

## Creation of a Nursery for Oman's New Botanic Garden<sup>®</sup>

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### INTRODUCTION

Established by royal decree in 2006 and currently under construction, the Oman Botanic Garden (OBG) will be a new and iconic botanic garden in the Sultanate of Oman. The mission of the Sultanate is "to conserve the unique botanical and ethnobotanical heritage of Oman and to ensure that its flora, heritage, and ecosystems are valued by all" and this will be achieved through the construction of a botanic garden aspiring to be world renowned in terms of its living collections, science, conservation work, and education programmes.

The 423-ha site lies near the village of Al Khoud in the north of Oman. It is beautiful, bordered by low hills, crossed by seasonal wadis, and with a healthy population of small trees such as *Acacia* and *Ziziphus* species. Oman Botanic Garden will only cultivate native plant species and the garden has the unique aim of propagating the complete indigenous flora of Oman (1,200 plant species including 78 endemics) and displaying it within seven defined major habitat zones. Two of these zones (the plants of the northern and southern mountains) will be housed in climate-controlled display greenhouses or "biomes" similar to those at the Eden Project in Cornwall, U.K.; the rest (central fog desert, northern gravel desert, sabkha, sand desert, and wadi) being irrigated habitat landscapes in the open.

The Flora of Arabia is a core taxonomic research project at the Royal Botanic Garden Edinburgh (RBGE) and for over 20 years this research has been led by botanist Tony Miller who is one of the world's experts on Arabian flora. Royal Botanic Garden, Edinburgh, is contracted to provide the botanical and horticultural expertise for the project (Morris, 2009) and because of his background in nursery production and training, over the last 4 years Leigh Morris has spent a significant amount of his time working in Oman as a consultant focusing on the design, construction, and operation of a new state-of-the-art nursery, which is growing all the plants for the project.

### NURSERY DESIGN AND CONSTRUCTION

One of the key horticultural challenges facing OBG is growing approximately 400,000 Omani plants required to landscape the habitats and amenity areas. To start the propagation process, space was initially rented in local nurseries (which grow exotic plants for the amenity and retail market) to commence plant production (Patzelt et al., 2009). Three small polythene tunnels and some shaded standing area became the first OBG nursery. The decision was then made early in the project to construct a much larger nursery on the OBG site to produce the majority of the plants required. Royal Botanic Garden, Edinburgh, was fundamentally involved in producing the nursery design, which was then constructed in 2008 by the British company Cambridge-HOK.



**Figure 1.** The newly constructed nursery at the Oman Botanic Garden (OBG). The car park, office block, and compost bays are in the foreground, followed by the glasshouses, polythene tunnels, shade house, and hard standing area. Some of the 423-ha OBG site is in the background.

This state-of-the-art nursery (Fig. 1) consists of 0.75 ha of glass, 0.5 ha of polythene tunnels, 0.4-ha shade house, outside standing areas, an air-conditioned potting and propagation building, storage areas, and an administration/office block. A fully computerised (Hoogendoorn: <[www.hoogendoorn-automation.com](http://www.hoogendoorn-automation.com)> climate control system is in place and greenhouse cooling is carried out by pad and fan evaporative systems. Oman Botanic Garden staff moved into the new nursery in July 2008 and it was officially opened on 15 Dec. 2008.

### STAFF DEVELOPMENT

German botanist Annette Patzelt has been working in Oman for around 10 years and is leading OBG's botanical and horticultural development. A key challenge for Patzelt was the creation and training of a botanical and horticultural "Green Team" to grow and maintain the plants of the garden. The OBG nursery staff team is all Omani, the supervisors are horticultural graduates (BSc and MSc) from the Sultan Quabos University in Muscat, with their degrees being predominantly focused on commercial crops, but the general workers (nursery assistants) had no previous horticultural experience.

A key part of RBGE's work at OBG has been training and capacity building within the Omani team. In December 2006 Peter Brownless, the nursery supervisor at RBGE, accompanied Leigh Morris to Muscat in order to deliver an initial 2-week intensive training programme in nursery propagation, production, and integrated pest management techniques. The training was extremely well received, nursery



**Figure 2.** Some of Oman Botanic Garden's nursery horticultural assistants during the RBGE Certificate in Practical Horticulture training on potting and growing media.

production progressed and by early 2008 there were 51,851 individual plants in the nursery, consisting of 346 species from 68 different families (29% of the country's flora), already representing the largest documented Arabian plant collection (Patzelt et al., 2008).

