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Short communication

The wild origin dilemma

Amy Hinsley[a,b], David L. Roberts[a,*]

[a] Durrell Institute of Conservation and Ecology, School of Anthropology and Conservation, University of Kent, Marlowe Building, Canterbury, Kent CT2 7NR, UK
[b] Department of Zoology, University of Oxford, Oxford, OX1 3PS, UK

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ABSTRACT

The sustainable production and trade of plants, animals, and their products, including through artificial propagation and captive breeding, is an important strategy to supply the global wildlife market, particularly when the trade in wild specimens is restricted by CITES or other wildlife trade legislation. However, these production methods can become a potential mechanism for the laundering of material illegally collected from the wild, leading to recent calls for the development of traceability methods to determine the origin of traded products. Currently, identifying wild origin can be complex and may require expert knowledge and/or resource intensive molecular techniques. Here we show, using CITES Appendix I slipper orchids as a model system, that production times can be used as a threshold to identify plants in trade that have a high likelihood of being of wild origin. We suggest that this framework could be used by enforcement officers, online vendors, and others to flag material of potential concern for orchids and other high value plants in trade. Specifically, this knowledge combined with nomenclature and the list of CITES Trade Database species could be used to construct a species watch list and automate online searches. The results suggest that had this been applied, questions would have been raised regarding online sales of three recently described species.

1. Introduction

Whilst artificial propagation and captive breeding may provide a sustainable source of wildlife for trade, both plants and animals, it also provides an opportunity for laundering of wild specimens into legal trade. Physical examination of specimens is often used to identify wild-origin, using factors including the general size and condition of the individual, and specific signs such as insect damage on the leaves and roots in plants, or damage such as scars in animals. Due to the subjective nature of this approach, and the difficulty that non-experts may face in making this judgement, there has been a move towards the use of molecular techniques such as DNA fingerprinting (Dawnay et al., 2009) and isotope analysis (Kelly et al., 2008) to determine wild-origin. Whilst these techniques have great utility, they require time, funding and technical capacity that makes them difficult to apply universally (Hinsley et al., 2016a).

The threat that laundering poses to legal, sustainable wildlife trade has led to an increased awareness of the need for traceability within the Convention on the International Trade in Endangered Species of Wild Fauna and Flora (CITES). Traceability was the focus of multiple decisions at the 2016 CITES Conference of Parties (e.g. Decision 17.152) and there have been several reports on traceability in major CITES species groups in recent years (e.g. reptiles: UNCTAD, 2013; sharks: Mundy and Sant, 2015; ornamental plants: UNCTAD, 2016). One such report commissioned by the United Nations Conference on Trade and Development's (UNCTAD) BioTrade Initiative in consultation with the CITES Secretariat highlighted the need for improved traceability in ornamental plants, the product group containing the largest number of species listed by the Convention (CITES, 2011). The high number of ornamental plant species on CITES is mainly due the listing of all orchids, which account for over 70% of all CITES taxa, with over 26,000 species known to science and a further 5000 likely awaiting discovery (Joppa et al., 2010). Currently several hundred new orchid species names are published annually (e.g. 370 in 2013: Schuiteman, 2017) and the family level listing means that these are automatically included on the CITES Appendices. New species of certain genera are listed automatically on Appendix I, including the entire Southeast Asian slipper orchid genus *Paphiopedilum*. This group is highly sought-after by the trade, leading to extreme depletion and extinction of wild populations of newly described species in some cases (e.g. *Paphiopedilum canhii*: Rankou and Averyanov, 2015). The process of species discovery, description and entry into the trade can vary. Following discovery, species can then be described relatively quickly, or in some cases they can languish unnoticed in museum collections before description. However, some species enter the trade under the name of an existing species, or as a trade name, only to be recognised as a distinct species at

* Corresponding author.
E-mail address: d.l.roberts@kent.ac.uk (D.L. Roberts).

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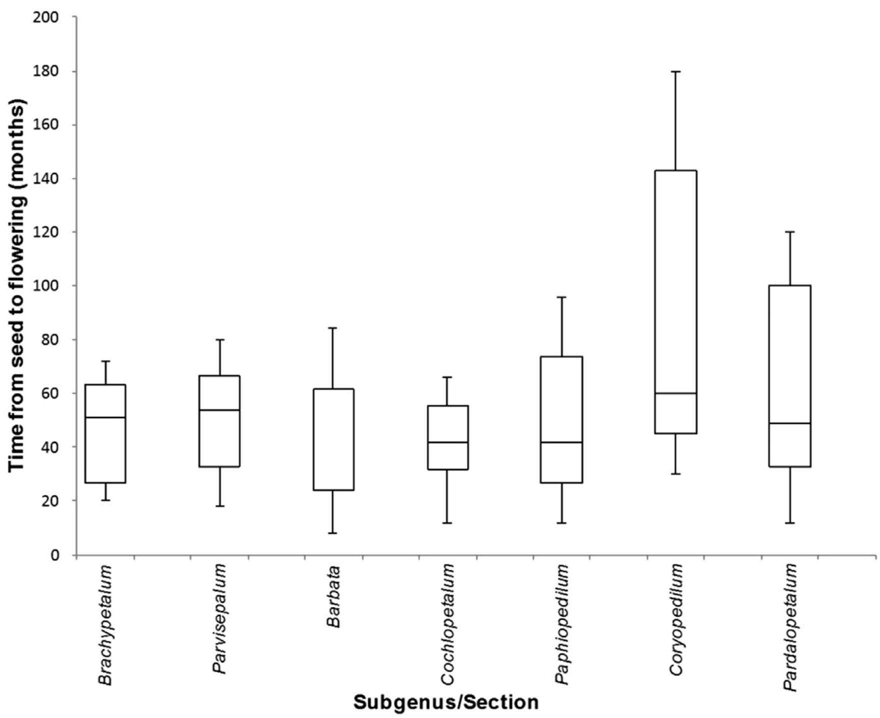

