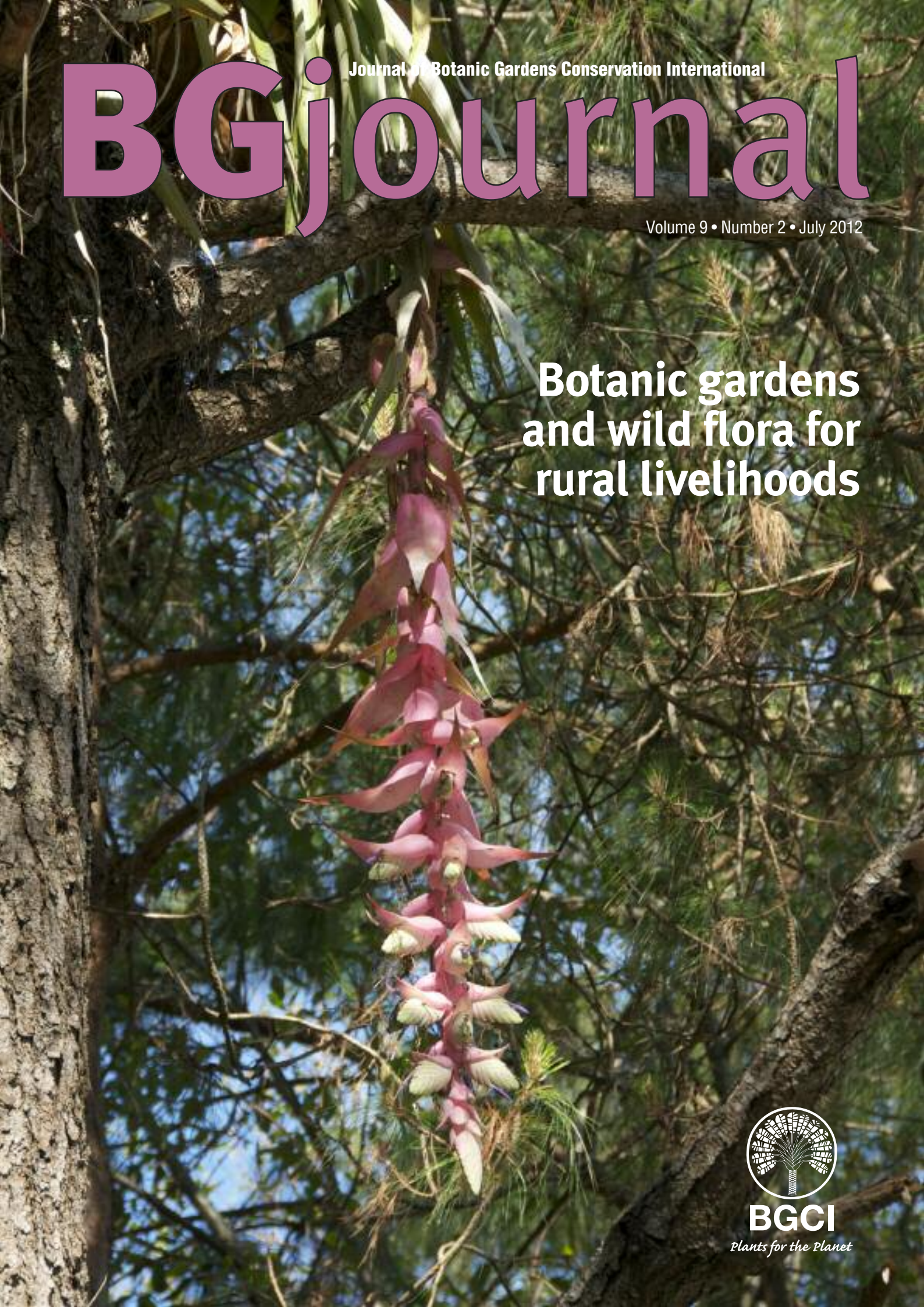
Journal of Botanic Gardens Conservation International

BGjournal

Volume 9 • Number 2 • July 2012

Botanic gardens and wild flora for rural livelihoods



BGCI
Plants for the Planet

BGjournal Volume 9 • Number 2

EDITORIAL SARA OLDFIELD 02

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Further details available from:

- Botanic Gardens Conservation International, Descanso House, 199 Kew Road, Richmond, Surrey TW9 3BW UK. Tel: +44 (0)20 8332 5953, Fax: +44 (0)20 8332 5956 E-mail: info@bgci.org, www.bgci.org
- BGCI-Russia, c/o Main Botanical Gardens, Botanicheskaya st., 4, Moscow 127276, Russia. Tel: +7 (095) 219 6160 / 5377, Fax: +7 (095) 218 0525, E-mail: seed@aha.ru, www.bgci.ru
- BGCI-Netherlands, c/o Delft University of Technology Julianalaan 67, NL-2628 BC Delft, Netherlands Tel: +31 15 278 4714 Fax: +31 15 278 2355 E-mail: I.j.w.vandenwollenberg@tudelft.nl www.botanischetuin.tudelft.nl
- BGCI-Canarias, c/o Jardín Botánico Canario Viera y Clavijo, Apartado de Correos 14, Tafira Alta 35017, Las Palmas de Gran Canaria, Gran Canaria, Spain. Tel: +34 928 21 95 80/82/83, Fax: +34 928 21 95 81, E-mail: jmlopez@grancanaria.es
- BGCI-China, 723 Xingke Rd., Guangzhou 510650 China. Tel:(86)20-37252692. email: Xiangying.Wen@bgci.org www.bgci.org/china
- BGCI-Colombia, c/o Jardín Botánico de Bogotá, Jose Celestino Mutis, Av. No. 61-13 – A.A. 59887, Santa Fe de Bogotá, D.C., Colombia. Tel: +57 630 0949, Fax: +57 630 5075, E-mail: jardin@gaitana.interred.net.co, www.humboldt.org.co/jardinesdecolombia/html/la_red.htm
- BGCI(US) Inc, c/o Chicago Botanic Garden, 1000 Lake Cook Road, Glencoe, Illinois 60022, USA. E-mail: usa@bgci.org, www.bgci.org/usa

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EDITORIAL
PLANTS MATTER!

Plant diversity is often taken for granted with the fundamental importance of plants in providing oxygen, regulating climate and feeding the world scarcely acknowledged and promoted. Birds and mammals are components of biodiversity that receive much greater recognition and conservation attention – an imbalance that botanic gardens can do much to help address. Attempts are increasingly being made to quantify the economic value of biodiversity – in terms of natural capital- and it is in this debate that the importance of plants should increasingly gain recognition. According to UNEP the global trade in timber and other forest products is estimated at almost US$330 billion/year. Its value multiplies exponentially as raw materials are processed into a myriad of products – paper, charcoal, medicine – often taken for granted because we use them every day. Furthermore, an estimated 1.6 billion people rely to some extent on forests for their livelihoods, while more than two billion people – a third of the world's population – use biomass fuels, mainly firewood, to cook and to heat their homes. Indeed, forests – and their plant resources - sustain nearly half of the population in the developing world, providing a wide range of non-timber products like fruit, nuts, rubber and medicines, as well as wood for fuel.

In this issue of BG Journal we look at the value of wild plants for livelihoods. We report on a project carried out by BGCI with partners in Brazil, China, India and Mexico that considered case studies of sustainable management of wild plants for improved livelihoods. This short study, funded by the UK's Department for Environment, Food and Rural Affairs, highlighted the challenges in collecting information on use, trade and sustainability of wild plants and assessing livelihood values. The results indicate that many plant resources are being used sustainably, given their natural abundance and low impact harvesting methods, but that there is huge scope for improved management and monitoring. The study suggests giving priority to those species that are important in international trade, for example in the cosmetics industry, but are not yet subject to any form of voluntary certification or international regulation. A summary report of this BGCI study will be launched at the World Conservation Congress in South Korea in September.

The Brazilian component of the project was carried out by Miguel Moraes and colleagues at the Brazilian Centre for Flora Conservation at the Rio de Janeiro Botanic Garden. The paper on p.8 highlights some of the issues raised by the national study linking to national implementation of GSPC targets on sustainable plant use. In Mexico, the national workshop for the project, hosted by CONABIO, also reflected on the GSPC sustainable use objective considering this is relation to a range of species case studies. Maite Lascurain the Mexican project consultant writes, with colleagues, about the values of an edible wild fruit for local communities on p.13 of this issue. The findings of the Mexican study will feed into a regional GSPC workshop to be organised by BGCI in November this year. Use of the FairWild Standard for wild harvested plants has major potential for enhancing rural livelihoods and increasing consumer confidence in green products. Anastasiya Timoshyna and Bryony Morgan explain how the FairWild Standard works and how botanic gardens can get involved on p.21

Two other issues in connection with use of wild plants are discussed in this issue of BGJournal. The fundamental importance of indigenous knowledge and ethnobotany in relation to Oman's fascinating flora are discussed on p.26 whereas Bob Ursem reflects on plants in biomimetics, the examination of nature as a source of emulation or inspiration in solving human problems.

Raising awareness of the importance of plants and their conservation needs is at the heart of BGCI's work and that of botanic gardens around the world. Developing consistent messages in relation to the implementation of GSPC will be a major theme at BGCI's 8th International Congress on Education in Botanic Gardens and we look forward to seeing many of you there. Please do share your views on how we can do more to support wild flora for rural livelihoods and please note that you can now follow us on Twitter!

Sara Oldfield
Secretary General, BGCI

Author: Sara Oldfield

WILD PLANTS FOR RURAL LIVELIHOODS

Can both poverty alleviation and biodiversity conservation goals be achieved through the sustainable management and commercialisation of wild flora?

Medicinal plants on sale in South Africa (Suzanne Sharrock)

Introduction

Wild plants provide a huge diversity of products of livelihood value. Millions of people around the world depend directly on wild plant resources for at least part of their livelihoods, be it for food, medicine, building materials, fuelwood or as a source of cash income. With the general global loss of biodiversity caused by habitat loss, the spread of invasive species and global climate change, the availability of the range and abundance of plant resources of livelihood value is under threat. The impact of harvesting of wild plant resources, whether for subsistence use or trade, may additionally be directly detrimental to the species or its habitat, or both, if the extraction exceeds the capacity of the species to recover or if the habitat is badly damaged in the process. The Millennium Ecosystem Assessment highlighted over-exploitation as one of the five main drivers of biodiversity loss impacting on the conservation status of species.

> *"GSPC Objective 3: Plant diversity is used in a sustainable and equitable manner"*

Cistanche tubulosa *hosted in the root of* Tamarix chinensis *(Li Zhijun)*

In a recent study supported by the UK Government, BGCI has researched the sustainable management and commercialisation of wild flora and its products in Brazil, China, India and Mexico. The study set out to provide guidance to policy-makers and conservation practitioners on ways to enhance integration of poverty alleviation and biodiversity conservation through sustainable plant use. The findings of the study will help to shape BGCI's role in the conservation of useful plant resources working with botanic gardens and other conservation partners around the world, specifically in the implementation of the Global Strategy for Plant Conservation (GSPC).

