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Perspectives on orchid conservation in Queen Sirikit Botanic Garden: recommendations based on a SWOT analysis

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ABSTRACT. Queen Sirikit Botanic Garden (QSBG) offers eminent conditions for growing native Thai orchid species and for contributing to the conservation of these species, both *ex situ* and in the wild. Based on a SWOT analysis, it is suggested that a more strategically structured organization of orchid-related activities in the garden may greatly facilitate QSBG's development into a science-based orchid conservation centre for Thailand and adjoining areas. Specifically, it is recommended that the activities should be combined into three basic components: (1) A "diversity collection" accommodating an immense number of native Thai orchid species – and serving the purposes of *ex situ* conservation and of PR, teaching and structural/taxonomic research that may directly or indirectly support *in situ* conservation; (2) a "propagation centre" for experimental *ex situ* research in germination, mycorrhiza and inbreeding vs outbreeding depression, and for propagating shifting priority species for reintroduction or reinforcement programmes; (3) a "field research unit" responsible for mapping ecological requirements of species that are high-profile candidates for reintroduction or reinforcement projects, and for providing molecular data for pinpointing genetically depleted populations that could benefit particularly from reinforcement. Additionally, it is emphasized that collaboration between QSBG and other scientific institutions should be further developed for the benefit of everyone involved – and for the benefit of orchid conservation.

KEYWORDS: Biodiversity, Orchidaceae, propagation, reinforcement, reintroduction

INTRODUCTION

Due to its situation in a phytogeographic transition zone, Thailand accommodates a highly diverse orchid flora (c. 1,200 species), especially if compared with neighbouring regions of a similar size. Unfortunately, the rich Thai orchid flora has suffered seriously from habitat loss, as demonstrated by the decreasing forest cover of the country (Collins *et al.*, 1991; Stibig *et al.*, 2004), and many orchid species are now included in the Thai redlist of plants (Santisuk *et al.*, 2006). The critical situation of many species is

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accentuated by illegal collecting for commercial purposes. This is particularly important for showy species belonging to widely cultivated genera such as *Vanda* (e.g. Seidenfaden, 1988: 197) and *Paphiopedilum* (e.g. Cribb, 1998), see also Figs. 1–2. Against this background, it is hardly surprising that native Thai orchids have been one of the focal groups of Queen Sirikit Botanic Garden (QSBG) ever since this institution was founded, and that the present director explicitly aims at developing QSBG into a science-based orchid conservation centre.

It is not only in Thailand that the need for orchid conservation has been realized in the later years. On the global scene, orchids are probably the only plant family that has been nearly as successful as mammals and birds in catching attention in a conservation context – and several books have recently been devoted to the field of orchid conservation worldwide (e.g. Pritchard, 1989; Hágsater & Dumont, 1996; Koopowitz, 2001; Dixon *et al.*, 2003). In a recent paper entitled "Perspectives on orchid conservation in botanic gardens", Swartz & Dixon (2009) demonstrated to which extent orchid conservation in botanic gardens in general could – and should – be intimately integrated with scientific research. In the present paper I will apply a SWOT analysis and the principles of Swartz & Dixon (2009) for exploring the perspectives on orchid conservation in QSBG. Does it seem possible to develop QSBG into a science-based orchid conservation centre for Thailand and adjoining areas – and how can such a development be promoted?

METHODS

SWOT analysis is a useful tool for evaluating the strengths (S), weaknesses (W), opportunities (O) and threats (T) for various situations in business, institutions and organizations, not least when it comes to identifying areas for development. As a first step, the desired objective (end state) is defined. Subsequently, the "strengths" can be identified as attributes of the concerned institution (or organization etc.) that are useful in order to achieve the objective; "weaknesses" can be identified as attributes of the institution that are harmful in order to achieving the objective; "opportunities" can be identified as external factors that are helpful in order to achieving the objective; and "threats" can be identified as external factors that may damage the objective. Based on the SWOT analysis, strong avenues of development may be created by matching strengths and opportunities. Furthermore, weaknesses or threats may be converted into strengths and opportunities; alternatively, they should be minimized or avoided.

