number of capsules produced. The individuals were sorted in ascending order by the number of fruits produced, and the cumulative percent of individuals were plotted against that of capsules to form a Lorenz curve (CALVO, 1990). Spearman's rank correlation coefficient was calculated to test for correlation between the inflorescence size (i.e., the number of flowers) and number of capsules produced. Student's t-test was used to determine

if larger inflorescence size increased the probability of the inflorescence producing at least one fruit.

Population Structure and Reproduction

The length of the longest stem in each *Pomatocalpa* individual was measured, and the plants were referred to arbitrarily defined size classes. When measuring the length of the stems, individuals in which the apex of the main shoot had been damaged were excluded. Current and old inflorescences were noted to indicate the frequency of flowering individuals in the population in 2001–2002. All shoots on each orchid individual were counted, as well as noting from where new shoots emerged (i.e., from the basal or apical part of the stem). Young leaf-bearing seedlings were searched for and counted on the phorophytes.

RESULTS

Phorophyte Preference and Distribution within the Phorophytes

In the study area, 466 *Pomatocalpa naevata* individuals were recorded growing on 50 phorophytes belonging to 18 species. In the plots, almost half of the woody species were found to serve as phorophytes for this orchid (Table 1). An over-representation of *P. naevata* individuals in the study area was found on *Scleropyrum pentandrum*, *Diospyros malabarica* var. *siamensis* and *Carallia brachiata* ($P < 0.05$), but it should be noted that these woody species were all among the dominant ones, at least in the plots (Table 1). Indeed, four of the five dominant species in the plots were recorded as phorophytes (Table 1). Thus, *P. naevata* is not dependent on particular species as phorophytes, but rather seems to avoid a few species. For instance, it was not found on *Mangifera* sp. although this was among the dominant woody species in the plots (Table 1).

Indicating the results as (min-) X_1 – X_2 (-max), where X_1 is the mean – SD and X_2 is the mean + SD, *P. naevata* individuals were found on branches 5.0 – 111.4 (-353.0) cm in circumference (mode = 162.0 cm) at (5.0-) 99.2 – 377.4 (-765.0) cm above the ground (mode = 250.0 cm). They were growing under (50.0-) 60.8 – 84.4 (-90.0)% canopy cover (mode = 80%) and never in direct sunlight. The inclination of branches supporting *P. naevata* was (0.0° -) 0.3 – 36.9 (-80°).

Pomatocalpa naevata was found to prefer phorophyte individuals with a dense cover of other epiphytes to those with a moderate or no cover ($P < 0.05$). Indeed, more than 50 % of the individuals occurred on phorophytes with a dense cover of other epiphytes (Table 2).

Flowering and Fruit Set

Forty percent of the plants with old inflorescences (from the previous year) produced inflorescences in the study year. 6.4 % of all individuals produced flowers, and 31 current inflorescences were found in the study area. In general, no more than a single inflorescence was produced by each flowering plant. However, one individual produced 2 inflorescences with 27 and 68 flowers, respectively. There were a total of 2,383 flowers, but only 50 (2.1

Table 1. List of woody species occurring in the plots. 15 of the 35 species (43%) were recorded as phorophytes.