Box 1 Biodiversity conservation and poverty alleviation

A recent review of biodiversity conservation and poverty alleviation published by the Convention on Biological Diversity has shown that there is a general paucity of empirical information about the ways in which people (especially the poor) use and benefit from the existence of biological diversity. The review notes that there is considerable reported variation in the extent to which biodiversity-based resources contribute to household income. The poor typically show higher levels of dependence with evidence suggesting that they tend to depend disproportionately on relatively low value subsistence or 'inferior' goods and services from biodiversity. More affluent groups may get interested in such resources if they have higher commercial values (often crowding out the poor in the process). This suggests that there is some evidence of a possible 'poverty trap', with poorer users stuck in low value extractive uses. Interventions that increase the value of wild plant resources to poorer communities, through improved negotiating, processing or marketing may be required.

The review suggests that biodiversity provides the poor with an insurance against risk, particularly in relation to food security, environmental hazards and health. However, the evidence that is available in the reviewed literature suggests that the poor benefit from the existence of, and access to, specific components of biodiversity (such as useful plants), rather than biodiversity in its strict sense. There seems to be inadequate published evidence suggesting that the diversity of biological systems themselves is significant for the livelihood strategies of the poor. It is considered important to carry out research which looks more closely at the ways in which biodiversity affects poor people's livelihoods.

Source: Secretariat of the Convention on Biological Diversity, 2010 *Linking Biodiversity Conservation and Poverty Alleviation: A State of Knowledge Review*. CBD Technical Series No. 55

The study conducted by BGCI

The study undertaken by BGCI, working with national partners, has drawn on a set of over 80 case studies for individual species that have been compiled through a comprehensive review of published literature, by local experts and through participatory workshops. The case studies, compiled in a common format linking biological, social and economic information, have been reviewed to identify factors that influence success in sustainable use of wild plants and improvement of rural livelihoods. Participatory workshops and in-country discussions brought together a wide range of interested parties to discuss the broad issues of wild flora for rural livelihoods. The paper on p.8, for example, outlines some of the issues highlighted at the Brazilian workshop organised by the Rio de Janeiro Botanic Garden. From the broad review we have identified some common issues and themes that can contribute to further discussion and policy relating to sustainable use particularly in relation to the implementation of GSPC Targets 11, 12 and 13.

"GSPC target 11: No species of wild flora endangered by international trade

GSPC Target 12: All wild-harvested plant-based products sourced sustainably

GSPC Target 13: Indigenous and local knowledge innovations and practices associated with plant resources, maintained or increased, as appropriate, to support customary use, sustainable livelihoods, local food security and health care"

In compiling the case studies, a major issue highlighted was the lack of available data on the conservation status, level of use and trade, and the impact of harvesting for the majority of

Tillandsia eizii *(Isauro Vidal Rodríguez)*

wild plant species – even those that are important commercial resources. This was clear from the literature review and from expert discussions at the workshops. Determining general factors that influence success both in sustainable use and improved rural livelihoods therefore proved problematic. We did however find good examples of use of plant resources with no apparent evidence of decline and case studies that demonstrated ways to improve livelihoods. A report of the study, together with the case studies and a comprehensive bibliography will be made available on line at www.bgci.org. Some of the factors important for success in particular situations are highlighted in the case study examples provided below:

Tillandsia spp.– Baseline population data are necessary for managing and monitoring collection

The indigenous peoples of the Altos de Chiapas, in Mexico collect large quantities of inflorescences of epiphytic bromeliads, *Tillandsia* spp. for ceremonial use. Informal payments are made to the owners of the land where the collection takes place and the flower stalks are sold at local markets.

The price is per dozen and is variable, depending on the time and resource availability. Communities in the municipality of San Juan Chamula, collect an estimated 215,000 inflorescences of *T. eizii* each year from the oak-pine forests. These are used to decorate sacred sites and altars. Other species are particularly valued for use in nativity decorations at Christmas.
The species collected are slow growing and can take 12-15 years to flower so cultivation is unlikely to be developed. A strong decrease has been noted in supply of the resource. Changes in land use prevent the recovery of populations affected by collection. Following detailed field survey, management recommendations have been made based on population studies to determine the density and population structure of the species, the size of minimum viable population, and the size of the sustainable collection.

Making 'ketupat' packages, Bogor market, Indonesia (B. Tan)

Schisandra sphenanthera – Management and certification of products as "sustainably-sourced" can enhance livelihoods

The berries of the vine *Schisandra sphenanthera* are harvested for medicinal use in China. Historically this species, known as Southern Schisandra, has been used as substitute for the more valuable Northern Schisandra *S. chinensis*. Southern Schisandra is also used locally in fruit juices, soups, and alcoholic beverages, and has global potential as a component of health drinks and dietary supplements.
In a recent project run by WWF, *S. sphenanthera* was selected as a target species for promoting sustainable management of traditional resources in Pingwu County, Sichuan Province. Since 2008 when the national policy of Forest Tenure Reform was enacted, villagers in the area have been given more freedom to manage their community forests. Subsequently forest clearance took place to grow economically valuable species but this practice has caused severe degradation of the secondary forests as habitat for wildlife, including the Giant Panda. Through the project sustainable harvesting protocols have been developed for *S. sphenanthera* in the area of collectively owned secondary forest. Resource baseline surveys were undertaken at the start of the project with subsequent monitoring. Based on these surveys, resource management plans were developed with participatory approaches, which suggested the amount, locations, and methods of collection and processing by the villagers. An association of medicinal plant harvesters has been formed to ensure that management plans are followed, and to negotiate prices with buyers, safeguarding the interests of the harvesters. An association of medicinal plant product dealers has also been formed to negotiate prices, sign trade contracts with buyers in the US, monitor harvesting and processing and work with certification companies to ensure product quality. There has been substantial increase in cash income from "sustainably harvested" Southern Schisandra in the project area, of greatest benefit to vulnerable groups such as women, elders and children. For some women, this has been the first time they have made money from harvesting wild medicinal plants, providing cash for education and improving their status within the family and in the wider community. The project is reported to have reduced pressure on some of the more threatened medicinal plants in the Wanglang National Natural Reserve.

Basketry - Mercado de Januária, Balaios. Brazil (M. Bacelar)

Astrocaryum murumuru – Establishing harvesting cooperatives can greatly assist in negotiating fair prices for products

This Amazonian palm has a wide variety of uses. Ethnobotanical uses include consumption of fruits and edible oil from

the seeds and use of leaves and seeds for handicrafts. Oil extracted from the seeds is used more widely in food, cosmetics, soap and for other industrial purposes. Local collection and production along the Amazon and its tributaries provides an important source of seasonal revenue for local communities that depend primarily for their livelihoods on extraction of natural products. Murumuru production is generally organized by cooperatives which own the machinery needed for extracting oil from the seeds, which are removed from the fruits by hand. The cooperatives, and in some cases local intermediaries, are involved in the trade with large companies. Oil is traded within Brazil or exported to other countries, primarily for the cosmetics industry. There is limited published information on trade. Virtually all harvesting of products is from wild populations. Despite high demand and limited population studies overall the wild plant population seems to be stable. Income obtained may vary according the tenure of land, number of intermediaries and local productivity. There is a minimum price for seed established by the federal government. Where a commercial company with a sustainable trade objective has negotiated with cooperatives a significantly improved price has been agreed.

Trichopus zeylanicus - Benefit-sharing agreements can ensure funds flow back to local communities

In the Western Ghats, India, this small perennial herb has been used by the Kani people to overcome fatigue. Following screening by the Tropical Botanic Research Institute (TBGRI) in Kerala an Ayuverdic drug known as Arogyapacha has been produced using the species as one ingredient. Cultivation techniques have been developed. Kani tribals receive 50 percent of the license fee for manufacture of the drug and 50 percent of the royalty received by TBGRI on sales. The Benefit Sharing Experiment with Kanis and the subsequent formation of a Kani Trust fund have helped the tribes to take up social welfare schemes, provide opportunities of employment and income generation through cultivation and post-harvest processing of Arogyapacha, establish linkage and prospective partnership with institutions/corporate bodies outside their communities, and empower them to protect, preserve and maintain their knowledge, innovations and conservation practices. *In situ* methods for long term conservation of *Trichopus zeylanicus* have been developed with the help of the Forest Department of Kerala.

Plant products on sale in Seoul, Korea (Suzanne Sharrock)

Euphorbia antisyphilitica – Follow-up is important to evaluate the impact of international policies

This succulent plant grows in the US and Mexico. It yields an important source of wax known as Candelilla that is used widely in the food and cosmetics industry. The collection of Candelilla wax is one of the most important economic activities for families in the Chihuahuan desert of Mexico. It is estimated that more than 20,000 families depend on the wax for their livelihoods. Collectors of Candelilla known as 'Candelilleros' work in small groups, leaving their families for a minimum of five days to collect Candelilla in the wild. Experienced collectors pull up Candelilla plants by hand to avoid contact with the toxic and caustic latex of the plant. Bundles of entire plants with small roots are transported by mule to processing sites where adequate supplies of water used in processing are available. Approximately one quarter of the range of *E. antisyphalitica* is exploited and plants in the more remote areas remain untouched. Along with almost all other succulent Euphorbia species it is included in Appendix II of the Convention on International Trade in Endangered Species (CITES). The species has been a recent topic of attention within CITES. In March 2010 a decision was made to exempt finished products ready for retail (lipsticks and other cosmetic products) containing *Euphorbia antisyphilitica* from CITES controls to ease the enforcement burden. There has been no follow-up to determine whether this decision has had any impact on the livelihoods of the candelilleros.

Sustainability and livelihoods: responses and recommendations

Trade in wild plants provides an important source of income for rural communities in countries such as Brazil, China, India and Mexico. The supply chain may be for local, national or international markets, in some cases

passing through many intermediaries. National biodiversity policies relating to implementation of the CBD should help determine and support sustainable plant use at a local or national level. Project interventions by NGOs, botanic gardens, and the commercial sector are of immense importance in working up practical protocols. Publication of results - both successes and failures – is necessary to overcome the current general lack of information.

For many plant species, including a proportion of the case study species, international trade is the major driver of harvest. Notable case study examples include the Brazil nut *Bertholletia excelsa*, Tonka bean *Dipteryx odorata*, candelilla *Euphorbia antisyphilitica*, Himalayan yew *Taxus wallichiana* and Matsutake mushroom *Tricoloma matsusake*. Where this is the case, international regulatory mechanisms and voluntary certification aimed primarily at consumers in importing countries can materially influence the management of the resource and the livelihoods of those involved in production. At present the two major mechanisms are CITES, the implementation of which links directly to GSPC Target 11 and the voluntary FairWild certification system. FairWild has huge potential to build on the relatively few certified non-timber plant products currently on the market. The role of FairWild certification and its links both with CITES and CBD are highlighted on p.21

Medicinal plant market (BGCI)

Given the huge diversity of plant products harvested from the wild and the complexity of management and trade in these products, a first step in improving overall sustainability will be to prioritise species for collaborative international action, concentrating on products of major international value. Species should be selected by livelihood value, trade value, and concern or lack of knowledge about conservation status. Mechanisms for sustainable production and monitoring should be developed for such species involving the wide range of different stakeholders.

