

Botanic Gardens as Environments For Learning

‘Without green plants the Earth would be a stark, largely lifeless place’

John King

Introduction

This document is designed to assist teachers around the world to access the educational opportunities available at their local botanic garden and help them plan pre- and post- visit activities. It also highlights the need for more research to be undertaken on learning experiences within botanic gardens. It is set out in six sections: sections one and two consider why plants matter, what a botanic garden is, a brief history and what botanic gardens do. Section three shows you how to locate your nearest one. The final three sections discuss research on teaching about plants, offer ideas for educational activities, both in and after your visit (s) and recommendations for future research.

1. Why Plants matter

Plants are the basis of much of life on Earth. They are unique organisms in that they can make their own food using the energy of sunlight in a process known as **photosynthesis**. They are able to live almost anywhere on earth. These facts are amazing in themselves but do they excite your students? A trip to your local botanic garden can take you round the plant life of the world from the desert to the tropics in a day. This journey can demonstrate **variation** and **adaptation** in different plant communities

and highlight the pressure to survive in diverse **habitats**. Seeing living plants rather than experiencing line drawings in a textbook will do much to encourage botanic learning. Experiencing a diversity of flower types will help your students to understand how broad a term 'flower' is. Observing protective spines and learning about the capacity of many plants to poison predators will help your students to perceive plants as organisms with diverse, and sometimes complex, means of protection. Watching a carnivorous plant trap an insect to compensate for nutrient poor soils will offer students evidence for how plants adapt to their environments. The visit can also stimulate discussion and debate on the impact of human actions on plant communities and how we might live more sustainably.

2. What are botanic gardens?

There are over 2,500 botanic gardens around the world ranging from the tiny South London Botanical Institute in England <http://www.slbi.org.uk/> to the 79 acres of the Missouri Botanic Garden in the USA <http://www.mobot.org/> from the remote Gurukula Botanic Sanctuary in Kerala, India <http://www.gbsanctuary.org/index.html> to the city sanctuaries of Rio de Janeiro in Brazil <http://www.jbrj.gov.br/> and the Chelsea Physic Garden in London <http://www.chelseaphysicgarden.co.uk/> A botanic garden can be as old as Padua, in Italy, <http://www.cbft.unipd.it/pdtour/garden.html> or as modern as the Eden Project in England, <http://www.edenproject.com/> but what exactly is a botanic garden?

' Botanic gardens are institutions holding documented collections of living plants for the purposes of scientific research, conservation, display and education' (Wyse-Jackson, 1999).

The early botanic garden collections were often composed of medicinal plants and called 'Physick' gardens. Very few gardens retain the name physic in their titles today, Chelsea Physic Garden in London being an exception. Some botanic gardens, such as Kirstenbosch <http://www.sanbi.org/frames/kirstfram.htm> in Cape Town, South Africa, are 'gardened ecosystems' of native species whereas others, such as most European botanic gardens, consist of specimens collected from around the world during periods of extensive colonisation. Many North American botanic gardens planned for the education of children from their inception, gardens such as The New York Botanic Garden <http://www.nybg.org/> and the Brooklyn Botanic Garden when others were more reticent to do so. However, a majority of botanic gardens today offer some form of educational facility for schools.

A brief history

These primary functions have evolved from an assortment of previous practices. Historically, the template for the modern day botanic garden or *Hortus botanicus* emerged in sixteenth century Italy in places such as Pisa, Padua, Florence and Bologna. These early gardens mainly contained medicinal and aromatic plants. The academic impetus for their construction was the greater emphasis placed on the living plant, alongside the invention of the **herbarium specimen**, as the source of botanical knowledge. The herbarium specimen is a pressing on paper of a typical example of a plant that can act as a reference for botanists working on particular **species** or **families**. They are still used in botanic gardens today.