Species	Number of individuals
Species recorded as phorophytes	
<i>Artabotrys harmandii</i> Finet & Gagnep. (Annonaceae)	4
<i>Carallia brachiata</i> (Lour.) Merr. (Rhizophoraceae)	13
<i>Cratoxylum formosum</i> (Jack) Dyer subsp. <i>formosum</i> (Guttiferae)	1
<i>Diospyros malabarica</i> (Desr.) Kostel. var. <i>siamensis</i> (Hochr.) Phengkklai (Ebenaceae)	13
<i>Dipterocarpus alatus</i> Roxb. ex G. Don (Dipterocarpaceae)	6
<i>Garcinia</i> sp. (Guttiferae)	1
<i>Gnetum</i> sp. (Gnetaceae)	2
<i>Meyna velutina</i> Robyns (Rubiaceae)	1
<i>Memecylon edule</i> Roxb. var. <i>ovatum</i> (Sm.) Cl. (Melastomataceae)	2
<i>Scleropyrum pentandrum</i> (Dennst.) Mabberley (Santalaceae)	18
<i>Shorea roxburghii</i> G. Don (Dipterocarpaceae)	8
<i>Streblus asper</i> Lour. (Moraceae)	7
<i>Syzygium cumini</i> (L.) Skeels (Myrtaceae)	10
<i>Vatica odorata</i> (Griff.) Symington (Dipterocarpaceae)	62
<i>Vitex glabrata</i> R. Br. (Labiatae)	8
Species not recorded as phorophytes	
<i>Anomianthus</i> sp. (Annonaceae)	2
<i>Capparis</i> sp. (Capparaceae)	1
<i>Careya arborea</i> Roxb. (Lecythidaceae)	1
<i>Casearia grewiifolia</i> Vent. var. <i>grewiifolia</i> (Flacourtiaceae)	1
<i>Cinnamomum</i> sp. (Lauraceae)	4
<i>Cissus</i> sp. (Vitaceae)	1
<i>Derris scandens</i> (Roxb.) Benth. (Leguminosae-Papilionoideae)	2
<i>Dillenia</i> sp. (Dilleniaceae)	7
<i>Flacourtia indica</i> (Burm.f.) Merr. (Flacourtiaceae)	1
<i>Garcinia cowa</i> Roxb. ex DC. (Guttiferae)	1
<i>Hopea odorata</i> Roxb. (Dipterocarpaceae)	5
<i>Lepisanthes rubiginosa</i> (Roxb.) Leenh. (Sapindaceae)	2
<i>Mangifera</i> sp. (Anacardiaceae)	19
<i>Memecylon edule</i> Roxb. var. <i>edule</i> (Melastomataceae)	7
<i>Ochna integerrima</i> (Lour.) Merr. (Ochnaceae)	10
<i>Phyllanthus emblica</i> L. (Euphorbiaceae)	4
<i>Pterospermum</i> sp. (Sterculiaceae)	1
<i>Semecarpus</i> sp. (Anacardiaceae)	2
<i>Siphonodon celastrineus</i> Griff. (Celastraceae)	4
Unknown	1
Total	232

Table 2. The distribution of *Pomatocalpa naevata* J.J. Sm. individuals in relation to the cover of other epiphytes on the phorophytes. Values are the number of individuals of *P. naevata* sampled in each category of phorophyte and epiphyte cover. The numbers in parentheses indicate the number of phorophyte individuals on which these orchids occurred and the largest number of *Pomatocalpa* individuals recorded from a single phorophyte.

Phorophyte species	No cover	Fragmentary cover	Continuous cover
<i>Artabotrys harmandii</i> Finet & Gagnep (Anonaceae)	0	0	5 (1/5)
<i>Carallia brachiata</i> (Lour.) Merr. (Rhizophoraceae)	4 (1/4)	14 (1/14)	38 (1/38)
<i>Cratoxylum formosum</i> (Jack) Dyer subsp. <i>formosum</i> (Guttiferae)	5 (3/3)	0	0
<i>Diospyros ferrea</i> (Willd.) Bakh. var. <i>ferrea</i> (Ebenaceae)	0	15 (1/15)	0
<i>Diospyros malabarica</i> (Desr.) Kostel. var. <i>siamensis</i> (Hochr.) Phengklai (Ebenaceae)	9 (1/9)	31 (4/18)	46 (2/41)
<i>Dipterocarpus alatus</i> Roxb. ex. G. Don (Dipterocarpaceae)	0	5 (1/5)	0
<i>Ficus restusa</i> L. var. <i>restusa</i> (Moraceae)	0	3 (1/3)	0
<i>Garcinia</i> sp. (Guttiferae)	4 (1/4)	0	0
<i>Gnetum</i> sp. (Gnetaceae)	12 (1/12)	0	0
<i>Knema</i> sp. (Myristicaceae)	22 (2/21)	0	8 (1/8)
<i>Meyna velutina</i> Robyns (Rubiaceae)	0	0	9 (1/9)
<i>Memecylon edule</i> Roxb. var. <i>ovatum</i> (Sm.) Cl. (Melastomataceae)	22 (5/9)	0	0
<i>Scleropyrum pentandrum</i> (Dennst.) Mabberley (Santalaceae)	10 (2/6)	8 (2/5)	130 (6/29)
<i>Shorea roxburghii</i> G. Don (Dipterocarpaceae)	13 (1/13)	0	0
<i>Sreblus asper</i> Lour. (Moraceae)	6 (1/6)	0	0
<i>Syzygium cumini</i> (L.) Skeels (Myrtaceae)	7 (1/7)	3 (1/3)	0
<i>Vatica odorata</i> (Griff.) Symington (Dipterocarpaceae)	19 (2/7)	0	0
<i>Vitex glabrata</i> R. Br. (Labiatae)	12 (5/8)	6 (1/6)	0
Total number	145	85	236
% of specimens	31.1%	18.2%	50.5%