Having defined the objective as "QSBG developed into a science-based orchid conservation centre for Thailand and adjoining areas", A SWOT analysis was prepared, based on my experience from more than a decade of close collaboration with QSBG. Collaboration has mainly happened as joint *in situ* orchid studies, combined with examination of plant material in the nurseries and the herbarium. During these activities I have thoroughly discussed diverse aspects of QSBG's organization and engagement in orchid conservation with a wide selection of

staff, especially scientists and leaders. Furthermore, I have participated in the organization of two international conferences and a workshop at QSBG, and I was deeply involved in the planning and organization of the DANCED/DANIDA-funded project "Capacity Building in the Field of Biodiversity, Queen Sirikit Botanic Garden" (1999-2005). As part of the latter project I also taught an orchid course at QSBG, and I was the supervisor for a PhD student from QSBG studying orchids. In August 2009 I was officially appointed external research consultant at QSBG with the special task to help develop and promote QSBG as a centre for orchid research and orchid conservation. Following this, my interest in orchid-related administration and organization of this institution naturally increased even further – soon leading to the SWOT analysis and recommendations presented below.

Results

The SWOT analysis is briefly outlined in Table 1, and the various issues of the four overall categories (viz. strengths, weaknesses, opportunities and threats) are elaborated below.

Strengths

The geographic and topographic situation of QSBG is a perfect setting – both for cultivating tropical orchids and for linking the *ex situ* conservation activities in the garden to *in situ* research and reintroduction activities in the wild. These features are even more pronounced if also QSBG's satellite gardens in other parts of Thailand are taken into account.

The logistic basis is excellent, too, with plenty of nursery space and exhibition areas, combined with for example herbarium magazines and laboratories for *ex situ* germination experiments as well as other physiological studies.

Both with regard to the number of species and the number of individual plants, QSBG has a remarkably large collection of live orchids collected in the wild; arguably it is one of the largest living orchid collections in Asia. In this context it should be noted that species composition of the collections in the satellite gardens is highly complementary to the composition of the collection at QSBG's main campus.

The scientific staff of QSBG includes several individuals who are more or less engaged in (often conservation-related) orchid research. Together, these dedicated staff members represent competences in a wide selection of research areas in orchidology – including, for example, systematics, phylogeny, population biology, germination, mycorrhiza, pollination and conservation genetics. Furthermore, both the present director and her predecessor have demonstrated a clear wish to include orchid conservation among the primary focal points of QSBG.

In the field of orchidology, QSBG has established research collaborations with a number of Thai universities (that typically offer complementary laboratory facilities), mainly in the northern part of the country. Furthermore, QSBG staff is thoroughly engaged in preparation of the orchid account for the multilateral Flora of Thailand project

as well as in studies of orchid ecology in collaboration with researchers from Copenhagen, Montpellier, Zürich, Tokyo etc.

QSBG hosts the secretariate of the Native Thai Orchid Network (NTON). With presently c. 85 members, NTON is potentially a powerful facility to help strengthen collaboration in orchid conservation between QSBG and other (primarily Thai) scientific institutions (Pedersen *et al.*, 2009).

Weaknesses

Activities regarding orchid conservation in QSBG appear somewhat dispersed. Furthermore, they suffer from lack of coordination, especially in relation to activities performed by various Thai universities.

No system of unique identifiers is consistently applied to the living orchid collection in QSBG. Therefore, it is often impossible to trace the provenance of individual plants – a circumstance that severely limits the scientific basis for conservation activities (Kell & Maxted, 2003).

In comparison with the vast orchid collections at QSBG, the availability of relevant scientific literature (both as hardcopy and electronically) is remarkably low for the staff studying and developing the collections. Indeed, this problem should be of major concern in connection with the ability of staff members to continuously keep their knowledge up-to-date.