Fig. 1. Box and whisker plot showing distribution of responses for the shortest and longest time from seed to flowering of different *Paphiopedilum* subgenera and sections.

a later date.

Here we describe a potential method to address the need for improved traceability to prevent laundering of ornamental plants, using the trade in CITES Appendix I *Paphiopedilum* orchids as a model system. Laundering to bypass CITES rules is known to occur in the orchid trade (Hinsley et al., 2016b) and laundering via plant nurseries may give plants the appearance of being artificially propagated, making the identification of wild material using physical features particularly difficult for a non-specialist. One strategy that may help address both points is to identify those species that have the greatest likelihood of being of wild origin, to focus attention and resources on the most 'at risk' species. Here we outline a method to do this, using the minimum timings for key growth stages as a potential metric to identify those species that are unlikely to have been artificially propagated. This method could equally be applied to animals to determine whether, given their growth rates, they could have been captive bred.

2. Materials and methods

Our study was approved by the University of Kent, School of Anthropology and Conservation's Research and Ethics Committee. We sent an online survey (hosted on SurveyGizmo.com) to professional commercial and hobbyist growers, and botanical gardens with *Paphiopedilum* collections (see Supplementary material A1 for survey). A call for survey participants was also shared through the British Paphiopedilum Society newsletter. Snowball sampling was also used to reach more experts; participants were asked to suggest anybody they knew with experience growing *Paphiopedilum* species from seed, until all new suggestions had already been contacted.

We asked participants to state the geographical location where they grew their orchids, and to rate the extent of their growing experience at the genus level, and specifically in relation to each subgenus and section of *Paphiopedilum*. For each section or subgenus where they had the relevant experience, we asked for the shortest, longest and average time (in months) from (a) seed to flowering and (b) pollination to seed. On the last page of the survey we provided an open text box for feedback, including a request for any specific information not gathered that may influence the timings from seed to flowering size.

We used the shortest and longest times reported by respondents to produce descriptive statistics for all sections and subgenera, including mean, median, maximum and minimum length of time from seed to flowering, and pollination to seed. We used these statistics to produce box and whisker graphs to show the distribution of the times stated, and a summary of estimated timings to produce key traded orchid products.

3. Results

We sent questions about seed to flowering, and pollination to seed timings for *Paphiopedilum* orchids to international experts. A total of 37 people accessed the survey page, with 18 completing at least one of the questions about pollination to seed, or seed to flowering times. The majority of people (n = 14) who abandoned the survey did so on the first question about specific experience of growing different subgenera and sections. As not all growers have expertise on all species, questions on timings from pollination to seed for specific subgenera or sections received between five and eight responses, and for seed to flowering between four and six. Some people responded by email to say that very few in the industry had specific knowledge of the growing times requested. Respondents also noted that timings may be affected by the growing conditions, including climatic conditions in different locations.

Respondents who gave their country of origin were from the United States (n = 9), United Kingdom (n = 4), Malaysia, the Netherlands, Spain, Switzerland and Viet Nam (n = 1 each), and were hobbyists specialising in *Paphiopedilum* (n = 7), professional growers (specialising in *Paphiopedilum*: n = 5 or other genera: n = 3), and researchers (n = 4). The median timings from pollination to seed ranged from 6 months (subgenus *Brachypetalum* and section *Pardalopetalum*) to 9 months (section *Paphiopedilum*), and from seed to flowering from 24 months (section *Barbata*) to 60 months (section *Coryopedilum*). The minimum timings from pollination to seed ranged from 3 months (sections *Pardalopetalum* and *Coryopedilum*) to 10 months (subgenus *Parvisepalum* and section *Coryopedilum*) and from seed to flowering from 8 months (section *Barbata*) to 96 months (section *Coryopedilum*). The distribution of timings from seed to flowering are shown in Fig. 1, and from pollination to seed in Fig. 2 (see Supplementary material A2 for all data).