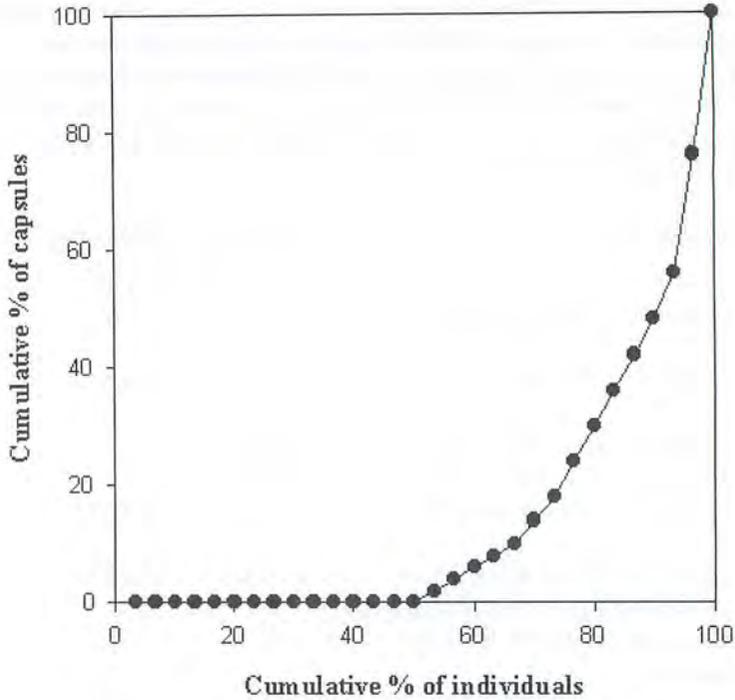


Figure 3. Lorenz curve for *Pomatocalpa naevata* J.J. Sm. A diagonal line from the lower left to the upper right corner would indicate equal contributions of individuals to the capsule pool, while curves deviating from this diagonal line indicate inequality (CALVO, 1990). Equality is usually associated with spontaneous autogamy.

%) developed fruit. The relative contribution of individuals to the capsule pool of the population can be seen from the Lorenz curve (Fig. 3).

No statistically significant correlation between the numbers of flowers and fruits was found. Thus, larger inflorescence size did not generally increase the fruit set, but it did increase the probability of the inflorescence producing at least one fruit ($P < 0.05$).

Population Structure and Reproduction

Generally, the number of individuals was found to decrease with increasing plant size (Fig. 4). The smallest size class (up to 20 cm maximum stem length) represented a much higher proportion of the total population (46.4% of the individuals) than any of the larger size classes. This pattern suggests successful reproduction in the population, but also a high mortality rate among young individuals. The smallest plant in which (current or past) flowering was detected had a maximum stem length of 28.5 cm. In general, the frequency of (current or past) flowering increased with increasing plant size (Fig. 4).

The longest stem measured in *P. naevata*, an epiphytic monopodial climber (Fig. 1), was 224 cm. Roots are produced along the stem and attach the orchid to the substrate. If the tip of a stem is damaged, a new lateral shoot will be produced from near the apex. On very long stems, new lateral shoots often appear from near the base. The basal part of stems, especially of long stems, continually dies from below, while the new subbasal shoots start to produce roots themselves (Fig. 5). Vegetative reproduction takes place by new, small shoots becoming disconnected and independent in this way.

