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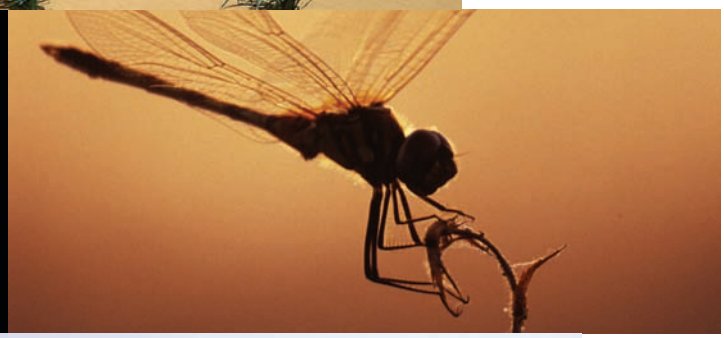
SUCCESS STORIES IN IMPLEMENTATION OF THE PROGRAMMES OF WORK ON DRY AND SUB-HUMID LANDS AND THE GLOBAL TAXONOMY INITIATIVE

Abstracts of Poster Presentations at the 11th Meeting of the *Subsidiary Body on Scientific, Technical and Technological Advice* of the Convention on Biological Diversity



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FOREWORD

At its 11th meeting in November-December 2005, the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA) will review the implementation of the programme of work on dry and sub-humid lands and the Global Taxonomy Initiative (GTI) in preparation for the eighth meeting of the COP, in March 2006.

Dryland organisms are unique in terms of their ability to adapt to extreme environments, and their ecosystems provide indispensable services upon which approximately two billion people depend directly. Hence efforts to conserve the biodiversity of dry and sub-humid land directly feed efforts to combat poverty, including the achievement of Millennium Development Goals. In recognition of the importance of conserving and sustainably using the biological diversity of dryland, Mediterranean, arid, semi-arid, grassland and savannah ecosystems, the Conference of the Parties (COP) to the Convention on Biological Diversity (CBD) adopted at its fifth meeting in 2000 a programme of work on dry and sub-humid lands.

Taxonomic knowledge can highlight areas containing high species diversity, identify species threatened with extinction, as well as provide a basis for biodiversity monitoring. In 2002, at its sixth meeting, the Conference of the Parties endorsed the programme of work for the Global Taxonomy Initiative (GTI) as a means to counteract the lack of taxonomic information and expertise in many parts of the world. The GTI is intended to support the implementation of the other programmes of work of the Convention, including the programme of work on dry and sub-humid lands biodiversity.

Despite efforts undertaken by the Parties to the CBD, biodiversity loss in dry and sub-humid lands has continued, and the taxonomic impediment remains. The Millennium Ecosystem Assessment (MA) has revealed that biodiversity loss has continued unabated over the past decades. Mediterranean forests and temperate grasslands, covered under the programme of work on dry and sub-humid lands, were identified as having suffered the highest rate of conversion to human use amongst the 14 biomes assessed by the MA. Research by the Secretariat for the in-depth review of the programmes of work further indicates continuing negative trends in drylands with regards to the extent of natural viable habitats, the populations of many threatened and endangered species and the effective control of threats. Meanwhile, the GTI is stagnating at an early stage of implementation due to the complexity and enormity of the task, as well as a widespread lack of capacity. These findings indicate that implementation of the two programmes of work requires renewed commitment and creativity.

This publication shows that despite negative trends in dry and sub-humid lands and the challenge remaining for the GTI, there are grounds for hope, and that there is much that is being done and could be done to slow the rate of biodiversity loss. The success stories presented include initiatives carved out at local, national and regional levels. They also exemplify available resources to assist with the implementation of the programmes of work on dry and sub-humid lands and the Global Taxonomy Initiative.

It is my hope that the contributions contained in this publication will inspire and inform further work towards implementation, promote the use of available tools and resources, as well as generate awareness of potential partners. The initiatives described could be replicated where possible and adapted to different local contexts. I hope the lessons featured in this publication will feed into discussions during the 11th meeting of SBSTTA and subsequently fuel implementation of national measures to achieve the 2010 target.

I wish to thank all those who have contributed abstracts in this issue of the CBD Technical Series.

Hamdallah Zedan
Executive Secretary

INTRODUCTION

The Conference of the Parties (COP) to the Convention on Biological Diversity (CBD) adopted, at its seventh meeting, decision VII/31 on its multi-year programme of work up to 2010. In paragraph 3 of that decision, the COP decided that at each of its meetings until 2010, it should assess progress, including obstacles, towards achieving the goals of the Strategic Plan, as well as the Convention's 2010 target and relevant Millennium Development Goals. An in-depth review of the programmes of work on dry and sub-humid lands and on the Global Taxonomy Initiative (GTI) will take place at the eighth meeting of the COP, in March 2006.

In preparation for the COP meeting, the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA) will consider in depth the implementation of the programme of work on dry and sub-humid lands and that of the GTI. In addition to the notes and information documents prepared by the Executive Secretary, it has now become usual practice to have a poster session during the period of the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA) meetings. The theme selected in consultation with the SBSTTA Bureau for the poster session to be held during the 11th meeting of SBSTTA is "Success stories in implementation of the programmes of work on dry and sub-humid lands and for the Global Taxonomy Initiative".

Parties, other Governments and relevant United Nations bodies, inter-governmental, non-governmental, regional and international organizations, indigenous and local communities, and the private sector, were invited to contribute posters and extended abstracts that describe success stories in the implementation of specific activities of (i) the dry and sub-humid lands programme of work and/or (ii) the Global Taxonomy Initiative.

This publication begins with an extended abstract of the keynote address on "Biodiversity, Land Degradation and Poverty Alleviation in Dry and Sub-humid Lands", delivered at the plenary session of the SBSTTA-11 meeting. Following are abstracts of posters presented on the margins of the meeting, divided into two parts.

The 23 abstracts in Part I, on the theme of dry and sub-humid lands, address the interlinkages between biodiversity loss, land degradation and poverty, and showcase successful approaches for conserving biodiversity and alleviating poverty. In Part II, the 35 abstracts on the Global Taxonomy Initiative demonstrate the existence of a taxonomic impediment, both in terms of limited knowledge of species and limited number of people with the expertise to study and identify them. Yet, they also highlight the work that is being done and the advances being made.

Success Stories in Implementation of the Programme of Work on Dry and Sub-humid Lands

BIODIVERSITY, LAND DEGRADATION AND POVERTY ALLEVIATION IN DRY AND SUB-HUMID LANDS

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Keywords: biodiversity, land degradation, poverty alleviation, ecosystem management

INTRODUCTION

Drylands occupy 41% of Earth's land area and are home to more than 2 billion people. Some 50 % of the world's poor live in the drylands. Water scarcity limits the production of crops, forage, wood and other ecosystem services. Some 10-20% of drylands are already degraded, and the process of desertification is on-going on a much larger area (Millennium Ecosystem Assessment, 2005). If these negative trends are unchecked, desertification and degradation of ecosystem services, including biodiversity, will threaten future improvements in human well-being.

A large majority of the dry areas meet the definition of marginal areas, and this is where most of the poor people have to make a living. Poverty in these areas goes well beyond financial indicators, and is largely determined by natural resources poverty, in particular water scarcity, which is further exacerbated by land degradation, low soil fertility and desertification. Increasing agricultural productivity in these areas has also been highlighted by the Consultative Group on the International Agricultural Research (CGIAR) Science Council as a clear pathway to poverty alleviation. Without substantial improvements in the agricultural production opportunities, these resource-poor conditions will increasingly lead to out-migration and the inherent negative socio-economic and political consequences. Consequently, enhancing the production capacity in these marginal areas through research investments has important implications in securing and improving the livelihoods and stability of rural communities in the dry areas. Indeed, in these regions well adopted research outputs are urgently needed international public goods.

At the global level agriculture has returned to the international development agenda, and it is now recognized again that improved agriculture is a key element in the economic development of the developing countries. The Millennium Development Goals (MDGs) were adopted in 2000 by the United Nations General Assembly in New York. They represent an international consensus on tackling issues of poverty, malnutrition, hunger and other key constraints to agricultural development. The CGIAR Science Council has developed the new system research priorities for 2005-2015. These priorities aim to contribute directly or indirectly to seven of the eight MDGs. They are meant to further focus the work on the 15 CGIAR Centers and to ensure that they respond to regional and national needs for international public goods research. The five System priority areas identified are:

1. sustaining biodiversity for current and future generations;
2. producing more and better food at lower costs through genetic improvement;
3. reducing rural poverty through agricultural diversification and emerging opportunities for high-value commodities and products;
4. poverty alleviation and sustainable management of water, land and forest resources; and
5. improving policies and facilitating institutional innovation to support sustainable reduction of poverty and hunger.

The International Center for Agricultural Research in the Dry Areas (ICARDA), one of the CGIAR Centers, included these priorities and contributions to MDGs in its research agenda and in its draft strategy for 2006-2015. The three Rio conventions, the Convention on Biological Diversity (CBD), the United Nations Convention to Combat Desertification (UNCCD) and the United Nations Framework Convention on Climate Change (UNFCCC), also provide guidance to ICARDA's research focused on biodiversity, land degradation and poverty in the drylands. The Center works with the National Agricultural Research Systems (NARS) in the developing countries to encourage inter-sectoral collaboration of different high-level stakeholders, ministries of agriculture and environment in particular, to implement the conventions' recommendations and the programmes of work through collaborative projects in the drylands agro-ecosystems. However, the full involvement of local communities of farmers and herders and their participation in research project development and implementation is the key element for finding successful and sustainable solutions to complex challenges affecting the people and their environment in the drylands.

ICARDA'S CONTRIBUTION TO CBD AND UNCCD

As already mentioned, the Center has contributed to the implementation of CBD in several aspects:

1. The extensive genetic resources collections held *ex situ* in the ICARDA genebank were placed under the auspices of FAO and are now part of the FAO Global System;
2. ICARDA participated in some COP and SBSTTA meetings and made a statement on drylands biodiversity as a part of the CGIAR delegation to COP-V;
3. The initiation and implementation, jointly with IPGRI and ACSAD, of a GEF-UNDP project on agrobiodiversity conservation in the four East Mediterranean countries;
4. Elements of CBD programs on drylands, agrobiodiversity and land degradation were integrated into ICARDA's research agenda;
5. Assistance is provided to NARS in the development of new projects for GEF funding;
6. NARS capacity to implement the CBD programs is promoted through training of national staff; and
7. Participation in two meetings of the SBSTTA ad hoc technical expert group (AHTEG) on dry and sub-humid lands.

LINKS WITH UNCCD

ICARDA is, more than any other CGIAR centre, well placed to link its work on land degradation to the UNCCD. ICARDA was actively engaged with NARS and other regional and international organizations in the preparation of action plans for implementation under the UNCCD.

Current collaborative activities include:

1. active participation in the Sub-Regional Action Program for W. Asia,
2. establishment of a Regional Program and Facilitation Office for West Asia and North Africa
3. membership in a Strategic Partnership Agreement for Central Asia with donor agencies
4. membership in the Task Force for the Central Asian Initiative on Land Management (CACILM)
5. preparation of an inventory of desertification-related activities within the CGIAR
6. membership of the Facilitation Committee of the Global Mechanism of the UNCCD (advisory committee).

As the CGIAR focal point for UNCCD, ICARDA has participated and made technical input in several UNCCD meetings.

To express their support to global conventions through the UNCCD, 13 West Asia and North Africa countries, represented by 17 ministers of agriculture, environment and finance, and representatives from donor agencies as well as regional and international organizations, met in Rabat in June 2001 to consider the challenges critical to the development of drylands in the region. The meeting resulted in a "Rabat Declaration," which both identified key areas for joint action and reflected strong support of the countries for its implementation, and entrusted ICARDA to take follow-up action. In a follow-up meeting in March 2002 with the participation of all stakeholders, a regional work plan was developed for sustainable development in dry areas in the Central West Asia and North African region (CWANA).

DRYLANDS BIODIVERSITY

Drylands are usually considered poor in biodiversity, when judged by number of species. However, some drylands are rich in plant biodiversity, the Mediterranean-type ecosystems being exceptional in this respect. It is estimated that the Mediterranean basin is a habitat of 25,000 species of higher plants. Among the 18 "hotspots" of endemic flora, defined by Myers, four belong to the Mediterranean-type ecosystems, while the remaining ones are located in the tropics (WCMC, 1992). Even the flora of arid and desert rangelands of northern Africa and the Near East contain some 5,500 species (Le Houerou and Boulos, 1991) and rangelands of Uzbekistan in Central Asia have some 3,700 species (Guintzburger et al., 2003). A number of globally important crops upon which livelihoods of millions of poor people in developing countries depend originate in dry and sub-humid lands. Genetic diversity of indigenous crop wild relatives and landraces is important for developing improved varieties adapted to the harsh environment of the drylands and tolerant to frequent stresses of drought, salinity, heat, or cold and resistant to diseases and insects. These attributes are essential for low-input subsistence farming systems that prevail in the drylands of the world.

Drylands biodiversity is not only important globally, but it is even more significant locally, providing food to people and feed to their animals in subsistence farming systems, where most of the rural poor of the developing world live. Plant diversity is also a source of fiber, fuel wood, construction material, aromatic and medicinal plants and plants used for other purposes that are essential for the local communities.

Unfortunately, the biodiversity of drylands is subjected to rapid genetic erosion that is primarily related to the high rates of population growth in most countries. Degradation of biodiversity is attributed to the destruction of natural habitats, largely through human activity, animal overgrazing and land reclamation. However, these same habitats represent the resource base for productive agriculture, the livelihood of farmers and pastoralists. Therefore, large exclusionary "reserves" to preserve biodiversity, which remove land from productive use and do not take account of local needs, will not be acceptable. For many species and environments, active management (often involving restoration or creation of niches and habitats within agricultural systems, promotion of traditional land management practices, or reform of social and economic policies) is required to conserve ecosystem, species, population and genetic diversity.

BIODIVERSITY CONSERVATION AND DRYLANDS DEVELOPMENT RESEARCH

ICARDA's mission is to improve the welfare of poor people through research and training in dry areas of the developing world, by increasing production, productivity and nutritional quality of food, while preserving and enhancing the natural resource base. ICARDA serves the entire developing world for the improvement of

lentil, barley and faba bean; all dry-area developing countries for the improvement of on-farm water-use efficiency, rangeland and small-ruminant production; and the CWANA region for the improvement of bread and durum wheats, chickpea, pasture and forage legumes, and farming systems. ICARDA's research provides global benefits of poverty alleviation through productivity improvements integrated with sustainable management practices.

The CWANA region encompasses an area of megadiversity of globally important food crops and pasture species. Three of the eight Vavilov's world centres of origin of cultivated plants are located in the CWANA region. It is the nucleus area where numerous species were domesticated (notably barley, wheat, lentil, pea, chickpea, faba bean and vetch). Their wild relatives and landraces of enormous genetic diversity are still found there. Many fruit and nut trees such as almond, olive and pistachio, also originate from this region and are actually present as a diverse range of wild relatives and local varieties. The region also contains major centres of plant diversity and endemism.

The CBD and UNCCD launched during the Rio de Janeiro World Summit, stressed the need to prevent and revert the processes of land degradation and biodiversity loss. The benefits of agrobiodiversity in sustaining agricultural development and food security were recognized by all the signatory countries. Subsequent meetings of COP and SBSTTA of the CBD have stressed the importance of agricultural biodiversity and of biodiversity of the drylands and mountainous areas. However, most of the efforts by national programs and GEF-supported projects were focused on biodiversity conservation in general and little attention was devoted to agrobiodiversity in the dry areas. ICARDA has conducted the first GEF-funded regional project aiming at promoting the *in situ*/on-farm conservation of dryland agrobiodiversity in the Near East to complement its on-going efforts of collecting and conserving *ex situ* the valuable genetic resources of CWANA region.

The Center coordinated during the period 1999–2005 a regional GEF/UNDP project on "Conservation and sustainable use of dryland agrobiodiversity in Jordan, Lebanon, the Palestinian Authority and Syria" to develop a holistic approach for promoting community-based *in situ* conservation of landraces and wild relatives of species of global importance originating from the Fertile Crescent (barley, wheat, lentil, alliums, vetch, medics, grasspea, trifoliums, figs, olives, almonds, pistachio, pears, prunes and apricots). The project field activities were conducted in 26 villages and 73 monitoring areas covering diverse ecosystems and representing different faming systems in the region. The activities were implemented at the national level by the national research institutions (NCARTT in Jordan, LARI in Lebanon and GCSAR in Syria) and by the Ministry of Agriculture in Palestine. Technical backstopping was provided by ICARDA, IPGRI and ACSAD and by other international experts.

Experience and lessons from this and other projects that ICARDA has implemented with NARS and other partners in the drylands may be briefly summarized in reference to the CBD's Program me of Work (PoW) on dry and sub-humid lands, which was adopted at the fifth meeting COP of the CBD:

STATUS AND THREATS TO LOCAL AGROBIODIVERSITY (POW ACTIVITIES 1 AND 2)

The household and farming systems surveys and the eco-geographic/botanic surveys have permitted the status and trends of local agrobiodiversity and its major threats to be assessed. The results showed that crop landraces are still widely used by farmers in the Near East region in the low-input and/or mountain farming systems. But the acreage of landraces is decreasing at the expense of the expansion of the plantations of apples, cherries and olives often subsidized by governments.

For the wild species in the natural habitats, including crop wild relatives, overgrazing and land reclamation for agricultural and urbanization expansion are seriously affecting the remaining native populations. Geographic information systems and remote sensing were used for assessing temporal changes in land use and environment similarities over the CWANA region. Negative trends such as natural habitat fragmentation and loss and degradation of vegetative cover have been documented.

Identification of the large number of taxa within each genus during the eco-geographic/botanic surveys may sometimes be a problem. To overcome this constraint and assist the NARS, field guides were produced and DELTA and LUCID programs were used to develop the interactive keys for the identification using computers. A FoxPro-aided program for ecogeographic and botanic survey was developed for the assessment and monitoring of species richness, plant density, frequency and distribution. This program also computes diversity indices and species associations.

DEVELOPMENT OF INDICATORS (POW ACTIVITY 3)

Indicators and survey methods used for general assessment of plant species biodiversity in the natural habitat may need some modifications for crop wild relative population assessment, where intra-specific diversity is most important.

IDENTIFICATION OF THE LOCAL AND GLOBAL BENEFITS (POW ACTIVITY 5)

Agro-biodiversity is strongly linked with the livelihoods of rural communities in the dry areas and mountain ecosystems. This link is more evident with farm income, food and diet because agro-biodiversity provides the basic components of nutrition, including energy, protein, minerals and vitamins for rural households. Agrobiodiversity is of particular importance for poor and vulnerable communities as it provides the main staple foods for their daily diet and source of income. Processing of some species also contributes to the livelihoods of rural households through income-generation. In addition to its role in supporting and sustaining food production, agro-biodiversity has a significant role in addressing under-nutrition associated with poverty in dry areas.

ICARDA assessed the status of agrobiodiversity in eight communities in Jordan, Lebanon, Palestine and Syria based on farm survey data, where simple quantitative indicators are used to document the impact of the project on conserving the local agrobiodiversity. Adopting the sustainable livelihood approach, household assets are quantified, wealth indices are calculated, and the importance of agrobiodiversity to household income is documented. Gender role in agrobiodiversity conservation is assessed and documented, and farmers' typologies are presented with respect to their wealth indices and agrobiodiversity indicators. Results indicated that targeted species contribution to the household income ranged between 19% and 38%, depending on community and country. More than one-third of the farm income is coming from these species in five out of the eight studied communities. Women contributed the most to the income generated from crops and fruit trees, with an average contribution of 14–35% in the four countries.

PROMOTION OF SPECIFIC MEASURES (POW ACTIVITY 7)

An integrated approach was adopted combining both the conservation and the improvement of the livelihoods of the custodians of local agrobiodiversity. Low-cost technologies were demonstrated (e.g., water harvesting, integrated pest management, seed quality improvement, crop rotation) for increasing the productivity of landraces. The seed cleaning and treatment resulted in significant increases in grain and straw yield of

cereals and legumes. In areas with committed local communities, degraded rangelands may be rehabilitated by reseeding with native species and plantation of shrubs using water harvesting techniques, proper grazing management and the introduction of feed blocks.

BUILDING CAPACITY AND INCREASING AWARENESS

Increasing the awareness of major stakeholders and of the general public on the importance of preserving environment and local biodiversity is done through different means. Mass media, documentary films, posters and brochures, rural theatre and agricultural fairs were used to show the values and benefits of preserving agrobiodiversity. The project has also focused on the introduction of biodiversity in the education systems in the four countries. In collaboration with the Ministries of Education, biodiversity conservation was introduced in the national education systems. The school curricula and syllabus and the teachers methodological guides were produced at the national level and the teachers' scientific guide was drafted by the regional component. Training in biodiversity conservation and other environmental challenges was provided to teachers and education specialists. Many extracurricular activities were initiated with schools in target areas (environmental clubs, field visits, participation to reforestation campaigns, creation of school gardens, documentation of parental knowledge, painting and drawing contests).

More than 4800 people were trained by the Dryland Agrobiodiversity project, including 1480 women. The training covered aspects such as: integrated natural resources management, *in situ/ex situ* conservation of genetic resources, participatory community approaches, rangeland management, alternative sources of income, use of molecular markers techniques, add-value technologies, and policy and legislation related to biodiversity.