Image from Melbourne University Herbarium

In the 17th century, botanic gardens became a meeting point for the collectors who ‘waited’ and the botanists who ‘travelled’ (Prest, 1981). The designs of these early gardens, their formality, their use of walls and the relationships between the botanists who travelled and the collectors who stayed at home, were all factors, which contributed to the perception of the botanic garden as a receptacle for the plants of the world.

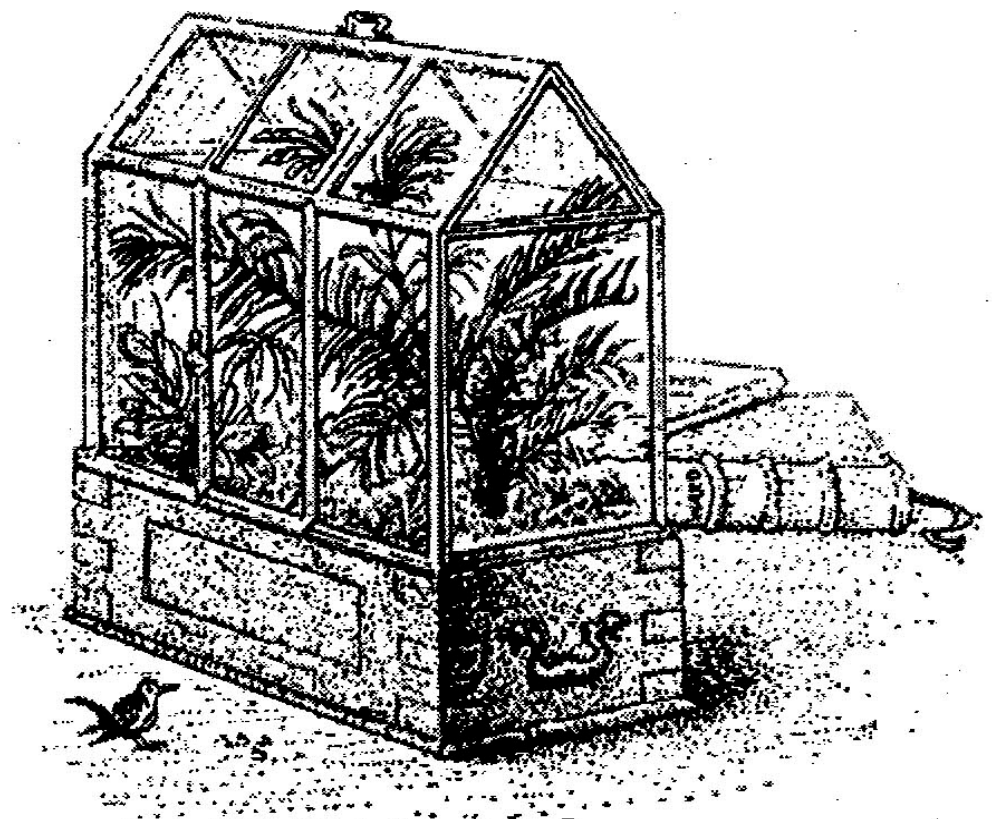
The period between the eighteenth and nineteenth centuries has become remembered, more than any other in botanic garden history, as a source for discussion on the relationships between colonialism, plants and power

(Brockway, 2002). In Missouri Botanic Garden in 1914, Arthur W. Hill, Assistant Director of Kew made the following statement,

‘ There are three things which have stimulated men throughout the ages to travel far and wide over the surface of the globe, and these are gold, spices and drugs. It is to the two latter of these universal needs of man that we may trace the origin and foundation of botanic gardens.’ (Hill, 1915).

In many contemporary European gardens, visitors can still see these historical traces for example, Chelsea Physic Garden in London contains a replica of the Wardian Case, a transportable miniature greenhouse, invented by Nathaniel Bagshaw Ward in 1829 which facilitated the movement of tea (*Camellia sinensis*) from China to India and Rubber (*Hevea brasiliensis*) from Brazil to Malaysia by botanists supported by the British government of the time.