Pomatocalpa naevata seedlings with emerging leaves (Fig. 6) were found on only three phorophyte species, viz. *Gnetum* sp. (6 seedlings), *Carallia brachiata* (3 seedlings), and *Scleropyrum pentandrum* (1 seedling). However, it is very likely that more seedlings were overlooked. The observed seedlings were shielded by a net of stems of epiphytic *Pothos scandens* and rhizomes and roots of *Pyrosia piloselloides*, or were partially covered by crustose lichens or bryophytes on the bark. Vegetative reproduction also appears to be significant in *P. naevata*. A total of 65 new subbasal shoots, bound to become new independent individuals, were found on 10.1 % of the *P. naevata* individuals.

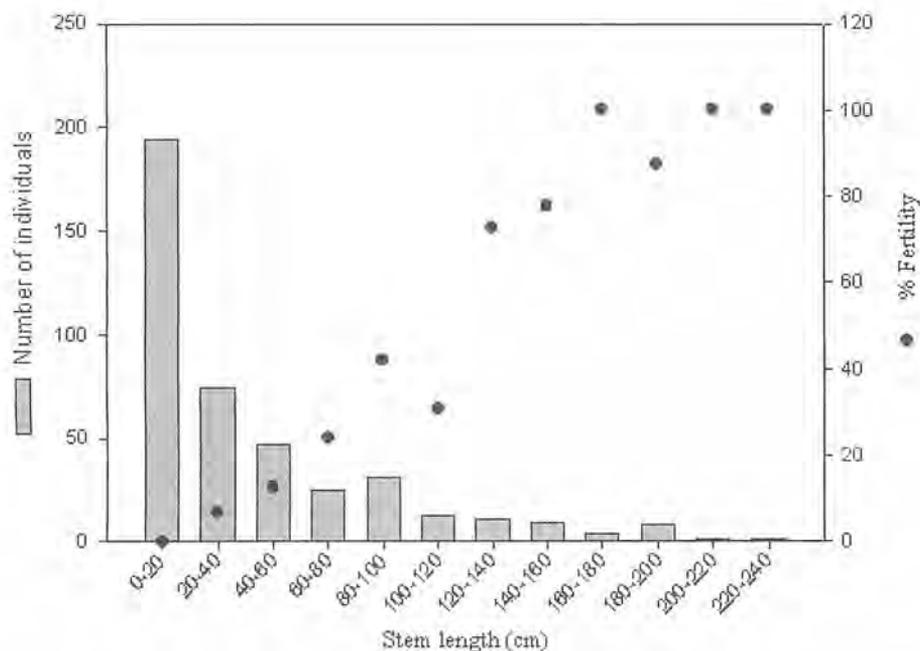


Figure 4. Population structure of *Pomatocalpa naevata* J.J. Sm. (number of individuals in different size classes) and the relative fertility of each size class (expressed as % of specimens having at least one new or old inflorescence).

DISCUSSION

Phorophyte Preference

Scleropyrum pentandrum, *Diospyros malabarica* var. *siamensis* and *Carallia brachiata* were found to accommodate more individuals of *P. naevata* than the other phorophyte species (Fig. 7). Furthermore, all of these were among the most frequent one-third of the phorophyte species, when the importance as phorophyte was calculated as the mean number of *P. naevata* individuals per phorophyte individual (Fig. 8). The other phorophyte species making up this uppermost one third were *Diospyros ferrea* var. *ferrea*, *Shorea roxburghii*, and *Gnetum* sp. (Fig. 8). However, due to fewer individuals being phorophytes (Fig. 7), the latter three species were of secondary importance to *P. naevata* in the study area. Most of the remaining phorophyte species seemed to be of relatively little importance to *P. naevata* (Figs. 7, 8). They may or may not support germination and seems to support the growth of mature plants very poorly.

The total number of tree species in the study area was not assessed, but within the plots, 43% of all woody species were found to be phorophytes (Table 1). A notable exception among the dominant species was *Mangifera* sp. (Table 1). The most dominant species, *Vatica odorata*, was registered as phorophyte, but accommodated only few individuals of *P. naevata*. Thus, seeds of *P. naevata* might be dispersed to the bark of *Vatica*, but germination and growth seem to be poorly supported by this substrate.

Distribution within Phorophytes

Judging from this study and from further observations from Ko Chang, Trat Province, Southeast Thailand (WATTHANA, unpublished), *P. naevata* is a species tolerant of shade (i.e. the dense canopy cover). This orchid can be found on the lower trunk and trunk zone (see the classification of JOHANSSON, 1975) of tall trees such as *Carallia brachiata*, *Vatica odorata* and *Shorea roxburghii*. On small trees such as *Scleropyrum pentandrum* and *Diospyros malabarica* var. *siamensis*, *P. naevata* occurs from near the ground to the outer canopy because of suitable light conditions. It was found growing on branches etc. of all size. Consequently, as long as light conditions are suitable, this species may grow on trunks, boughs, branches, or twigs.

