Developing tools for plant identification in the field

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Abstract

Identifying tropical forest plants in the field is often difficult, and published data for equatorial regions are relatively sparse by comparison with Europe. Greater understanding of plant diversity in local communities contributes to the long-term sustainability of rural livelihoods. By developing local field guides that can be used by non-experts, better forest inventories can be produced, plant growth and yield studies made more precise, and costly mis-identification of timber and other forest products avoided.

Efforts are being made in a number of institutions to develop tools that will enable local communities to access recorded information stored in libraries and herbaria, and to contribute their own local knowledge which can then enhance global understanding of world resources. By accurately linking local and scientific species names, foresters, farmers and other land users are enabled to check whether species are globally rare, locally used, toxic, dangerous to livestock, nutritious or self-fertile, etc. There can also be benefits in developing eco-tourism, with more knowledgeable local people able to earn more as guides; and published field guides can themselves generate income, both as practical tools and as souvenirs for tourists.

This presentation focuses on the Virtual Field Herbarium (VFH) designed at the University of Oxford, now an operational tool and growing in content. The project provides guidance, literature and images to allow the development of local field guides, helping users explore the range of plant characteristics which are particularly useful. Developed in conjunction with partners in Ghana, Cameroon, Grenada and Mexico, and with other related projects, the VFH offers a database and website accessible in the field by mobile phone.

Introduction

Most countries of the world have signed up to the Convention on Biological Diversity (CBD) (http://www.cbd.int/) and are thus committed to conserve and monitor biodiversity and local knowledge about it, and to support sustainable management of biodiverse ecosystems. In 2010, designated ‘International Year of Biodiversity’, it is apparent that the target adopted in 2002 by 110 Heads of State and Government to substantially reduce the rate of loss of biodiversity by 2010 has not been achieved and biodiversity continues to be lost at an unprecedented rate (UNESCO, 2010). The identification of plant biodiversity ‘hotspots’ is now a major priority in plant conservation, crucial to the saving of fragile ecosystems, and to our understanding of the global distribution of biodiversity and the response of hotspots to the impacts of climate change and human activity. Rapid botanical survey techniques now employed in the field are generating a mass of new data which is greatly assisting research in these areas. Innovative ways of accessing this information are enabling local communities to identify correctly many plants previously unknown to them, thereby helping to prevent

the destruction of rare plant communities and simultaneously improve livelihoods through creating better appreciation of their surroundings, raised awareness of plants with economic value, and the ability to act as effective guides in the growing eco-tourism market.

Traditional methods of plant recording and identification generally rely on sterile specimens stored in herbaria around the world, and annotated checklists often published in limited editions and available only in specialized libraries. Many institutions are now engaged in initiatives to digitize existing information and supplement it with digitally captured data which can be interrogated online world wide. Virtual herbaria have been developed, for example, at the New York Botanical Garden (http://sciweb.nybg.org/science2/ VirtualHerbarium.asp), the National Botanic Garden of Belgium (http://www.br.fgov.be/ RESEARCH/COLLECTIONS/HERBARIUM/advancedsearch.php), the Botanic Garden and Botanical Museum Berlin-Dahlem (http://ww2.bgbm.org/herbarium/), and a consortium of institutions in Australia (http://www.chah.gov.au/avh/), amongst many others. These typically provide images, descriptive text and identification tools, with customized search engines allowing retrieval by a variety of plant and site characteristics. They are generally designed for use both by professional and amateur botanists and non-specialists needing information on plant distribution, and are increasingly important sources of image data used by a very wide constituency for a great variety of purposes, one of which is the development of field guides.

Development of biodiversity field guides

A plant field guide is a book or other document or device designed primarily for identifying plants in the field. For tropical forest trees it will often be designed for use even when flowers and fruits are not available. Details of leaves are however almost always essential for identifying green plants in the field. A means of identification is needed, even if this is simply flicking through pictures until a look-alike is found. There are many types of field guide, but most are designed to be usable by the general public with limited practice, or by foresters and others without special botanical skills. More specialised guides still focus on highlighting the types of features visible at all times on the plants in question, not requiring detailed dissections, high powered microscopes or non-portable equipment.