Participants in the BGCI study expressed a strong interest in more in-depth studies both at a national level and for individual species. The need to recognise, value and enhance knowledge of indigenous and local communities was fully agreed and the need to engage the private sector in developing approaches and solutions. Botanic gardens have a major role to play- for example in education and promoting awareness; supporting FairWild and CITES initiatives; working with local communities to develop sustainable harvesting protocols/cultivation techniques; providing livelihood species for replenishment of natural populations and ecological restoration schemes. The CBD Strategic Plan aims to *"Take effective and urgent action to halt the loss of biodiversity in order to ensure that by 2020 ecosystems are resilient and continue to provide essential services, thereby securing the planet's variety of life, and contributing to human well-being and poverty eradication."* With significantly increased action, sustainable use of wild plants for rural livelihoods could be a major contribution to the outcomes of the Strategic Plan.

Arnica (Edelmira Linares)

Sara Oldfield
BGCI
199 Kew Road, Richmond,
TW9 3BW, UK.
Email: sara.oldfield@bgci.org

Authors: Miguel A. Moraes, Danielli Kutschenko, Tainan Messina, Roberto L. Romão, Arthur Sérgio Mouço Valente and Gustavo Martinelli

RECONCILING SUSTAINABLE USE OF PLANT RESOURCES WITH BIODIVERSITY CONSERVATION IN BRAZIL

The sustainable use of plant diversity in mega-diverse countries has the potential to play an important role in economic development.

Introduction

Brazil is globally recognized as one of the world's most diverse nations with up to 20% of all terrestrial plants (Mittermeier *et al*., 2005; Giulietti *et al*., 2005; Giulietti *et al*., 2009; Forzza *et al*., 2010). Sustainable rural livelihoods based on plant genetic resources can generate wealth without impairing ecosystem stability, provision of ecological services and natural resources. However, biodiverse-rich nations face the challenge of reconciling a green economy with political and social instability. In developing countries, the use of wild-collected natural resources by rural communities is rarely a choice but an economic imperative (Abensperg-Traun, 2009). In this context, biodiversity targets must be pursued from the human needs perspectives, and conservation actions must be planned in order to promote poverty alleviation.

Bromeliaceae living collection at Rio de Janeiro Botanic Garden, Rio de Janeiro, Brazil (Nara Vasconcellos)

Collecting plant material in Barcelos municipally, Amazonas state, Brazil (Ricardo Azoury)

Botanic gardens are places to inspire, inform and educate different groups of society through research and strategic partnerships, actions which are widely acknowledged as important factors for successful conservation projects (Waylen, 2006). They are a global repository for documented plant material maintained in seed banks, DNA banks and living collections. Combining the knowledge gained from these collections, related herbaria and libraries, with knowledge from field work and research, botanic gardens bring the understanding necessary to ensure that rural livelihoods based on commercialization of plant resources do not adversely affect biodiversity conservation status. Furthermore, botanic gardens may establish linkages between government, civil society and the private sector helping to promote access and benefit sharing (ABS) (Williams, 2001), and reduce poverty.

The ultimate and long-term objective of the Global Strategy for Plant Conservation (GSPC) is to halt the current and continuing loss of plant diversity, paying special attention to the conservation of species of direct importance to human societies. Sub-objective C of the Strategy: "Using Plant Diversity Sustainably" has two components: i) strengthen measures to control unsustainable utilization of plant resources; and ii) support the development of livelihoods based on sustainable use of plants and to promote equitable sharing of benefits arising from the use of plant diversity. Both refer to integrating sustainable livelihoods with conservation of plant diversity.
Facing this challenge, the Botanical Garden of Rio de Janeiro (JBRJ) through the National Centre for Flora Conservation (CNCFlora), with the support of Botanic Gardens Conservation International (BGCI), promoted a workshop to debate approaches to achieve the targets within GSPC sub-objective C, at national level. The event brought together representatives from government, universities, NGOs and private companies to integrate perspectives and to identify the main obstacles. The present paper aims to communicate the workshop outcomes. Results were organized in two topics as follows.

Government incentives and regulation

In recent years, Brazil has experienced significant progress in poverty reduction and economic development (Ravallion, 2009). Advances, however, do not rest today in sustainable economic activities and the federal government has made decisions at home that go against the same global policies that it advocates (Scarano *et al*., 2012). Furthermore, public policies hardly stimulate good practices of biodiversity sustainable use, reinforce conservation law and regulations, or even put into practice the lessons learned, such as those related to the sugar cane biofuel industry and its impacts on the Atlantic Rainforest (Moraes, 2011). Instead, they perpetuate the permanent conflict between economic growth and conservation. The continuous isolation of the environmental agenda is the expression of a broader social process that perceives conservation actions as obstacles in the way of economic development, instead of considering it as a potential axis for creating opportunities in the fight against poverty.

Several components of a national strategy for sustainable development can be found scattered through governmental policies and biodiversity management plans. Scaling up to the national level requires some degree of project-scale activities (Groom and Palmer, 2012). However, these parts are far from forming a coherent whole, which deprives them from the strategic reach needed to promote a gradual shift towards sustainable use of plant resources.

Governmental projects such as *Plants for the Future* (Coradin *et al*., 2011) start to offer a guide for species with potential value that could leverage regional economies. Technological innovations,

genetic improvement and the refinement of cultivation practices, may allow enhancement of productivity associated with plant genetic resources, ensuring the scale needed for commercial production. Furthermore, by aggregating value and raising public awareness of their importance, we might be able to avoid species becoming threatened by international trade. This new paradigm, which reconciles sustainable use of plant resources with biodiversity conservation, may help to embrace local knowledge, offering innovations and practices to support sustainable livelihoods, food security and health.

Sustainable use of plant resources must be treated as a cross-cutting theme to be discussed by several governmental sectors. Legal regulation still limits development of alternative economic activities based in extractives. Despite the interest of several NGO's and private companies the incipient regulation represents a significant obstacle to be overcome. For countries considered as genetic resources providers, like Brazil, strict rules to regulate ABS are needed. The Brazilian government published an interim measure on ABS (Vélez, 2010), while consistent legislation on the subject could be discussed. However, it ended up immobilising investments from the private sector and derailing ongoing initiatives. Clear policies to regulate ABS are essential to scale up initiatives on sustainable use of plant diversity.

Developing sustainable practices based on traditional knowledge

Traditional knowledge related to the local use of genetic resources is needed to overcome challenges related to local and regional productivity of plant products, incorporating innovative approaches to the process. It may vary from collection techniques to processing of plant resources, transporting, production flow, or even management of natural populations of species. Knowledge on the various ecosystems, alternative food sources, nutritional and pharmaceutical potential of plants, and their ecological relations in the wilderness must be used as valuable information. They contribute to increasing the value of plant resources, allowing wealth transfer to early stages of production, and helping to support rural livelihoods.

Botanic gardens may help to catalogue practices and traditional knowledge related to the use of plants associated with different regions and habitat types, facilitating access and organizing information to secure benefit sharing to the proper sources. Botanic gardens may also help to enhance local communication as a way to increase productivity. Enabling the means for subsistence in their native land is a way of preserving people's identity and providing life quality to families.

Dua Busẽ, healer at Ika Nai Bai Park, a Huni Kuin indigenous botanic garden used for cultivation of medicinal plants, at São Joaquim tribe, Jordão River, Acre state, Brazil (Camila Coutinho)

Amazon rural livelihoods, Negro River, at Novo Airão municipality, Amazonas state, Brazil (Eduardo Fernandez)

Biodiversity conservation represents long-term opportunities for rural communities. Sustainable livelihoods must bring wealth without prejudicing the provision of ecosystem services and natural resources. The supply of plant products can be very attractive to the international market. This demand should be captured through high-value niche markets avoiding low commodity pricing and subsequent pressures to improve financial returns through over-harvesting (Lilieholm and Weatherly, 2010). Nevertheless, profit is generally not properly shared, especially at lower stages in the production chain and rural communities that play an important role in on-the-ground conservation often receive an uneven share of benefits from these activities.

As mentioned earlier, conservation has been based, predominantly, on preservationist approaches (Callicott and Mumford, 1997) that consider relations between people and their environment as the main source of biodiversity depletion. Therefore, protected areas (PAs) have been the instrument adopted by most nations to reduce human influence over pristine areas (WWF, 2006). However, currently, over 86% of all PAs worldwide allow some kind of

Workshop held at the Brazilian National School of Tropical Botany, to debate approaches to achieve the targets within GSPC sub-objective C (Eduardo Fernandez)

human use (Peres, 2011). In Brazil, extractive reserves were legally instituted in 1990, aiming at an integrative approach based on the assumption that the sustainable exploitation of natural resources can contribute to protection of the forest. The emergence of Brazilian extractive reserves reinforced the notion that sustainable forest use could play a central role in conservation (Wadt et al., 2008). But, as in other countries, human population growth, social inequity, and lack of funding for management represent, all together, a threat to this model.

Biodiversity depletion within PAs is a reality (e.g. Safford, 2001; Alho *et al*., 2002; Ribeiro and Veríssimo, 2007; Aximoff and Rodrigues, 2011). Conservation units are increasingly under pressure as communities living in and around these PAs are income-poor and rely on the local ecosystem for fuel, wood, fodder, water, and other ecosystem services (DeFries *et al*., 2010). Generally, instead of supporting sustainable livelihoods and local subsistence, these PAs keep people outside of their limits, dragging them away from their own identity and turning them against local conservation initiatives. The communities rarely benefit economically from the establishment of PAs and thus have little incentive for their maintenance (Abensperg-Traun, 2009). A lack of autonomy in household decisions over land use due to government intervention may lead to income losses and in an unwanted shift in traditional livelihoods (Groom and Palmer, 2012). On the other hand, enforcing reserve regulations and co-managing natural resources with local communities is usually prohibitively expensive (Peres, 2011).

Traditional knowledge is being used to derive new concepts that may help us to engage empiricism and science (Iaccarino, 2003), which is a knowledge system among many others (Nakashima, 2000). Botanic gardens can help to establish a bridge between these knowledge systems, bringing actors together through sustainable use projects. At its heart, the greater engagement of scientists with the holders of traditional knowledge is really about the greater engagement of people (Huntington, 2011). Education programs can be implemented teaching new generations the importance of the sustainable use of biodiversity based on traditional experiences. Also, introducing communities to new uses of plants can enhance local healthcare and nutrition, or inspire new sustainable livelihoods (Waylen, 2006).

Conclusions

The workshop held at the Rio de Janeiro Botanical Garden was an opening discussion on national implementation of GSPC targets related to the sustainable use of plants. Discussions are expected to result in actions, since the sustainable use of plant resources may represent an alternative model for development in mega-diverse countries. Social and economic inequity is one of the challenges to be overcome in order to reduce pressures on natural areas, avoiding species loss, depletion of natural stocks and ecosystem services.