Image
Chelsea
Physic
Garden



Surprisingly, the majority of botanic gardens originate from the period post-1960 to the present day.

Education is now believed by many to be one of the primary functions of botanic gardens, as Smith (1990) states, 'Botanic gardens have a definite role to play in developing appropriate attitudes and behaviour that may ultimately be responsible for saving the earth' (p.8). These educational remits are seen in many institutions to work alongside scientific work in places such as the Millennium Seed Bank at Wakehurst Place, Sussex, England (part of the Royal Botanic Gardens, Kew)

<http://www.kew.org/msbp/visit/index.htm> and Atlanta Botanic Garden, Georgia, USA in preserving their local endangered bog plant communities <http://www.uga.edu/gpca/member-abg.html>

Did you know-

There are botanic gardens and arboreta in 148 countries worldwide. Amongst their collections are representatives of more than 80000 species, almost one third of the known vascular plant species of the world.

There are a total of 142 million herbarium specimens in botanic garden herbaria and 6.13 million accessions in their living collections.

Over 500 botanic gardens occur in Western Europe, more than 350 in North America and over 200 in East and Southeast Asia, of which the majority are in China. Most of the southern Asian botanic gardens are to be found in India.

Source BGCI website accessed May 2009

What do botanic gardens do?

There are three main elements to the work of contemporary botanic gardens:

- **Science and conservation** - developing knowledge of plants and threats to their conservation- both 'in-situ' in their native habitat, and 'ex-situ' in botanic gardens. Debating current challenges to science and society such as the impacts of climate change and biodiversity loss alongside research on taxonomy and bioinformatics. For further information on this role please go to the BGCI website link
http://www.bgci.org/botanic_gardens/bgs_in_conservation/
- **Horticulture** - cultivating, propagating and landscaping the living collections within the gardens is an important aspect of creating a botanic garden that reflects both local and global landscapes in ways that draw visitors. Some of this work involves partnerships with architects to design and build iconic structures such as The Great Glasshouse at The National Botanic Garden of Wales.
- **Education** - Creating and developing educational activities and programmes for both children and adults in botanic gardens and their local communities. The role of education is becoming more important as gardens move into the 21st century and human beings have an even greater impact on the natural environment.

3. Where to find information on your nearest botanic garden

Botanic Gardens Conservation International is an organisation set up to support botanic gardens around the world by distributing topical publications on plant conservation and education, and by holding world-wide conferences and seminars on key issues such as plant biodiversity. The BGCI website offers visitors a range of useful information including the distribution of botanic gardens worldwide

http://www.bgci.org/garden_search.php. Most countries also have a nationwide association of botanic gardens, for example the USA has the American Public Gardens Association <http://www.publicgardens.org/>

Some botanic gardens have formed regional networks such as the Latin American and Caribbean Association of botanic Gardens

<http://www.alcjb.org/>. Botanic gardens are predominantly situated in urban settings making them an accessible educational resource. However, some such as the Gurukula botanical sanctuary in north Kerala, India are situated in more remote settings where they can offer a different kind of educational experience:

‘The stay at the sanctuary [Gurukula] involves a number of different and complementary aspects. Attention is given to the whole day, from dawn to dusk, rhythms of other living beings, chores and jobs around the garden and kitchen, quiet contemplative moments, health and physical activity, investigation and discussion’ (Suprabha Seshan, staff member)

4. Research on teaching about plants

Research has demonstrated that teaching with and about plants is considered to be a pedagogical challenge by many biological educators working in today’s classrooms. Key messages from this research are:

- A reduced repertoire of specimens are being used in classrooms and laboratories
- Most children and young people prefer to study animals

Honey has noted that ‘as animals draw attention to themselves plants need to have attention drawn to them and there is a need to show things related to plants which are varied and interesting’ (Honey, 1987 p.187). Kinchin (1999) builds on this statement by observing that, ‘where plants are the teaching vehicle, teachers may have to work harder to generate enthusiasm among their pupils’ (p.99). Recent research on education in botanic gardens <http://www.bgci.org/worldwide/article/0298/> has concluded that for children aged between seven and eleven it is the active, odorous characteristics of plants that excite them, hence, for example, their identification of *Dionaea muscipula* (Venus’ Fly trap) as ‘Killer plants’ and *Ginkgo biloba* (The Ginkgo Tree) as ‘The big smelly tree’.