The monopodial growth habit of *P. naevata* determines that the shoot apex has the potential for unlimited growth. If the apex of the main shoot is damaged, a new branch subsequently emerges near the apex (HOLTUM, 1955). Roots emerge along the stem and make it possible for the plant to climb on a branch or trunk. It seems to prefer horizontal branches or trunks to vertical ones.

Germination Sites

A soft or spongy bark with roughened surface as well as a bark covered by lichens and bryophytes might offer better germination conditions for tiny orchid seeds by giving shield and moisture (ARDITTI, 1992; DRESSLER, 1981). Six *P. naevata* seedlings were found on the bark of *Gnetum* sp., densely covered by crustose lichens. This suggests that such lichens may facilitate orchid germination and establishment (another 4 seedlings were



Figure 5. Subbasal shoot producing roots itself. It will later be disconnected from the mother plant.



Figure 6. Seedling of *Pomatocalpa naevata* J.J. Sm. on *Gnetum* stem where covering dense crustose lichens.

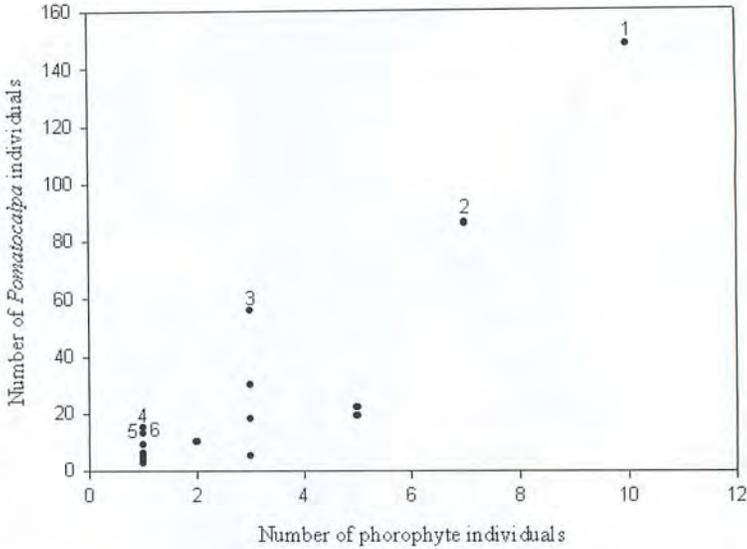


Figure 7. Quantitative distribution of *Pomatocalpa naevata* J.J. Sm. among phorophyte species (arranged according to their frequency as phorophytes). Each dot represents one phorophyte species. The most important of these phorophyte species are: 1. *Scleropyrum pentandrum*; 2. *Diospyros malabarica* var. *siamensis*; 3. *Carallia brachiata*; 4. *Diospyros ferrea* var. *ferrea*; 5. *Shorea roxburghii*; 6. *Gnetum* sp. The dots representing the latter two species are confluent.

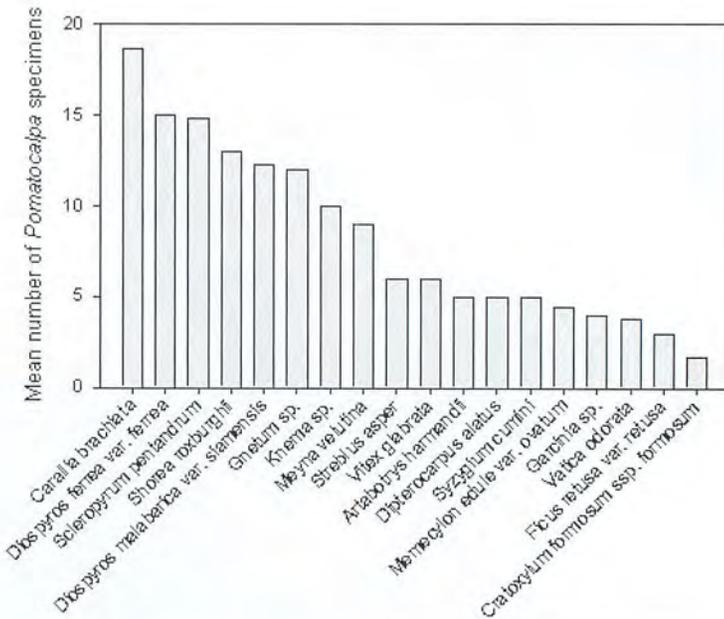


Figure 8. Mean number of *Pomatocalpa naevata* J.J. Sm. specimens per phorophyte specimen in each phorophyte species.