Several unarticulated initiatives are already being undertaken and we must seize the momentum. Civil society is more organized than ever and scientific advances are helping to provide guidance. Environmental sectors of the government are supporting actions on sustainable use of plant resources. Nevertheless, there is still a lack of articulation and communication between efforts, due to the absence of national coordination and poor communication among actors. The Brazilian National Centre for Flora Conservation has been working to fill these gaps (Martinelli, 2010), promoting technical meetings, publishing manuals, and offering tools for different sectors of society. But, research and legal regulation is still needed to ensure institutional mandates and a strategic outreach for ongoing actions.

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Acknowledgements

We are grateful to the Global Environmental Facility (GEF) for funding activities of the Brazilian Centre for Flora Conservation (CNCFlora), through The National Biodiversity Mainstreaming and Institutional Consolidation Project (Probio II). The workshop was also supported by the Department of Environment, Food and Rural Affairs (Defra), United Kingdom. Participant institutions in the workshop are thanked for their valuable contributions: Detzel Consulting; Embrapa Florestas; MAPA; JBRJ; MMA; INEA; SFB/ MMA; Embrapa – CENARGEN; SOS Mata Atlântica; OrquidaRio; UFRPE; Fund. Florestal - AT/GPRA; INEA; Natura; Embrapa Cerrados; CI Brasil. We are also grateful to the Brazilian Tropical School of National Botany – ENBT/ JBRJ for hosting the workshop.

Miguel d'Ávila de Moraes
Centro Nacional de Conservação da Flora - CNCFlora
Instituto de Pesquisas Jardim Botânico do Rio de Janeiro
Rua Pacheco Leao 915,
Rio de Janeiro 22460-030, Brazil
Email: miguel@cncflora.jbrj.gov.br

Authors: Maite Lascurain, Sergio Avendaño, Citlalli López, Juan Carlos López and Melissa Covarrubias

ECOLOGICAL, PRODUCTIVE AND CULTURAL VALUES OF CACHICHÍN (*OECOPETALUM MEXICANUM*): AN EDIBLE WILD FRUIT FROM VERACRUZ, MEXICO

Cachichín provides an example of a sustainably harvested, wild fruit that provides social, economic and nutritional benefits for local communities

Cachichín for sale in local markets (Avendaño/Lascurain)

Introduction

Mexico is one of the countries in the world with the highest number of vascular plant species, around 31,000 (Sarukhán *et al*., 2009). Of these, around 7,000 are used and maintained in the wild and they support the livelihoods of a quarter of the Mexican population who live in rural areas. In recent years, wild edible fruits have been gaining in prominence to such an extent that forests are now being managing for the economic benefits and supply of food to rural communities provided by these species. In 2003 to 2006 a group of researchers worked on a project funded by the National Forestry Commission to identify relevant aspects of wild edible fruits in central Veracruz, Mexico. One species that was of great interest was the tree *Oecopetalum mexicanum* Greenm. & C. H. Thomps, the cachichín, which is from the Icacinaceae family. From 2007 to 2011 further studies were conducted to better understand the use and management of this fruit in the mountains of Misantla, located in the center of the state of Veracruz, Mexico.

The cachichín tree

O. mexicanum is often confused with *O. greenmanii* Standl. & Steyerm and it is known by a range of names. In Oaxaca, Chiapas and Tabasco it is called kakatez (or kakaté) (Tzeltal language), cacaté, jacaté, jamajuquilla (Tojolobal language), September cacaté (Simojovel, Chiapas) and jamacuquiaca (Zoque language, Tapalapa) (Martinez, 1987).

Both the tree and the seed of *O. mexicanum*, are known by the name of cachichín which is a word of Totonac origin meaning bitter fruit. The collection and use of this seed is part of the everyday life of about 100,000 inhabitants of the Sierra de Misantla who are involved directly and indirectly in its collection, processing, consumption and sale.

The cachichín tree (Avendaño/Lascurain)

The seed is valued for sale in regional markets and for home consumption, where it provides a food supplement for much of the year.

This tree grows at an altitude of 400 to 1,000 m, and reaches anything between 2m and 25m in height. Its flowers have white petals and yellow anthers, the fruit is a drupe, which when when ripe is green and brown, 2 to 3 cm long and with a white seed that is about 1 to 2 cm wide (Gutierrez, 1994).

According to Carballo (1996), the protein content is 11.5% when roasted, 4.9% when boiled and 5.17% raw. The highest percentage of sugar occurs when the seed is roasted (0.04%). It is known that it also contains high amounts of potassium, calcium and magnesium (Gutierrez, 1994).

Wood from fallen, sick, old or pruned cachichín trees is used as a source of firewood and the timber is also used for building houses and barns. In its green condition, it has similar or superior properties to pine (Lascurain et al., 2007).

The cachichín occurs in a range of systems in the continuum between natural forests and mixed arboriculture (Wiersum, 1997). It is mainly located in four different management systems that offer multiple resources for the people: forest or monte, forest enriched (cachichinal), shade coffee plantations and home gardens.

The forest or monte is vegetation fragments which more or less preserve the natural cloud forest and evergreen forest. Here *O. mexicanum* grows naturally and is abundant, making it one of the favorite places for collectors. The cachichinal is a forest enriched with *O. mexicanum* and other species of utilitarian interest. In the traditional shade coffee crop, the species is tolerated at low density and home gardens also maintain a small number of these individuals.

Harvesting the seeds

Although private ownership predominates at the sites where the study took place, collectors harvest the cachichín from any piece of land where the trees grow. Locals expressed that there is little competition for access to trees and fruits, but there is a little more control in the enriched forest system (cachichinal), where people invest more time and effort in the introduction and care of these trees.

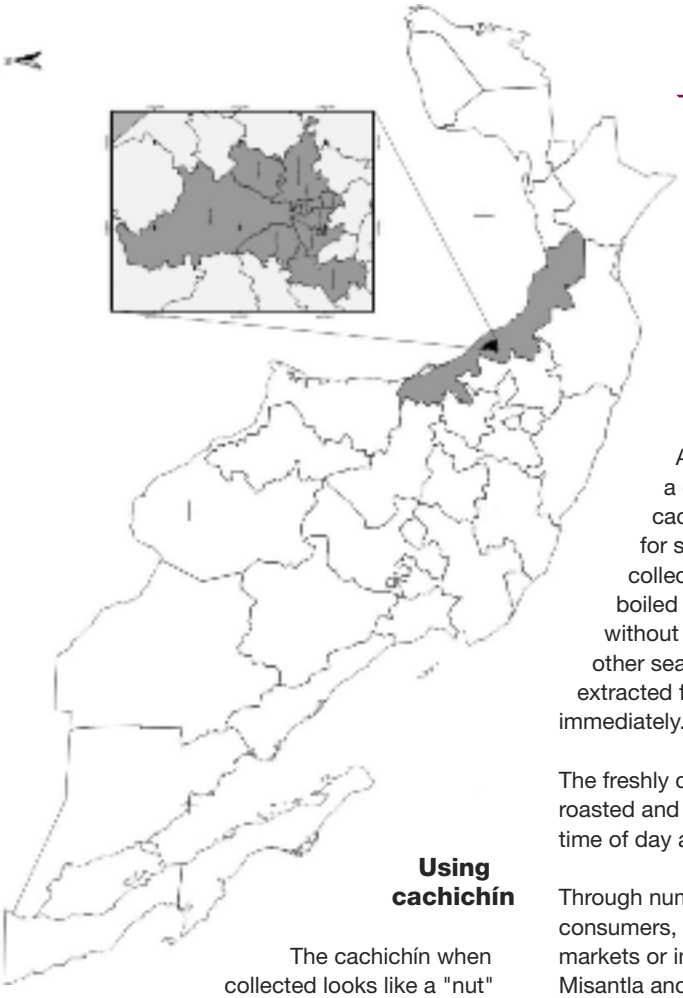
The seed collection is carried out during April and May. Collectors often begin their journey at dawn with bags, backpacks and if necessary use flashlights. The fruits are collected from the ground, looking among the dead leaves, sometimes with the aid of a stick. Times of collection vary depending on the ability of each collector and the final destination of the product.

Cachichín harvesting is a traditional event, an entertainment and an opportunity to spend time with friends and family. Groups are sometimes organized between members of the same family or between people of different ages. This form of collective collection has been maintained for several generations and allows locals to renew and strengthen ties within the family and between friends, as well as maintaining a sense of belonging and identity.

The amount of fruit collected can vary from 7 to 30 kg per day of cachichines. People who go in groups and collect for commercial purposes can collect up to 500 kg or more in 15 or 20 days during the harvesting season.

When collectors come home with the load, the fruit are spread out on the floor in every room, even under the bed and furniture and left to dry in the shade for about 20 days. The dried fruit can be stored for up to five months if kept dry in plastic bags.

Roasted fruits and edible seeds of cachichín (Avendaño/Lascurain)



Using cachichín

The cachichín when collected looks like a "nut" of two valves. The seed is bitter, and similar in flavor and texture to peanut. The most common way to eat cachichín is roasted as this makes it less bitter. To roast the people use a griddle or a drum, stirring the fruit constantly. The drum is a rotating cylinder (similar to a coffee roaster) that is heated with firewood and turned slowly with a hand crank. A pale gold colour indicates a good level of toasting. The cachichín is roasted as needed for sale or consumption. Freshly collected cachichín can also be boiled whole for around 2 hours, without the addition of salt of any other seasoning. The seed is then extracted from the shell and eaten immediately.

The freshly collected cachichín is eaten roasted and sometimes boiled, at any time of day as a treat.

Through numerous suppliers and consumers, cachichín is sold in local markets or in the streets of the city of Misantla and nearby towns, as well as in Xalapa (Veracruz state capital) (Lascurain *et al*., 2009). Cultural ties and family networks play a key role in marketing efforts.

Conclusions

The ecological, productive and cultural values of cachichín are important for biodiversity conservation, since the management and harvesting of the fruit causes no apparent adverse effects to the trees or ecosystems where it grows. Instead, each management system offers a wide range of production possibilities, species diversity, community arrangements, selection of management practices and conditions appropriate to the particular needs of each producer.

The different management systems for *O. mexicanum* maintain cohesive social and cultural networks that are observed from harvest to the consumption of the fruits. These are based on traditional knowledge, respecting the forms of ownership and access. Although more research is needed, we can say that this is a resource that is managed in a sustainable way providing nutritional value, consumption and economic benefits. The species has high levels of regeneration, and remains productive and abundant in certain areas of the Sierra de Misantla.

Above: Landscape of Sierra de Misantla (Avendaño/Lascurain) Top: Map of Sierra de Misantla, Veracruz, Mexico (Avendaño/Lascurain)

Collecting the fruit (Avendaño/Lascurain)

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Cachichín flowers (Avendaño/Lascurain)

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Ana González (eight years old). Song written in October 2007
We always together pick cachichín to the hill early.
My family likes to collect cachichines because we had fun.