It has also been suggested that the use of ‘marquee plants’, that is plants that attract the public’s attention, during some or all of their life cycles, are an important part of gaining the attention of students. In their list of ‘marquee plants’ Wandersee and Shussler include the Giant Arum (*Amorphophallus titanum*) and the stonecrop *Lithops lithops* (Wandersee and Shussler, 2001) demonstrating that it is not only large plants that attract attention. Charles Darwin was captivated by carnivorous plants and conducted extensive experiments on them resulting in his book ‘Insectivorous Plants’ published in 1875. A recent article in *School Science Review* (Freeland, 2008) demonstrates Darwin’s investigations on Sundew (*Drosera rotundifolia*), many of which can be replicated in school using simple equipment.

In the light of these findings botanic gardens offer children and students a stimulating range of specimens in diverse environments complemented by knowledgeable staff. Some of these specimens are chosen for use in 'touch tanks'. A study by Askham (1976) found that being able to touch plants positively impacted on how children classified plants. More recently, research funded by The European Union has resulted in a programme of educational activities that have been evaluated through trials in European gardens. A resource website has been created for educators and can be found at

<http://www.plantscave.net/index.htm>

5. School visits

What can a visit offer?

Most curriculum subjects can be taught during a visit to a botanic garden (e.g. numeracy, literacy, science, geography, history, art). A science curriculum can be taught through topics such as:

Plant adaptations

With their diverse plant collections botanic gardens can demonstrate a range of adaptations to challenging environments from desert to rainforest, tundra to mountain.

Plant life cycles

Botanic gardens offer the ideal living classroom in which to study the life cycle of flowering plants and topics such as seed dispersal techniques, and flowers and their pollinators.

Basic genetics

Many gardens now offer courses for students in basic genetics, often in partnership with their scientists or specialised plant education organisations.

Biodiversity around the world

Botanic gardens are a living encyclopaedia of world biodiversity providing a unique learning environment in which to study the extraordinary range of plant forms in our world, and the biogeographic zones they exist in.

Plant defence mechanisms: from spines to poisons

Plants are often perceived as passive organisms, if students are given opportunities to study the diverse ways they defend their tissues; through complex chemistry and fascinating structural adaptations, this perception can be challenged. Botanic gardens with their wide-ranging collections demonstrate these defensive capabilities through exhibitions, labels, educational workshops and garden tours.

Human uses of plants

As human populations grow our relationships with the natural world becomes increasingly complex. A current issue is the sustainable use of natural materials, and plants are no exception. Many botanic gardens are committed to education for sustainability which includes incorporating social, political and economic aspects within their teaching programmes. Through this, the role plants play in our modern world and the need to use these resources sustainably is evident. Education and interpretation programmes often offer students and their teachers opportunities to study and debate current issues

related to this topic, subjects such as climate change, fossil fuels and the need for more food as the human population expands.

Endangered species

One of the main remits of botanic gardens is to educate their visitors on the increasing rates of extinction of plant species across the world. Through interpretation and education programmes supported by a global commitment to plant conservation, working in partnership with IUCN, your students can engage with this pressing issue.

A place for art and poetry

As mentioned earlier, botanic gardens are not just environments for science education they also offer activities where learners can stimulate their imaginations by for example:

- Finding their favourite place in the garden and taking time to reflect
- Creating performances
- Building natural sculptures
- Working with local artists
- Seeing the garden through the eyes of a poet.