PROMOTION OF RESPONSIBLE RESOURCE MANAGEMENT (POW ACTIVITY 8)

The large-scale adoption of technological and economic options requires the development and enforcement of the enabling policies and legislations. Conservation of agrobiodiversity should be well integrated into national rural development strategies and should allow the empowerment of local communities over the sustainable use of natural resources.

Reforms were proposed to government institutions and the Parliaments for adoption. Some of the proposed reforms and institutional changes are already implemented in some Near East countries, such as the use of native species in reforestation and landscaping, the introduction of biodiversity conservation in the education systems, and the establishment of agrobiodiversity units within the research institutions and the Ministries of Agriculture. The process of developing national legislation on access to plant genetic resources was initiated with the help of FAO.

SUPPORT FOR SUSTAINABLE LIVELIHOODS (POW ACTIVITY 9)

In its strategy for conserving local agrobiodiversity, the GEF/UNDP project on dryland agrobiodiversity tried to promote add-value technologies and alternative sources of income to improve the livelihoods of the local communities. Training and technical backstopping were provided mainly to women to create business-oriented activities. Training in hygienic food processing, packaging and labeling was provided for burghul, freikeh, jams, compotes and syrups. The project introduced the jams of ziziphus and wild prunes. Food processing centres were established with the financial help of international NGOs in Lebanon and Palestine.

Home gardening and cultivation of medicinal and herbal plants were encouraged, leading to self-sufficiency in many vegetables, fruits and medicinal herbal plants; some families are making additional income from selling the surplus. Dairy, honey and mushroom production was encouraged to diversify sources of income. An ecotourism experience was launched in Lebanon between private eco-tour companies and local communities, and the returns are very rewarding. The project has helped to establish an agrobiodiversity shop in Syria and a weekend market in Jordan for the local communities to sell their products. Many national and regional agrobiodiversity fairs were organized where local NGOs have shown their local products, including handcrafts.

CONTRIBUTION TO THE CBD'S STRATEGIC PLAN

In the dryland context, CGIAR Centers in collaboration with NARS also contribute to a number of 2010 targets listed in COP VII/30. In particular, the contribution is directed to targets on biodiversity protection, conservation and sustainable use, and also to those addressing threats to biodiversity, protecting local knowledge and community practices, and the sharing of benefits arising out of the use of genetic resources.

CARBON SEQUESTRATION

Since carbon is built up mostly in the organic matter of rangeland soils rather than wood as in forests, carbon sequestration is low per unit area. However rangelands are still important in sequestering atmospheric CO^2 because of the extensive area they occupy. The soils of the West Asia and North Africa area sequester carbon at an annual rate of 200-400 Tg C, which amounts to 20% of the potential of global dryland ecosystems (Lal, 2002). Of their proposed strategies, desertification control may provide a potential of 40–100 Tg C per year, but reliable data on soil, vegetation and land use would be needed for verification. Central Asian rangeland may also be important for carbon sequestration. Johnson et al. (1999) estimated CO^2 exchange in three countries of Central Asia. They observed 175 g CO^2 per square metre per season in the sandy deserts of Turkmenistan to 698 g CO^2 per square metre per season in the semi-deserts of Uzbekistan. This amount could be improved through management that would increase productivity and organic matter of the overgrazed rangeland. Carbon sequestration benefits the global community, not the pastoralist directly, so mechanisms to provide incentives are needed. Payment for environmental services may be a viable option to provide incentives to the pastoralists (Dutilly et al., 2004). Incentives could be provided not only for carbon sequestration but also for maintaining biodiversity and reducing water and wind erosion.

CONCLUSION

Finding solutions for sustainable dryland development requires a holistic approach that focuses on three key components. First are technological interventions that address biodiversity, land, water and food security problems. Second is the active involvement of local communities via a strategy that increases their knowledge and organizational capacity. With the increased capacity to manage risk and to solve problems, communities can reverse land degradation, improve their livelihoods and become responsible stewards of the natural resources, including biodiversity. Thirdly, appropriate incentives at the policy and institutional level are required to induce land users to adopt more conservation technologies.

ICARDA is only a part player in this process, and it welcomes the opportunity to work jointly with CBD, UNCCD and UNFCCC and engage in dialogue and cooperation with national, regional and international organizations.

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STATUS OF GLOBALLY THREATENED BIRDS AND ENDEMIC BIRD AREAS IN DRY AND SUB-HUMID LANDS

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Keywords: birds, drylands, trends, indicators, pressures

STATUS AND TRENDS OF BIRD SPECIES IN DRY AND SUB-HUMID LANDS

The seventh meeting of the Conference of the Parties (COP-7) to the Convention on Biological Diversity (CBD) identified a comprehensive review of the status and trends of dryland biodiversity as a key activity (Activity 1) in the adopted Programme of Work on Drylands Biodiversity up to 2012 (UNEP/CBD/COP/7/3). This synopsis, mainly on the work of the 100 NGO Partners of BirdLife International (BLI) around the world, is a contribution towards that goal.

About 48% of the world's land can be considered as dry or sub-humid, lying in the hyper-arid, arid, semi-arid and dry sub-humid zones; it is no surprise then that a similar proportion of the world's 9,906 bird species occur in dryland ecosystems, such as shrublands, grasslands, savannas, deserts and dry cultivated areas. After forests, shrublands are the second-richest natural habitat on Earth for bird species, supporting 26% of all species, while grasslands and savannas each support 15% (BLI 2004).

About 25% (2,623 species) of the world's birds are restricted to a small range (less than 50,000 $km^{2?}$), and many are restricted to a particular habitat or biome, e.g. 42% of species in Africa are biome-restricted (BLI 2004). In the dry and sub-humid lands, these less-flexible species, with their ecological or geographical restrictions, can be vulnerable to land degradation, even if it only occurs locally. The more widespread and adaptable bird species of the drylands, less restricted to a particular habitat or geographical area, are also vulnerable to land degradation, since relatively few of their individuals are likely to occur in protected-area networks. The health of their highly dispersed populations is thus especially dependent on the sustainability (or not) of the human land-uses in the wider environment.

Globally Threatened Birds (GTBs) are those species with at least a 10% chance of going extinct in the next 100 years. A shocking one in eight of the world's birds is now considered to be globally threatened (BLI 2004). About a third of the world's 1,212 GTBs (32%) are dependent on dryland habitats, with 66% of these occurring in shrublands, 43% in grasslands and 8% in savannas (BLI 2000). Most of these dryland-dependent GTBs (70%) are restricted to the tropics. The dryland-dependent GTBs are less habitat-restricted than the forest GTBs, but still 54% of them occur in only one particular type of dryland habitat, e.g., dry tropical shrubland, or temperate grassland.

AREAS OF PARTICULAR VALUE FOR BIRD SPECIES IN DRY AND SUB-HUMID LANDS

In Africa, Asia, Latin America and Europe, BirdLife International has already reviewed and assessed "areas of particular value and/or under threat" for birds, thereby contributing to Activity 2 of the CBD Programme of Work on Drylands Biodiversity. Inventories of these areas — Important Bird Areas (IBAs) — show that dryland ecosystems are of great significance at many of these sites.

For example, a network of 352 IBAs in Africa (27% of the regional total) has been identified for the conservation of the 305 bird species that are restricted to dryland biomes in Africa (Fishpool and Evans, 2001). In the countries of Central and Eastern Europe, the Northern Mediterranean and the Middle East, about 1,000 IBAs have drylands as a primary habitat, covering 25% or more of their area (WBDB, 2005). These sites represent 58% of all IBAs in the countries concerned, and include 441 sites where a primary habitat is cultivated land, 367 sites where it is grassland, 337 shrubland, 123 desert and six savanna sites.

Other areas of "particular value" for dryland birds (but which are usually too large to be managed as discrete protected areas) are the Endemic Bird Areas (EBAs) — priority landscapes where restricted-range species are concentrated. Most of the world's 218 EBAs are dominated by forests (Stattersfield et al., 1998), but nevertheless, 39 of the EBAs (18% of the total) have at least 75% of their terrain falling within the hyper-arid, arid, semi-arid or dry sub-humid zones of the world (see Table 1).

BIRDS AS INDICATORS OF BIODIVERSITY IN DRY AND SUB-HUMID LANDS

A review of indicators for the assessment of the status and trends of dryland biodiversity was agreed at COP-7 to be another key area of activity (Activity 3) under the CBD's Programme of Work on Drylands Biodiversity. BirdLife International is contributing to this goal by developing three types of indicator, all of which can be used for assessing progress in drylands biodiversity conservation.

1. The Red List Index is being developed to track the fortunes of the world's GTBs. It can be expressed in numerous useful ways, e.g. in terms of different regions or different habitats (BLI, 2004).
2. IBA Monitoring is being developed to assess the state of biodiversity at IBAs, the threats or pressures they are facing and the responses. Since 2002, 13 African countries have initiated such monitoring schemes, and the evidence so far suggests that threats to IBAs continue to degrade the status of biodiversity, but also that efforts to protect these sites are increasing, and that the status of biodiversity at some IBAs has improved (Ng'weno *et al.* 2004).
3. Common Bird Indicators are being developed to show change in the overall condition of ecosystems, which is difficult and expensive to measure directly, and to help measure progress towards reducing the rate of biodiversity loss at the national, regional and global levels (BLI 2004).

PROCESSES THAT AFFECT BIRDS AND OTHER BIODIVERSITY IN THE DRY AND SUB-HUMID LANDS

An assessment of knowledge on processes that affect drylands biodiversity was agreed at COP-7 to be another key activity (Activity 4) under the CBD's Programme of Work. The BirdLife International Partnership is actively gathering information on threats to GTBs and IBAs in the world's drylands via its work on indicators. This information is stored in a database (the World Bird Database) and summary data are available on the BirdLife website (http://www.birdlife.org/datazone/index.html). Inappropriate and land-degrading processes, such as intensive grazing or too-frequent fires, can have major impacts on GTBs, IBAs and common birds.

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TABLE 1: The 39 Endemic Bird Areas (EBAs) that are situated mainly within the dry and sub-humid lands

EBA NAME	TYPE	PRIORITY	HABITAT LOSS	KNOWLEDGE	AREA (KM^2)	ALTITUDE
AFRICA						
Cape Verde Islands	oceanic island	high	severe	incomplete	4,000	lowland
São Tomé	oceanic island	critical	limited	incomplete	860	lowland/ montane
Cape fynbos	continental	high	moderate	good	110,000	lowland/ montane
South Malagasy spiny forests	continental island	urgent	moderate	incomplete	46,000	lowland
East African coastal forests	continental	high	major	incomplete	25,000	lowland
Central Somali coast	continental	high	possible	poor	15,000	lowland
Jubba and Shabeelle valleys	continental	urgent	unquantified	poor	35,000	lowland
North Somali mountains	continental	urgent	unquantified	poor	32,000	lowland/ montane
ASIA						
Socotra	oceanic island	high	major	incomplete	3,500	lowland
South-west Arabian mountains	continental	urgent	moderate	incomplete	150,000	montane
Mesopotamian marshes	continental	high	major	incomplete	130,000	lowland
Taklimakan Desert	continental	high	unquantified	poor	60,000	lowland
Qinghai mountains	continental	high	unquantified	incomplete	230,000	montane
Sumba	oceanic island	high	major	incomplete	11,000	lowland/ montane
Timor and Wetar	oceanic island	urgent	major	poor	34,000	lowland/ montane
South-west Australia	continental	critical	major	good	280,000	lowland
North-west Australia	continental	urgent	moderate	incomplete	560,000	lowland

	Louisiade archipelago	continental island	urgent	moderate	poor	1,600	lowland
	LATIN AMERICA AND THE CARIBBEAN						
	California	continental	high	major	good	180,000	lowland/ montane
	Baja California	continental	high	moderate	incomplete	43,000	lowland/ montane
	North-west Mexican Pacific slope	continental	high	moderate	incomplete	93,000	lowland
	Sierra Madre Occidental and trans-Mexican range	continental	urgent	major	incomplete	230,000	montane
	Northern Sierra Madre Oriental	continental	high	moderate	good	15,000	montane
	North-east Mexican Gulf slope	continental	high	moderate	good	100,000	lowland
	Yucatán peninsula coastal scrub	continental	high	major	good	3,400	lowland
	Bahamas	oceanic island	high	major	good	14,000	lowland
	Galápagos Islands	oceanic island	critical	moderate	good	8,000	lowland/ montane
	Caripe-Paria region	continental	critical	major	good	6,000	montane
	Cordillera de la Costa Central	continental	urgent	moderate	good	6,200	montane
	Caribbean Colombia and Venezuela	continental	critical	moderate	good	89,000	lowland
	Santa Marta Mountains	continental	critical	major	good	11,000	lowland/ montane
	Tumbesian region	continental	critical	severe	good	130,000	lowland/ montane
	Andean ridge-top forests	continental	urgent	moderate	poor	3,800	montane
	Peru-Chile Pacific slope	continental	high	moderate	good	95,000	lowland/ montane
	Southern Patagonia	continental	urgent	moderate	incomplete	170,000	lowland
	North-east Brazilian caatinga	continental	critical	major	incomplete	200,000	lowland
	Deciduous forest of Bahia	continental	urgent	severe	incomplete	10,000	lowland
	NORTHERN MEDITERRANEAN						
	Madeira and the Canary Islands	oceanic urgent island		major	good	8,000	lowland/ montane
	Cyprus	oceanic island	high	major	good	9,300	lowland/ montane

For more information on individual EBAs, see Stattersfield et al. (1998) and the BirdLife website: http://www.birdlife.org/datazone/ebas/index.html.

THE BIOLOGICAL SURVEY OF CANADA (TERRESTRIAL ARTHROPODS): PROMOTING BIODIVERSITY STUDIES IN GRASSLANDS AND ELSEWHERE

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Keywords: cooperative research, biodiversity assessment, Canada, insects, grasslands

INTRODUCTION

The Biological Survey of Canada (BSC) is an agency that has been successful in characterizing the insect biodiversity of the country by coordinating and catalyzing taxonomic and ecological work. Past projects have delivered many sources of data, critical syntheses, commentaries, and other products. One major current project addresses the arthropods of grasslands.

ROLES AND ORGANIZATION OF THE BIOLOGICAL SURVEY

The BSC (established in 1977) helps to coordinate scientific research among cooperating specialists. It synthesizes knowledge and ideas, focuses available expertise on topics that are particularly significant, and acts as a clearing-house for information. The BSC establishes priorities and organizes research projects. Projects of the scope and scale undertaken would not be possible without the catalysis, organization, coordination, and planning provided by the BSC, which is able to address needs for fieldwork, publication, and other elements of comprehensive, long-term projects. The organization thereby serves as a catalyst for more efficient scientific progress and gives national direction for work on Canada's insect fauna.

The organization is deliberately streamlined. Day-to-day work is carried out by a small secretariat based in Ottawa, supported by the Canadian Museum of Nature. An advisory Scientific Committee, established by the Entomological Society of Canada, contributes expert guidance, and there is wide involvement and broad consultation with the scientific community. Cooperating scientists from a range of organizations conduct most of the direct research work.

PRODUCTS OF THE BIOLOGICAL SURVEY

Major scientific products include research monographs and keys. Also published are synthetic scientific works, such as a major book characterizing the insect fauna of the Yukon Territory (Danks and Downes 1997). The BSC also produces briefs and other commentaries on subjects of particular faunal interest, including the monitoring of biodiversity (Marshall et al. 1994; Danks 1996; Danks and Winchester 2000). Information exchange is facilitated by the general *Newsletter of the Biological Survey (Terrestrial Arthropods)*, and more specific vehicles for active projects (currently *Arthropods of Canadian Forests* and *Arthropods of Canadian Grasslands Online*). The BSC also maintains an extensive web site with information, a database of personnel, and publications in electronic form (Biological Survey of Canada web site, cited below).

KEY PROJECTS

Scientific projects are chosen for particular attention on the basis of their scientific relevance in understanding Canada's fauna and on their feasibility, given the existing state of knowledge and required resources of expertise and other assets. Major projects on several regions and habitats of particular importance have been completed in the past (details are available on the BSC web site). Major current initiatives are shown in Table 1.

ARTHROPODS OF CANADIAN GRASSLANDS

A large expanse of grassland spans the southern portion of the Prairie Provinces, but similar grasslands are found from the Yukon to eastern Ontario. Canada's grasslands have been heavily exploited for agriculture and are now seriously threatened. Despite their close relationship to human activities, we know very little about the biodiversity, ecology and responses to habitat change in grassland communities, especially for insects and other arthropods. The Biological Survey of Canada is the only organization in the country capable of coordinating a major project to rectify this lack of knowledge.

STRUCTURE AND OBJECTIVES OF THE PROJECT

The BSC Grasslands project comprises collaborative systematic and ecological research in a range of Canadian grasslands and standardized sampling programs in selected habitats. Its aim is to assess the biodiversity of arthropods associated with Canadian grasslands, differences among grassland types and between grasslands and other habitats, ecological interactions between arthropods and other species, and significant species assemblages in selected grasslands and their ecological roles. These investigations include impacts of human activity and climate change on grassland arthropods, and impacts of grassland arthropods on human activities. Therefore, the project will assemble core knowledge on arthropod diversity and ecology, including a long-term source of specimens and data to provide the necessary framework for ecological and applied studies. Quantitative data on arthropod populations for analysis of the communities of different localities and grassland types, and data for habitat conservation and other applications, are also being collected.

ACHIEVEMENTS AND PLANNED PRODUCTS

The project has undergone a long developmental phase pending completion of other BSC projects requiring similar expertise. Background activities include a newsletter (11 issues published, now online), an informal conference (2000), a formal symposium (2002), a comprehensive prospectus (Shorthouse and Wheeler 2002), and a series of focused annual collecting opportunities in key sites from 2001 onwards (Floate 2002, Roughley and Borkowski 2002, Sperling and Hervieux 2004, Langor 2005, Roughley 2005).

Over the next few years, three major volumes will be published. The first volume considers ecology and interactions of the arthropods of Canadian grasslands. Most chapters for this volume have already been submitted and are under review. A second volume deals with altered grassland ecosystems and the interaction between human activities and arthropods. The third volume will address grassland faunas more broadly, with in-depth treatments of the occurrence and distribution of key arthropod groups in grasslands.

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TABLE 1: Current scientific projects of the Biological Survey of Canada

PROJECT TITLE	RELEVANCE	CURRENT STATUS
Arthropods of Canadian grasslands	Major biome greatly modified by humans.	Highly active, see below.
BSC Journal of Arthropod Identification	A modular, fully reviewed web-based e-journal for publication of richly illustrated regional guides to Canadian arthropods.	First keys to be posted in early 2006.
Insect fauna of Newfoundland and Labrador	A boreal fauna derived mainly by postglacial immigration from the mainland.	New collecting and study of existing collections and literature in progress.
Insects of the arctic	Insects of the large areas of Canada north of tree line are incompletely known.	Many past publications; current phase studies the northern mainland.
Modes of seasonal adaptation in the insects	How insects survive the winter and control the life cycle are especially important in a northern country like Canada.	Major reviews published and in progress.
Forest arthropods	Forest habitats dominate life zones in the country.	Coordination of research on the diversity, ecology and impacts of the arthropods of Canadian forests.
Arthropods and fire	Fire and arthropods interact in a number of important habitats.	Recent symposium held.
Faunal analysis	Numerical data on Canada's arthropod species are required for various purposes.	Web database available, updates in progress.
Invasions and reductions	Further scientific analysis of the basis of invasions is required.	Symposium under development; research on lady beetles in progress.

SAHARA AND SAHEL OBSERVATORY (OSS) ENVIRONMENT PROGRAMME TO SERVE ENVIRONMENTAL GOVERNANCE IN AFRICA: IMPORTANCE FOR BIOLOGICAL DIVERSITY

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INTRODUCTION

In the framework of its 2010 strategy, the Sahara and Sahel Observatory (OSS) developed an integrated programme called "Environmental Observations and Assessment Device" (EOAD) with a view to establish structuring elements to facilitate decision-making for sustainable management of environment and natural resources in the OSS action zone (North Africa, West Africa and East Africa). In this programme, environmental monitoring will focus mainly on the monitoring of natural resources and factors influencing their spatial distribution and their state.

The programme also aims at continuing the conceptual, methodological and operational support OSS offers to member countries and sub-regions willing to improve their existing environmental monitoring mechanisms on a local, national and sub-regional level and to ensure their sustainability within the framework of implementing international environmental conventions on desertification, biodiversity and climate change (United Nations Convention to Combat Desertification — UNCCD, United Nations Framework Convention on Climate Change — UNFCCC, United Nations Convention on Biological Diversity — UNCBD) whose implementation hitherto had not been synergized.

The programme has three components:

1. Environmental monitoring by setting up national environmental monitoring mechanisms
2. Environmental early warning by strengthening or setting up early warning mechanisms
3. Monitoring-evaluation of national and sub-regional Action Programmes

ENVIRONMENTAL MONITORING IN CIRCUM-SAHARAN AFRICA

Our purpose in this paper focuses on the implementation of the environmental monitoring device. In the framework of the EOAD programme, the activities will thus be based on sampling, collection and processing methods developed by the regional Long Term Ecological Monitoring Network ROSELT/OSS and on the use of the Local Environmental Information System (SIEL) so as to elaborate spatial impact assessments of the uses made of natural resources and prospective scenarios.