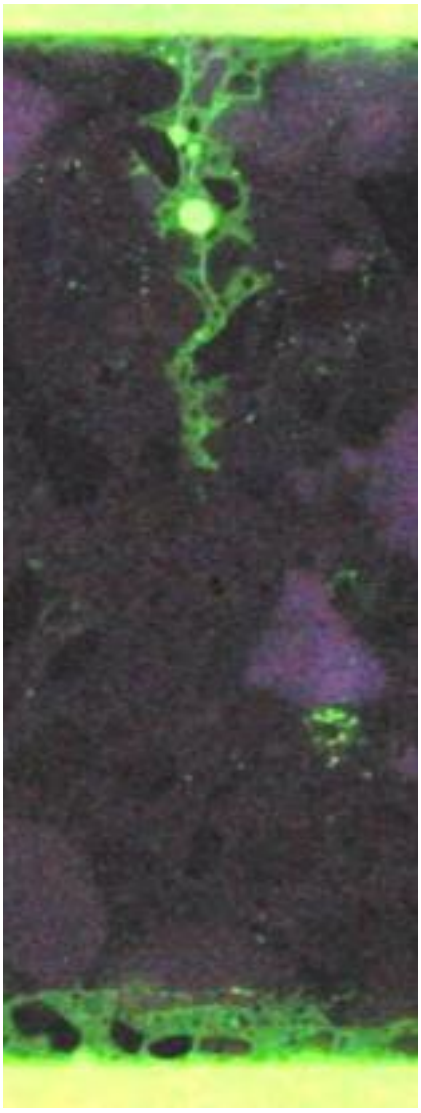
Ignacio González
On my property pick my nephews, grandchildren and godparents; even I myself have come to buy what they gather from my own mountain.

Maite Lascurain
Instituto de Ecología, A.C.
Carretera antigua a Coatepec
No. 351. El Haya.
Xalapa, Veracruz,
Mexico. C.P. 91070.
Email: maite.lascurain@inecol.edu.mx

Author: Bob Ursem

BIOMIMETICS - A POSSIBLE NEW AREA FOR RESEARCH AND ECONOMIC BENEFIT FOR BOTANIC GARDENS

The large and diverse plant collections of botanic garden provide a largely untapped resource for the development of innovative bio-inspired industrial solutions.



Concrete mixed with coiled and filled fibres and fluorescent spaces after self-healing

Introduction

Botanic gardens are known for their expertise in floral research, for conserving plants, promoting conservation and raising awareness of the loss of biodiversity on our planet. These are indeed extremely important roles for the modern botanic garden. But botanic gardens increasingly have to face the effects of a global economic downturn, and some gardens are even facing an uncertain future. On the other hand industry and governments are more and more aware of the need to develop sustainable economies based on new innovations and bio-based approaches. The answer to such approaches and the path towards a sustainable bio-based economy can be found in botanic gardens. The plant collections of botanic gardens are the source of many hidden values for humankind and botanic gardens can provide inspired solutions, with the potential to have a huge impact in industry, food and feed, human wellbeing and many other areas.

Burrs of Arctium lappa

What is biomimetics?

Since 1917, the Botanic Garden of Delft University of Technology has used plants for industrial application and implementation. Initially work was focused on raw materials, oils, waxes, gums, latex, fibres and wood, but more recently the focus has shifted to modern approaches in biomimetics and bio mimicry.

Because there is no doubt that nature is the best engineer and the most ingenious designer of all, bio mimicry is based on translating and copying nature's solutions into human technology. But we can go one step further, into the world of biomimetics.

"A new field of research for botanic gardens can be found in biomimetics."

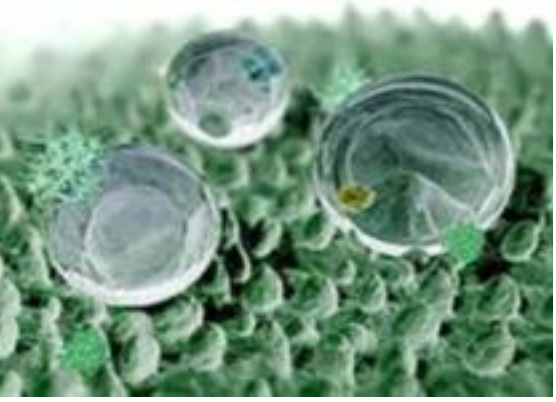
Biomimetics is an inter-disciplinary approach in science that combines botany and in a broader sense biology, engineering science, chemistry, physics, architecture, design and mathematics. The basic principle is not only to copy nature, but to understand the principles of nature's ideas and solutions, which have stood the test of millions of years of evolution, and make these useable for humankind. The aim is to use nature's principles and use them as a stimulus for innovation in industry. The products or concepts thus developed achieve their objectives economically, with the minimum use of energy, corresponding to the principles of sustainability, conservation of resources and complete recycling of waste.

There are many advantages for botanic gardens from this approach. Firstly you are contributing directly to a sustainable green society by using industrially applied innovations based on plants and secondly, you create a totally new source of income for the botanic garden allowing the strengthening of other important tasks in the area of plant and environmental conservation, education and research. Work in this area, promoted in Delft at the BGCI World Scientific Congress in 2008, has some followers already and we hope that this article convinces others to do the same.

Botanic gardens presently have limited connections with industry, but we do have a huge resource for research and development in stock! A few to mention...

Early examples

The most famous example of plant use in industry, based on this novel approach of bio-inspired solutions, is the zipper. In



The Lotus effect (Bonn Botanic Garden)

Mountain pine

1941, the Swiss engineer George de Mestral, took his dog for a walk and on his return he noticed that burrs (*Arctium lappa* or greater burdock) got stuck in its fur. Because these burrs stuck tenaciously to the dog's hair, he examined them under a microscope. He noted the tiny hooks on the end of the burr's spines that caught anything with a loop, like hairs, fur, clothes, curtains and carpets. Soon after, the very first bio mimicry zipper made of the burrs arose, and this was later improved to a second invention, the Velcro brand fasteners.

Another striking example of bio mimicry from plants can be found in the "super hydrophobicity," phenomena of the Lotus leaf (*Nelumbo nucifera*). This is known as the Lotus Effect, first discovered by Prof. Dr. Wilhelm Bartlott, Botanic Garden, University of Bonn, Germany. The surface of the Lotus leaves is covered with laminar wax that water rolls off, taking any contaminates with it. Researchers have developed ways to chemically treat the surface of plastics and metal to evoke the same effect. Applications are nearly endless and not just in making windshield wipers and car waxing obsolete; using this technology for example, aircrafts won't need to be de-iced any more.

Flood defences

The use of plants in flood defence is exploited by the Botanic Garden of Delft University of Technology using Vetiver grass (*Vetiveria zizanoides*). This species can be used to protect the banks of rivers and canals against erosion by waves from shipping. The root system grows extremely deeply into the soil, easily up to 4 meters or more, and creates many side roots, forming a matrix that prevents soil erosion on slopes. Vetiver grass planted in front of a dike can reduce the flood volume by 55 per cent, while if planted on the dike it can reduce the dike height by 90 cm and the dike volume by 20%, while maintaining the same water retaining capacity.

Another approach worth mentioning in this respect is the rehabilitation of mangroves for coastal defence. In 2009, the Delft Botanic Garden was involved in an official visit to Vietnam with the Dutch Delta Committee and its president and former Dutch Minister of Agriculture, Environment and Fisheries, Prof. Dr. Ir. Cees Veerman. During this visit we looked at typical Dutch solutions to coastal engineering - solid dikes as sea walls. But the subsoil conditions are very different to Holland and appear to be clay instead of sand. In some places, the dike systems fell apart and even subsided and sank away. While we were on excursion, I noticed an extremely thin line of isinglass on the remnant, not fully eroded, patches of beach in many different places along the sea shore. This indicated the influence of both dominant rivers of Vietnam, the Mekong River and Saigon River, because isinglass could only have been carried by these rivers

from the silicon rich mountains at the border of Cambodia and Vietnam. The influence of both rivers appeared to stretch along 780 kilometres of coastline along Vietnam. This meant that nearly the whole coast of Vietnam could be secured with the Botanic Garden's plan of the recovery of the mangrove forest. Together with the Department of Water Management and Coastal Engineering of Delft we developed a plan to put bars on the tidal zone to capture coarse particles from the sea. After creating the desired shallow coast, we reduced the space between the bars to settle silt and clay. At a certain thickness of clay sediments suitable for a mangrove habitat, we started to plant primary mangroves (*Rhizophora apiculata* and *Sonneratia caseolaris*). These mangroves soon grow and due to limited aeration of the compressing soil, are forced to grow stilt pneumatophores that take over the role of the previous set of bars in the tidal zone. As the density of pneumatophores increases, so does the sedimentation of silt and clay. The next step will be to follow the natural succession and at the right time, introduce the properly adapted species for the ever changing edaphic environmental conditions.

Rehabilitation of mangroves not only breaks up the waves produced by typhoons and tsunamis, but also provides a long-lasting, relatively cheap and sustainable coastal defence. Furthermore, mangroves contribute as a source of income through leisure activities, ecotourism, fishing and wildlife observation. In the hinterland of the mangrove forest, a simple clay dike is all that is needed at typhoon height to prevent flooding.

Secondary metabolites

Biomimetics can also be applied in the harvesting of secondary metabolites from plants, as undertaken at the Delft Botanic Garden. The use of secondary wax components of the Alpine Mountain Pine (*Pinus mugo mughens*) is a prime example. This species grows at around 3,000masl near the snow line, or nivale zone. Secondary metabolites in the wax of the Mountain Pine shift UV radiation via the fluorescence effect into blue light. Recently we traced the RNA and are still working on the genetic engineering of micro-organisms to produce this translucent innovative product, which will be implemented in industry.

A second example is the harvesting of secondary metabolites with the technology of electrostatic hydrodynamic atomization (EHDA-technology). In the past the EHDA-technology has been successfully applied for the extraction of paclitaxol and taxol from yew trees (*Taxus baccata* of Europe and Western Asia, *Taxus brevifolia* of North America, *Taxus wallichiana* of China and Japan). Recently the use of secondary metabolites has moved to the food and drinks industry, especially in relation to their anti-bacterial properties.

Novel uses

A very novel use of plants is the detection of the hygroscopic movements of mosses. This has led to the formation of an interdisciplinary research team involving from Switzerland - ETH Zurich, Sensiel Research and CSEM, from Germany - the Max Planck Institute of Frankfurt and Potsdam, and in the Netherlands, the Delft University of Technology, Faculty of Industrial Design (Department of Process and Industrial Management) and Faculty of Applied Sciences (Botanic Garden and Nanostructures (Department of Chemistry)). Intra crystalline swelling as a mechanism is new in biology and there has been limited exploration of this as a phenomenon in chemistry. One of the first applications for this in industry is in car-tyre manufacturing. Based on the knowledge of adaptation to wet and dry conditions, the application of an all-weather tyre is feasible in the coming years. Presently we still have to change tyres during the year for dry summer conditions or snowy and extreme wet winter conditions.