At the University of Oxford, two projects funded by the UK Department for International Development (DFID), from 1998-2004, investigated various formats and methodologies for the production of forest and biodiversity field guides for use in rural development (Hawthorne, 2004; Lawrence, 2004). Building on existing research strengths, partnerships were established with Ghana's Forest Service and Biodiversity Unit, Limbe Botanical and Zoological Gardens Cameroon, and Grenada Forestry Department, investigating a variety of species including large trees in Ghana along with rattans and other non-timber forest products; *Cola* (as in Coca-Cola) trees in Cameroon; and a wide spread of species from different habitats in Grenada, with the main emphasis on ecotourism. Various formats of skeleton guides or ‘guidelets’ were tried out for these differing applications, with the projects perhaps unexpectedly revealing limited general awareness of local plant species, other than the very commonest or most used, amongst the villages of the study areas (Hawthorne, 2003). The Ghana big-tree ‘guidelet’ drew on experiences of a previous field guide to all 700 species of trees in Ghana (Hawthorne, 1990), which was illustrated with line drawings with text; it works reasonably well for technical and experienced field botanists, but the text demands a good grasp of English and the A4 format is too large for convenient field use. The project established that for effective use by a large range of the population field guides need photographs rather than drawings; simple or optional text; and a sturdy but lightweight format. Tests using laminated cards in postcard and A5 sizes with photographic illustrations showed that without the guides local people recognized on average about 25% of species, but this rose to around 80% with use of the cards; the size made little difference. In Cameroon, the guide characteristic tests included comparisons of various combinations of photos of fresh or dried leaves, photocopies, x-rays of venation, line drawings and actual dried leaves (pressed, in a polythene bag). *Cola* identification is notoriously difficult, and surprisingly little difference

emerged between the formats in terms of accuracy, but overall accuracy was relatively low at 45-55%; but this compared with near zero without the guides.

The Grenada project involved 439 Grenadians and tourists for ages 11 upwards, who were invited to identify 20 test plants using a shuffled pack of cards in three formats – photos, line drawings and paintings. Average success rates of around 80% were achieved, with an audience of whom many had little interest in or experience of tropical botany, had received no training on attributes to look for, and were not offered any guiding text or keys to help diagnosis. It was thus evident that picture-based field guides offered good scope for 'mostly-right' identifications. While colour photographs were most popular with respondents, and of more or less equal effectiveness along with coloured paintings in aiding recognition of 'easy and familiar' vegetation, line drawings, which force amateurs to concentrate on shape and structure rather than colour, were more successful for unfamiliar vegetation.

These tests were also carried out on volunteers at Oxford University, including a group of librarians during a staff conference workshop which proved very popular! The results were, interestingly, very similar to those obtained in the field.

Printed products

Resulting from these experiments, two full-colour comprehensive printed guides were produced: *Caribbean spice island plants* (Hawthorne, Jules and Marcelle, 2004) and *Photoguide for the forest trees of Ghana* (Hawthorne, 2006) which have proved very successful both as identification tools and as tourist guides. A summary of the lessons learnt in the two DFID projects are comprehensively summarised in *Plant identification: creating user-friendly field guides for biodiversity management*, by Anna Lawrence and William Hawthorne (Lawrence and Hawthorne, 2006).

The Virtual Field Herbarium

A further output from these projects has been the development of the Virtual Field Herbarium (VFH), an on-line database giving access to the thousands of botanical images collected, with links to their creators or others responsible for deciding who can use them. Most images are linked to herbarium specimens, so names used are potentially verifiable in the herbarium by reference to the specimen, or by using the links provided to contact the original photographer or plant collector. Integral tools enable the production of simple field guides using selected images. These could be used, for example, in schools or for local sale to tourists. The specimen data, with linked species, genus and family information in some cases, is useful for field guide writers, and the site includes step-by step advice on for producing various types of guide. Links to the relevant literature and results of the format trials are also provided, along with a glossary of 'jargon' botanical terms linked to illustrative images and texts.