Immersion visits

In some more remote gardens, students are offered opportunities to immerse themselves in the garden and local flora, gardens such as Gurukula Botanic Sanctuary in India, or the more urban experience of The New York Botanic Garden USA, which offers young people the opportunity to work alongside botanists studying their local metropolitan flora and the Fairchild Tropical Botanic Garden (Florida, USA), which

provides an immersion day for over 300 young people every year at the botanic garden and other local natural sites.

How to prepare

Most botanic gardens suggest that teachers make a preparatory visit before bringing their students to the gardens, and some offer teachers open evenings and training courses. A primary factor in planning your visit is to become familiar with the garden layout and the activities you are planning to undertake. It is also important to consider how long it will take to get round to the areas/glasshouses you wish to work in with your students, as some botanic gardens cover large areas and the walking distance from one greenhouse to another for example, can be extensive. Being familiar with what is available and the educational resources you can use will add value to your teaching and your students learning experiences. As noted earlier plants are not passive organisms –some are extremely poisonous while others might possess sharp thorns- it is important that your students are aware of these health and safety issues before you visit the garden

If your local botanic garden does not provide much in the way of educational resources the BGCI website offers extensive ideas for activities in their education pages. You could also create a community of local teachers wishing to use the garden and develop resources as a group. Some teachers have developed blogs as resources for example “Passionately Curious days spent as a grade two teacher”

<http://passionatelycurious.typepad.com/>

Activities in the garden

Botanic gardens have much to offer educators and their students. To give you a flavour of what is possible here are three case studies from botanic gardens in New York, USA, Cape Town, South Africa and London, UK.

Case Study One: Public School 8, The Bronx and the New York Botanical Garden, U.S.A.

New York botanical garden offers a wide range of curriculum related ‘in the garden’ experiences for school students. Three elementary school teachers in the Bronx area of New York were asked about their educational use of the New York Botanical Garden, why they chose to use the garden and the strategies they adopted for their teaching programmes, both in the garden and back at school. Here are extracts from their interviews:

Teacher One:

Visiting the garden is also an opportunity for students to play because there is no open field [where they live] I mean I let them roll down the hills just to *experience* nature.

Teacher Two

It’s very peaceful, it’s very calming on children-that’s the original reason I wanted to go. I was amazed how much they liked the rose garden, that I never expected, and the boys... ‘This one smells better’, ‘What do you think of this one?’ ‘This one is pinker!’ That was something I didn’t think they would be interested in.

They all planted-last year I had 34 planters. You'll find that there's no in between though with the children who become obsessed with watching them and children who are not interested. They take care of it all, I tell them if they don't they'll die.

Teacher Three

We go a couple of times a year.... I'm big on writing with the kids and using materials like twigs-we bind the books together and then write about what they found at the garden, if they were doing germination, cycle of trees...I have taken them into the garden where the vegetables and the fruits were grown. They had bugs at one thing we went to and they were touching everything.

We went to look at the flowers -talking about different types of flowers, parts of the flower and I would tell them: you're this flower and you're growing, tell me about your experience. They were amazed at the differences in the sizes of leaves in The Haupt Conservatory. I told them that's where the beans are to make coffee... "wow! Wow!" For parts of the plant I brought in vegetables. What part of the spinach you eat-the leaves, the carrot-the roots-and they were like "wow," you know, and then I tried growing potatoes in the classroom.

With these three teachers the outdoor, 'hands-on' aspect is motivating for their students. They also feel it is important for students to have learning experiences where they can touch the plants and times when they can just experience being in the garden, complemented by their classroom experiences of growing and caring for plants.

Case Study Two: Outreach work - Kirstenbosch and schools in the Cape Flats area of Cape Town, South Africa

School visits to botanic gardens are not the only model of botanic garden education available. Teachers in the townships of Cape Town, South Africa are involved in a different type of educational relationship with their local botanic garden.