Despite a high number of native Thai orchids (including threatened species) being on display at QSBG, little is being done to provide the public visitors with relevant information on the various species. As the visitors are hardly being taught seminal knowledge of orchid-related biodiversity, QSBG does not fully utilize its immense public contact for raising public awareness of orchid conservation. Indeed, botanical gardens like QSBG have great opportunities for contributing to public education in an orchid conservation context (Light *et al.*, 2003).

Scientific institutions may be granted CITES registration numbers by the national CITES authorities, so that scientific exchange of material of species covered by the convention can be exempted from the standard procedures established for regulating international trade in these species. QSBG does not yet have a CITES registration number. This means that, currently, no orchid material (living or preserved) can be exchanged, not even on loan, with foreign collaboration partners without formal import and export permits being issued on each single occasion.

QSBG offers a splendid settting for teaching student courses on orchid-related biodiversity and conservation. Indeed, botanical gardens like QSBG have great opportunities for contributing to education and capacity building in an orchid conservation context (Light *et al.*, 2003). Courses at QSBG could well include both activities in the collections and laboratories of QSBG and field activities in nearby nature reserves – but no such courses are taught on a routine basis.

Opportunities

Internationally there is a long tradition for botanical gardens to share living material of rare and threatened orchid species (e.g. Stewart, 1992: 133). The size of nurseries and existing orchid collections in QSBG would clearly allow for expanding the international collaboration of the garden to include exchange of live orchid material – or to join/initiate multilateral conservation programmes on orchids.

No internationally important orchid conservation centre already exists in Thailand or immediately adjoining areas, and no other scientific institution in the same region can offer similarly wide-ranging, comprehensive and extensive facilities and abilities for establishing such a centre.

As indicated above, the orchid flora of Thailand is remarkably species-rich. Furthermore, as many orchid species have their northern, eastern, southern or western range boundary in the corresponding part of Thailand, QSBG has direct access to various floristic elements that are only marginally represented in Thailand.

Last, but not least, there is a massive public admiration of orchids – both globally in general and in Thailand in particular (Kamemoto & Sagarik, 1975; Thammasiri, 2005). The admiration of orchids is often accompanied by an interest in their intriguing adaptations, and there is a steadily growing public realization of the need for orchid conservation. Furthermore, the public interest of orchids in Thailand is currently growing, as demonstrated by the distinctly increasing frequency by which new orchid field guides are being published (Pedersen *et al.*, 2009). This is an eminent background for further developing orchid conservation activities in QSBG which has a vast yearly number of visitors.

Threats

Reduction in staff and funding is naturally a threat towards any progressive development of QSBG as a centre for orchid research and orchid conservation. Apart from intensifying already existing weaknesses (such as scarcity of available literature, limited scientific information to public visitors and the lacking registration of collections at individual level), reduction in staff and funding also has the potential to harm the capacity for research, orchid care and international collaboration etc.

In recent years, the environmental political focus has started changing from direct conservation of biodiversity (including orchids) to issues such as global warming and other environmental threats to public health and the well-being of humanity. Clearly, this development must be expected to gradually remove previous funding possibilities and political support for orchid conservation in QSBG and elsewhere.

Discussion

Following the SWOT analysis, the task remains to evaluate how identified weaknesses and threats can be avoided, minimized or even converted into strengths and opportunities – and how strengths and opportunities can be matched to create

promising avenues for development, eventually leading to achievement of the objective: QSBG developed into an orchid conservation centre for Thailand and adjoining areas. In general, externally governed reductions in funding and change of political focus are difficult to influence by QSBG. However, to which extent these threats will harm the above objective (rather than other parts of QSBG) depends heavily on the internal priorities made by the management of QSBG. Apart from the lack of a CITES registration number (for the issue of which the QSBG management should lobby intensively), all other identified weaknesses can be converted into strengths by the QSBG management, given the necessary attention, funding and time. The identified opportunies together represent a splendid setting, and there are several ways in which strengths and opportunities can be matched to create promising avenues for development.