Rizophora apiculata young plants with lined up bamboo bars

Rhizophora apiculata in sedimented mud with dense bars in the tidal zone

Vetiver grass (Henk Jan Verhagen)

Re-visiting traditional uses

Even old and at first-hand traditional uses of plants can be applied in modern technology. A good example in this respect is the use of fibres. In the past fibres were used for rope making, matting or basket making, and such properties were studied by the Botanic Garden. In the last decade, the focus has changed to exploring the inner side of the fiber. For example, fibers of conifers are known to have a hollow space of 50 - 70 nanometers. As well as this space inside the fibre, another property that appears to be very useful is the existence of pores. Using vacuum injection technology, we are able to fill the lumen of a fiber with liquids and seal them afterwards. This application provides us the possibility of self-healing systems in concrete. After filling with iron-hydroxide and sealing and drying, the fiber gets coiled in a spiral morphology. These filled spirals can then be added to the concrete mixture. While the process of drying takes place, the concrete shrinks and this normally creates cracks. Cracks are not important for the ridged capacity of concrete, but they do allow air that contains sulphur-dioxide to flow into the crack. Sulphur-dioxide is super reactive to calcium-carbonate or chalk and transforms the chalk into gypsum or calcium-sulphate. Gypsum is very weak and brittle and makes concrete rot. In this situation the fibres in the concrete release and react into iron-carbonate which acts as a filling glue and water. The water shrinks the fibre and closes the crack.

EHDA extraction of a yew tree with visible secondary metabolite deposits

A final plant-based innovation developed in conjunction with colleague scientists of our Department that will possibly open your eyes to new industries, is the biosilification project. The process of biosilification is based on the natural ability of diatoms or microscopic silicon algae to create silicon outer tubes. Diatoms can produce large amounts of silicon-based nano devices and nanotubes for specific uses. Thanks to genetic engineering, living diatoms can be used to manufacture reliably working valves of various shapes and sizes that can be used in nano devices, for example to deliver drugs to specific targets in the body, as chemo stats in chemical engineering applications, and in artificial photosynthetic processes. Their silicon skeletons can provide specialized sensors and filters with different release systems, allowing chemicals to be released in specific sequences. In relation to light, nanotubes concentrate and bundle light and make solar- induced reactions possible and there are a wide range of other engineering and defence applications for biosilification.

Conclusions

With this novel scientific research, I hope I have highlighted the huge and diverse possibilities of plant–based innovations for industry and humankind. Botanic gardens have plant collections with an extremely high potential in this respect. You just have to see and observe plants and nature, relate this to urgent needs in society and start research. The outcome is always interesting, economic, smart, energy–efficient and has endured tests over time.

Bob Ursem,
Botanic Garden Delft University of Technology,
Department of Biotechnology,
Faculty of Applied Sciences,
Julianalaan 67,
NL-2628 BC Delft,
The Netherlands.
E-mail: W.N.J.Ursem@ TUDelft.nl

Authors: Anastasiya Timoshyna and Bryony Morgan

FAIRWILD STANDARD – BEST PRACTICE FOR SUSTAINABLE USE AND TRADE OF WILD-COLLECTED PLANTS

Botanic gardens are often key players in national and local plant conservation initiatives, and hence have an important role to play in the further application and development of the FairWild Standard.

Above: Harvesting Allium ursinum *in Bosnia (Sladjana Bundalo)*
Left: Halakki Vokkaliga from the Honnavar tribe (Arpana Basappa)

Introduction

Humans around the world rely on an estimated 50,000–70,000 wild medicinal and aromatic plant (MAP) species (Schippmann *et al.*, 2006). Wild harvest and trade provides a critical source of income, particularly for the rural poor in developing countries, and underpins production of numerous traditional medicines, pharmaceuticals, cosmetics, food, beverages and other products. Annual international trade in pharmaceutical plants alone was valued at USD1.7 billion in 2009 (COMTRADE, 2010). MAPs are the main ingredients in widely used Asian traditional medicine systems (e.g. Ayurveyda, Traditional Chinese Medicine (TCM)), and are central in primary health care systems throughout the developing world. They also provide compounds that underpin many modern healthcare practices.

However, the ongoing demand for wild plant materials to supply these needs poses major ecological and social challenges. MAP populations around the world are declining due to overharvest, endangering local ecosystems and the livelihoods of collectors. There is evidence that as many as one-fifth of all plant species are threatened with extinction in their natural habitats, from unsustainable harvesting and other pressures (Anon 2010). In response to these concerns, the FairWild Foundation and partners, such as TRAFFIC, promote sustainable, fair and value-added management, including supply chain development, of wild-collected natural ingredients and products thereof. At the core of these efforts is the FairWild Standard: a set of principles and criteria guiding best-practice in sustainable management and trade. It is unique in providing ecological, social and fair-trade criteria for sustainable collection of wild plants and similar resources.

The FairWild Standard was developed through a multi-stakeholder consultation process with experts and resource users. It incorporates an older initiative - the International Standard for Sustainable Wild Collection of Medicinal and Aromatic Plants (ISSC-MAP), developed by TRAFFIC, WWF, the German Federal Agency for Nature Conservation (BfN) and IUCN – the International Union for the Conservation of Nature. The FairWild Standard helps address primary threats to plant conservation (over-harvesting and conversion or destruction of habitats) by providing stakeholders with detailed guidance in establishing robust, knowledge-based resource management

Fruit of Amomum elephantorum*, Cambodia (Eanghuort Khou)*

schemes, and also in developing policy and regulations. Uptake pathways provide incentives to communities, traders and the private sector to establish sustainable use schemes in a cooperative and participatory way.

How does the FairWild Standard work?

At the core of the FairWild Standard is a set of social, ecological and fair trade sustainability principles (FairWild Foundation, 2010a). These provide best-practice guidance in key areas:

1. Maintaining wild plant resources
2. Preventing negative environmental impacts
3. Complying with laws, regulations, and agreements
4. Respecting customary rights and benefit-sharing
5. Promoting fair contractual relationships between operators and collectors
6. Limiting participation of children in wild-collection activities
7. Ensuring benefits for collectors and their communities
8. Ensuring fair working conditions for all workers of FairWild collection operations
9. Applying responsible management practices
10. Applying responsible business practices
11. Promoting buyer commitment.

The Standard is accompanied by detailed Performance Indicators (FairWild Foundation, 2010b), allowing resource users to assess their performance and identify ways to improve. FairWild Standard implementation is based on actions in areas common to all sustainable use projects, underpinned by a set of novel tools and methodologies.

Risk assessment

Not all species respond to harvesting pressure in the same way. One of the first steps in applying the FairWild Standard is to judge how resilient the target species is to collection – the overall potential of the species to be managed on a sustained yield basis. Members of the IUCN/SSC Medicinal Plants Specialist Group have developed a "risk assessment" methodology, analysing species' resilience pressure based on a number of attributes such as population distribution, reproductive biology, and regeneration potential (FairWild Foundation, 2011). The outcome is classification of the species as being at low, medium or high risk of unsustainable collection. This helps resource managers know the rigour and complexity needed in their management planning and monitoring. Additional performance indicators are set for "high risk" species.

Resource assessment and adaptive management planning

Conducting an assessment of the available resource that can be harvested is a key step in establishing

Sustainable harvest at FRLHT, India (Arpana Basappa)

management and monitoring systems for the target species. These activities are necessary for all species, but activities can be adapted based on the risk classification. This helps to make FairWild Standard implementation less time consuming and costly for species where risk of overharvesting is low. The FairWild Foundation provides guidance on conducting the resource assessment (Leaman & Cunningham, 2008) and developing management plans (Winkler, 2010).

Social and fair trade requirements, including access and benefit sharing (ABS)

Sustainable use also requires attention to social issues, including the livelihoods of the collectors, access by traditional and other user groups, as well as respect to the ABS principles incorporated in the Convention on Biological Diversity (CBD). Requirements are set on a number of social and labour issues, preventing discrimination based on gender, ethnicity or religion. ABS elements are included as important constituents of sustainable use practices. Fair trade requirements are based on transparency and cost-calculations along the trade chain, and result in increased prices paid to collectors and the establishment of a community premium fund for social projects (Meinshausen, 2012).

Experiences of the FairWild Standard application

Designed to be relevant to private sector, civil society organizations and governments alike, the FairWild Standard is being used by industry to inform product sourcing guidelines; governments and inter-governmental organizations in designing harvest and trade controls; and communities in their management systems. It forms the basis of a third-party audited certification system – complementing organic and fair trade certification processes, which typically lack mechanisms for certifying that wild harvest levels are sustainable. The FairWild Standard was piloted in a number of scenarios around the world (for example, Kathe *et al*. 2010), and is now recognized as a globally-relevant best-practice tool.

FairWild certification

FairWild certification means that buyers can know they are supporting fair trading—the products are legally and sustainably sourced, and the benefits are felt by all those involved, right down to the local communities harvesting the wild plants. Producers from 7 countries (29 species in total) were certified in 2011. The first retail products labelled with the FairWild logo appeared in the US market in 2009, with the first FairWild-labelled product in the UK launched in July 2012 (Pukka Herbs' peppermint and licorice tea).

FairWild informing national legislation

Governments can use the FairWild Standard as a model for the development of national laws and other regulations governing fair trade practices, the conservation of biodiversity and the management of plant collection from the wild. For example, the National Medicinal Plants Board of India has included FairWild's ecological principles in its Guidelines for Good Field Collection Practices of Medicinal Plants. FairWild has also helped shape biodiversity and resource management legislation in Bosnia-Herzegovina and development of the Biodiversity Management Plan for *Pelargonium sidoides* in South Africa and Lesotho.

FairWild in communities

FairWild has been successfully piloted with communities in a number of countries. For example, in India, where the establishment of community-based management structures for the use of natural resources is well advanced, the FairWild Standard has been trialled with communities in two States: Uttarakhand and Karnataka. In Brazil, the FairWild implementation project with AVIVE (Associação Vida Verde da Amazônia) focused on the sustainable harvest of native medicinal and aromatic plant species to improve livelihoods and create incentives for habitat

Resource assessment for Pelargonium sidoides *in South Africa (Britta Pätzold)*

conservation. The project worked to establish agreements on conservation and benefit-sharing with different partners, including the private sector.

FairWild and international policy implementation: CBD and CITES

The FairWild Standard is also proving instrumental for the implementation of regulatory frameworks – bridging the gap between existing broad conservation guidelines and management plans developed for specific local conditions. The Standard is a useful tool for Parties in meeting their commitments under international conventions.

FairWild and the Convention on Biological Diversity (CBD)

The FairWild Standard has clear links to the CBD's core aim of conservation of biological resources, including their sustainable use and fair sharing of benefits resulting from such use. In particular, it is an excellent tool to help implement the CBD's *Global Strategy for Plant Conservation (GSPC)*, adopted in 2002 – in particular achievement of Targets 11, 12 and 13. The FairWild Standard is included in the online toolkit for the implementation of GSPC's Target 12, identifying it as a tool to help governments, companies and other stakeholders verify sustainable and ethical sourcing of plants from the wild. The FairWild Standard's precursor (ISSC-MAP) is also referenced in the European Plant Conservation Strategy (EPCS), a document which translates the GSPC into a European context. TRAFFIC and the FairWild Foundation are keen to support the step-by-step achievement of the GSPC's sustainable use targets in national contexts, e.g. through incorporating actions based on the FairWild Standard into National Biodiversity Strategies and Action Plans (NBSAPs).