School gardens

In contrast with the rich biodiversity of the Cape area of South Africa, there are major social inequalities among local communities, particularly in the Cape Flats townships. In response to the barren landscape of the townships, school gardens have become pivotal sites for social and cultural change. Two organisations work in these townships on 'greening' programmes: Trees For Africa, a non-governmental organisation which plants trees throughout South Africa and the Kirstenbosch National Botanical Garden in Cape Town.

The Botanical Garden has an outreach programme which helps to build the skills base of teachers, caretakers and children, to develop their school grounds in partnership with the wider community. This has a substantial impact on both schools and parents:

At the present moment we have got a flowering garden, but in the near future we are looking to have a vegetable garden. We are helped by our caretakers and our schoolteachers. We have 15 children in our environmental club, they help us in making a garden then by the end of the month we are planning to have a vegetable garden.....We are going to plant different kinds of vegetables and by

doing that the children are going to sell these vegetables and these fruits to the community.

Teacher, Ikhusi School, Khayelitsha

Through vegetable garden we plant some vegetables so that at the end we also feed the kids from the garden, because 75% of the parents are unemployed. When we started this thing you find that the kids themselves they've got their own gardening at home and as a result even in our township, they establish even the environmental groups because of the influence of the school. Now in that way through the environment the people now empower themselves; take for instance they are recycling-trying to collect all the things and they are getting money. Self-employment has been created through this project.

Teacher, Intshinga School, Gugulethu

One of the primary activities of the Kirstenbosch outreach team is to run 'compost awareness' courses for both teaching and caretaking staff in township schools. The soil here is pure sand and has extremely low water retention capabilities. The creation of functioning compost heaps is therefore a priority, in order to be able to develop soil fertility. These projects in school gardens have not only developed 'edible landscapes' within schools, but they have also opened the doors of the schools to their local communities, encouraging self-sufficiency in a context of poverty and high-unemployment:

Our school is now more open for the community, unlike before it was closed-it did not have a working relationship with the community, now through projects like this developing gardening, now all the community members become part and parcel of us and also gardening is part of the cultural life.

Teacher Intshinga School, Gugulethu

In the Cape Flats area, teachers along with their pupils, and with the support of botanic garden educators, are creating gardens that are transforming and inspiring both the schools and their local communities.

Case study Three: The ecology of the imagination - Chelsea Physic Garden, London.

A teacher from a North London primary school brought her class of nine year olds to Chelsea Physic Garden, London for termly visits over a whole academic year. In coming to the garden she stated that she had wanted the children to have ‘a Wordsworthian experience’ and quoted the following lines from the poetry of Wordsworth:

Fair seed-time had my soul,
And I grew up
Fostered alike
By beauty and by fear:

(The Prelude: Childhood and School Time)

The main project that this class took part in, was to find, in the Physic Garden, their secret place and spend time there, thinking, drawing, writing or just 'being'. The teacher commented that the children had reported feeling both 'excited and fearful', about coming to the garden, hence her analogy with the poetry of Wordsworth. She noted that, 'these were children who would need an oasis somewhere in their psyche and maybe we gave them an inch of it'. She felt that because the children had returned to their 'secret places' over time, that this had made it 'a powerful experience for them', and indeed, when she was leaving the school, children from this particular class said 'do you remember when we found our secret place?' This is a teacher who used the botanic garden to do more than study science; she wanted to develop creative imaginings with children who rarely, either at home or school had an opportunity to do so. She considered stories and story telling an important part of that, 'the science curriculum caters for science processes that they need to know. Stories give the earth a face, children need to see things personalised'.

This third case study situated in the Chelsea Physic Garden, London suggests that botanic gardens can offer educational activities that explore the poetic imagination through the discovery of secret places, foraging, and reflection.