As demonstrated by the SWOT analysis, the orchid-related facilities and activities at QSBG already today include a wide range of what could possibly be done in a science-based conservation context – in line with the principles of Swartz & Dixon (2009). There is a multitude of species which are partly on display; there are high-capacity propagation and nursery facilities, and several staff members are engaged in studying and reintroducing orchids into the wild. However, since these facilities and activities serve different purposes that only overlap to a limited extent, I do believe that QSBG's contribution to orchid conservation would benefit from an organizational structure and planning that more clearly recognizes the different purposes. More precisely, I would recommend a structure consisting of three basic components, viz. a "diversity collection", a "propagation centre" and a "field research unit". It is clear that the three components will interact in various ways (Fig. 2), for which reason their activities should be closely coordinated. However, as the components basically serve different purposes (see below) I think that QSBG's overall contribution to orchid conservation will benefit from a tripartite structure.

It is an important feature of all three components that they would greatly benefit from expanded collaboration with other scientific institutions in Thailand and abroad. Apart from strengthening research, collaboration with universities would offer opportunities for teaching orchid-related biodiversity and conservation at QSBG (including field activities in nearby nature reserves) – either as special orchid courses or incorporated into more widely defined courses on tropical biodiversity and conservation.

Especially with regard to collaboration within Thailand I would like to emphasize the existence of the so-called Native Thai Orchid Network. This formal network of about 85 professional orchidologists is a major resource for stimulating and coordinating joint research projects in orchid conservation in Thailand (Pedersen *et al.*, 2009). QSBG accommodates the secretariat and therefore has a unique opportunity to invite relevant network members for joint projects.

International exchange of plant material could take place on a continuous basis (supporting the overall development of the orchid collections both at QSBG and botanical gardens abroad) as well as on special occasions – for example as a means to increase the genetic diversity among plants to be included in a specific propagation programme. However, the Thai authorities eventually issuing a CITES registration number for QSBG is an essential prerequisite of establishing such exchange collaborations between QSBG and botanical gardens abroad.

The diversity collection

The primary task of the "diversity collection" would be to accommodate as many native Thai orchid species as possible. In principle, just one or two individuals of each species would be sufficient for solving this primary task. However, the "diversity collection" should not only focus on taxonomic diversity, but also on intraspecific genetic diversity. Thus, a secondary purpose would be to have as many species as possible represented by different provenances. For example, *Dendrobium secundum* should not only be represented by a plant from the neighbourhood of Chiang Mai – but also by a few plants originating from northeastern, eastern, southeastern and peninsular Thailand.

The diversity collection serves a number of different purposes. Two important purposes are to provide a gene bank for *ex situ* conservation and a study collection for taxonomists and other scientists (de Vogel *et al.*, 1999). However, the "diversity collection" is also a very important tool for education and for raising public awareness of conservation (Light *et al.*, 2003).

It is clear that in a collection where it is not only attempted to reach a high level of taxonomic diversity, but also comprenhensive intraspecific genetic diversity, it is extremely important that all individual plants are numbered and databased together with all such data that also accompany herbarium specimens. Obviously, it is equally important that this necessity is clearly communicated and explained to all members of the staff, not least to the gardeners responsible for the day-to-day care of the plants.

In order for QSBG to develop into an orchid conservation centre of not only national but also international importance, establishment of online access to the database is strongly recommended. Apart from helping to promote QSBG on the international scene, this would also support conservation-related research through transparency and collaboration (cf. Kell & Maxted, 2003; Lughadha & Miller, 2009).