Special efforts has been made by the ROSELT/OSS network to define a "minimum data set", to be collected at lower cost, which would allow for spatialization of the data, their possible extrapolation to larger zones and their integration within models of space and resource use. Within this framework, the "data sets" will be used by national environmental monitoring observatories to monitor and assess the evolution of:

1. **Bio-physical features:** climate, soil, water, vegetation (production, structure, quality, spatial distribution and floral diversity), fauna (structure and spatial distribution)
2. **Socio-economic features:** human population, micro-economic parameters
3. **Interface data:** land tenure rules for access to resources, production and exploitation system for characterization of uses/activities, production and extraction of resources

The "networked thematic data series" can also be defined; it has been adapted specifically for specific issues, proper to one or several observatories (biodiversity, sand encroachment…). The topics identified in connection with the Rio conventions on biodiversity (fauna and flora), desertification (decrease in plant cover, soil erosion, soil salinisation…) and climate changes (land cover / land uses).

Using these data sets, indicators of synchronic and diachronic changes (biodiversity, land occupation, soil use, vegetation cover…) will be regularly elaborated. The needed indicators will be identified in close consultation with the stakeholders involved in implementing the Multilateral Agreements on the Environment, in connection with the needs in implementing the UNCBD, the UNFCCC and the UNCCD. A study of these needs has already been carried out on the basis of the commitments stemming from the three conventions; these results will have to match the specific needs of each country and sub-region. These tools and data will be extremely helpful for decision-making to develop adaptation strategies, particularly needed to mitigate the effects of climate changes on human population.

ENVIRONMENTAL MONITORING TO ASSESS BIODIVERSITY IN CIRCUM-SAHARAN AFRICA

It is well known that arid, semi-arid and sub-humid regions in Circum-Saharan Africa are characterised by an original fauna and flora, well adapted to climatic constraints (high temperatures combined with low rainfall) and intensive human activities (i.e., grazing, cropping, wood cutting). Due to its long-term evolution, this region is characterized by specific genetic heritage and endemism at both higher levels (i.e., family, genus, species) and within species (i.e., populations, ecotypes, varieties, races, forms). Moreover, the circum-Saharan zone exhibits a mosaic of adaptive and evolutive areas. Nevertheless, arid lands have not received the necessary attention concerning their contribution to national and international conservation, protection and biodiversity preservation strategies; furthermore, their biological diversity has not been assessed.

From a scientific viewpoint, it is well established that a higher biological diversity will increase an ecosystem's resistance to disturbances (overgrazing, overexploitation of natural resources generally) and stresses (climate changes, drought, floods…) and will improve its resilience.

Unfortunately, in circum-Saharan Africa data is often unavailable, incomplete, dispersed, disparate and not shared between institutions. Data gathering has to be reinforced in order to better share knowledge, thereby helping decision-makers to manage natural resources. Environmental monitoring devices are thus primordial to evaluate and assess natural resources, and particularly biological diversity at three different levels of observation: species, ecosystems and landscapes.

Environmental monitoring observatories could be used as platforms for research and development to inventory biodiversity and describe its evolution over the long term, develop biodiversity indicators, understand the dynamic of biodiversity and predict its changes. These observatories may help to evaluate biodiversity loss and also offer an opportunity to accurately sample the biological heritage of arid lands, thanks to the establishment of red lists species for fauna and flora allowing assessment of their vul-

nerability. This will help to better understand the role of such species in the communities, ecosystems, and agrosystems to which they belong. The main effort will consider the functional aspects and evolutive roles of species groups of highly meaningful bio-indicators to evaluate biodiversity and its long-term conservation potential.

Studies on biodiversity within observatories will develop from the precise identification and evolutive mapping of the land use types or habitats most apt to increase biodiversity. Special attention will be given to arid areas that have obtained or may obtain status as protected areas (national parks, reserves, protected biological zones, biosphere reserves, etc.), to contact zones between biota (Mediterranean-Saharan Saharan-Tropical, etc.) and to particularly sensitive zones (refuges for plant or animal species, humid areas surrounded by arid lands).

Increasing knowledge about biological diversity will also help to underline the ecosystem services it provides and to quantify the economic value of such diversity in arid zones, particularly for cropping and medicinal plants, and animal races well adapted to constraining conditions.

Sustainable development in Africa requires good environmental governance. It needs reliable and precise environmental data (collected in the environmental monitoring observatories) to monitor long-term changes in biodiversity, climate and lands.

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ENDEMISM AND DIVERSITY IN NAMIBIA

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Keywords: endemism, plant diversity, distribution

INTRODUCTION

Approximately 4,000 indigenous spermatophyte plant species occur in Namibia. Their distribution, where available, were mapped in order to determine where areas of high diversity and high endemism occur in Namibia. These distributions were then also correlated with natural landscapes to establish whether there is a relationship between natural features of the landscape and high levels of plant diversity and/or endemism.

METHODOLOGY

An analysis of the distribution patterns of spermatophyte plant species in Namibia was done using a simple grid-diversity count with each species carrying equal weight. Data sources used include georeferenced specimens in the SPMNDB (a database used for capturing and storing herbarium specimen information). Endemism status was sourced from the *Checklist of Namibian Plant Species* (Craven 1999). Other literature that contained distribution data was also consulted.

It was observed that gaps existed due to collection biases and database input areas. Adjustments to the dataset were therefore made using keyword searches, literature sources, and GIS shapefiles of physical features of Namibia. It was also observed that there existed no particular pattern in terms of the distribution of endemic taxa. High values for endemic taxa may have been caused by widespread endemic species and therefore do not necessarily indicate sites of importance. The dataset was therefore rearranged to find areas where range-restricted species occur in Namibia.

RESULTS

1. Richness in overall plant species diversity = richness in overall endemics in many localities
2. These "rich" areas indicate number of species
3. They cannot be distinguished by a particular combination of plant species or endemics
4. QDS with associated floral elements cannot be identified
5. The value of this type of mapping for conservation or management purposes is limited
6. Centres of endemism have a high concentration of species with restricted distributions
7. Centres of endemism will have their own distinctive complement of species, while areas rich in overall endemics cannot be distinguished by a particular combination of species
8. Boundaries, floristic elements and origins remain fairly sketchy and need further study
9. Centres of endemism are important for conservation and land use management

CONCLUSION

High species diversity in Namibia depends on particular topography, climatical and geological conditions. Summer rainfall species overlap with winter rainfall species. Endemic numbers increase in mountains (especially in deserts), in diverse substrates and microclimates.

SUSTAINABLE RANGELANDS ROUNDTABLE: A VISION FOR THE ACCEPTANCE AND USE OF SOCIAL, ECONOMIC AND ECOLOGICAL INDICATORS OF RANGELANDS SUSTAINABILITY

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Keywords: Sustainable rangeland management, criteria and indicators, monitoring protocols

INTRODUCTION

Sustainable management is being adopted as an appropriate approach for monitoring and assessing natural resource systems. Drylands, including rangelands, occupy 40% of the Earth's land area or roughly 65 million km^2. Of this total, about 34 million km^2 are used for grazing livestock (World Resources Institute 1986; Sere and Steinfeld 1996). In 1994, 12 nations organized as the Montreal Process to develop and promote 67 indicators of sustainable management of temperate and boreal forests. The utility of the Montreal Process criteria and indicators (C&I) for sustainable rangeland management was later demonstrated (Mitchell and Joyce 2000; Mitchell and Hill 2002).

In the United States, representatives from federal agencies, universities, conservation organizations, the livestock industry, and local and state governments joined together in April 2001 to form the Sustainable Rangelands Roundtable (SRR)[1]. Since its inception, more than 50 organizations and 100 individuals have participated on the SRR. The SRR initially considered the Montreal Process C&I as a starting point, but participants later decided to develop their own C&I. While focusing primarily upon domestic issues, SRR members have also participated in international dialogues concerning sustainable rangeland management (Bartlett et al. 2003).

INDICATOR DEVELOPMENT

Initially, SRR participants committed to a mission statement saying "The Roundtable will identify indicators of sustainability, based upon social, economic, and ecological factors, to provide a framework for national assessments of rangelands and rangeland use." At a series of meetings held in different cities between 2001 and 2003, the Roundtable converged upon 64 indicators supporting the following five criteria:

- Soil and water conservation
- Conservation and maintenance of plant and animal resources
- Maintenance of productive capacity
- Maintenance and enhancement of economic and social benefits to current and future generations
- Legal, institutional, and economic framework for rangeland conservation and sustainable management

SRR published an on-line first approximation report in May 2003.[1] The following February, at a meeting in Fort Myers, Florida, Roundtable participants were asked by Elizabeth Estill, USDA Forest Service

1. http://sustainablerangelands.warnercnr.colostate.edu/34

Deputy Chief for Program Planning and Legislation, to prepare a shorter list of key indicators that agencies could actually monitor. The key indicators would be selected on the basis of being known important measures of their respective criteria. They would also have existing data sets showing regional or national trends, or could soon be monitored across broad scales within current budgets and technology. By April 2005, SRR participants had identified 27 key indicators of sustainable rangeland management (Table 1).

ADOPTION OF SRR INDICATORS

In December 2002, SRR leaders met to review the original mission and vision of the SRR and to map operational plans for the future. This group decided that while the C&I had been identified and adequately described, they were still not yet widely accepted. In fact, the group felt that the C&I not only needed broad acceptance, but also needed to be widely used. The inability to consistently report upon rangeland resources at regional and national scales reduces the capacity of society to understand their conditions and trends. As a result, the group developed strategic goals, objectives and actions necessary to facilitate acceptance and use of the C&I by agencies and other organizations responsible for monitoring rangelands.

Changing the way we monitor natural ecosystems at multiple scales is a long process. A high proportion of indicators describing conditions at regional and national scales require research and development, legal authority to collect data, or additional funding. As a consequence, we know very little about the status of U.S. rangelands — and most likely the rangelands of other countries (The H. John Heinz Center for Science, Economics and the Environment 2002). To start the process in the U.S., the White House Council on Environmental Quality initiated a series of meetings, starting in mid-2005, to facilitate adoption of a few key indicators by the major land management agencies. At a meeting on 17 August, representatives of the Forest Service, Bureau of Land Management, Natural Resources Conservation Service (NRCS), and U.S. Geological Survey agreed to begin monitoring four core environmental indicators: bare ground cover, invasive plant abundance, ecosystem fragmentation, and species composition of rangeland communities. In addition, these agencies decided to develop a proposal to identify protocols for monitoring these indicators within the framework of two Department of Agriculture national inventory programs: the Forest Inventory and Analysis program within the Forest Service and the National Resources Inventory program within NRCS.

Accepting and monitoring indicators serves no real purpose in itself. If C&I are to be used, recurring assessments are needed to describe trends in various indicators. To achieve this goal, the SRR is working on two documents — a memorandum of agreement to be signed by federal land management and research agencies, and a charter to be signed by non-governmental organizations and state and local governments. Both documents promote the preparation of a national report on sustainable rangelands by 2010. Such a report would be similar to the recently released national report on sustainable forests by the U.S. Forest Service (http://www.fs.fed.us/research/sustain/).

INTERNATIONAL ENDEAVORS

The SRR has encouraged dialogue about the usefulness of C&I for monitoring trends in ecological, economic, and social conditions in all nations with rangelands. One of the most fruitful formats for exchanging ideas is the International Rangeland Congress (IRC). SRR members have presented papers at both the 1999 IRC in Townsville, Australia, and the 2003 IRC in Durban, South Africa. We hope to work with representatives from these and other countries to conduct a major symposium on sustainable rangeland management at the 2008 IRC in Hohhot, Inner Mongolia, China.

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TABLE 1: List of key indicators developed by the Sustainable Rangelands Roundtable

I. CONSERVATION AND MAINTENANCE OF SOIL AND WATER RESOURCES

1. Area and percent of rangeland soils with significantly diminished organic matter.
2. Area and percent of rangeland with a significant change in extent of bare ground.
3. Area and percent of rangeland with accelerated soil erosion by water or wind.
4. Percent of water bodies with significant changes in natural biotic assemblage composition.
5. Percent of surface water with significant deterioration of their chemical, physical, and biological properties.
6. Changes in the frequency and duration of surface no-flow periods in rangeland streams.

II. MAINTENANCE AND CONSERVATION OF PLANT AND ANIMAL RESOURCES ON RANGELANDS

7. Rangeland area by plant community.
8. Fragmentation of rangeland and rangeland plant communities.
9. Extent and condition of riparian systems.
10. Area of infestation and presence/absence of invasive and other non-native plant species of concern.
11. Population status and geographic range of rangeland-dependent species.

III. MAINTENANCE OF PRODUCTIVE CAPACITY ON RANGELANDS

12. Rangeland aboveground phytomass.
13. Number of domestic livestock on rangeland.

IV. MAINTENANCE OF MULTIPLE ECONOMIC AND SOCIAL BENEFITS TO CURRENT AND FUTURE GENERATIONS

14. Value of forage harvested from rangeland by livestock.
15. Rate of return on investment for range livestock enterprises.
16. Number of conservation easements purchased.
17. Index of social structure quality.
18. Sources of income and level of dependence on livestock production for household income.
19. Employment diversity.
20. Value produced by agriculture and recreation industries as percent of total.
21. Employment, unemployment, underemployment, and discouraged workers by industrial sector.
22. Land tenure, land use, and ownership patterns by size classes.
23. Population pyramid and population change.

V. LEGAL, INSTITUTIONAL AND ECONOMIC FRAMEWORK FOR RANGELAND CONSERVATION

24. Professional Education and Technical Assistance.
25. Extent to which land management programs and sustainable management of rangelands.
26. Extent to which agencies and organizations devote resources to monitoring rangelands.
27. Nature and extent of research and development programs affecting sustainable management of rangelands.

IDENTIFYING ECOSYSTEM PROCESSES THAT MAINTAIN BIODIVERSITY IN COASTAL PERU

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Introduction

How can animals survive in a place with low primary productivity? By definition, drylands have low annual precipitation (less than 250 mm/year) or net negative evapotranspiration. Most drylands are also characterized by withsoils poor in nutrients. Low precipitation and low nutrient availability consequently limit plant primary productivity in deserts (Polis, 1991). The Peruvian coastal desert is hyper-arid, with a scarce vegetation cover largely restricted to river valleys, and a recorded rainfall of less than 2 mm/year. We would expect to find very little species diversity in such a habitat. However, a relatively large number of taxonomic groups are represented along the Peruvian desert, and in some taxa (such as tenebrionid beetles, solifuges, geckos, etc.) the number of species is higher in the coastal desert than in other ecosystems.

One of the activities recommended by decision VII/2 of the Conference of the Parties on the biological diversity of dry and sub-humid lands is to improve the knowledge on processes that affect biodiversity. Drylands are different from other ecosystems in that they have strong temporal and spatial variations in abiotic factors and productivity (Shachak et al., 2005). It is therefore important to understand the role of this heterogeneity and of any factor that contributes to generating and maintaining species diversity in drylands.

COASTAL DESERTS ARE INFLUENCED BY ADJACENT MARINE ENVIRONMENTS

Studies on islands in Baja California by the late Gary Polis and co-workers demonstrated that the cross-habitat movement of nutrients, detritus, and prey could sustain communities of abundant consumers even in places with little primary productivity (Polis and Hurd, 1996). Baja California shares several characteristics with the Peruvian desert, such as the difference in productivity between sea and land. The Peruvian desert faces one of the world's most productive marine ecosystems, the Peru-Chile cold current. We therefore expected to find a similar dependence on marine resources for terrestrial consumers in Peru.

We worked at the Paracas National Reserve and on guano islands off the coast of Peru. Paracas National Reserve is a protected area that conserves a rich marine fauna and a barren desert over 3,350 km^2 around the 14° S meridian and 76° W parallel. The desert is a nutrient-poor system dependent on import of nutrients from the marine ecosystem. Landforms function to direct the flow of energy and nutrients from the intertidal zone to the terrestrial landscape. Marine wrack, which is composed of stranded algae and cadavers, provides most of the energy and nutrients available to coastal desert consumers. On guano islands, large colonies of sea lions and guano birds provide a constant source of food to terrestrial consumers by supplying organic detritus and by supporting large populations of ectoparasites and other invertebrates.

We investigated how marine subsidies influence the diversity and distribution of terrestrial consumers by using methods such as population monitoring, measuring body size and condition, mapping the distribution of consumers, dietary analyses, and analytical techniques such as stable isotope and fatty acid analyses.

THE MARITIME DIET OF DESERT ANIMALS

Our dietary analyses show that terrestrial consumers in several taxonomic group benefit from the input of marine subsidies. Geckos and solifuges, for example, mostly prey upon intertidal crustaceans in Paracas. These crustaceans derive their food from marine green algae washed ashore. The abundance of intertidal invertebrates allows a diversity of terrestrial predators to share a common resource in a hyperarid environment. The proximity and population abundance of these predators promote trophic interactions and indirect effects among consumers of the desert food webs. These interactions and effects increase the potential number of species that can be supported in the food web. Therefore, marine subsidies contribute to maintain a higher level of species diversity in the desert than we would expect based on precipitation patterns and vegetation cover.

The effects of marine subsidies are even stronger on guano islands. These islands are completely devoid of vegetation (with a few exceptions), because they do not receive precipitation and because they are covered with guano. Most guano is produced by three seabird species: the Guanay Cormorant, Peruvian Booby and Peruvian Pelican. These seabirds mainly feed on stocks of anchovies. Large colonies of guano birds (Figure 1) support extremely high densities of ectoparasites, such as ticks and parasitic flies, and of carrion feeder invertebrates that consume dead birds. These terrestrial invertebrates are the prey of scorpions, spiders and lizards. The availability of organic material and detritus (feathers, regurgitated material, feces, etc.) provides food to omnivorous and detritivorous invertebrates, such as tenebrionid beetles and silverfishes. Carbon and nitrogen isotopic analyses indicate the dependence of terrestrial consumers on marine-derived energy and nutrients.

MARINE-CONTROLLED PROCESSES THAT AFFECT SPECIES DIVERSITY IN THE DESERT

A synthesis of marine-controlled processes that contribute to generating and maintaining animal and plant species diversity in the Peruvian desert include:

- *Tidal action*: tides and waves wash ashore important amounts of marine wrack, which terrestrial consumers use as source of food and shelter. Marine wrack includes marine algae, invertebrates, carcasses of marine vertebrates, detritus, and floating debris.
- *Biotic vectors*: marine vertebrates such as seabirds, sea turtles and sea lions transport marine-derived energy and nutrients from sea to land, especially in places where they congregate to reproduce or nest.
- *Wind patterns*: winds can carry marine spray that is rich in nutrients from sea to land; they can also move ammonia originating from guano and fertilize terrestrial plants, thus increasing the number and abundance of herbivores.
- *Seasonal fogs*: this is a physical process caused by the low temperature of the Peru-Chile current. In some locations, seasonal fogs envelop the slopes of the coastal desert, allowing annual plants to grow during the austral winter.

IMPLICATIONS FOR CONSERVATION

Marine-controlled processes are important factors affecting species diversity in the Peruvian coastal desert. The intimate linkage between marine and terrestrial ecosystems has important consequences for conservation. Conservation initiatives in coastal aquatic and terrestrial ecosystems should acknowledge the interdependence between these two adjacent ecosystems. The establishment of marine reserves will benefit not only aquatic communities, but also the terrestrial producers and consumers that depend upon marine inputs of nutrients, detritus and prey.

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FIGURE 1: Nesting colony of Guanay Cormorants (*Phalacrocorax bougainvillii*) on a Peruvian Guano Island. Hundreds of thousands of birds can congregate on islands ranging in area from 30 to 800 ha.

HIV/AIDS AND ENVIRONMENTAL LINKAGES: FROM ANECDOTES TO ANALYSIS

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INTRODUCTION

"Poaching increases, logging timber for coffins, soil erosion" — these are typical descriptions of the effects of HIV/AIDS on the environment in sub-Saharan Africa. Though likely to reflect reality, little analytical research has been carried on the links between HIV/AIDS and the environment has been largely anecdotal. Exploration of this topic has emerged largely from experiences in Southern and Eastern Africa — where the HIV/AIDS epidemic is greatest and where the majority of people depend directly on natural resources for their livelihoods. HIV/AIDS is beginning to be understood as threatening conservation in unique ways. The HIV/AIDS pandemic severely impacts on natural resources and biodiversity management in dry and sub-humid land ecosystems in sub-Saharan Africa. Addressing HIV/AIDS in the environmental management context will be a priority in the coming decades.

A RESEARCH EFFORT: WHAT ARE THE LINKAGES BETWEEN HIV/AIDS AND THE ENVIRONMENT?

A "Status Assessment of the Relationship between HIV/AIDS and Environment in Namibia" has been undertaken to address the knowledge and action gap between HIV/AIDS and the environment. The outcomes will be used as a basis to better formulate strategies for addressing potential losses in environmental quality, both from the angle of environmental users and managers. In the absence of time and quantitative research on HIV prevalence and effects of HIV in parks, conservancies and on a localized rural basis, the study sought (a) to assess the threat identified by the HIV/AIDS and Environment Group (HEWG), a multi-stakeholder initiative formed in Namibia, and the National Capacity Self Assessment (NCSA) for Global Environmental Management undertaken earlier in Namibia, and (b) examine more deeply the anecdotal evidence on HIV impacts on the environment. The study accomplishes this by drawing out people's experiences. Such experiential research is an important step: it helps qualify threats and anecdotal evidence and, while not giving quantifiable data, provides insights as to where to target future research and interventions. Thus, the value of this study is to provide a basis for decision-making on what to do next.