A number of RBGE staff have since been to Oman to deliver training in various topics ranging from plant quarantine to plant records and creation and use of databases. The formal RBGE Certificate in Practical Horticulture has been delivered to 16 of the OBG team (Fig. 2) and some of the supervisors will subsequently teach the course in Arabic to the horticultural assistants.

A specific focus has been given to the development of the Omani horticultural graduates who have now taken control of the organisation of work schedules and meetings, procurement of materials, and staff management. A programme is also in place for them to visit other countries and institutions and three have already spent time in the U.K., predominantly at RBGE, but also visiting a range of U.K. gardens and nurseries. Membership and engagement with the IPPS is also proving very useful to the OBG nursery team. The assistant propagation supervisor, Hanan Moqbali, is a horticultural graduate of Sultan Qaboos University in Muscat, Oman, and she joined the OBG team as a horticulture expert in 2009. Hanan (hanan.obg@gmail.com) attended the IPPS conference in Ipswich in September 2010 and the plan is that others from OBG will attend and present at future IPPS events.

## **PLANT COLLECTION AND PROPAGATION**

Propagation of the plants required has been the main horticultural focus for the OBG team during the first 4 years of the project (Patzelt et al., 2008). Only Omani



**Figure 3.** RBGE BSc horticulture with plantsmanship students Will Ritchie (left) and David Tyler, assessing germination rates in the seed viability testing at Oman Botanic Garden (OBG). Ritchie and Tyler carried out tests on a wide range of annuals and perennials as part of their 2-month internship at OBG in August/September 2009.

plants are being cultivated, with all propagation material being wild collected from across the whole of Oman by Patzelt's team, supported by RBGE staff. Most of the propagation material collected is seed to ensure a wide diversity within each habitat. Cuttings are taken for some species if seed is difficult to obtain, but in those cases a large number of mother plants are used. Seed collection was relatively straight forward, but the collection of cuttings in such a hot climate was more challenging and protocols had to be developed involving the use of cool boxes and ice packs.

Very few (<5%) of the Oman plant species were in any form of cultivation prior to the start of the project, which meant there was little or no knowledge on how to propagate and grow them. The OBG team, led by propagation supervisor (and IPPS member), Ismail Al-Rashdi, with assistance from RBGE staff, has therefore had to start developing plant propagation protocols for all the approximately 1200 Omani plant species. To achieve this, a huge amount of experimentation is being carried out in areas such as seed germination and dormancy breaking (Fig. 3).

Ismail Al Rashdi and Hanan Moqbali are recording and collating all the propagation data in respect to seed collection dates, pre-treatments (e.g., stratification or soaking), sowing rates, use of germination cabinets, viability, media type, and hormone usage.



**Figure 4.** Oman Botanic Garden nursery production supervisor, Khalid Al Farsi, checking the drip tubes on outdoor stock.

## PLANT PRODUCTION

Khalid Al-Farsi (Fig. 4) is OBG's nursery production supervisor. Khalid, like Ismail Al Rashdi, has a master's degree in horticulture from Sultan Qaboos University, and he also gained experience in plant cultivation on his family farm before working at OBG. The aim for Khalid and his plant production team is to produce plants of a relatively mature size for planting in scheduled batches over the next 3 to 4 years, so that the garden appears established at the time of opening in 2014. An initial OBG plant production list was drafted by Morris and then much work has been done over the last 2 years by Patzelt on developing it into an extremely detailed and comprehensive document.

The OBG nursery is now growing plants solely for the planting up of the seven habitats and the various landscaped areas within the garden. However, the nursery is being run in a way that many commercial growers would recognise: the gardens are being treated as a "customer" who has placed a production order and the nursery is scheduling its production to coincide with the planting dates of the different locations within OBG. Oman Botanic Garden is quite different from other botanic gardens around the world as it is growing all the plants for the complete planting of such a large area itself. In effect it is growing commercial quantities of botanically interesting and challenging plants.

The plants being grown in the nursery are all used to the relatively harsh Omani climates and so when provided with good growing media, fertiliser, a plentiful supply of water, and a greenhouse environment, many of them start to grow extremely quickly (Fig. 5). One of the challenges has been to grow the plants quicker than they would grow naturally, but without making them too soft, lush, and unnatu-



**Figure 5.** Some of the c.80,000 plants currently in the nursery at Oman Botanic Garden. Many, but not all, Omani plant species thrived in this environment.

rally leggy. Khalid's team is therefore required to balance the feed and water, and manipulate plants by other horticultural techniques such as pruning in order to reproduce strong, natural-looking plants with variation in their sizes.