For public relations purposes it is naturally a basic condition that the public visitors to QSBG are admitted into the "diversity collection", but it is also important to remember that the fascinating stories must be told. If QSBG does not display boards with information on the different species – or, alternatively, provide such information electronically one way or another – the visitors will see nothing but beautiful orchids that they might like to buy and grow themselves. On the other hand, here QSBG really has a chance to enlighten the

public and to let the visitors into a fascinating and vulnerable world of adaptation, symbiosis, mimicry, extremes and deception. Admittedly, there is not a long tradition for botanical gardens to do so comprehensibly – but this also means that the way is open for QSBG to take a lead

The propagation centre

In the "propagation centre", activities should be focused on shifting priority species, and they should mainly be performed in preparation of specific reintroduction or reinforcement programmes. However, the actual translocation of plants into the wild should preferably be done by members of the field team (see below), as these people will have the maximum hands-on ecological knowledge of the species concerned.

It is important that mass propagation of selected species is not being done without proper scientific considerations and preparations. For example, seed provenances for propagation should be chosen following screening of geographic patterns of genetic diversity as well as tests for inbreeding vs outbreeding depression. The material for such screenings and tests can be harvested from natural populations – or partly from the "diversity collection", provided that the species in question is represented by different provenances in that collection. Another relevant *ex situ* research activity would be the testing of mycorrhizal specificity.

It should be emphasized that laboratory research in the propagation centre should not be limited to aspects that can be studied by equipment already at hand at QSBG. Collaboration with universities offering supplementary facilities should be expanded – partly in order to make the studies more complete, partly to involve more researchers and students in orchid conservation studies. Luckily, this should not be too difficult, due to already existing research collaborations between QSBG and several university institutes that offer facilities and competences for scanning electron microscopy (SEM), DNA analysis, pollinator identification etc. A particularly recommended option would be to initiate collaboration with existing *in vitro* germplasm collections of native Thai orchid species.

In connection with the propagation centre, selection of the priority species to be included in the various programmes is clearly a task of fundamental importance. First of all, a gross selection should be made among those species that are in particular need of conservation efforts. Subsequently, the gross selection should be narrowed in by selecting those species that would be expected to benefit the most from reintroduction or reinforcement. Finally, the ultimate choice of priority species should be made by closely considering the practical opportunities for performing specific reintroduction or reinforcement programmes. Wheras the final appointment of priority species from the gross selection of candidates relies heavily on specific evaluations and on local conditions that change over time, the selection of the gross pool itself should be governed by more general criteria.

In principle, the most obvious starting point of all would be to focus primarily on

species that are classified as threatened on the global scale. However, the official global redlist on IUCN's homepage includes remarkably few orchids. Indeed, in its present shape it is useless for pinpointing potential priority species for orchid conservation programmes in Thailand.

A much better approach would be to address orchid species classified as nationally threatened in Thailand. The current Thai redlist of plants (Santisuk *et al.*, 2006) includes a total of 173 nationally rare or threatened orchid species that would all benefit from being included in a conservation programme (Fig. 2). Still, it should be remembered that a high share of these species also occur elsewhere in tropical Asia – and sometimes with larger and more numerous populations than in Thailand.

Probably the best approach to making the gross selection of candidates for conservation programmes would be to focus primarily on species endemic to Thailand or its border regions, as these species will all become extinct globally, if they are not secured in their narrow ranges. In a paper on endemism in the orchid flora of Thailand (Pedersen, 2005), I distinguished between national, regional and local endemics – a series characterized by decreasing geographic range. At the same time it seems obvious to generally expect a positive correlation between the degree of endemism and the risk of extinction. Therefore, it might be a good idea to primarily focus on the approximately 90 local endemics (Fig. 3).

The field research unit

Also in the "field research unit", it would be natural to focus activities on shifting priority species. The activities should include empirical studies of natural populations as well as projects dealing with reintroduction or reinforcement. Obviously, the priority species should mainly be identical with those addressed by the "propagation centre".

Reinforcement and reintroduction projects should involve the local community – partly to raise public awareness of conservation, partly to offer the local community a sustainable way of utilizing local orchid species. Furthermore, any reinforcement or reintroduction programme should be followed by several years of monitoring – to evaluate the success of the project and to help explaining possible failures (Menges, 2008).