SOME EVIDENCE — KEY FINDINGS

Some of the findings of this study are:

- The majority of interviewees from environmental organizations felt that HIV/AIDS is negatively affecting the ability of their organization to achieve its core duties relating to environment and natural resource management. Nearly two-thirds of respondents have experienced a position in their organization being vacated due to AIDS. Some organizations have reported reassigning staff to less strenuous duties such as administration. The organizations whose respondents felt that HIV/AIDS would not affect their organization were generally those that have already taken mitigatory measures.
- Respondents felt that it was primarily unskilled labourers most likely to be affected by HIV/AIDS.
- In the communities that conservation organizations work with, funerals, missed meetings, and cancellations lead to the slowing or stoppage of outcomes and objectives, and the changing of community priorities, which are all cited as common frustrations.
- More than other environmental institutions in Namibia, the Ministry of Environment and Tourism (MET) is challenged because of the integration of ex-combatants into the workforce who have a higher rate of infection and lower social controls.
- Two-thirds of respondents in parks felt that HIV/AIDS impacted their ability to manage the park that they work in. The most frequently mentioned impact is when staff take vehicles with permission to attend funerals or go for medical treatment. Park workers felt that they faced a unique risk situation based on their position, working in a remote site distant from family, friends and services. These circumstances reduce the overall social controls for appropriate behaviour. Relationships among staff working in the park was reported to be very common, despite the marital status of many workers.
- What might be more important than environmental impacts is the sustainable utilization of natural resources to improve livelihoods, reduce the risk of HIV infection (especially for women) and improve the lives of people living with HIV/AIDS.

THE WAY FORWARD...

- Based on the findings of the status report, a targeted research/project proposal will be developed by the HEWG, housed at MET, addressing research and HIV/AIDS prevention and mitigation, especially relating to institutions concerned with environmental management.
- The HEWG's mandate will be reviewed to establish strong interventions and support relating to HIV/AIDS and the Environment. HEWG is composed of the Ministry of Environment and Tourism, Ministry of Health and Social Services, Namibia Nature Foundation, Namibian Association of CBNRM Support Organization (NACSO), the UN Development Programme, and UNAIDS, and forms a unique institutional platform of effective stakeholder collaboration.
- Upscaled financial support to the Namibian Association of Community-Based Natural Resource Management Support Organizations HIV/AIDS programme, including basic HIV/AIDS education for the environment sector, and training of HIV counselors for parks and conservancies.
- Potentially mobile Voluntary Counseling and Testing (VCT) and Anti-retroviral (ARV) provision for park and other remotely situated staff should be instituted; mobile HIV/AIDS education and condom provision and display of HIV/AIDS-Environment linkages in environmental education centres to be considered.
- Human resource consultant to support MET to develop a strategic human resource and succession plan.

PROMOTING BEST PRACTICES FOR THE CONSERVATION AND SUSTAINABLE USE OF BIODIVERSITY OF GLOBAL SIGNIFICANCE IN ARID AND SEMI-ARID ZONES

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Keywords: best practices, case studies, centres of excellence, network, dryland biodiversity

TWNSO

The Third World Network of Scientific Organizations (TWNSO) was established in 1998 as a non-governmental international alliance of organizations devoted to the promotion of science-based sustainable economic development in the South. Currently, TWNSO counts some 151 members, including 38 ministries of science and technology, 48 academies of science, 38 research councils and 27 other organizations in 77 countries in the South. TWNSO maintains close links with the Academy of Sciences for the Developing World (TWAS), collaborating on various projects.

INTRODUCTION

The overall goal of the project, which began in 2001, was to disseminate more widely lessons learned and other important findings from pre-existing studies conducted by centres of scientific excellence. The premise behind this aim is that there are an ever-increasing number of on-the-ground experiences in developing countries that successfully use science and technology to overcome social and economic obstacles to development. Although these experiences frequently have a significant impact where they take place, they often remain unknown elsewhere. Using a database of centres of excellence developed by TWNSO and its partner organization, the Academy of Sciences for the Developing World (TWAS), scientific institutions throughout the South were invited to present their case studies at regional and international meetings. Fifty-six of these case studies were selected and have since been published and disseminated widely throughout the developing world.

IMPLEMENTATION

The project itself ran from 2000 to 2003, although TWNSO continues to work on dryland biodiversity issues.

During the Global Environment Facility (GEF) project, regional workshops were held in:

- Asia: Ulaanbaatar, Mongolia, August 2001, attended by 25 representatives from 11 Asian countries.
- Latin America and the Caribbean: Santiago, Chile, March 2002, attended by 67 representatives from seven countries other than Chile.
- Africa and the Middle East: Muscat, Oman, April 2002, attended by 47 representatives from some 24 countries.

In addition, two large international conferences were organized in:

- Cairo, Egypt — December 2002, in collaboration with the Desert Research Centre, Cairo, attended by 100 participants from 32 countries.
  During the meeting, project participants made a number of recommendations focusing on: (1) improving the science used in biodiversity research, public policy and management; (2) making connections between local, national and global biodiversity efforts; (3) building institutional capacity for research and benefits of biodiversity protection in drylands; (4) clarifying practical strategies to implement biodiversity protection in drylands; (5) developing the role of TWNSO as a focal point and advocate for research in the protection and sustainable use of biodiversity in arid and semi-arid zones of Southern nations in collaboration with national agencies, institutions and other stakeholders; (6) and effectively using information obtained from this project to address GEF and other donor issues and positively impact their future activities and programmes.
- Rabat, Morocco — August 2003, in collaboration with the AUI Centre for Environmental Issues and Regional Development (AUI CEIRD), Al Akhawayn University, Morocco, attended by 50 participants from 27 countries.
  Participants discussed a number of issues focusing on: (1) strategic issues in protecting biodiversity in drylands; (2) establishing more effective linkages between the Convention on Biological Diversity (CBD), the Convention to Combat Desertification (CCD) and the United Nations Framework Convention on Climate Change (UNFCCC); (3) increasing capacity building; (4) improving practical management of biodiversity; (5) increasing commitments of policy makers to biodiversity protection and sustainable development; and (6) developing regional networks to enhance the conservation and sustainable use of biodiversity in arid and semi-arid regions of developing countries.

OUTCOMES

Based on the presentations made during these various regional and international meetings, a series of 'best practices' case studies were selected for publication. Kluwer Academic Publishers published a collection of 36 detailed case studies (2003), while the United Nations Development Programme special unit for South-South Collaboration (UNDP-SCC) published a further 18 (2004). These were edited into a more reader-friendly style, making them more accessible to non-scientists such as policy makers, members of nongovernmental organizations and other stakeholders. TWNSO has distributed both books free-of-charge throughout the South, including to institutions working on dryland biodiversity issues and to ministries of science and technology.

Another outcome has been the creation of a network of scientific institutions. TWNSO now maintains a database of some 60 institutions in more than 30 countries that focus on dryland biodiversity issues. These institutions are regularly kept informed of ongoing TWNSO activities in the area of dryland biodiversity. For example, many were contacted recently in order to put forward proposals for a future TWNSO project that will aim to develop further interactions among network members and instigate practical initiatives of sustainable land management in arid and semi-arid regions.

In addition, TWAS has now collated 16 case studies, mostly based on those collected during the TWNSO project, that will be published in spring 2006 in collaboration with Harvard University Press as a fully illustrated, reader-friendly, 'coffee-table' book entitled simply '*Dry*'. This publication will help to disseminate to a wider, more general audience some of the 'best practices' identified during the implementation phase of the project.

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Acknowledgments

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For additional information see *www.twnso.org* and *www.twas.org*.

NEW APPROACHES FOR CONSERVATION AND SUSTAINABLE USE OF DRY GRASSLANDS IN SWITZERLAND'S CONSERVATION POLICIES

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Keywords: habitat conservation, low intensity land use, inventory, dry grasslands, conservation policies

INTRODUCTION

According to Swiss Federal Law on the Protection of Nature and Landscape (LPN, article 18a), the Federal Council designates biotopes of national importance. The ruling of conservation measures is regulated by specific Federal Ordinances (for Federal Inventories). There are basically two habitat inventories that affect agricultural grasslands: the Federal Inventory of Fenlands of National Importance (1994) and the Federal Inventory of Dry Grasslands of National Importance, which is in preparation. Each inventory includes a total area of about 20,000 ha which is some 1-2% of Swiss agricultural land.

Both inventories aim to conserve and promote the most valuable sites for habitat and species conservation. The current efforts to encourage ecological agriculture through agricultural legislation will be complemented and enforced by specific conservation measures. New conservation policies concerning the conservation of dry grassland are being sought.

WHAT ARE DRY GRASSLANDS OF NATIONAL IMPORTANCE?

Eggenberg *et al.* (2001) describe 18 vegetation groups that constitute the inventory content. Because of actual threats, meadows and pastures (up to the tree line) are primarily included. Sites are accepted if they satisfy a set of requirements, including size and quality. Diverse information that is necessary to quantify each site is collected. Data collection and data evaluation are standardised according to Eggenberg *et al.* (2001). The inventory project will establish more than 10,000 site information sets on species-rich dry grasslands of Switzerland. These data sets will provide basic information for conservation measures as well as for research. The following data are provided for each site information set and may be of particular relevance for research: a standard test point with full vegetation relevé, vegetation cover with very high resolution of both quality and quantity (although compatible with CORINE biotope types), land use type, and standardised data on zoologically relevant structures. Site boundaries are fully digitised and can be superposed to any thematic map.

GENERAL FRAMEWORK FOR POLITICAL IMPLEMENTATION

Several basic assumptions are relevant for the political implementation of the dry grassland inventory:

- Dry grasslands are linked to low-intensity land use on small surfaces scattered over the area.
- Agriculture and forestry are subject to severe pressure for adaptation following accelerated structural change. Abandonment of uneconomical areas is the consequence.
- The distribution of dry grasslands (Figure 1) and their endangerment varies quite significantly from one region of the country to another.
- Unlike habitats like raised bogs, dry grasslands can regenerate in the medium term.

- Cantonal conservation bodies are the main agents for the implementation. Many of them have extensive experience in grassland conservation.
- The current agricultural policy intends to promote an increase in the importance of the ecological aspect, especially on grasslands, through the Federal Ordinance relating to Ecological Subsidies (EOS) and the Federal Ordinance relating to Ecological Quality. Hence this situation is the essential precondition for the conservation of dry grasslands.

THE CONCRETE IMPLEMENTATION STRATEGY IN DRY GRASSLAND CONSERVATION

Dry grassland conservation is implemented in co-ordination with agriculture and forestry policy. It is based on the principle of sustainability and is pushing a strategy of incentives, so that conservation and promotion of dry grassland areas should be economically interesting for the farmers. This means that our dry grassland conservation policies will contribute to the structural improvement of economically marginal areas in the mountains. By means of financial contributions economical value is added to these economically marginal but biologically rich grasslands, with the aim to stop the retreat of agriculture in these mountain areas.

The highest shortfall in terms of biodiversity is in the Central Plateau. Further loss through intensification of the remaining grassland areas must be stopped. Mandatory regulations are available to achieve this. On the other hand financial incentives can motivate the regeneration of formerly valuable dry grassland areas.

The central instrument of the implementation will be voluntary contracts (between farmers and conservation bodies). These contracts contain agreements on land management, conservation, maintenance measures and the financial compensation for all efforts. With the contract model, "bio-diversity as a product" becomes a value that is demanded and compensated by the public. This model prioritises an approach that is applied in many cantons with great success. Furthermore, management contracts can easily be combined with other instruments of agricultural policy and are well accepted by the farmers.

Beside classical object conservation, a further implementation tool is offered to the cantons: priority zones. The cantons will be enabled to conserve the dry grassland objects in combination with their surrounding biotopes, in order to enhance the flexibility of implementation. In doing so the common principle of "undiminished conservation" of the single object can be put on one side in favour of the overall biotope combination.

Thus, interplant and regionally adapted solutions that are holistic in their approach are made possible for optimally achieving the conservation targets.

Regional concepts are the base for priority zones whose implementation is ruled by a service agreement. Furthermore, there is a connection between these priority zones and the agricultural legislation: Regional networking projects according to the Federal Ordinance relating to Ecological Quality. Valuable synergies can be created between these two instruments of execution by co-ordinating the targets, especially the definition of target species.

CONCLUSIONS

It is the aim of the dry grassland conservation policy to conserve these areas mainly by supporting traditional land use. The appreciation of this traditional agricultural landscape is a very important factor, both for farmers and the general public. Specific public-relations activities, direct contact with agricultural schools and advisory services are important accompanying activities in the strategy of protecting and promoting dry grasslands.

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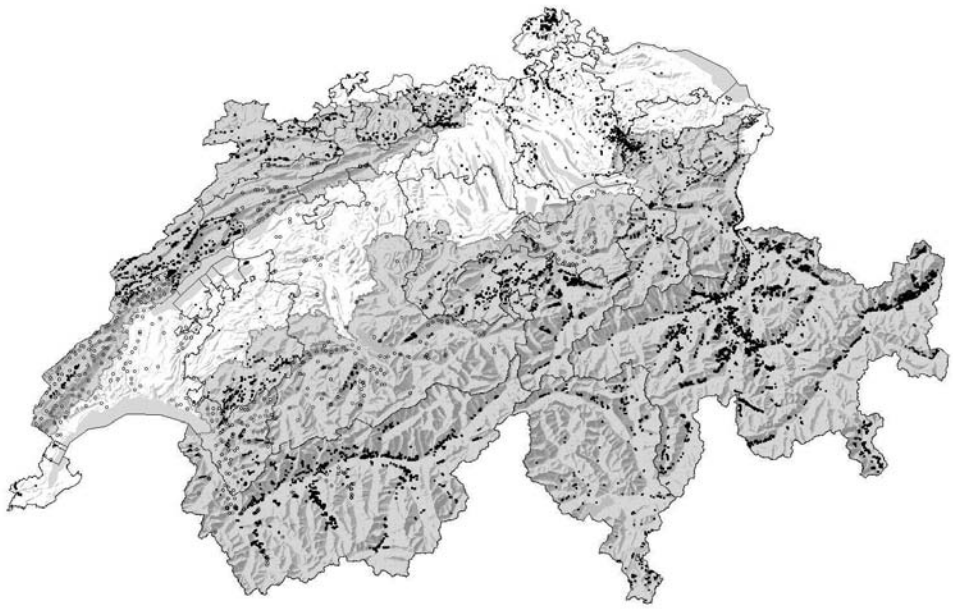
FIGURE 1. Distribution pattern of dry grasslands in Switzerland (2003). It is clear that the most valuable sites are concentrated in the mountainous area (grey area). This is in contrast to the area of the arable plains, where only few relicts are left.



PENDJARI NATIONAL PARK, BENIN: WORKING TOGETHER TO PROTECT NATURAL RESOURCES SERVES BOTH NATURE AND HUMANKIND

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Keywords: Benin, protected areas, natural resources, Millenium Development Goals, governance

PROJECT DESCRIPTION

The Pendjari National Park in the northern dry savannahs of Benin was granted special protection in 1954 as an animal reserve. It is part of a protected area covering 28,600 km2? and stretching into Burkina Faso and Niger. In 1986 it was recognized by UNESCO as a biosphere reserve. The demarcation of the protected area and the resettling of the population were conducted without prior involvement of the local people, and without any parallel promotion or development measures. This led to the over-exploitation of natural resources in the now densely populated border zones of the national park. The people found it difficult to accept the new regulations designed to protect the park. In the hunting zone, for instance, land was farmed illegally, and settlements were built. As a result, the protection of the environment was no longer ensured; conflicts between the park authorities and the local population were the order of the day.

The "Pendjari National Park" project aims to maintain the protected areas in the long term, to establish efficient park management, and to ensure the active involvement and participation of the local people. To this end, the project is promoting the development of the inhabited zones bordering on the national park. It is advising the partner on the establishment of an effective executing organization structure and on the management of the park and hunting zones. In addition, an ecological monitoring system is being set up to observe and monitor the ecological status quo and the development thereof. At the heart of these activities is the active involvement of the local people, be it in the management of the protected and hunting areas, for instance by giving them a say on personnel-related decisions, or by creating additional sources of income through the promotion of tourism and small crafts.

With the park authorities, which are now financially independent, it has been agreed that 30% of revenues from big-game hunting will be accorded to the surrounding villages for development measures to be decided by the villagers. The villages are also given the meat from big-game hunting for consumption or sale. New agreements between the inhabitants of the areas around the national park, the park authorities and the local authorities have removed the stigma of illegality from agricultural activities within the protected area, provided certain conditions are met (no permanent buildings, paths, etc. may be built).

Many donors are contributing to the success of the Pendjari project: the national protection programme of which the Pendjari National Park is an important component, is promoted by the European Union, the Global Environment Facility, France and the Netherlands as well as the German development cooperation. Within the framework of financial cooperation, roads are being built, restored and maintained, administrative and residential buildings are being constructed, water points are being created, and machinery and communications technology are being provided. A trust fund ensures the financial sustainability of the measures.

WHAT DID WE ACHIEVE?

- In and around the park, 130 full-time jobs have been created for inhabitants of the surrounding area; 90% of park personnel (60 full-time staff) has been recruited from the surrounding villages.
- The number of big-game hunters is constant at about 65. The revenues generated by this type of tourism are in the order of EUR 103,000.
- Consideration has been given to the cultural needs of the local people (ceremonies) within the hunting zone. This has been contractually regulated.
- Representatives of the village groups are involved in all park activities (monitoring, taking admission fees, camps for hunters), and they act as wardens.
- On the basis of the business plan, 52% of present running costs are covered by revenue. This figure can rise to about 60%. The remainder must be made up by contributions from international donors and foundation funds.
- Agreements regulate the sustainable utilization of the most important resources, such as medicinal plants, oyster fishing, fishing and roofing materials. Utilization is steered by imposing time limits.
- The executing organization (CENAGREF) has far-reaching financial independence; 70% of revenues will cover operational costs.
- The meat of the game shot goes directly from the hunting camps to the villages for sale. The village groups are responsible for organization and transport.
- 900 individuals in 22 village groups are the main contact for the park authorities and the new communities.
- The illegal occupation of parts of the hunting zone has been legalized, under certain contractually agreed conditions.
- The park authorities have a management/land use plan which takes into account both the core zone and hunting zones. These planning documents are incorporated in the land use plans of the local communities.
- The agricultural promotion measures have to date reached some 64% of the farming population — about half of whom are women.
- For four years, funds generated by big-game hunting have been paid to the village groups (in 2004 about EUR 34,500).
- The number of tourists has risen from 3,800 to 4,800. Admission fees have been raised slightly. Revenues have thus risen from about EUR 21,000 to about EUR 34,000.
- The populations of some species have increased, but overall figures remain stable. Poaching is declining; wildlife is no longer forced to flee as far as it used to.
- The funds generated are used for monitoring and patrolling (about EUR 5,000) and increasingly also to equip schools and health stations as an input from the local population.

ROYAL BOTANIC GARDENS, JORDAN — A COMMUNITY APPROACH TO CONSERVING NATIVE FLORA

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Keywords: Jordan, indigenous plants, botanic gardens

INTRODUCTION

On Monday, 21 March 2005, HRH Prince Faisal, the Regent of Jordan inaugurated the first national botanic garden in the Hashemite Kingdom of Jordan. This pioneering community project is being championed by HRH Princess Basma bint Ali and is supported by Botanic Gardens Conservation International (BGCI) as a part of its Investing in Nature Programme, funded by HSBC.

Nationally, the establishment of a botanic garden in Jordan is part of the Biodiversity Strategy and Action Plan, prepared by the Ministry of Environment to implement the 1992 Convention on Biological Diversity, ratified by Jordan in 1993. The Ministries of Planning and Agriculture have also stated their support for it.

The Royal Botanic Garden has been established as a private non-profit company that is being funded by a range of Jordanian and international sources. It is seeking not only to raise Jordanians' awareness in relation to the importance of their flora, but also to conserve it through the restoration of the site's natural vegetation and the establishment of *ex situ* plant collections.

The Jordanian Ministry of Agriculture donated the site for the new botanic gardens, which extends over 1 km^2 of land in a country park at Tel el Ruman, 25 km from the capital Amman. The area is one of outstanding natural beauty, already rich in wild flowers, and overlooks the King Talal Dam. The Royal Botanic Garden will be the first botanical collection of living plants that is open to the public in Jordan. It will be a regional centre for native plant conservation, public education, and scientific research and will have links with other gardens, both in the region and worldwide.

RICH HERITAGE OF BIODIVERSITY

Despite its small size, Jordan is a country rich in indigenous plants, with about 2,500 species, many of them endemic to Jordan or the immediate region. However, this rich heritage of biodiversity is, in most cases, endangered by urbanisation, poor land use and population expansion. The Black Iris (*Iris nigricans*), the national flower of Jordan, is on the brink of extinction in the wild. Only limited scientific research has been done on this flora, and there are quite likely plants in the country still unknown to science.

So far, conservation efforts in Jordan have been limited in scope, with some flora conserved in a few nature reserves. However, there are not enough reserves to protect the country's rich botanical diversity. Through the Royal Botanic Garden, the diverse botanical heritage of Jordan can be conserved, while educating the public as to its importance.