As internet connections penetrate to ever more remote regions, it is particularly important to give access to pictures and information dealing with living plants as well as to digitised herbarium specimens preserved in other countries. The former are far less often available, a problem which the VFH is designed to fill. For Grenadian species, for example, it provides effectively an interactive version of the *Caribbean spice island plants* guide, but containing more images and information. Although accessible in the field on mobile devices such as smartphones and netbooks, the website has not yet been optimised for display on small screens as, in practice, the printed format has proved a more practical medium. This may change as larger displays such as the iPad become available, and the development of appropriate apps is under consideration.

The central component of the VFH is its 'successively filtered' image gallery. Filters are arranged hierarchically and cover taxonomic, species and geographic characteristics, including habitat and location, and can be used in any combination. The retrieved images can be zoomed, allowing fine detail to be revealed at high resolution. Registered users can save images to a custom list and generate a pdf for printing, in various formats and sort orders. For maximum verifiability, most images are

directly linked to herbarium specimens in Oxford's BRAHMS herbarium management system, from which botanical data is exported.

Content of the VFH is about to grow exponentially with the loading of new data from a number of new sites including Trinidad and Tobago, Chile, Mexico, Honduras, Peru, Bolivia, West Africa, Congo, Gabon, Malaysia, Indonesia and Japan. These data have been compiled using rapid botanical survey techniques which allow inventories of which plants grow where to be conducted quickly over wide areas; these can then be weighted by rarity to identify the 'hot spots'. Improved online hot spot maps linked to the data that defines them will reveal hotspots at all scales including small areas in otherwise 'cold' regions, which are generally neglected by conservation agencies. Conversely this will also identify extensive 'coldspots' in hotspot regions, which might be highlighted as places more suitable for sustainable forest use and economic development. The aim will be not always to say 'protect this, protect that', but rather to recommend 'protect this, use that'.

Funding and economic benefit

Much of this new work is being funded by the International Hotels Group (IHG), a perhaps 'non-traditional' source (http://www.ox.ac.uk/media/news_stories/2009/090902_1.html). Their concern is to find innovative solutions to the environmental, social and economic effects of travel and to ensure hotels are developed and operated in a responsible way. By partnering with Oxford University they hope to better understand conservation, address environmental concerns and ultimately safeguard the world's favourite tourist destinations for generations to come. This echoes the basic rationale for promoting field guide production which motivated the original DFID projects. When people are not aware of the plant diversity around them, they are in no position to make optimum use of their environment, or even to notice when species are going extinct. By promoting field guide production, the hope is to promote the sustainability of rural livelihoods and conservation of biodiversity at the same time.

Field guides cost money to produce and distribute, a major factor in determining their existence and availability. They can pay for themselves most obviously when linked to improvements in performance. Hundreds of pounds can be saved by preventing a single wrong tree being felled and carted to the sawmill, for instance. Environmental benefits of biodiversity conservation and costs of species loss can be credited to field guides, but it is hard to put a price tag on these functions. Development and research agencies are in the best position to see these potential long term benefits and to support guide production financially. It is increasingly important for this sector that field guides are designed to work by and for the rural poor, and for students in developing countries. Local field guides can be sold for use by, or as souvenirs for, ecotourists. For this aspect, the guides need to be immediately interesting and attractive. The more technical and detailed field guides tend to be significantly more accurate than the less technical types, when used correctly. However, less technical guides are often usable by a wider range of people, which often results in better local knowledge, with more plants being correctly named by more people.

Conclusion

Although early field guides were usually herbals, biased towards medicinal plants, over the last century tropical guide development has been driven more by a need for accurate tree identification for commercial forestry, and more recently for biodiversity inventories, environmental impact assessments, long-term ecological studies and eco-tourists. The demand for comprehensive tropical field guides is stronger than ever and the proliferation of popular field guides in Europe and America has shown tropical botanists what is possible, even if publishers are not currently over-excited by the market for such guide books in the tropics. By providing high-quality, reliable data to simplify guide production and thus reduce costs, the VFH hopes to redress the balance and contribute to increased 'botanical literacy' across the globe.

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