A wide range of topics are relevant to address by field studies in preparation for reintroduction or reinforcement (e.g. Hagemann, 1996; Watthana & Pedersen, 2008). Relevant topics include, for instance, observations of pollination biology and fruit set patterns, *in situ* germination experiments, demographic inventories, studies of mycorrhizal specificity, mapping of substrate diversity and studies of genetic variation within as well as between populations. The latter can be decisive for which conservation strategy is the more appropriate (Ackerman, 2001), and they can help pinpointing genetically depleted populations where reinforcement projects could be especially beneficial.

It is important to note that field studies should not be limited to collection of such data and samples that can be analyzed by scientific competence and equipment already present at QSBG. Joint research projects with universities offering, for example, entomological competence and facilities such as SEM and DNA laboratories should be further developed – partly in order to make the autecological surveys more complete, partly to involve more researchers and students in orchid conservation studies.

Perspectives

In order for QSBG to develop into a science-based (cf. Swarts & Dixon, 2009) orchid conservation centre of international importance, comprehensive and thoughtfully set-up projects like the "Blue *Vanda* Project" (Fig. 2) is the way to go. Based on the SWOT analysis, I believe that establishment of the tripartite organization outlined above would greatly facilitate such integrated conservation programmes. At the same time, however, QSBG should expand its national and international networking, *inter alia* by actively promoting itself as a serious player. This could be done on the QSBG homepage, through increased production of scientific publications and by active participation in (and organization of) international orchid conservation conferences. Given the necessary attention, funding and dedication, I have no doubt that QSBG can achieve the objective of becoming a science-based orchid conservation centre for Thailand and adjoining areas in the foreseeable future. Furthermore, the recommended expansion of collaboration with other scientific instutions in Thailand would strongly support conservation-related orchid research at those institutions as well.

FIGURE 1. *Paphiopedilum thaianum* Iamwir. seems endemic to a small area in Phang Nga, peninsular Thailand. Following its description in 2006, virtually all adult individuals have been ripped off by unscrupulous illegal collectors, and the species is now on the brink of extinction in the wild. Photo by H.Æ. Pedersen.

Figure 2. *Vanda coerulea* Griff. ex Lindl. has suffered an alarming decline due to habitat destruction and collecting for commercial purposes, and it is now red-listed as "endangered" in Thailand. One of the few populations left is found in the vicinity of Queen Sirikit Botanic Garden (QSBG), and for the last few years it has been the object of an integrated research and conservation project headed by Santi Watthana from QSBG. The "Blue *Vanda* Project" includes: (A) field studies of the natural growth and germination environment etc.; (B) a propagation programme; (C) reinforcement of the natural population by introduction of artificially propagated plants; (D) extensive cooperation with the local community; (E) efficient utilization of the media, including television, for communicating the purposes and activities to the public. Photo by H.Æ. Pedersen.

Figure 3. *Paphiopedilum sukhakulii* Schoser & Senghas is only known from Phu Luang in Loei, northeastern Thailand. The population has been heavily depleted by illegal collecting, but the local environment is very well preserved. This is one obvious example of a natural population that should be reinforced by artificially propagated individuals before it is too late. Photo by H.Æ. Pedersen.

TABLE 1. SWOT analysis of QSBG as a science-based orchid conservation centre for Thailand and adjoining areas. The content under each main category is elaborated in the text.

Strengths	**Weaknesses**
Geographic and topographic situation • Logistics • Large collection of live orchids • Staff includes skilled orchidologists • Established national and international research collaborations • Hosting the secretariat of the Native Thai Orchid Network	• Relevant activities dispersed and largely uncoordinated • Collection data for individual plants often lacking • Limited availability of scientific literature • Limited scientific information to visitors • No CITES registration number • No standard courses on orchid-related biodiversity and conservation are taught
Opportunities	**Threats**
• International conservation programmes and exchange of plant material • No direct competitors in the region • Species-rich orchid flora in Thailand • Public admiration and fascination of orchids	• Reduction in staff • Reduction in funding • Environmental political focus changing from conservation of biodiversity to climatic and other issues

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