The botanic garden will also be locally important by providing:

- employment for the local people;
- an important resource for schools;
- an outlet for handicrafts made by the local women;
- increased income to the local community; and
- improved facilities and infrastructure of the area in terms of communications, transportation, and electricity.

A NEW VISITOR ATTRACTION

The botanic garden will be a place where visitors can learn about Jordan's heritage in a beautiful setting, as well as being a place where these plants will be preserved. It will be a regional as well as a national public attraction, in a country where few such amenities currently exist. The botanic garden will also have a very positive and sustainable impact on a beautiful area of Jordan that is being considered for tourism development.

GARDEN DESIGN AND CONSTRUCTION

The Royal Botanic Garden is envisaged as one main site, but in the future may include a number of satellite gardens in different parts of the country. In addition to the main site at Tel el Ruman, plans are also being developed for a smaller garden of about two hectares in Aqaba, which will specialise in tropical plants.

The Royal Botanic Garden will feature, showcase and conserve some of the habitats and indigenous plants typical of the different bio-geographical regions of Jordan. Eventually the Garden may also include themed collections, for example, a display of medicinal herbs and orchids. The first phase of the botanic garden development is being funded by BGCI and is planned to be completed by the end of 2006.

Jordan's botanic garden in Jordan will be an important biodiversity resource. It will preserve collections of plants that may exist in Jordan and nowhere else, and will be a source of technical advice to governments and NGOs.

The Garden as a whole will work to educate the public to appreciate plants and reverse the limited awareness of plants that currently exists in the general public. It will be a chance to both educate them and show them something new. It is accepted that people cannot be engaged to care about loss of diversity if they do not understand or have any feeling for what it really means.

PROMOTING *IN-SITU*/ON-FARM CONSERVATION OF DRYLAND AGROBIODIVERSITY IN THE WEST ASIA CENTER OF DIVERSITY

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ABSTRACT

The Global Environment Facility–funded project on "conservation and sustainable use of dryland agrobiodiversity" implemented in Jordan, Lebanon, the Palestinian Authority and Syria was carried out for six years to develop a holistic approach to promote community-driven actions for the conservation of landraces and wild relatives of globally important crops originating from the Fertile Crescent. The socioeconomic and eco-geographic surveys, along with geographic information systems and remote sensing tools, have allowed for better knowledge of the status of and changes in local agrobiodiversity and its major threats. Low-cost technological packages (water harvesting, integrated pest management, rotations, improvement of seed lots, etc.), and add-value and alternative sources of income (food processing, dairy products, cultivation of medicinal plants, ecotourism, etc.) were investigated and demonstrated. Institutional, policy and legislation options were recommended to government and those related to the use of native species in reforestation were already adopted. A regional alliance to exchange genetic resources was signed among the ministries of agriculture of the four countries. Diverse types of support were used to increase public awareness, including the introduction of biodiversity conservation into education systems. The best options tested with key stakeholders were packaged into community development and natural habitats management plans to be implemented by local communities, NGOs and government institutions with technical support from international organizations and expertise gained from the project at the national levels.

IN-SITU CONSERVATION AND AGROBIODIVERSITY IN JORDAN: *TRITICUM DICOCCOIDES* AS AN EXAMPLE

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Keywords: durum wheat landraces, introgression, morphological characterization, wild emmer wheat

INTRODUCTION

Wild emmer wheat, *Triticum dicoccoides* (Körn. ex Asch. & Graebner.) Schweinf is used to improve durum wheat. This species possesses higher grain protein content and nutritional value than cultivated wheat. Genes for grain quality, stress tolerance and disease resistance have been transferred from wild relatives to the cultivated wheat. It is believed that introgression plays a significant role in affecting genetic diversity of natural populations of crops. Introgression can be defined as the transfer of genes among taxa. Wild emmer wheat of the Near East does come into contact with cultivated wheat sufficiently to cross occasionally. These crosses can result in substantial increases in variation. Previous studies in wild emmer wheat populations did not investigate introgression occurrence by either morphological or molecular markers. Therefore, introgression occurrence in wild wheat populations in their centres of origin was investigated.

The present work was carried out to study the presence of natural introgression among 15 natural populations of wild emmer wheat sampled from different locations in Jordan. Morphological, developmental and productive traits measured for individual plants of wild emmer wheat conserved *in situ* indicated the presence of natural introgression. This result was based on similarity between certain morphological traits of durum wheat hybrids and wild emmer wheat, including absence of pigmentations, early growth vigour, awn length, spike length and number of spikelets per spike. High levels of introgression in natural populations of wild emmer wheat were found in or around cultivated durum wheat fields. Presence of natural hybrids within wild emmer wheat populations is further evidence of introgression occurrence.

MORPHOLOGICAL AND VEGETATIVE CHARACTERISTICS

Large differences in the morphological traits were detected between the wild emmer wheat conserved *in situ* (Table 1) and the hybrid durum wheat. Analysis of Variance (ANOVA) for most morphological data showed highly significant differences between *T. dicoccoides* populations and the hybrid durum wheat population. Morphological similarities between *T. dicoccoides* and durum wheat cultivars are believed to be a result of gene flow from durum into *T. dicoccoides.* Wild emmer wheat populations surveyed during 2000 were evaluated on site. ANOVA indicated high significant differences for most morphological data within and between wild emmer wheat populations.

The number of fertile tillers for durum wheat hybrid was significantly different from wild emmer wheat within and among populations. Zaatari *T. dicoccoides* was significantly different from other populations by having low number of tillers. The Qadesieh population was not significantly different from the durum

wheat hybrid by having relatively high number of fertile tillers per plant (Table 2.). Plant breeders could benefit by introgressing this trait into durum wheat for drought conditions.

Plant height showed heterogeneity within and among wild emmer wheat populations. ANOVA indicated significant differences between all wild emmer wheat and durum wheat hybrid population. This could be attributed to favourable adaptation of these accessions to their microhabitats. The variability in wheat populations reflected specific adaptation or interaction with the environment.

INFLORESCENCE CHARACTERISTICS

Heterogeneity regarding spike length was recorded for wild emmer populations. ANOVA of this character indicated highly significant differences between and within groups of wild emmer wheat populations. Natural hybrids were encountered at Balila site, the glumes and the awns were pale and the spikes of this population were intact. These hybrids were very close to durum wheat fields. These similarities are an indication of introgression (Table 2). This is an important character for breeding durum wheat in dry areas.

ANOVA of this character indicated high significant differences among and within wild emmer wheat groups.

SEED CHARACTERISTICS

This character was not significant between and within groups of wild emmer wheat population. Heterogeneity was encountered regarding all wild emmer wheat populations in 1000 kernel weight. ANOVA analysis of this character indicated differences between wheat populations. Glume colour showed heterogeneity within and among wild emmer wheat populations.

Lack of pigmentation was reported to be an indication of introgression. Thus it could be concluded that introgression for this character could be localized to Balila, Sakhra, Samta, and Natifa populations. Awn colour showed heterogeneity within and among wild emmer wheat populations. However, The Sakhra population was not significantly different from these populations having no pigmentation in awns. Seed length and width showed heterogeneity among and between all wild emmer wheat populations. ANOVA analysis of these characters was highly significant. Jubeiha *T. dicoccoides* were significantly different from all wild emmer wheat populations by having relatively lower seed length than other wild emmer wheat populations. This indicated that some introgression occurred in these populations regarding this character.

Some natural hybrids were found within the wild emmer wheat populations at Balila, Sakhra and Hudeib sites, at a distance of one to two metres away from durum wheat field edges; these were indehiscence individuals very close to durum. These samples may suggest introgression. Introgression was assessed based on similarities between durum wheat and *T. dicoccoides* population.

CONCLUSION

Introgression is most likely to occur in Sakhra, Balila, Tafila, Zatari due to the significant similarity in various characters with durum wheat and due to presence of natural hybrids. The great variability in all characters studied may be a reliable indicator of massive introgression. However, few researchers car-

ried out morphological measurements to detect natural introgression. Furthermore, habitat destruction, as indicated from previous collection missions, may play an important role in decreasing the rate of introgression.

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TABLE1: Location description of collection sites of wild emmer wheat during the year 2000 with longitude, latitude an altitude.

SITE NUMBER	SITE NAME	LONGITUDE	LATITUDE	ALTITUDE
1	Samta	E 35 49 331	N 32 23 258	1065
2	Sakhra	E 35 50 395	N 32 22 003	1018.4
3	Zobia	E 35 46 399	N 32 25 915	840.2
4	Huseniat	E 35 47897	N 32 149 87	990.9
5	Jubeiha	E 35 52 505	N 32 00 594	958.3
6	NeimehA	E 35 52 094	N 32 24 386	798.2
7	NeimehB	E 35 56 140	N 32 25 175	1033
8	Samad	E 35 505 22	N 32 25 731	1046.4
9	Natifa	E 35 49 811	N 32 30 832	747
10	Balila	E 35 55 491	N 32 24 391	704.4
11	Al-Hudeib	E 35 44 203	N 32 06 211	860
12	Um Al-Amad	E 35 46 100	N 32 06 631	820
13	Zaatari	E 35 44 538	N 32 04 087	889
14	QadesiehA	E 35 37 922	N 30 42 226	1525.9
15	QadesiehB	E 35 37 974	N 30 40 152	1497.9

TABLE 2. Means for groups in homogeneous subset are displayed using Duncan, subset for alpha =0.05

NUMBER	LOCATION	SPIKE LENGTH	AWN LENGTH	AWN COLOR	GLUME COLOR	NUMBER OF SPIKELET PER SPIKE
1	Zatari	4.72abc	15.22bcd	1.0a	1.0a	8.60ab
2	Sakhra	6.04bc	14.46bc	1.2a	1.0a	10.60bc
3	Huseiniat	5.12abc	15.90cde	1.4ab	1.4ab	8.80abc
4	UmAlAmadA	6.08bc	18.58e	1.0a	1.0a	9.20abc
5	Behaira	4.44ab	16.30cde	1.4ab	1.6bc	8.20ab
6	Balila	4.66abc	12.50ab	1.0a	1.0a	9.60abc
7	Neimeh A	4.68abc	17.52cde	1.8bc	1.6bc	7.60a
8	Qadesieh A	6.18c	18.86e	2.0c	2.0c	10.60bc
9	Samad	5.48abc	14.48bc	2.0c	2.0c	9.00abc
10	Samta	5.02abc	16.94cde	1.0a	1.0a	8.60ab
11	Qadesieh B	4.86abc	17.88de	2.0c	2.0c	11.20c
12	Jubeiha	6.20c	9.90a	2.6d	2.0c	13.80d
13	Zobia	4.26a	16.52cde	1.0a	1.0a	7.40a
14	Natifa	4.48ab	18.62e	1.0a	1.2ab	8.60ab
15	Neimeh B	3.90a	17.04cde	2.0c	2.0c	8.00a

INTEGRATING EDUCATION WITH ENVIRONMENTAL PROBLEM SOLVING

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Keywords: arid environments, land use, research communication, research training

INTRODUCTION

Arid and semi-arid ecosystems are complex, variable, often support diverse organisms and sometimes difficult to understand. These drylands occupy approximately 41% of the world surface and support more than 2 billion people (Millennium Ecosystem Assessment, 2005). Namibia, one of these dryland countries, gained its independence in 1990. Many of Namibia's decision-makers were in exile before independence, often in higher rainfall areas such as in equatorial Africa, northern Europe or the US. Therefore, while there is an understanding that the fertility of terrestrial and aquatic ecosystems determines their ability to support human livelihoods, understanding is limited with respect to the functioning of drylands, particularly of climatic variability or the role of biodiversity.

For 13 years, a programme of integrated research training and environmental problem solving was undertaken with undergraduates and recent graduates of Namibia's new and evolving tertiary education institutions. In partnership with a variety of research partners institutions, we identified these research projects as critical issues that required better understanding. Consequently, groups of students and key supervisors addressed issues ranging from water use and management in ephemeral rivers and wetlands (Amoomo 2000; Dausab 1994) to options for development by resettled San people (Shilomboleni 1999) to environmental impacts of illegal fencing on communal rangelands. These projects involved not only learning about and using various research methodologies, but also communicating of the research results in different formats (e.g., Seely and Wöhl, 2004) to a variety of appropriate audiences ranging from the communities (e.g. Seely and Moser, 2004) where the research was undertaken to relevant high-level decision-makers.

RESULTS

Table 1 provides a brief overview of the 13 projects undertaken, using an educational approach to research for environmental problem solving, and key results obtained. The topics were identified year by year in consultation with training partners in response to identified environmental challenges throughout Namibia. Key research methodologies learned during the field research and subsequent analysis and review were, inter alia: participatory research methods with communities; surveying methodologies; resource and resource use mapping using GIS and remote sensing; basic hydrological modelling; use of diverse and alternative information sources; analytical and writing skills; and preparation and delivery of presentations to diverse audiences. Many of the results were adopted by and integrated into ongoing programmes and developments in Namibia (e.g., Botes et al., 2003).

DISCUSSION

Throughout the programme, internal and external evaluations were undertaken. From the viewpoint of the students, they always concluded that their expectations were met, and often exceeded, in terms of, *inter alia*: understanding research and developing essential skills; independently planning and implementing research; having a positive attitude toward learning, research and teamwork; applying research as a tool for environmental problem solving; and appropriate reporting of research results to selected audiences. Development partners were unanimously positive about the information and understanding generated by the team's research. It became apparent that participation in the programme was a good recommendation for future job opportunities and was used as such by potential employers. The approach has been discussed, modified and adopted by a variety of institutions and programmes (Seely *et al.*, 2003, 2004). Although it is an exaggeration to suggest that senior decision-makers have altered their views on biodiversity or on climate variability based on programme results, perhaps those persons who have taken part in the programme have done so. Also, it is fair to say that because of this and other complementing programmes both research education and the environment are viewed differently than they were 15 years ago when dryland Namibia started to address sustainable development.

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TABLE 1: Overview of programme activities integrating education and environmental problem solving and key results.

PROJECT TITLE AND DESCRIPTION	KEY RESULTS
Rainfall range map: using long-term data, participants calculated and mapped the range of rainfall experienced in 90% of years.	Mean rainfall is not a good planning tool in drylands. Map of expected rainfall range currently used by agricultural unions and government extension.
Water use patterns in Kuiseb catchment: using measurements, observations and interviews, water use by six stakeholder groups was assessed.	Results clarified differential use of groundwater and identified potential for reduction of water use and water waste by some stakeholders.
Productivity change assessment: focusing on soils and vegetation, perceptions were assessed amongst residents and researchers.	Perceptions depended on previous experience in the area with older residents comparing current productivity to one exceptional year in past three decades.
Elephants, communal and commercial farmers: perceptions and effects of elephants on productivity in different land tenure systems.	Communal farmers considered elephants a threat to their livelihoods while freehold tenure farmers viewed them as a tourist attraction and asset.
Economic value of natural resources: perceptions and livelihood impacts were assessed in two contrasting villages examining woody vegetation.	Replacement values for natural resources were higher than cash available. Cash outlay for fuel and fencing was higher where forest had been depleted.
Illegal fencing in communal areas: participants examined the social and environmental impact of fencing off large tracts for private use.	Illegal fencing was new in the area and social impacts on small-scale farmers were identified as more serious than direct environmental impacts.
Options for development of recently resettled San: soil, groundwater, state of vegetation and current economic activity were analysed.	Contrary to opinion of extension services, a shift to livestock from use of natural products was not an option preferred by residents or students.
Environmental reserve in the Kuiseb aquifer: a preliminary model analysed water inputs, storage and outflows based on use by catchment stakeholders.	Modeling revealed apparently large lateral losses and difficulties of estimation under arid conditions with a limited data base.
Influence of farm dams in the Kuiseb: using detailed surveys in two sub-catchments, water balance was modeled under varying rainfall conditions.	Farm dams were measured and found to have little effect during above average rainfall when most recharge takes place in the lower alluvial aquifer.
Potential of Etaka Canal to provide water for livestock: detailed surveys assessed use of natural, recently dammed watercourse to provide raw water.	The Etaka Canal could reduce use of purified water for livestock but mechanisms for payment for canal water posed a problem to the bulk supplier.
Value of fruit trees to communal farming: stakeholder, soils and use analyses investigated role and management of fruit trees in rural livelihoods.	Although fruit trees are not purposely planted by farmers, preferred species that germinate and become established are then protected.
Water balance in the Omaruru catchment: detailed dam surveys & stake-holder assessments investigated perceptions & modeled water balance.	Perceptions of availability of groundwater and access to it varied amongst stakeholders depending on livelihoods, technical access and income levels.
Monitoring water use at communal water points: a baseline understanding and monitoring system were elaborated for pipeline water point management.	Local level monitoring by those directly involved in using and managing water from communal water points provides opportunity to increase understanding.

BEYOND THE BUZZ-WORD: A CAPACITY BUILDING ACTION PLAN FOR NAMIBIA

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Keywords: dry and sub-humid lands biodiversity, National Capacity Self-Assessment (NCSA), implementation of Rio Conventions

CAPACITY BUILDING: OPTIONS FOR A SYSTEMATIC APPROACH

Capacity building is at the heart of the Convention on Biological Diversity's (CBD) Programme of Work (PoW) on Dry and Sub-humid Lands (DSHL). It is (i) recognised that the majority of drylands are situated in developing countries, (ii) that capacity building for improved environmental and biodiversity management is essential to conservation, development and poverty alleviation, and (iii) that the CBD can only be operationalised if country-level capacities for its implementation are strengthened.

Namibia was one of the first countries worldwide and in Africa to complete the first phase of the National Capacity Self Assessment (NCSA) for Global Environmental Management in 2005. The process was funded by the Global Environment Facility (GEF) and facilitated by the United Nations Development Programme (UNDP). The Ministry of Environment and Tourism (MET) and the National Planning Commission (NPC) at the Office of the President were the local government institutions responsible for the implementation of the two-year process, whilst a number of private and academic institutions, NGOs and CBOs were involved as steering committee members, process facilitators and participants.

The National Capacity Self-Assessment (NCSA) assists countries to assess their priority national capacity for implementation of the Multilateral Environmental Agreements (MEAs). The MEAs considered include in particular the CBD, the UN Framework Convention on Climate Change (UNFCCC) and UN Convention to Combat Desertification (UNCCD). Namibia has ratified all three Rio Conventions and has obligations to enact their provisions — and a real need to deal with environmental issues in support of sustainable development.

NAMIBIA'S NCSA ACTION PLAN: THE LINK BETWEEN ENVIRONMENT AND POVERTY REDUCTION

Namibia has engaged in a NCSA process, and in its first project phase has developed an Action Plan to address priority capacity needs systematically over the next decade. The Action Plan is based on a series of local, regional, and national assessments, which allowed Namibian people and natural resource users to identify their own priorities. The NCSA Action Plan has been prepared recognising that for all Namibians, but particularly for rural Namibians, the ecological integrity of the land they live on is crucial

to their existence and livelihoods. Poverty reduction is a key concern to Namibia, as about 38% of the population live below the poverty line. Poverty is on the increase, especially in some rural areas. Implementation of the Rio Conventions and environmental management in Namibia must address poverty reduction as a strategy to reduce the vulnerability of the poor. It is recognised that loss of biodiversity and its goods and services, desertification/land degradation, as well as the negative impacts of climate change expected over the longer term put poor people at greater and greater risk, and reduce their livelihood options. These factors are exacerbated by the negative impacts of HIV/Aids and poverty per se.

The NCSA Action Plan consists of three objectives, of which objective 3 "To address key individual, institutional and systemic capacity needs identified at the local, regional and national level through targeted priority interventions. Cross-cutting priorities to be emphasized include decentralisation and focus on the needs of the users of natural resources" forms the heart of proposed interventions (actions) for programmes and projects and is sub-divided into a set of sub-objectives and tangible activities (Table 1).

KEY LESSONS LEARNED

Excerpts of lessons learnt from the Namibian experience include:

- There are many excellent local-level environmental management efforts ongoing, and the understanding of issues pertaining to such issues is high. Efforts to further strengthen local-level activities have to be prioritised as the environmental impact will be highest and most meaningful on this level.
- Synergies between the Rio Conventions are identified naturally at the local level. There is little benefit in addressing biodiversity, desertification and climate change in isolation.
- Cross-cutting issues such as HIV/AIDS, gender and poverty alleviation are extremely important and may very strongly impact environmental management successes.
- The NCSA process helps focus the way of thinking about capacity building and provides a useful planning framework for targeted interventions.
- It is important to operationalise the NCSA so that its outcomes do not end up as paper plans and just another assessment report. Formulating an Action Plan is a good first step.

THE WAY FORWARD

1. The Action Plan implementation is linked to newly emerging project development especially, but not only, in the preparation of GEF-funded initiatives.
2. Regional feedback sessions on the findings of the NCSA process and the way forward are currently being held in the three pilot regions. Regional Councils and extension officers from relevant line Ministries are particularly sensitised to the action plan.
3. A NCSA follow-up project has been developed in Namibia, and its focus is the strengthening of regional environmental management capacities. This will support the decentralisation efforts underway and further support the local-level initiatives.

References

All outcomes from phase 1 of the NCSA are available from the Ministry of Environment and Tourism webpage at www.met.gov.na.

TABLE 1: Extracts from Namibia's NCSA Action Plan.