## IRRIGATION

A fundamentally important aspect of building a nursery and botanic garden in a desert environment is the supply of water for irrigation. At OBG two wells have already been dug and there will be five more drilled over the next 2 years. However, this ground water needs to be treated and de-salinated before it can be used on plants and until the reverse osmosis equipment is in operation, all water is currently being brought onto the site in tanker trucks. Ideally recycled water from the local town would be used, supplemented with water from the wells, and this is currently being worked on. Water conservation is paramount at OBG and the nursery has been designed to collect and recycle all irrigation water and the waste water from the wider project (cafes, toilets, etc.) will be cleaned in reed beds and re-used for irrigation in the landscapes.

In terms of nursery irrigation systems; drip tubes are used on the larger nursery plants (and within the landscape habitat plantings), but there are also overhead sprinklers in the greenhouses (as much for cooling as actual irrigation) and capillary benches.



**Figure 6.** Oman Botanic Garden's plant health coordinator Shadia Al-Rijeiby (left), monitoring succulent plants in a polythene tunnel with Ismail Al Belushi, one of her crop protection team.

## EQUIPMENT AND MATERIALS

There are horticultural suppliers and wholesalers in Muscat, but the range of nursery products they hold within their stock is quite limited. Therefore the majority of supplies for the nursery such as pots, growing media, fertilisers, propagation trays, as well as nursery machinery, have to be imported from Europe. Over the last 3 years OBG has brought in materials such as controlled-release fertilisers, liquid feeds, ingredients for growing media, and machinery such as compost mixers, compact tractors, nursery trailers, hose trolleys, and an industrial pot washer.

## PESTS AND DISEASES

Initially there were very few pest and disease issues. As expected, however, as time went on they started to appear. Many of the major problems are the same as encountered in many nurseries; red spider mite, thrips, mealy bug, nematodes, vine weevil, *Pythium* spp., and mildews.

Shadia Al-Rijeiby is OBG's plant health coordinator (Fig. 6). Shadia was also a horticultural graduate of Sultan Qaboos University and then spent time working in a vegetable farm before arriving at OBG. Shadia is implementing OBG's integrated pest management programme. Monitoring the crops regularly is a key strategy and as well as carrying out daily walks of the nursery herself, Shadia is also training the wider horticulture team in monitoring techniques — visual pest identification sheets have been produced to assist with this. Some pesticides are currently being used in the nursery, but these are kept to a minimum and the aim within the wider gardens and biomes is to adopt a non-pesticide regime.

## MATURE PLANT COLLECTION

The majority of the plants required for the OBG habitats are being propagated in the nursery. However, in order to provide a sense of maturity within the biomes, some mature trees are being collected from the wild (Patzelt et al., 2009). This is being carried out as sustainably as possible and in accordance with the OBG collections policy, which stipulates that whole plants must only be collected from areas that are, for example, already scheduled to be damaged or destroyed by development projects such as roads or building construction).

To facilitate this work a team from RBGE has developed protocols for tree translocation to OBG, trained OBG staff in the methods of tree translocation, and carried out initial tree translocation work. Accompanied by Saif Al-Hatmi (OBG's ethnobotanist), Khalid Al-Farsi, and a team of OBG horticultural assistants, two specific regions were targeted:

Jabal Al Sarah (in the northern Hajar Mountains) on a site destined to become farm land, the initial preparation (i.e., root pruning and crown thinning) was carried out for the translocation of specimens of *Juniperus excelsa* subsp. *polycarpus*, in advance of lifting them next year for the northern biome.

Mountains of the Dhofar, where Saif had arranged for us to link up with a current road construction project. One of the key framework species for OBG's three southern biomes is *Anogeissus dhofaricus* and more than 20 mature specimens have now been collected and are currently being held at Royal Farm in Salalah, prior to re-location to OBG.

## THE FUTURE

OBG is set to open in around 2014 (the date is still to be confirmed) and once the growing of the plants for the garden is complete, the nursery will be able to take on other roles. These could include continued cultivation of plants for planting into the collections — new accessions or replacements for plant deaths; production of plants for sale in the retail outlet at OBG; and growing of plants for conservation projects within Oman.

Another aim for OBG is to promote the use of indigenous plants for landscaping projects. The information being gathered on plant propagation and production, as well as the subsequent knowledge that will be acquired from the actual growing of the plants in the garden, will be extremely valuable in encouraging more people to grow native plants. The aim is to eventually publish guidelines from OBG on the cultivation of Omani plants.

## LITERATURE CITED

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