Ideas for building on the visit

Back at school

Using digital photography to take pictures of the plants you and your class encountered on their visit students can create a slide show that will help stimulate recall of the environments they experienced. In addition

students can create short films of their trips. This image bank can be added to student research on specific topics and the design and display of individual posters and power-point presentations for older students. Posters can be created on a theme such as plant conservation or the impact of plants on climate change. A visit to a botanic garden can be a catalyst for creative writing and personal reflection in your student community. Students can interview local politicians and botanic garden scientists as part of their post trip assignments and use this research material to lobby for local environmental change.

There are many resources available on-line to support both you and your students. If your school does not have access to the internet botanic gardens often have paper- based resources such as posters and booklets. The educational magazine '*Roots*' published by BGCI has resources and articles in both English and Spanish. They also publish topical documents on subjects such as the global plant conservation strategy and climate change and plants.

Re-visiting the botanic garden

There has been much research on the impact of 'the novelty factor' on fieldwork visits to museums and science centre, botanic gardens are no exception. Building the botanic garden into your programme as a long-term partnership offers your students regular contact with living plants, an experience often missing from contemporary urban life.

6. A vision of learning in the future

As the world becomes more urbanised and risk-averse, children are being offered a diminishing set of fieldtrip experiences, this state of affairs has for some time caused concern among scientific learned societies and policy-makers. If botanic gardens are to play a role in learning outside the classroom and developing greater environmental awareness then more research evidence is needed on student's experiences of botanic garden visits.

Recommendations for further research

This document is part of a recent rise in educational research activities in informal science centres around the world. However, botanic gardens remain an under-studied context. Six areas in particular require further attention:

- ♦ the long term impacts of botanic garden teacher training on teachers' perceptions and practice
- ♦ the possible impacts of cultural identity and heritage on children's relationships with botanic garden plants
- ♦ the potential influence of a botanic garden educator's enthusiasm for plants on visiting learners
- ♦ the contribution that learning theory can make to understanding the botanic garden learning experience
- ♦ the pedagogical models botanic garden educators use to inform their teaching
- ♦ any perceivable impacts on environmental values a visit(s) might have.

A crucial question to emerge from this work is - to what extent botanic garden learning supports or challenges the learning pupils undertake in the classroom? Furthermore, how is this learning integrated into pupil's indoor learning and *visa versa*? The involvement of classroom teachers and botanic garden educators in engaging with this question is key to the utilisation of botanic gardens for learning outside the classroom and greater use of botanic garden resources in curricula materials.

‘No matter what the future face of botanic gardens may look like, one thing is certain: botanic gardens will continue to be humanity’s main scientific, aesthetic and social link to plants. The foundations of the first botanic gardens nearly five centuries ago are little different than they are today. They serve to educate, to explore, to fascinate, to discover. They will continue to reflect our evolving relationship with plants and the rest of the natural world, and they will continue to remind us of the many wonders of life here on earth.’

Botanic Gardens-A Living History

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Further reading

Books

Botanic Gardens - A Living History:

Edited by Brian Johnson and Scot Medbury

Published by Black Dog Publications

Plant [Eyewitness] by *David Burnie*

Published by Dorling and Kindersley

Plant Survival: Adapting to a hostile world: Brian Capon

Published by Timberland Press

Web 2.0 Resources

Many botanic gardens are now on Twitter.

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Glossary

Photosynthesis: The process within green plants of combining sunlight and chemicals to create a primary nutritional resource

Variation: The differences exhibited by different individuals of the same species

Adaptation: Characteristics species develop over time to suit a specific environment

Habitats: The physical environments in which species occur

Herbarium Specimen: A pressed, dried plant specimen used for reference, laid out on specialised paper and stored in a cabinet to prevent damage by pests and damp air

Species: There are different definitions of the word species but very generally it refers to groups of individuals that share characteristics not shared with other families

Families: Groups of species that share characteristics not shared with other families

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