The full Action Plan contains targets, timelines for implementation, identifies key responsible institutions and has an indicative budget. The Action Plan is currently under implementation and follow-up project funding is being sourced in support of certain priority activities.	
OBJECTIVE 3: ADDRESSING OF PRIORITY INDIVIDUAL, INSTITUTIONAL AND SYSTEMIC CAPACITY NEEDS AS IDENTIFIED AT LOCAL, REGIONAL AND NATIONAL LEVEL	
3.1 Support mainstreaming of environmental management into regional governance actions	3.1.1: Prepare projects and funding proposals that explicitly target the strengthening of environmental management capacities of regional authorities
	3.1.2: Promote mainstreaming of environmental management in existing decentralisation initiatives
	3.1.3: Make specific provision in national project proposals for projects to be carried out at the regional and local levels
3.2 Encourage, strengthen and continue support to local level environmental management; up-scale pilot approaches and channel resources to that level	3.2.1: Continue implementation of programmemes and projects; and development of novel and effective approaches to local level development
	3.2.2: Facilitate broad application of best practices
	3.2.3: Address Rio Conventions in integrated manner, where appropriate
	3.2.4: Improve community access to information
	3.2.5: Stimulate investment (GRN, private, donor) into local level environmental management
3.3 Strengthen existing and help establish new and emerging collaborations especially at the local and regional levels	3.3.1: Strengthen existing collaborations and support new and emerging inter-institutional collaboration
	3.3.2: Strengthen regional and local level Government extension services
3.4 Address individual and aspects of institutional capacity needs through national strategy/policy on skills development, training and capacity building (in support of environmental management)	3.4.1: Review existing policies/strategies and draft potential white paper and follow-up policy process; or components mainstreamed into ongoing NPC activities
	3.4.2: Solicit support from key stakeholders especially OPM (in charge of capacity development in public service)
	3.4.3 Improve life-science, environmental and natural resource courses at UNAM and Polytechnic, and support sustainable livelihood training at other institutes e.g. Nara Training Centre, Rössing Foundation, GTRC
3.5 Review and analyse existing policy and legal framework for gaps, conflicts and contradictions and opportunities for improved frameworks; communicate content and focus on implementation at appropriate levels (in support of improved/sustainable environmental management)	3.5.1: Undertake systematic analysis of existing policy framework and identify areas where environmental management should be explicitly/better addressed and ways and means to do so
	3.5.2: Communicate content of policies to key stakeholders; facilitate implementation and enforcement
3.6 Address key topical areas under the Conventions currently not much acted on (i.e. economic valuation of natural resources; feasibility study on potential of natural resources/biodiversity products for economic development)	3.6.1: Promote focus on economic valuation of natural resources
	3.6.2: Promote focus on potential of natural resources/ biodiversity products for economic development
3.7 Efficiently adhere to key reporting obligations and capitalise on negotiation opportunities under the three Rio Conventions	3.7.1: Strengthen Environmental Conventions Unit
	3.7.2: Train negotiators on Convention content, process and current issues of relevance to Namibia (international environment. politics per se)

REINTRODUCTION OF THE MEXICAN WOLF (*CANIS LUPUS BAILEYI*) TO THE SOUTHWESTERN UNITED STATES: AN ECONOMIC PERSPECTIVE

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Keywords: economic valuation, non-use values, wildlife reintroduction, Mexican gray wolf

Our poster focuses on the reintroduction of the Mexican gray wolf (*Canis lupus baileyi*) to the Southwestern United States from a perspective of economic valuation (Activity 7g of the work program on dry and sub-humid lands under the Convention on Biological Diversity). The study assesses both the economic costs and benefits of Mexican wolf reintroduction, from regional and national perspectives.

BACKGROUND

In 1998 the Mexican gray wolf was reintroduced to the Blue Range Wolf Recovery Area (BRWRA), located in east-central Arizona and west-central New Mexico in an effort to reestablish a wild population of Mexican gray wolves in the species' former home range. Because the gray wolf is a large predator and elicits interest nationwide, its reintroduction to an area used by humans is bound to generate economic impacts ranging from direct uses (e.g., tourism, livestock losses, wildlife watching, hunting) to indirect uses (ecosystem services, e.g., control of other predators, impacts on riparian vegetation) and non-uses (existence, stewardship, and bequest values), and comprising both market and non-market impacts. Although there have been several comprehensive estimates of the economic impacts of the reintroduction or conservation of gray wolves in other regions in the U.S., to date no such study has been carried out in the Southwest. The purpose of this study is to remedy this shortcoming.

METHODS

We apply different valuation approaches in order to generate a comprehensive assessment of the economic impacts caused by the reintroduction of Mexican wolves to the BRWRA. These approaches rely both on individuals' observed and stated willingness-to-pay (WTP) for wolf reintroduction. We estimate observed WTP based on the results of a market experiment in the sale of "wolf-friendly" beef that was conducted in New Mexico in 1998. Stated WTP is estimated in two ways: first, we apply a single-point benefit transfer to the WTP for wolf reintroduction reported in the study whose context most closely resembles that of the BRWRA, namely, reintroduction of gray wolves to central Idaho (U.S. Fish and Wildlife Service, 1994); in addition, we conduct a meta-analysis of all available WTP studies on gray wolf reintroduction and apply the estimated WTP regression function to derive WTP estimates for reintroduction of wolves to the BRWRA. Besides WTP for reintroduction, we also provide quantitative estimates of other impacts associated with reintroduction for which sufficient data were available.

On the cost side, these impacts comprise depredation by wolves on livestock, dogs, and horses, veterinary expenses for injured livestock, the cost to ranchers of filing claims for compensation of livestock losses, and the economic multiplier effects associated with uncompensated livestock losses; wolves have not had

any impact on elk and deer populations, and hunting activity in the area actually increased since reintroduction (Unsworth et al., 2005).

On the benefits side, quantified impacts, besides WTP for reintroduction, are the compensation payments to ranchers for livestock losses to wolves. Expenditures by state and federal agencies managing the reintroduction effort constitute costs from the perspective of society as a whole, but together with the economic multiplier effects associated with these expenditures, they constitute benefits from the perspective of the reintroduction region, because without reintroduction, these expenditures would not have occurred in the region. The estimates of impacts other than WTP for wolf reintroduction are based on a recent study by the Fish and Wildlife Service (Unsworth et al., 2005). In addition to these impacts, reintroduction of wolves may also generate increased tourism activity in the region, as has occurred in the Yellowstone area. Furthermore, a number of educational activities surrounding Mexican wolf reintroduction have been taking place. Finally, wolves may have impacts on the structure and functioning of the ecosystem of the reintroduction area, well-documented in the Yellowstone case (Smith et al., 2003), that benefit humans. Unfortunately, the necessary data do not exist to quantify these potential impacts in the BRWRA. To capture the uncertainty that characterizes most impacts, we develop low and high impact estimates, based on our three WTP approaches for wolf reintroduction and on the low and high impact estimates given in Unsworth et al. (2005). Because some impacts have different spatial scales and intensities, we develop impact estimates both for the reintroduction region (Arizona, New Mexico) and for the U.S. as a whole.

RESULTS

Our results suggest that reintroduction of Mexican wolves to the Southwest has generated substantial benefits as well as costs. Our analysis further indicates that benefits outweigh costs by a large margin, at both the regional and the national levels of analysis. We find that non-use values are the single largest component of total benefits associated with reintroduction. Table 1 presents estimates of the average annual impacts since reintroduction, disaggregated into benefits, costs, and net benefits, that is, the sum of costs and benefits. Regional economic net benefits resulting from Mexican wolf reintroduction have averaged $3.2-$3.8 million per year since 1998. This figure includes the benefits received by out-of-state visitors to the Gila and Apache National Forests, where the reintroduction area is located. The average annual net benefits at the national level range from $13.2 million to $44.6 million since reintroduction. These numbers may appear large. However, if one considers that they represent the total impacts of reintroduction on 4.4 million households (Arizona and New Mexico, plus National forest visitors from other states) and 113 million households, respectively, it becomes clear that they translate into very small impacts on a per-household or per-capita basis. This is the result of several conservative assumptions we made in deriving our WTP estimates for wolf reintroduction. In addition, even if one followed Duffield (U.S. Fish and Wildlife Service, 1994) and assumed that the amount individuals would actually pay is only about 30% of their stated WTP, annual net benefits of reintroduction would still be $2.0-$2.1 million at the regional level, and $3.0-$11.9 million at the national level.

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TABLE 1: Average annual economic impacts in USD of Mexican wolf reintroduction, 1998-2004

	2004$ (LUMP SUM)					
	BENEFITS		COSTS		NET BENEFITS	
REGION	High	Low	High	Low	High	Low
WTP for reintroduction	3,133,571	1,652,245	786,421	–	2,347,151	1,652,245
Livestock depredations	–	–	18,681	5,522	-18,681	-5,522
Assoc'd lost regional output	–	–	18,002	625	-18,002	-625
Compens. payments to ranchers	4,806	4,806	–	–	4,806	4,806
Agency expenditures	1,107,871	1,107,871	–	–	1,107,871	1,107,871
Assoc'd regional output increase	400,434	400,434	–	–	400,434	400,434
Sales of wolf-related products	(+)	(+)	–	–	(+)	(+)
TOTAL	4,646,683	3,165,357	823,103	6,147	3,823,580	3,159,209
NATIONAL LEVEL						
WTP for reintroduction	49,239,948	14,304,258	3,458,240	–	45,781,709	14,304,258
Livestock depredations	–	–	18,681	5,522	-18,681	-5,522
Assoc'd lost regional output	–	–	18,002	625	-18,002	-625
Agency expenditures	–	–	1,107,871	1,107,871	-1,107,871	-1,107,871
Assoc'd regional output increase	–	–	–	–	–	–
Sales of wolf-related products	(+)	(+)	–	–	(+)	(+)
TOTAL	49,239,948	14,304,258	4,602,793	1,114,019	44,637,155	13,190,239

STATUS, CONSERVATION AND SUSTAINABLE USE OF BIODIVERSITY IN THE DESERT MARGINS PROGRAM

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Keywords: crops, livestock, land degradation, endemism, Sahel, Desert Margins Program

INTRODUCTION

Poverty and food insecurity continue to create suffering across Africa's drylands. Unpredictable droughts cause food shortages for both humans and the livestock they depend on. As human populations increase, so does the number of livestock, and the cropped area expands into ever more marginal lands. This places increasing stress on the natural resource base and contributes to degrade soils and biodiversity.

Within this overall picture, there are marked differences in the details and dynamics of degradation processes in different agro-ecological regions. For example, the people in the driest study sites in southwestern Africa (Namibia, Botswana and South Africa) rely almost entirely on livestock for their livelihoods, while those in Zimbabwe and southern Kenya have mixed crop-livestock systems. The synergies between crops and livestock permit viable livelihoods under increased human pressures. The challenges that communities in northern Kenya face are dramatically different. The freedom of nomadic pastoralists is increasingly curtailed as other land uses grow, compelling them to seek alternative livelihoods.

BIODIVERSITY STATUS

In contrast to other arid and semi-arid areas of Africa (e.g., Namib, Karoo) there are fewer endemic species in the desert margins of the Sahel, probably because of (i) the amplitude of fluctuations in environmental conditions, both at present and during the whole quaternary period, and (ii) the relative homogeneity of the soil resource.

Some species are locally rare, either because they are close to the limits of their distribution area or because of the small extent of their specific habitat, e.g., wetlands or rocky outcrops.A huit of farming in the Desert Margins lands

The transient nature of the seed stock causes sharp changes in herbaceous vegetation composition (Cissé, 1986; Boudet, 1981; Carrière, 1989; Grouzis, 1988).

In spite of the large inter-annual variations in biomass production, fecundity and species composition, natural vegetation is remarkably resilient to droughts, as demonstrated by the spectacular spontaneous "regenerations" of northern Sahel rangelands following the drought crises in 1973-74 and 1983-84 in the Gourma region of Eastern Mali (Hiernaux, 1995; de Leeuw, 1993). Monitoring of woody plant populations in desert margins of the Sahelian rangelands indicates active dynamics, although at a more extended time scale than for the herbaceous community, including drought-induced mass mortality of populations at some time lag after droughts, and occasional waves of regeneration (Couteron and Kokou, 1997).

The Sahel has evolved as a distinct agro-ecosystem for at least the last 6,000 years (Beauvilain, 2003). This is the cradle of major cereal crops such as millet, sorghum, fonio millet, African rice species, cowpea, voandzou (*Vigna subterranean*) and watermelon. The Sahel is also a secondary centre of diversification for crops that originated from other continents such as okra, roselle and corette (*Corchorus olitorius*). On the livestock side, although zebu cattle originated on the Indian subcontinent, they were introduced long enough ago to diversify into many distinctive breeds such as Gobra in Senegal, Maurish and Macina in Mali, Azaouak, Jelli and Bororo in Niger, and Gudali and White Fulani in Nigeria, Chad and Northern Cameroon (Rege, 1996).

These adaptations of flora and fauna have conferred on the Sahel ecosystem a strong resilience to abiotic stresses and disturbances, such as droughts, floods and, bush fire although these are most often human-induced. This resilience extends to biotic stresses such as pest outbreaks (locust, rodents, granivorous birds) and heavy grazing by wild as well as domestic ungulates.

However, the unprecedented increase in human populations since the mid-twentieth century, and the rapid build-up of urban centres have profoundly changed land use and challenged the resilience of the Sahel ecosystem. Cropped land area has expanded by 2 to 4% per annum on average for decades. Together with increasing livestock populations, this has reduced the quantity and quality of grazing land available to livestock in the late dry and early wet season, and increased the grazing pressure on rangeland during the growing season because livestock are excluded from croplands.

Overgrazing during the wet season often triggers changes in vegetation composition, favouring short-cycle annuals which are less productive though palatable (such as the legume *Zornia glochidiata*, the dicotyledon *Tribulus terrestris* or the grasses *Tragus berteronianus* and *Microchloa indica*), and/or the less-palatable, aggressive species such as *Sida cordifolia*, *Cassia tora* and *Hyptis suaveolens* (Hiernaux 1998). In both cases, these changes result in a degradation of grazing resources.

Another risk with the expansion of cropping and the reduction of fallow duration is the fragmentation of the savanna biome, which could hinder the capacity of some species to regenerate or propagate, and thus lead to progressive loss in genetic diversity. Expansion of crop area and reduction of fallow duration, without increased input of organic matter and nutrients, also contribute to the impoverishment of soil fertility, both by enhancing nutrient exports and by aggravating soil erosion (Manlay et al 2004, Schlecht,et al 2004). To a lesser extent, increased grazing pressure also increases nutrient exports and soil erosion.

The steady decline in soil fertility affects the productivity of vegetation and thus the efficiency of water and solar energy use. Progressive loss of soil fertility and fragmentation of the landscape converge to erode biodiversity due to habitat loss and reductions in population size (i.e., the species remnants are too small and isolated to maintain their specific biomes). This syndrome also favours a small number of invasive species, to the detriment of indigenous species (*Cassia* ssp, *Hyptis suaveolens*, *Sida cordifolia,* etc.). All these processes contribute to the downward spiral of desertification.

RESEARCH HIGHLIGHTS

The central hypothesis of the Desert Margins Program (DMP) is that the desertification trend can be avoided or reversed by adopting resource management policies that simultaneously (i) enhance the resilience and biodiversity of the agro-ecosystem, and (ii) improve farmers' livelihoods through more productive, profitable and stable land management options. The DMP has been actively identifying, developing, and promoting such options. In broad terms the options fall into four categories:

- Crop-livestock integration generates higher resource use efficiency and functional stability of ecosystems. Synergies among farm operations (e.g., recycling of crop wastes for livestock feed) and a better distribution of labour requirements' over the year also generate major economic benefits. Diversification and strengthening of skills, social networks, and cultural values also promote system sustainability.
- The diversification of crop and livestock products, especially trade-oriented commodities, with a special focus on new fruit trees (figs, pomme du Sahel, date palm), dual-purpose legume crops, poultry and small ruminants.
- Smallholder-appropriate introduction of farm inputs such as small amounts of precisely-placed inorganic fertilizers (fertilizer microdosing), pesticides for cash crops (especially legumes), and mineral feed supplements for livestock. These inputs generate high returns investment because they overcome binding constraints in the agro-ecosystem.
- Integration of woody plant management with both crop and livestock activities, with special focus on the biological, economic, social and tenure aspects of agro-forestry systems, and the husbandry of parkland and field edges.

These options need to be adapted to each region (West Africa versus East and Southern Africa) and farm type because farming systems are diverse in terms of access rights, productive assets, labour and skills. Their adoption and development by farmers entail both social and environmental costs that should be evaluated and discussed among agricultural development partners.

There are economic, social and political prerequisites to the adoption of these options by farmers. The use of external inputs as well as the marketing of cash crops, livestock products, and wood-related products depends on the market situation and national and international regulations. Access rights and tenure systems depend on social institutions and laws which are in turn influenced by the regional and global political environment. Although this complexity appears formidable, it creates a wide spectrum of situations that could provide insight into system dynamics.

TABLE 1: Zimbabwe DMP Site Characterization at a Glance

CHIVI

The Chivi site is characterized by Miombo woodlands. The sites are in the southern part of the district. The contrast in land management and biodiversity between the DMP site and the Great Zimbabwe Shrine (a National Heritage site) to the north, provide insights into program design and management options. Loss of soil fertility and the increased (and probably indiscriminate) use of tree resources for craft in the Chivi site are major areas of concern. Time series photography and imagery is expected to unravel the trends in natural resource availability and loss.

SITE INFORMATION: CHIVI

OPPORTUNITIES	CHALLENGES	POTENTIAL INTERVENTIONS
◆ Mountain ecosystems ◆ Wetlands ◆ Abundant surface water	◆ Deforestation ◆ Biodiversity losses esp. economically important species ◆ Land pressure and land degradation ◆ Legitimacy of local institutions ◆ Loss of grazing lands	◆ Management of mountain ecosystems ◆ Rangeland improvement & management ◆ Wetlands protection & utilization ◆ Soil/water conservation for improved crop yields ◆ Traditional knowledge systems & medicines development.

MATOBO

The Matobo site is a low-lying hot, semi-arid area with Mopane and Acacia woodlands over large areas. The site shares a boundary with Botswana to the south. To the north is the Matopos National Park, a World Heritage site. The use of natural resources such as Mopane worms, river sand, gold panning and trees as part of the local livelihood options provides challenges for biodiversity conservation, alternative livelihood activities and the interplay of policy.

SITE INFORMATION: MATABO

OPPORTUNITIES	CHALLENGES	POTENTIAL INTERVENTIONS
◆ Wildlife, including big game ◆ Abundant grazing lands under three-tier resettlement ◆ Mopane worms ◆ Groundwater resources ◆ Alluvial gold	◆ Deforestation ◆ Gully erosion and siltation of dams ◆ Biodiversity losses esp. economically important species ◆ Land degradation through gold panning	◆ Mopane woodland management & Mopane worm harvesting and marketing ◆ Integrated wildlife and rangeland & management ◆ Gold panning – options, management, policy ◆ Catchment management & rehab. of dams & river systems

TSHOLOTSHO

Tsholotsho, like the other two sites, has Acacia and Mopane woodlands, and also large tracts of deep Kalahari sands which stretch into neighbouring Botswana. The site is near the Hwange National Park, with which it shares common features due to flora, fauna and movement of wildlife. The San communities inhabit one of the four wards selected. This presents yet another opportunity for comparison of management systems and livelihood options. This will be complemented by long-term datasets that will provide a better understanding of trends in biodiversity conservation, use and loss.

SITE INFORMATION: TSHOLOTSHO

OPPORTUNITIES	CHALLENGES	POTENTIAL INTERVENTIONS
◆ Wildlife, including big game ◆ Timber availability (teak, mahogany) ◆ Mopane worms ◆ Groundwater resources ◆ Legitimate local leadership	◆ Deforestation (south-eastern and northern parts) ◆ Gully erosion and siltation of surface water sources ◆ Biodiversity losses esp. economically important species ◆ Poor soils	◆ Water conservation: control of deep percolation losses in arable areas ◆ Soil fertility enhancement & management ◆ Integrated wildlife and rangeland management ◆ Wildlife management options, policy esp. for the San communities ◆ Catchment management & rehab. of dams & river systems

MPALA RESEARCH CENTRE LAIKIPIA, KENYA: ADVANCING WILDLIFE CONSERVATION IN HUMAN-OCCUPIED LANDSCAPES

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Keywords: drylands, ecosystem approach, protected areas, wildlife management

INTRODUCTION

Most protected areas in Africa are too small to support viable populations of wide-ranging species such as elephants and large predators. Recognition that protectionism alone is insufficient to sustain Africa's spectacular wildlife has broadened the scope of conservation to include human occupied landscapes. In principle, conservation of wildlife in unprotected areas should help to maintain ecosystem integrity and permit ecological dynamics to remain as natural as possible.

Yet large mammals are far harder to conserve in unprotected than protected areas. That human communities must benefit from sharing the landscape with wildlife is a necessary, but insufficient condition for success. Informed intervention is increasingly required to manage wildlife towards stated conservation goals, minimize conflict between humans and wildlife, and compensate for the diminishing role played by natural ecological processes.

For a decade, Mpala Research Centre (MRC, www.mpala.org) has addressed challenges to the conservation and management of wildlife in this semi-arid savanna region of central Kenya known as the Greater Ewaso Ecosystem. The importance of this region derives not only from the fact that wildlife is abundant (second in Kenya only to the renowned Masai Mara Reserve), but that little of the region is formally protected. Given its varied land uses, and the diversity among land holders in attitudes to wildlife, the Ewaso region is of value as a model for large mammal conservation in unprotected areas. This vast and diverse area hosts exceptional biodiversity. To survive, elephants must migrate across much of this region, but this will not persist without effective conservation action. Little of the region is formally protected. Sufficient space for wildlife must be conserved on land that is privately and communally owned, such that the "connectivity" of the landscape is maintained for wildlife migration.