Convention on the International Trade in Endangered Species of Fauna and Flora (CITES)

Countries exporting plant and animal species listed in Appendix II of CITES are required to demonstrate that levels of export are not detrimental to the survival of the species concerned. This is achieved through the compilation and issuing of a so called Non-Detriment Finding (NDF) by the CITES Scientific Authority of the country concerned. The ecological criteria of the FairWild Standard have informed technical discussions on development of NDF procedures for perennial plants at international CITES expert meetings in Mexico (Anon 2008, Leaman in prep) and elsewhere. The FairWild Foundation also provides guidance on adaptive management schemes for wild-harvested resources; an important consideration for NDF evaluations. TRAFFIC has field-tested the FairWild Standard as a means of guiding the development of an NDF for *Pelargonium sidoides* in Lesotho and South Africa, funded by the German Federal Ministry for Economic Cooperation and Development (BMZ). TRAFFIC is currently engaged in a project to further develop guidance and training modules for scientific authorities on conducting NDFs for perennial plants, partially based on the FairWild Standard.

Group discussion at training course in Xuan Lac commune, Vietnam (Nguyen Thi Mai/TRAFFIC)

Role of botanical gardens

Botanical gardens are often key players in national and local plant conservation initiatives, and hence have an important role in the further application and development of the FairWild Standard. In particular,

1) Botanical gardens are encouraged to use the FairWild Standard Principles and Criteria when engaging with in-situ conservation projects, including with local communities.
2) Botanical gardens and herbariums could be on the forefront of the research to support the application of the FairWild Standard. It is crucial that sustainable use projects are based on sound science, including the correct taxonomic identification of voucher specimens using herbarium reference collections. There is also the potential to research best practice in enrichment planting and restoration, which can be part of sustainable use projects if properly designed and with monitoring of impacts. The living collections of botanical gardens provide the biological materials to use in such projects.
3) Experts of botanical gardens around the world are encouraged to engage in work related to the field implementation of the FairWild Standard.
4) Botanical gardens can communicate the use of the FairWild Standard to their visitors and partners, including through poster displays on sustainable wild use of plants; incorporation into educational programmes; and stocking FairWild-certified products in their shops.

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Anastasiya Timoshyna and Bryony Morgan
TRAFFIC International,
219a Huntingdon Road,
Cambridge, CB3 0DL, UK
Email:
anastasiya.timoshyna@wwf.hu

Authors: Darach Lupton, Thuraiya Al Jabri, Abdulrahman Al Hinai, Saif Al Hatmi

PEOPLE AND PLANTS IN THE SULTANATE OF OMAN
ETHNOBANY AT OMAN BOTANIC GARDEN

The Oman Botanic Garden (OBG) has initiated an ethnobotanical research, conservation and education programme aimed at preserving the long and intimate association between the Omani people and their wild and cultivated plants.

OBG ethnobotany team members Aldulrahman Al Hinai and Salim Al Rahbi collecting herbarium material in the Al Hajar Mountains (Fathi Al Hasani)

Introduction

Ethnobotany is described by Veilleux *et al*., (2005) as the study of how people of a particular culture and region interact and use indigenous plants and how they classify, identify and relate to them. The study of ethnobotany has had an important resurgence in recent years. Both the Convention of Biological Diversity (CBD, 1992) and the Global Strategy for Plant Conservation have recognized this importance and placed great emphasis on it (Amusa, 2010). However, indigenous knowledge relating to traditional plant uses is under increasing threat. Habitat and species loss, migration of indigenous people to urban centres, fragmentation of people from their environment, the move away from traditional medicine, the decline of traditional agricultural practices and the loss of their associated landraces or cultivars are among some of the many pressures facing the conservation and perpetuation of ethnobotanical knowledge. The situation in Oman is no different, as many of these issues are influencing traditional Omani society and its associated customs, resulting in the potentially irretrievable loss of ancient traditional practices. In its response to this worrying situation, the Oman Botanic Garden (OBG) has initiated an ethnobotanical research, conservation and education programme aimed at preserving the long and intimate association between the Omani people and their wild and cultivated plants.

Bedouin women in traditional dress making jewelry in Muscat (Marina Tsaliki)

Located on the south eastern fringe of the Arabian Peninsula, Oman has been at the centre of human and plant migration for millennia. Oman enjoys a rich mix of cultural influences originating from Asia, Persia, Africa and south eastern Europe. This rich variety of life and traditions are mirrored in Oman's botanical diversity, with influences from Africa and Asia and beyond permeating throughout the country's flora. Both the human and botanical diversity have flourished in this climatically unsympathetic part of the world, largely as a result of Oman's varied landscape. In contrast to most of Arabia, Oman has a wide range of habitats, which through time have supported and promoted an abundance of life. The breathtaking Al Hajar Mountains, stretching along the northern coastline have provided food and shelter for humans over millennia and have created a wide variety of ecological niches allowing botanical life to abound. The Dhofar Mountains in southern Oman, with their globally unique seasonal deciduous cloud forest that results from precipitation from the Indian summer monsoon have accommodated humans for thousands of years and have provided a unique habitat in which plant endemism reaches dizzying proportions. The centre of Oman, largely made up of vast expanses of gravel and sand deserts has been home to nomadic tribes since the late Bronze age and is, to this day, home to semi-nomadic Bedouin tribes in which traditional Bedouin practices are infused with the trappings of modern living.

Throughout the history of human settlement in Oman plants have played a vital role. Wheat (*Triticum* spp.), barley (*Hordeum* spp.), Frankincense (*Boswellia sacra*) and the date palm (*Phoenix dactylifera*) are just a few of the plants that have been fundamental to Oman's way of life and prosperity. In tandem with these largely economic plants, the role and use of medicinal plants in Oman has had, and continues to have, an important function in traditional Omani society. A visit to any souk around the country will quickly provide clear evidence of a thriving herbal medicine trade. Traditional crafts, including basketry, clothing, dyes, jewelry making and a whole wealth of other practices are abundant. Of course Oman's long, prosperous and spiritual relationship with Fankincense and its cousin Myrrh (*Commiphora* spp.) is well known and is still very much in evidence today. You don't have to walk very far in Oman before you are beguiled by the unmistakable aroma of smoldering Frankincense that immediately transports your imagination back in time and gives you a real sense of the longevity of human settlement and interaction with the landscape throughout Oman.

Oman's rich ethnobotanical heritage is endlessly fascinating and exciting and provides a wonderful window to the past and untold potential for the future. However, the security of the heritage and associated knowledge is unclear. How will it be conserved for future generations? As with many ancient cultures, much of the traditional knowledge relating to plant uses in Oman is orally passed from one generation to the next. In Oman the oral tradition is still very much the preferred conduit for transferring traditional knowledge. The inherent problem with this system in modern times is the breakdown of communication between the older and younger generations.

As is commonplace in many parts of the world, the pressure on young people throughout Oman's relatively rapid ascent to modernism is to move away from tradition and embrace technology and mass consumption and all their associated charms. While this is of course understandable, some caution and forward thinking is required to mitigate the potential erosion of traditional practices and knowledge. With these seismic cultural shifts in Oman there is a real danger that much of the valuable traditional knowledge will be lost in a generation or two.

The core mission of the Oman Botanic Garden is the conservation and promotion of Oman's native flora. The endless ways in which plants have shaped the way of life of Omani people and their traditions are deeply embedded within the OBG *modus operandi* and have been the key inspiration for the formation of the Ethnobotany Research Group, under the umbrella of the Botany and Conservation Department. At the heart of the ethnobotany team's motivation is the preservation, perpetuation and promotion of Oman's traditional plant knowledge. OBG will offer a unique blend of well researched and documented botanical-cultural heritage within a natural setting, subtly designed to convey the message that plants and people are inextricably linked in a wonderful and utterly captivating way.

Of course all of this knowledge must first be documented, verified, stored and ultimately put to good use within the Oman Botanic Garden. What was clear from the outset is that very little

Village elders explaining the uses of plants in Wadi Karous, Northern Oman (Andrew Anderson)

documented information relating to ethnobotany in Oman exists. The beautifully illustrated book, *Plants of Dhofar* (Miller & Morris, 1988), is the leading ethnobotanical text in the country and provides an excellent and detailed account of many of the key ethnobotanical plant species in southern Oman. Apart from that one seminal book – and a few less detailed publications – the traditional plant uses of Oman are largely undocumented. On the one hand this is daunting as the task ahead for the Oman Botanic Garden is enormous; however, it is also very exciting and offers the team and future researchers a virtually infinite array of research and conservation opportunities.

The nascent ethnobotany research group, formed in late 2010, is striving to create a dynamic research team, focusing initially on documenting baseline data relating to traditional plant uses in local villages throughout Northern Oman. This is the chosen area for the time being due to its close proximity to Oman Botanic Garden and because of its rich and virtually unknown ethnobotanical potential. The area is also very familiar to many of the Omani OBG staff, which has proven to be extremely useful when building trust and working relationships with the local village elders and experts. Baseline data collection is currently focused within a number of key areas: medicinal plants, traditional crops and plants used for traditional crafts. The team is keeping the research aims modest until such time that the garden is complete and functioning as a research institution. The small steps taken over the coming years will allow the ethnobotany team to hone their research skills, while building up vital relationships with local villages, village elders and national and international ethnobotanical institutions.

Over last 18 months the team has embarked on a series of exercises aimed at focusing their data collection methods. A literature review relating to Ethnobotany in Oman was completed in 2011, and all useful and reliable data were extracted and added to a working data sheet. The data sheet has allowed the team to detect the gaps in the Omani ethnobotanical knowledge and has thus provided baseline direction for data gathering and subsequent management in to the future. Following on from this, the team commenced field work, which involves visiting local traditional villages and conducting interviews with local experts, including farmers, herbalists and other relevant individuals.

Baled Seet village in the Al Hajar Mountains, Northern Oman with traditional agricultural terraces in the foreground (Darach Lupton)

Without question the fieldwork is the most important aspect of the project and it is where the real fun lies. Interviews are conducted on a semi formal basis, using semi structured interview techniques which allow the respondent to answer the question without constraint. Interviewees, typically village elders are fully briefed on the research objectives and have to date been completely willing to share their knowledge. The good natured, verbose interviewees are only too happy to divulge their expertise to an eager audience and are typically enthusiastic to have their photographs taken. All interviews are recorded using video and audio recording equipment to ensure that data are secured and to minimize loss due to translation. Individual interviews generally last about one hour, however the process of arriving at a village, greeting the locals and enjoying the local hospitality, means the actual data collection process is very time consuming, although utterly fascinating and always full of fun.

In relation to the interview process and subsequent data use and management, Oman Botanic Garden is currently reviewing its policies on Intellectual Property Rights and Access and Benefit Sharing. The team is revising their existing protocols in line with the Convention on Biological Diversity and draws from the Nagoya Protocol on

Access and Benefit Sharing. OBG is cognisant of these important issues and is determined to put in place fair and equitable benefit sharing arrangements related to the use of genetic resources and traditional knowledge obtained in the process of its ethnobotanical work.