given shelter and moisture from a net of stems of *Pothos scandens*). On the other hand, the relations between epiphytic orchid seedlings and foliose lichens can be negative as the thalli may overgrow and presumably kill the seedlings (ZOTZ & VOLLRATH, 2003).

Most individuals of *Pomatocalpa naevata* were found on phorophytes with a continuous cover of other epiphytes, mainly *Pothos scandens* (Table 2). They might have changed the physical character of the substrate and increased water retention, presumably to the benefit of the germination and/or growth of *P. naevata*. Some *P. naevata*, however, grew on phorophytes such as *Knema* sp. (Myristicaceae) that had no other epiphytes.

Demography and Reproduction

The demographic pattern in the *P. naevata* population of the present study was similar to the one that ZOTZ (1998) and WINKLER & HIETZ (2001) found in the orchids *Dimerandra emarginata* (G.F.W. Mey.) Hoehne and *Jacquiniella leucomelena* Schlechter, respectively. The dominance of small individuals in the population demonstrates reproductive success, but, since only few very young leaf-bearing seedlings were detected, the frequency of sexual reproduction seemed to be low. Although one capsule can contain several thousand seeds, successful germination depends heavily on environmental factors. Thus it is not surprising that few seedlings survive.

This study did not include direct observations on the breeding system of *P. naevata*. However, the Lorenz curve (Fig. 3) is much more similar to the curves that CALVO (1990) provided for allogamous orchid species than for the autogamous *Oeceoclades maculata* Lindl. Inflorescence size was found not to affect the relative fruit set. Plants with larger inflorescences did tend to have a higher probability to set at least one fruit—a phenomenon known also from studies of other orchid species (e.g. FIRMAGE & COLE, 1988; CALVO, 1990). More than 60 % of the individuals with fresh or old inflorescences did not produce flowers in the study season, possibly due to resource limitation (cf. ACKERMAN 1989; MONTALVO & ACKERMAN, 1987).

Quantitatively, vegetative reproduction seems more important than sexual reproduction. More plantlets are produced and they are more likely to survive. Since vegetative reproduction involves no genetic recombination and dispersal is limited, even rare instances of sexual reproduction are probably important in order to maintain adaptability and increased colonization ability.

Threats and Recommended Conservation Measures

The low number of large individuals of *P. naevata* might be due to falling down of phorophytes, which is a frequent phenomenon in tropical forests (VAN DER MEER & BONGERS, 1996). Large tree-falls are known to occur during storms in the study area. Such large tree-falls have the potential of destroying entire populations of epiphytes (ZOTZ & VOLLRATH, 2003). However, such epiphytes as *P. naevata* that rely heavily on large/ or old individuals for sexual reproduction are also vulnerable to degradation of the forest through selective logging. This is because the large trees tend to go first—those which naturally tend to hold most of the older epiphyte specimens.

In order to preserve *P. naevata* at Ban Pe (and probably elsewhere), care should be taken not to allow too much direct sunlight through the canopy. Additionally, in order to

secure the genetic diversity of the population, special care must be taken to preserve large individuals and their phorophytes, since large plants of *P. naevata* have higher reproduction value than younger plants. Long-stemmed monopodial orchid species with climbing habit are found in several Thai orchid genera, e.g. *Acampe*, *Micropera*, *Staurochilus* and *Thrixspermum*, and it seems likely that some of the findings from the present paper may be valid for those species too. However, similar studies should be conducted to reveal ecological features and the conservation biology of short-stemmed monopodial orchids—leaf-bearing (e.g. *Pomatocalpa spicata*) as well as leafless ones (e.g. *Taeniophyllum* spp.).

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