UNDERSTANDING WILDLIFE DYNAMICS

To conserve unprotected wildlife effectively we need to know not only how and where their numbers are changing over time, but why — especially if they are declining. Regular aerial censuses show wild and domestic herbivores in this ecosystem to have complementary distributions. Most wildlife is found on large-scale properties actively engaged in conservation and eco-tourism. Elsewhere, livestock is the principal land use on communal and small-scale properties.

RAINFALL LIMITS PLAINS ZEBRA NUMBERS... BUT PREDATION IS LINKED TO HARTEBEEST DECLINE:

Mathematical modeling of census time series has helped us understand the dynamics of wild and domestic species. Further modeling and field observations showed the hartebeest population decline was due

to greatly diminished survival of calves and subadults — but only on properties having predators. Where predators were absent, calves and sub-adults were abundant. These observations implicated predation as a major contributor to declines, not only of hartebeest, but also other prey species, like eland and waterbuck. Numbers of plains zebra, Grant's gazelle, and impala showed no persistent trend. The inference of a major role for predation in prey population declines prompted additional questions. For example, predators do not naturally cause such protracted declines in their prey: what was "unnatural" about the observed declines? A look at changing land use patterns and attitudes to predators suggested likely answers. Until the late 1980s beef production was the principal land use in Laikipia, and predators were severely suppressed. In the 1990s, a declining beef market and growing enthusiasm for conservation prompted many large-scale landholders to venture into ecotourism. By the end of the 1990s, over 30 ecotourism enterprises had been established in Laikipia, creating a demand for predators, at least on the "pro-wildlife" properties.

It is probable that some prey species, like hartebeest, achieved unnaturally high numbers in the decades leading up to the 1990s, when predator densities were kept low. Since 1990, when management and conservation practices changed to favour wildlife, both prey and predators have been returning to more 'natural' densities and distributions. Estimates of plains zebra numbers over the last 20 years can be reconstructed using a simulation model driven solely by annual rainfall and zebra density. Predictions of the model after 1999 are independent of, but continue to agree with, the census estimates. Fluctuations in hartebeest numbers also corresponded with varying rainfall patterns, but only until 1997. Thereafter, the population declined steadily, its trajectory departing radically from expectations based on rainfall patterns. Differences in age structure of hartebeest on properties with predators (Mpala, Segera, and El Karama), and without predators (Solio, Mugie Rhino Sanctuary). A wildlife fencing strategy for Laikipia District, intended to minimize crop raiding by elephants, showing existing fences and planned fences.

ALLEVIATING HUMAN-WILDLIFE CONFLICT

Successful conservation on the pro-wildlife properties has, however, aggravated the human-wildlife conflict for landholders in Laikipia who make a living through cultivation or livestock production. Crop raiding by elephants, and predation on livestock not only have grave economic and social impacts they arouse hostile attitudes to conservation among a voting majority.

In collaboration with LWF and KWS, Mpala Research Centre has defined a strategy to alleviate the human-wildlife conflict in Laikipia. This includes a wildlife fencing strategy designed to keep elephants out of croplands, and a dedicated system for reporting the details and locations of conflict incidents. In collaboration with Save the Elephants, we are also exploring the potential to anticipate where and when elephants will raid crops, using satellite data to monitor crop status.

CONCLUSIONS

Following are a few of many examples of how research guides wildlife conservation and management in this ecosystem:

Livestock versus Wildlife

Mixed systems promote landscape connectivity, but are unlikely to be profitable. A sufficient number, size, and distribution of "wildlife-only zones" will be necessary to ensure not only ecological, but also economic viability.

Zebra Dynamics

The Zebra Model was developed to help define a sustainable harvest (now discontinued), but the model remains useful in warning of change: should census estimates consistently fall below model predictions, this would prompt a search for causal factors in addition to rainfall and density.

Impact of Predators

What first appeared to be alarming declines of some herbivore species turned out to be symptomatic of a remarkable conservation success for Laikipia: the restoration of an intact community of large predators. This finding not only provided profound insights into the effects of predation on a large herbivore community (massive effects on some species, undetectable effects on others), it also suggested appropriate conservation actions.

It is not a foregone conclusion that wildlife has a future outside — or even inside — protected areas in Africa. But the future of wildlife cannot be secured without informed management intervention, which in turn rests on a basic understanding of wildlife and ecosystem dynamics. The role of research is vital, but under-emphasized.

Acknowledgment

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IT IS PEOPLE THAT MATTER: COMMUNITY BASED NATURAL RESOUCE MANAGEMENT (CBNRM) APPROACHES AND SUSTAINABLE LAND MANAGEMENT (SLM)

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DRY AND SUB-HUMID LANDS BIODIVERSITY AND SUSTAINABLE LAND MANAGEMENT: THE PEOPLE LINKAGES

One of the greatest challenges today is to translate the Convention on Biological Diversity (CBD) and other environmental conventions into tangible actions and impacts on the ground. Part B of the Programme of Work (PoW) on Dry and Sub-humid Lands (DSHL) aims to promote targeted implementation actions. In countries such as Namibia, where people's livelihoods are directly dependent on the use of natural resources, biodiversity conservation directly depends on resource users' ability to manage land sustainably. Given the fragility of ecosystems and habitats in arid to hyper-arid countries such as Namibia, land degradation poses a severe threat to dryland biodiversity of global significance. In turn, sustainable land management is key to the preservation of rare endemic dryland species. Consequently, the implementation of the CBD and its various work programmes has to take place at the level of the people using the natural resources.

In the past, biodiversity conservation has been largely associated with locking resources up in protected areas and banning people from making use of their potential wealth. Namibia has identified and implemented community-based management approaches, which allow communities to directly realise benefits from using biodiversity in a sustainable manner, thus creating incentives for biodiversity conservation. There are, however, barriers at the institutional, systemic and human capacity levels hindering the mainstreaming and institutionalisation of successful approaches to achieve sustainable land management at a big-enough scale to conserve critical ecosystems and habitats.

THE COUNTRY PILOT PARTNERSHIP FOR INTEGRATED SUSTAINABLE LAND MANAGEMENT

During 2004/2005, Namibia developed a country framework for sustainable land management, the Country Pilot Partnership (CPP) for Integrated Sustainable Land Management (ISLM), which forms a pilot approach to the implementation of the Operational Programme (OP 15) on Sustainable Land Management of the Global Environment Facility (GEF). The CPP is based on the recognition that the lack of systemic, institutional and individual capacity at all levels leads to sectoral approaches of land management which are cost inefficient and fail to render desired impacts. Planning and implementation are top down, ignoring local knowledge and approaches to integrated sustainable land management

which could ensure not only environmental benefits but also social and economic benefits which create incentives for biodiversity conservation in the long run.

The CPP aims to create an enabling environment that puts communities into the driving seat to gain support from a wide range of partners (including ministerial extension service providers, NGOs, and the private sector), which is suited to their particular context (environmental, social, economic, political). Under the CPP, critical activities at national level include policy revision and harmonisation, the introduction of cross-sectoral planning and decision-making that integrates all relevant ministries. More importantly however, is to identify and institutionalise best practices at the local level, which lead to win-win solutions within the particular regions and allow communities to benefit from the sustainable use of biodiversity.

BEYOND THE FRAMEWORK — COMMUNITY ACTIONS/BRINGING CPP ONTO THE GROUND

Local-level initiatives include three main components: (i) building local institutions which empower communities to draw down support services as required, i.e. giving them a voice to plan and implement resource use in a coordinated fashion; (ii) to develop tools which support adaptive management at the local level, including management and work plans that identify what will be done by whom and when; local level monitoring tools that allow resource users to track the state of their natural resource base; integrated land use planning tools that aid for long-term sustainable land use and management decision making; and financial management tools, which allow communities to manage incomes generated from resource use to the benefit of all community members; and (iii) to build the capacity of resource users to actually manage their resources sustainably: this latter point includes not only resource management *per se,* but just as importantly building skills in business and entrepreneurship to enable communities to capitalise on the economic benefits of biodiversity.

SYNERGY AT THE NATURAL RESOURCE MANAGER LEVEL

An important notion is that especially the individual and institutional capacities established at the local/natural-resource manager level provide an excellent platform for the implementation of actions in support of a variety of Multi-lateral Environmental Agreements (MEAs), and especially the Rio Conventions. A broadband impact can thus be achieved where these capacities are being strengthened. Support interventions have to focus on these levels to have long-lasting impacts.

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TANZANIA HASHI PROJECT: REGENERATING WOODLANDS

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Keywords: land restoration, sustainable livelihood, local knowledge, inequity

"At a time when conservation is increasingly being asked to justify itself in the context of the Millennium Development Goals, the HASHI experience offers detailed insights into the reasons for considering biodiversity conservation as a key component of livelihood security and poverty reduction." (Barrow, 2005b.; Barrow and Mlenge 2004:1 in World Resources 2005, WRI)

A SHORT HISTORY OF THE HASHI PROJECT

Shinyanga is one of Tanzania's poorest regions. Its low hills and plains are characterized by long dry summers with only 700 mm of rainfall a year on average. As its woods were cleared from the 1920s onward, land and soil became over-used and degraded, causing a sharp decline in the natural goods on which the Sukuma people had depended for centuries. Women spent more time collecting formerly plentiful fuel wood; grasses to feed livestock became scarcer, as did traditionally harvested wild fruit and medicinal plants. By the 1970s Shinyanga was under severe ecological strain, its people feeling the consequences in the form of falling incomes and lost livelihoods.

THE REVIVAL OF *NGITILI*

The innovative efforts to improve rural livelihoods introduced by the Shinyanga Soil Conservation Programme, simply addressed as HASHI (from the Swahili: "Hifadhi Ardhi SHInyanga") are based on reviving *ngitili. Ngitilis* are natural resource enclosures based on the indigenous management system. There are two types of *ngitili*: enclosures owned by individuals or families, and communal enclosures owned and managed in common. Both were originally developed by the Sukuma in response to acute animal feed shortages caused by droughts, the loss of grazing land to crops, and declining land productivity. The HASHI project's approach to *ngitili* revival was to work with local people, first to identify areas requiring urgent land restoration, and then to restore these areas according to customary practice. In many villages, HASHI field officers used residual natural seed and root stock to restore *ngitili* enclosures. In others, active tree planting (first of exotic species, later of indigenous tree species preferred by local people) was carried out, especially around homesteads. In addition to restoring *ngitili*, villagers were encouraged to plant trees around homesteads (particularly fruit and shade trees), field boundaries, and farm perimeters. This helped improve soil fertility and provide firewood, and had the side benefit of helping farmers to stake out and formalize their land rights within villages. Farmers and villagers received training in how to get the most out of their *ngitili.* By the early 1990s, with the project's effectiveness beyond doubt, restoration efforts spread rapidly through the region. In 1986, about 600 hectares of documented *ngitili* enclosures existed in Shinyanga. A survey of 172 sample villages in the late 1990s revealed 18,607 *ngitili* (284 communal, the rest owned by households) covering roughly 78,122 hectares.

PAYING DIVIDENDS TO PEOPLE

A major study by a ten-person task force combined detailed field research to quantify the HASHI project's benefits. The task force estimated the cash value of benefits from *ngitili* in Shinyanga at US$14 per person per month—significantly higher than the average monthly spending per person in rural Tanzania (US$8.50). They also concluded that *ngitili* restoration "demonstrates the importance of tree-based natural resources to the economies of local people" and offers "a significant income source to supplement agriculture to diversify livelihoods in Shinyanga region." The study also documented the ripple effect of these economic benefits in people's lives. Maintaining *ngitili* has enabled some villagers—mainly through sales of timber and other wood products—to pay school fees, purchase new farm equipment, and hire agricultural labor. Income generated by communal *ngitili* has been used to build classrooms, village offices, and healthcare centres.

UNEQUAL DISTRIBUTION OF BENEFITS

Not everyone is benefiting equally from *ngitili* restoration, however. Land use patterns in the region are strongly influenced by Sukuma traditions, with women controlling low-income crops while men control higher-earning livestock and cash crops. The task force found this culture persisting with *ngitili* restoration, with married women rarely owning individual *ngitili* or having a meaningful say in their management. On the other hand, all women have access to communal *ngitili*, a right and resource which has helped them acquire essential household needs such as fuel-wood, thatch, and food, and to save time on chores. Better-off households are also capturing a bigger slice of benefits from reforestation measures than poorer families. The task force reported that differences in land and cattle ownership were the most obvious indicators of the scale of benefits reaped, and noted that well-off people were buying additional land from poorer households, thus exacerbating local inequity. At the other end of the scale, the poorest households cannot afford individual *ngitili*, although they are entitled to harvest products from communal enclosures, sometimes for a fee. Acknowledging the benefits gap between richer and poorer households, the task force warned that additional strategies would be required to prevent social conflicts from erupting and to ensure the long-term sustainability of *ngitili*.

A FRAGILE FUTURE?

The HASHI project is clearly a success story, drawing attention far beyond Shinyanga's borders. Yet several demographic and land-use trends threaten the continued expansion of *ngitili* as a cornerstone of natural resource management in Tanzania. These include:

- Scarcity of land and insecurity of tenure;
- Rapidly growing human and livestock populations increase demands on the still recovering landscape;
- Damage to livestock and crops caused by growing populations of wildlife fauna; and
- Growing, unregulated sales of individually owned ngitili.

IMPROVE *NGITILI* BENEFITS STREAM

- Support better *ngitili* management
- Monitor *ngitili* activities and facilitate lesson-sharing
- Expand markets for *ngitili* products

HASHI'S ROLE IN FULFILLING THE MDGs

The success of HASHI's project in fulfilling the Millennium Development Goals stands as follows:

- Reverse loss of environmental resources (MDG-7): the rejuvenation of dryland areas of Shanyanga through tree planting, degraded hills and river edges protection and the creation of enclosures (*ngitilis*) has drastically reduced the risks of soil erosion and watershed depletion. As a result of biodiversity conservation, poverty issues were addressed and MDG-1 was achieved.
- Eradication of extreme poverty (MDG-1): the cash value of benefits in Shinyanga was estimated at US$168 per person (yearly) — significantly higher than the average US$102 per person in rural Tanzania.
- Universal primary education (MDG-2) and empowerment of women (MDG-3), were approached closely as a result of *ngitilis* establishment and poverty reduction through biodiversity protection.

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TABLE 1: Improving Livelihoods through *Ngitili*: Key Findings

Economic value of restored *ngitili*	US $14.00 per person, per month
National average rural consumption	US $8.50 per person, per month
Average annual value of 16 major natural resource products harvested from *ngitili* (Bukombe district)	Per household US $1,190 per year Per village US $700,000 per year Per district US $89.6 million per year
Costs of wildlife damage as a result of forest restoration	US $63 per family, per year
Species of trees, shrubs, and climbers found in restored *ngitili*	152
Other flora found	Up to 30 different families of grass and herbs
Bird and mammal species recorded	145 bird species and 13 mammals
Reduction in time spent in collecting natural resources	Colection time reduced by: Fuelwood 2-6 hours per day Poles 1-5 hours per harvest Thatch 1-6 hours per harvest Water 1-2 hours per day Fodder 3-6 hours per harvest
Pearcentage of households in seven districts across Shinyanga using *ngitili* products	To diversity diet 22% To provide animal fodder and forage 21% To collect medicinal products 14% To collect fuelwood 61% To pay for children's education 36%
Source: Monela et al. 2004:3-4, 53, 61, 67-69	

TABLE 2: Money Grows On Trees: Value of *Ngitili* Products Used By Households In Bukombe District, Shinyanga, 2004

***NGITILI* PRODUCT**	**PERCENT OF HOUSEHOLDS USING PRODUCTS IN SURVEYED VILLAGE**	**AVERAGE HOUSEHOLD VALUE, PER YEAR (DOMESTIC USE AND SALES IN US DOLLARS**
Timber	59	71.74
Fuel woods	64	13.09
Poles	29	2.87
Withies	36	8.97
Water	21	34.04
Honey	14	2.39
Bush meat	7	0.72
Edible insects	36	0.48
Mushrooms	36	2.87
Medicinal plants	7	10.76
Thatching materials	36	2.15
Fodder	7	1.15
Vegetables	29	2.15
Fruits	43	2.87
Carpentry	14	1,021.60
Pottery	7	12.91
Total economic value. Per household, per year		$1,190.77
Source: Monela et al. 2004: 61, Table 3.17		

MANAGING FOR BIODIVERSITY IN AUSTRALIA'S RANGELANDS

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AUSTRALIA'S RANGELANDS

Australia's rangelands have long been viewed as nationally significant in terms of their biodiversity, environmental and social values. They cover some 80% of the continent (over 6.2 million square km), and include some of the most remote places and least disturbed landscapes. This includes a diverse group of relatively undisturbed ecosystems such as tropical savannas, woodlands, shrublands and grasslands. Rangelands feature low rainfall and variable climate arid and semi-arid areas (averaging 800 mm of rainfall per annum) while northern tropics feature seasonally high rainfall areas (up 4,800 mm per annum). Fifty-three of Australia's 85 bioregions incorporate rangelands systems, covering a great diversity of species, habitats and communities.

Recent studies suggest that rangeland ecosystems are declining and as a result are more vulnerable to management practices, particularly to grazing and fire, and alien invasive species. In response, the Australian Government, communities and industry are committing increased investment in targeted rangelands activities.

The Australian Government is implementing a range of programmes and projects and initiatives in the rangelands to improve and promote sustainable land management and biodiversity conservation. We report here on projects with a strong focus on biodiversity conservation. These initiatives have focussed on evolving science and innovation to develop tools to support and inform government, individual and community decision making.

BIODIVERSITY CONSERVATION

The fact that many rangelands ecosystems are still relatively intact increases the range of conservation options available. This means that action is likely to be highly cost-effective and will alleviate the need for costly investment in remedial action in the future. Available options include:

- developing alternative grazing ventures and land use options in areas vulnerable to current grazing regimes;
- diversifying farm income at the enterprise level, including addressing constraints in the current leasehold system;
- improving the information base and access to relevant information to better match land use with land capability;
- setting up institutional frameworks that ensure natural resource information is incorporated into management decisions; and
- exploring market-based mechanisms for promoting conservation activities on privately managed lands.

The Australian Government is preparing a series of short guides examining major threats to biodiversity in the rangelands. Alternate or improved management approaches hold the key to dealing with and reducing biodiversity loss in the rangelands. The guides will be presented as a series of publications covering:

- Total grazing pressure
- Fire
- Invasive species - weeds
- Invasive species - feral animals
- Water, climate and biodiversity
- Monitoring biodiversity in the rangelands (regional and property-level examples)
- Environmental and financial implications of property-level land management decisions
- Industry environmental best practice

Many of the guides (e.g., total grazing pressure, invasive species, fire) look at existing research projects and provide advice on future funding opportunities. In this way they assist land managers and those seeking to assist them.

Additionally, The Australian Government has or is funding:

- Methods for remotely choosing biodiversity monitoring sites
- Multi-criteria analysis of rangeland regions' capacity to undertake environmental management
- Development of market-based approaches to environmental projects
- An examination of conservation of traditional ecological knowledge
- Determining places of high conservation value in areas of high climatic variability
- An intergovernmental agreement for Lake Eyre (The Lake Eyre Basin covers about 1.2 million km2, almost one-sixth of Australia, and is the world's largest internally draining system)
- The Great Artesian Basin Coordinating Committee (1.7 million km2, with an estimated water storage of 8,700 million ML), working on the largest artesian basin on earth.

TRACKING CHANGE

Observing and understanding change in the environment across a massive landscape with low human population is challenging. All Australian rangeland governments are working in partnership to develop the Australian Collaborative Rangelands Information System (ACRIS). The ACRIS brings together rangeland information from government agencies and private sources.

Governments have agreed to report on change in Australia's rangelands by 2007. The ACRIS partnership will provide the foundation for reporting on the condition of natural resources across the rangelands. Reporting will look at change in vegetation extent, climatic conditions, fire, pressure by grazing animals and monitoring dust storms. The ACRIS will provide information on agriculture, environment and socio-economic change to assist decision-makers.

THE MAKULEKE REGION: A SUCCESS STORY IN SOUTH AFRICA

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Keywords: South Africa, co-management, good governance, poverty alleviation, Millenium Development Goals

PROJECT DESCRIPTION

To tap new sources of income for poor sections of the population in South Africa while at the same time conserving natural resources — this is the objective of the "Transform" (Training and Support for Resource Management) programme launched by GTZ and the South African Department of Environmental Affairs and Tourism (DEAT). The programme has piloted approaches for the sustainable development and use of protected areas — reserves and national parks — in a way that generates income for the local population.

Transform targets the community level. Natural resources underpin the livelihoods of rural people. The programme aims to help these people make commercial use of these resources in such a way that they are maintained for future generations.

The combination of broad-based public-awareness raising with technical assistance for the Makuleke community has been a key element in Transform's success. The Makuleke region of Kruger National Park is made up of grasslands and savannahs, and can thus be described as dryland.