The ethnobotany team is slowly building up a large body of information and is becoming increasingly proficient at documenting local knowledge. One of the team's initiatives in 2012 was to begin documenting and collecting seed of traditional wheat and barley landraces in Northern Oman. Abdulrahman Al Hinai, Salim Al Rahbi and Fathi Al Hasani have done sterling work this year and have collected seed and herbarium material of at least 10 traditional wheat and barley landraces, some of which may be completely new records, although confirmation is required. The seed is now in storage in the Oman Botanic Garden seed bank, and the herbarium vouchers have been added to the OBG herbarium. This has been a very successful sub-project and will continue into the foreseeable future.

The study of ethnobotany in Oman is a vast, largely untapped and very exciting discipline. There is an enormous body of research required to secure the traditional knowledge and protect it from erosion and loss. Through its initiatives, acquired knowledge and research facilities, the Oman Botanical Garden aims to significantly contribute to the conservation of this knowledge. Using its location and soon-to-be state of the art interpretation facilities, the Oman Botanic Garden aims to promote the endlessly curious, fascinating and vitally important value of Oman's ethnobotanical heritage to the Omani people. It is the aim of the garden to become a leading research and conservation institute on a regional and global scale. The small, measured steps taken now by the ethnobotany team at the Oman Botanic Garden will, with time, expand to play a significant role in national and international ethnobotanical conservation.

Acknowledgements for all their support and dedicated work

Dr Annette Patzelt, Salim Al Rahbi, Fathi Al Hasani and Andrew Anderson

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Darach Lupton
Oman Botanic Garden
P.O. Box 808,
Postcode 122,
Muscat, Sultanate of Oman
Email: dluptonian@gmail.com

RESOURCES

The Nagoya Protocol on Access and Benefit Sharing

The *Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity* is a new international agreement which aims at sharing the benefits arising from the utilization of genetic resources in a fair and equitable way. It was adopted by the Conference of the Parties to the Convention on Biological Diversity (CBD) at its tenth meeting on 29 October 2010 in Nagoya, Japan. The Nagoya Protocol will enter into force when 50 countries ratify it.

The Nagoya Protocol will create greater legal certainty and transparency for both providers and users of genetic resources by:

- Establishing more predictable conditions for access to genetic resources
- Helping to ensure benefit-sharing when genetic resources leave the contracting Party providing the genetic resources

By helping to ensure benefit-sharing, the Nagoya Protocol creates incentives to conserve and sustainably use genetic resources, and therefore enhances the contribution of biodiversity to development and human well-being.

The Nagoya Protocol applies to genetic resources that are covered by the CBD, and to the benefits arising from their utilization. It also covers traditional knowledge (TK) associated with genetic resources that are covered by the CBD and the benefits arising from the utilization of such knowledge.
The Nagoya Protocol sets out core obligations for its contracting Parties in relation to access to genetic resources, benefit-sharing and compliance.

The basis of Access and Benefit Sharing (ABS)

ABS is based on:

- Prior informed consent (PIC) being granted by a provider to a user. PIC is the permission given by the competent national authority of a provider country to a user prior to accessing genetic resources.
- Negotiations between the provider and the user to develop mutually agreed terms (MAT) that ensure that the benefits from the use of genetic resources are shared equitably.

Why is it important to have a Protocol on ABS?

By setting out a clear and transparent framework for ABS, the Nagoya Protocol will ensure that biodiversity-rich countries obtain a fair share of benefits arising out of the use of their genetic resources. Benefit-sharing, through technology transfer, research results, training and profits, can contribute to poverty reduction and sustainable development. Furthermore, ABS can contribute to further research and development contributing to human well-being through the use of genetic resources in pharmaceuticals, cosmetics, agriculture and many other sectors.

Why is ABS important to botanic gardens?

Botanic gardens are users of genetic resources which they access for a range of purposes, including display, education and research. These uses are generally considered to be non-commercial. Botanic gardens may also be providers of genetic resources if they share materials from their collections with other users. It is essential that botanic gardens understand and act within the provisions of the Nagoya Protocol, most specifically ensuring that plants in their collections have been accessed in accordance with prior informed consent, and that mutually agreed terms have been established with the provider of the materials. While the use of genetic resources by botanic gardens may be for non-commercial use, it is still important that benefits are shared with the provider country. Such benefits can include joint research projects, technology transfer, training etc.

Further information about the Nagoya Protocol is available on the website of the Convention for Biological Diversity: https://www.cbd.int/abs/

The International Plant Exchange Network (IPEN)

IPEN was established by European botanic gardens in order to comply with the access and benefit-sharing provisions of the CBD. It covers the non-commercial exchange of plant material between botanic gardens. Botanic gardens that want to join the network must adopt the IPEN Code of Conduct and use its common documents for plant material transfer. It covers acquisition, maintenance and supply of living plant material by the gardens as well as benefit-sharing.

Further information is available here: http://www.bgci.org/resources/ipen/

The Union for Ethical Biotrade

The Union for Ethical Biotrade (UEBT) is a non-profit association that promotes the "Sourcing with Respect" of ingredients that come from native biodiversity. Members commit to gradually ensuring that their sourcing practices promote the conservation of biodiversity, respect traditional knowledge and assure the equitable sharing of benefits all along the supply chain. In joining UEBT, a company agrees to comply with the principles of Ethical BioTrade. This means using practices that promote the sustainable use of natural ingredients, while ensuring that all contributors along the supply chain are paid fair prices and share the benefits derived from the use of biodiversity. By adopting the Ethical BioTrade practices of UEBT, companies foster long-term relationships with their source communities, creating employment, contributing to local development and helping to preserve local ecologies.

The idea behind forming the Union was born out of the need expressed by small and medium-sized enterprises (SMEs) in developing countries for ways to differentiate BioTrade products in the market. It stems from efforts initiated by the BioTrade Initiative of the United Nations Conference on Trade and Development (UNCTAD), which was created to contribute to international efforts to promote sustainable development and biodiversity conservation.

The fair and equitable sharing of benefits derived from the use of biodiversity is at the core of Ethical BioTrade, and constitutes one of the key elements of the work of UEBT. ABS principles are included in the Ethical BioTrade standard, both expressly and in the context of broader benefit sharing requirements. The UEBT third-party verification system assesses company policies and their implementation, and determines any necessary changes that need to be gradually implemented to comply with Ethical BioTrade practices, including on benefit sharing. In addition, UEBT provides technical advice and support on benefit sharing and ABS issues, including through practical tools and workshops. By addressing benefit sharing in its outreach activities, UEBT is also helping to raise awareness of these issues within industry.

Further information is available at www.ethicalbiotrade.org/

BioTrade

BioTrade refers to those activities of collection, production, transformation, and commercialization of goods and services derived from native biodiversity under the criteria of environmental, social and economic sustainability.

The BioTrade Initiative was launched by the United Nations Conference on Trade and Development (UNCTAD) in 1996 to promote sustainable BioTrade in support of the objectives of the Convention on Biological Diversity. The Initiative has developed a unique portfolio of programmes in Asia, Africa and Latin America that enhance the capability of developing countries to produce value-added products and services derived from biodiversity, for domestic and international markets.

BioTrade is about business, it is about going beyond the mitigation of negative impacts on the environment and on the welfare of populations; it is about using biodiversity in a sustainable manner and not only ensuring its conservation but also creating opportunities to integrate some of the most marginalized and poorest populations into the world economy.

The contribution of BioTrade goes beyond the sharing of successful experiences in engaging business in the sustainable use of biodiversity. It highlights the importance of having enabling policy and legal frameworks in place and the need for further involvement of the private sector in the formulation and implementation processes of policies.

Unfortunately, BioTrade does not provide all the answers to all the challenges and complexities of conserving biodiversity, but being the longest running United Nations initiative on business and biodiversity, it provides an interesting case for advancing in the effective engagement of business in the implementation of the CBD.

Further information is available at: www.biotrade.org

Branching out for a Green Economy

Developed to celebrate the launch of UNEP's Green Economy Report, this short animated film highlights the role forests can play in national development, a green economy and climate change. The film also reviews the impact of forest on business as usual and on transformative solutions.

Narrated by David Attenborough.
To view the film, visit: http://www.youtube.com/watch?v=Vi2GLNT9v9Y

For more information, visit: www.unep.org/greeneconomy/

Please join Botanic Gardens Conservation International (BGCI) and help us to save plants from extinction

Established in 1987, BGCI links more than 500 botanic gardens and conservation organizations in 115 countries, working together to save Plants for the Planet.

BGCI's INSTITUTION members receive numerous benefits:

- Opportunities for involvement in joint conservation and education projects
- Tools and opportunities to influence global conservation policy and action
- Botanic Garden Management Resource Pack (upon joining)*
- Our twice yearly e-publications:
  - *BGjournal* – an international journal for botanic gardens
  - *Roots* - Environmental Education Review
- A wide range of publications and special reports
- Invitations to BGCI congresses and discounts on registration fees
- BGCI technical support and advisory services

	Institution Membership	£ Stlg	US $	€ Euros
A	BGCI Patron Institution	5500	7500	8500
B	Institution member (budget more than US$2,250,000)	1000	1200	1500
C	Institution member (budget US$ 1,500,000 - 2,250,000)	550	700	900
D	Institution member (budget US$ 750,000 - 1,500,000)	400	500	650
E	Institution member (budget US$ 100,000 - 750,000)	220	280	350
F	Institution member (budget below US$100,000)*	100	120	150

INDIVIDUAL members and donors support BGCI's global network for plant conservation, and are connected to it through our publications and events.

BGCI's INDIVIDUAL members receive

- Regular e-publications (these publications are sent as a pdf file via email):
  - *BGjournal* - an international journal for botanic gardens (2 per year)
  - *Roots* - Environmental Education Review (2 per year)
- Invitations to BGCI congresses and discounts on registration fees

	Individual Membership	£ Stlg	US $	€ Euros
J	Conservation donor (*BGjournal* and *Roots* publications & special reports)	275	375	400
K	Associate member (*Roots* and *BGjournal*)	80	100	125
M	Friend-available through online subscription only (www.bgci.org)	15	20	25

***Contents of the Botanic Garden Management Resource Pack include:**
Darwin Technical Manual for Botanic Gardens, A Handbook for Botanic Gardens on the Reintroduction of Plants to the Wild, *BGjournal* - an international journal for botanic gardens, *Roots* - Environmental Education Review, *The International Agenda for Botanic Gardens in Conservation, Global Strategy for Plant Conservation, Environmental Education in Botanic Gardens*, additional recent BGCI reports and manuals.

Many of these publications have been translated into Chinese. Please contact us for more details.

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Please contact info@bgci.org for further information.

This publication is supported by the Rufford Foundation

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Botanic Gardens Conservation International

Descanso House, 199 Kew Road,
Richmond, Surrey, TW9 3BW, U.K.

Tel: +44 (0)20 8332 5953
E-mail: info@bgci.org
Internet: www.bgci.org
https://twitter.com/bgci

Printed on 100% recycled paper

ISSN 1811-8712

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