In 1969, more than 3000 South Africans were forcibly evicted from their home in the present-day northern tip of Kruger National Park. Only after adoption of the Land Restitution Act in 1996 did the South African government return this 24,000 hectare area to the Makuleke, to which the tribe added a further 5000 hectares of their community land. In return, the Makuleke undertook to utilise their land fully in line with sustainability principles, specifically for species conservation.

The people living in the Makuleke region have a long history of cooperation with external experts and consultants. The GTZ-supported Transform programme has provided ongoing financial and technical assistance. Jobs have been created for local people, for instance in the six-star Outpost Lodge, located in a part of the park with outstanding scenic beauty. The Makuleke thus generate revenue from tourism, and have at the same time a vital interest in conserving biodiversity, for instance by taking targeted steps to control poaching.

WHAT DID WE ACHIEVE?

- The Makuleke have entered into cooperative business ventures with the private sector; by mid-2005 these had already triggered investments totalling R 60 million (USD 8.7 million). For example luxury lodges and eco camps have been built in partnership with the private sector and an old airstrip has been rehabilitated (investment is about 80 million Rands (USD 6.1 million).

Skills training, and subsequently jobs, are given to local people and contracts to small local business. The lodges are generating substantial rental revenue for the Communal Property Association (CPA) based on a percentage off turnover.

- The area is administered by a specially established CPA, whose executive committee is elected democratically every two years. The CPA takes traditional forms of local self-government into account.
- A development forum represents the needs of local people and thus safeguards transparent and sustainable community development.
- The CPA uses its financial resources to encourage the establishment of artisanal and textile businesses as well as cultural facilities in villages outside the national park.
- The Makuleke can make commercial use of this area — including arrangements in cooperation with the private sector. When doing so, they guarantee to conserve animal and plant species, and undertake to abstain from all consumptive forms of management, such as mining.
- A joint management committee made up of the Makuleke CPA and South African National Parks is responsible for maintaining roads and fences and for managing resources; 15 park wardens have been trained to prevent poaching and collect data.
- The CPA now uses a replica of the old homestead of the former Makuleke chief as a guesthouse; together with the local museum, this generates additional income.
- A committee comprising villagers and representatives of environmental protection organizations jointly determines the details of how the land is to be protected.
- Through targeted training and upgrading activities, the Makuleke are qualifying themselves for key posts in management, resource conservation, tourism and customer service.
- The Makuleke CPA has facilitated improved agricultural production in the villages. Money earned from hunting and tourism was spent to electrify the villages as well as to improve health and education conditions.

BIODIVERSITY KNOWLEDGE MANAGEMENT: TEN YEARS OF INTERVENTION UNDER NAMIBIA'S NATIONAL BIODIVERSITY PROGRAMME

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Key words: dry and sub-humid lands biodiversity, National Biodiversity Strategy and Action Plan (NBSAP), implementation of Rio Conventions, biodiversity knowledge assessment

BIODIVERSITY MANAGEMENT IN NAMIBIA: A REVIEW

Namibia has a long-standing track record of good environmental management and conservation impacts. After the United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro, Namibia ratified the three Rio Conventions, and implemented national programmes addressing issues such as biodiversity, desertification and climate change. Whilst adhering to the international obligations of the Convention on Biological Diversity (CBD), UN Convention to Combat Desertification (UNCCD) and UN Framework Convention on Climate Change (UNFCCC), Namibia developed her own approaches to deal with urgent environmental threats to drylands, integrating and upgrading ongoing conservation and environmental management initiatives and focusing new investments on key priorities. A great number of actions formulated under the CBD's programme of work on dry and sub-humid lands are being translated into tangible in-county and on-the-ground biodiversity conservation and sustainable use interventions.

Since the early 1990s, Namibia has received international support to formulate responses to the CBD, i.e. through the UN Environment Programme (UNEP) and the CBD Secretariat. Namibia was also able to leverage bi-lateral donor support, i.e., through a targeted support programme of the German Agency for Technical Cooperation (GTZ). Since 1996 funds and technical advice have been forthcoming for the institutionalisation of a National Biodiversity Programme (NBP) housed in the Directorate of Environmental Affairs (DEA) in the Ministry of Environment and Tourism (MET).

BIODIVERSITY KNOWLEDGE MANAGEMENT

MET, together with GTZ and UNEP, is currently undertaking a "biodiversity knowledge assessment" documenting the key lessons learned from the 10-year implementation of the National Biodiversity Programme. These lessons will be an integral part of a forthcoming biodiversity book, which will communicate the key achievements of targeted biodiversity action in Namibia and their impacts to decision-makers at home and internationally. Direct linkages to the review of the dry and sub-humid lands programme of work of CBD and Target 2010 are planned, especially in the context of achievements made in the implementation of Namibia's ten-year National Biodiversity Strategy and Action Plan (NBSAP) (2001–2010).

Preliminary suggested knowledge management modules to be addressed include:

- Institutional cooperation/cross-sectoral cooperation
- Innovative management arrangements
- National-level institution building
- International/regional cooperation
- Leverage in getting international support
- Information management/information exchange/access to biodiversity information
- Capacity building of key stakeholders (i.e., involvement of young professionals, Biodiversity Masters Programme, schools, etc.)
- Capacity building of professionals
- Monitoring and evaluation to track biodiversity status
- Policy and strategy development support on biodiversity
- Political commitment
- Mainstreaming of biodiversity issues into other sectors
- Country-driven priority setting and ownership
- Use of local-level expertise
- Awareness-raising/creation
- Protection and rehabilitation of priority biodiversity areas
- Setting up a national action programme to implement the provisions of the CBD
- Funding — implementation mechanisms
- Biodiversity research and management

VALUE ADDED

1. Formal documentation and illustration of ten-years interventions in support of biodiversity conservation and sustainable use in Namibia, a dryland country.
2. Awareness-raising, leverage and further national level support of decision-makers to continue engaging in environmental management investments
3. Sharing lessons learned and synthesis of guiding principles for other national programmes (especially now that a new generation of GEF-supported programmes are in their early implementation phase), as well as other countries to adapt their own interventions.
4. Renew commitment of bilateral and non-governmental donors to continue technical and financial support to biodiversity issues in Namibia and elsewhere through demonstration of tangible impacts.
5. Tie outputs and impacts to CBD processes such as the review of the dry and sub-humid lands programme of work and to the 2010 Biodiversity Target.

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Convention on Biological Diversity www.biodiv.org

Success Stories in Implementation of the Programme of Work for the Global Taxonomy Initiative

TAXONOMISTS: AN ENDANGERED SPECIES?

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Keywords: taxonomy, taxonomists, identification of organism, succession of knowledge

INTRODUCTION

The Convention on Biological Diversity (CBD) is to a very large extent concerned with natural organisms. In order to successfully pursue and achieve the objectives of the CBD and the 2010 biodiversity target, organisms must be accurately and reliably identified. Taxonomists provide the expertise required. The Programme of Work for the Global Taxonomy Initiative (GTI), included in COP Decision VI/8, adopted in The Hague in 2002, states that: "Broadly understood, *taxonomy* is the classification of life, though it is most often focused on describing species, their genetic variability, and their relationships to one another. For the purposes of the Convention *taxonomy* is taken in its broadest sense and is inclusive of systematics and biosystematics at the genetic, species and ecosystem levels".

We attempted to survey available information about the number of active or working taxonomists by country and region (fig. 1). It was possible to collect data from several different sources, notably the database of the Expert Centre for Taxonomic Identification (ETI), BioNET-INTERNATIONAL, and the Zoological Record, as well as including published directories and membership lists of taxonomy-related societies, projects and initiatives (e.g., FaunaEuropaea), and data from GTI national focal points (SBSTTA/9/INF/17, and see the regularly updated list of data sources on http://www.gti-kontaktstelle.de/taxonomy_E.html).

The data sources consulted show widely different scope, degrees of comprehensiveness, and reliability. Not all taxonomic experts will be members of any society or organisation, and only a limited number will voluntarily register in an open-access database such as the ETI expert database. On the other hand, many registered experts are not professional taxonomists in the sense that they are not paid for taxonomic research but pursue a different job, often not at an academic institution. The situation is further complicated by the fact that several valid definitions of a "taxonomist" can be applied. Is a taxonomist a person publishing taxonomic papers such as checklists and revisions or is it someone who is sufficiently knowledgeable to identify some organisms? Must a taxonomist to be employed by an academic institution? For the purpose of this presentation and the goals of the CBD, a rather wide definition seems favourable: anyone with a good and extensive knowledge of a group of organisms.

Considering these problems and caveats, and with a broader definition of a taxonomist in mind, we suggest that there are no more than 30,000 to 40,000 individuals with taxonomic qualification worldwide, and probably no more than 4,000 to 6,000 professional taxonomists. The detailed data from this survey are available and will continuously be updated on the GTI website: http://www.gti-kontaktstelle.de/taxonomy_E.html

TAXONOMISTS DECLINING IN NUMBERS

We also searched for information on how the number of taxonomists has changed over the last decade or longer. Although a significant decline in the number of taxonomists is frequently reported, few figures documenting trends or giving detailed figures appear to be available. A report (Hebert, Smith, Hamer and Scholtz, 2001) from South Africa shows that the number of research staff dropped from 62 in 1991 to 40 in 2001 (72 to 52 for support staff). For the United Kingdom, a report from The House of Lords titled *What on Earth* states that CAB International had 34 taxonomists employed in 1992, but only 8 in 2002. In Australia the number of taxonomic experts at universities declined to 64 in 1996, down from 193 in 1974. For Asia, a recent survey of taxonomists currently employed at institutions revealed that more than 60% are over 40 years old (Shimura 2003).

In no instance did we find evidence of a recent increase in the numbers of taxonomists; so, despite all efforts of the GTI, we are still loosing valuable expertise required for the sustainable use and conservation of biodiversity. A possible reason could be the remote connection of the CBD to national science panels and funding bodies commonly supporting taxonomic institutions, and increasingly project-oriented funding strategies lacking a longer-term perspective. In contrast to many other fields of science, expert knowledge any group of organisms cannot be developed quickly from textbooks and courses but depends on long term practical experiences, on examining and memorising often subtle and minute differences in organisms over longer periods of time. International initiatives and programs such as the Global Biodiversity Information Facility (GBIF), Species2000, FaunaEuropaea, or FishBase, and many initiatives of individual researchers and groups (e.g., Earwig Research Centre, Orthoptera Species File) are currently taking the data exchange and information aspects of taxonomy to a new level, accelerating the practical work enormously. However, they cannot replace true expertise accumulated by learning and memorising shapes and properties of organisms. A continuously declining number of taxonomic experts not only puts the sustainability of biological knowledge at risk, it also further impedes any efforts to implement the CBD and to conserve biodiversity. It is high time to act on building taxonomic capacity!

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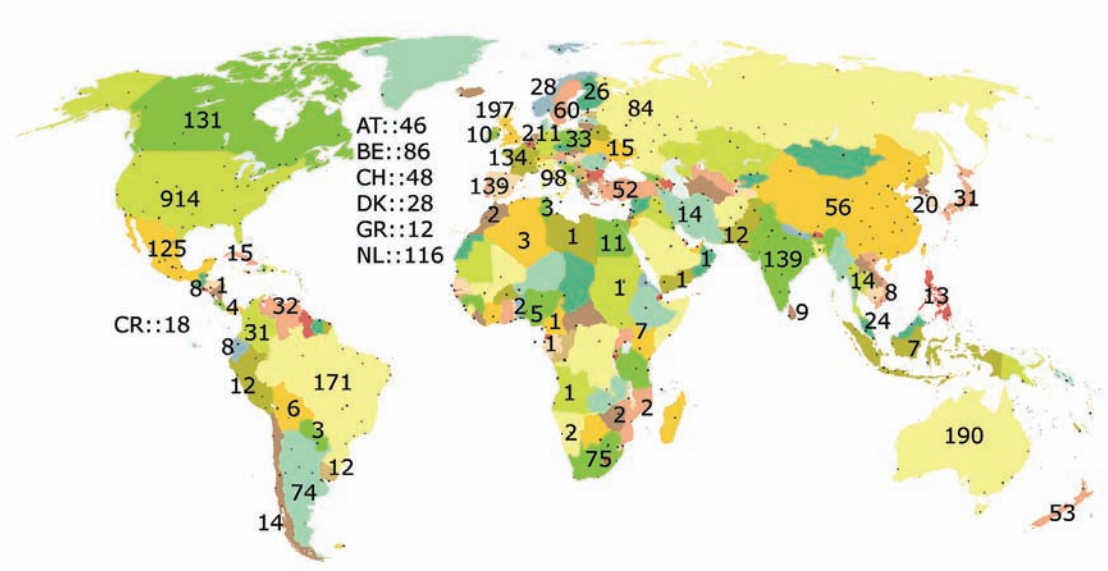
FIGURE 1: Number of taxonomists currently working in each country according to the database of the Expert Centre for Taxonomic Identification, ETI (http://www.eti.uva.nl/). There are several other directories for taxonomists (see German GTI-NFP website, above) with significantly different numbers. We still believe that the basic distribution pattern shown here presents an accurate view of the actual situation.



GLOBAL STRATEGY FOR PLANT CONSERVATION TARGET 1: TOWARDS A WORLD LIST OF KNOWN PLANT SPECIES

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Keywords: plant species, world checklist, Catalogue of Life, Global Taxonomy Initiative, Global Strategy for Plant Conservation

INTRODUCTION

Creating a Working List of Known Plant Species is target one of the CBD Global Strategy for Plant Conservation, to be completed by 2008, or 2010 at the latest. The Species 2000 Secretariat at the University of Reading and the Royal Botanic Gardens Kew are working together within a wide community of plant taxonomists to stimulate planning, implementation and delivery of such a list.

GAP ANALYSIS WORKSHOP

A gap analysis of the taxonomic coverage needed for an electronic Working List of Known Plant Species was carried out at a workshop organised by Species 2000 and the Royal Botanic Gardens, Kew in June 2004, and sponsored by Global Biodiversity Information Facility (GBIF) and the UK Biotechnology and Biological Sciences Research Council (BBSRC).

Experts from around the world, and covering a wide range of taxa, made the analysis based on existing checklist databases plus existing monographic and checklist activity. An attempt was made to identify contacts with groups of specialists who might assist with filling these gaps, since wide international participation will be needed if the target is to be met. The preliminary results of the analysis were tabulated and displayed on the organisations' websites, prior to their inclusion in the metadatabase being developed by Species 2000, Integrated Taxonomic Information System (ITIS) and GBIF.

The principal conclusions drawn from examining the preliminary results are:

- Coverage of Angiosperm families: global checklists are done for approximately 15% of species, in progress for approximately 22%, and in draft stages for a further 30%.
- Angiosperm families that are not yet started constitute approximately 33% of species.
- Jointly planned activities of the Royal Botanic Gardens Kew, Missouri Botanical Garden and New York Botanical Garden are likely to account for some 55% of the total, leaving a 'missing area' of about 45% that needs taxonomic expertise, leadership and co-ordination.

Priorities stemming from the workshop

1. The larger missing sectors (thought to be the families Compositae (Asteraceae), Melastomataceae, and Malvaceae) must be started urgently if there is to be any chance of even nearing completion by the 2010 target date of the Global Strategy for Plant Conservation, or by 2011, the

target date for completing the *Species 2000 & ITIS Catalogue of Life* (Bisby et al. 2005a,b,c) illustrated graphically in Figure 1 and Figure 2.

2. For the very many smaller and middle-sized families to be started or brought to completion, it is both an issue of focusing appropriate expertise on the task, and providing leadership, co-ordination and funding to the programme of work. A vigorous co-ordinating process, possibly led by Species 2000, International Organization for Plant Information (IOPI) or ITIS is required for the 45% of sectors needed from outside the joint programme of RBG Kew, Missouri Botanical Garden, and New York Botanical Garden.
3. The preliminary coverage table created at the workshop should be publicised and developed, working with the Species 2000 metadatabase and GBIF to keep track of who is doing what.

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FIGURE 1: Progress to date with *The World List of Plant Species*
(made available through the *Species 2000 & ITIS Catalogue of Life*)

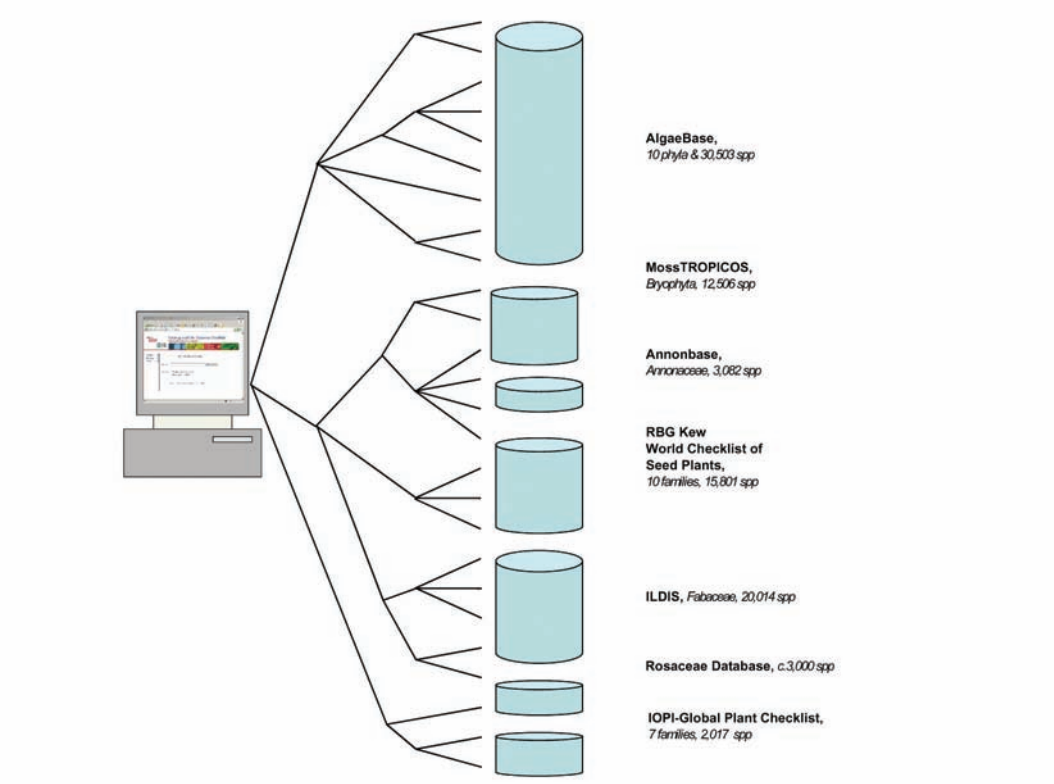
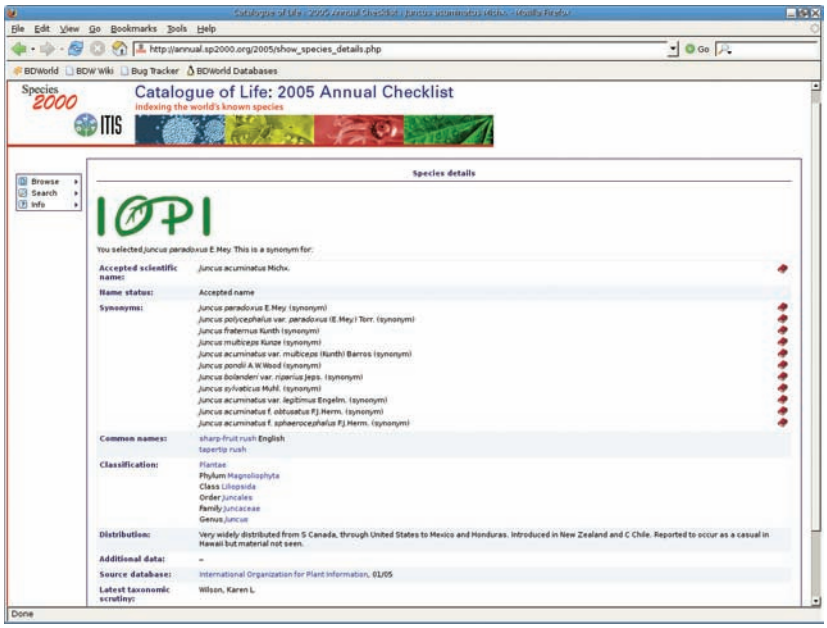


FIGURE 2: Sample page, Bisby et al. (2005).



HERBARIA AND THE END-USERS OF BOTANICAL INFORMATION IN SOUTHERN AFRICA

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Keywords: end-user needs, SABONET, herbaria, botanical information

INTRODUCTION

Southern Africa contains approximately 30,000 different plant species on less than 2% of the global land surface. This incredible plant diversity and its implications for biodiversity issues and conservation planning indicate the fundamental importance of herbaria within the region. Herbaria should be equipped to deal with this diversity of plants but unfortunately very few of them are. Lack of funds has resulted in a reduction in expertise and the required infrastructure needed to maintain these institutions effectively. The Southern African Botanical Diversity Network (SABONET) provided the necessary funding and support to help alleviate some of these problems. Unfortunately, as funding in scientific institutions becomes harder to obtain, herbaria face numerous challenges. To survive they need to demonstrate their relevance and deliver useful, high quality products and services for a wide range of end-users at affordable prices (Steenkamp and Smith 2002).

WORKSHOPS

On recommendation of its Midterm Evaluation, the SABONET Project held a series of end-user and other stakeholder workshops in the ten countries that participated in the SABONET Project (Angola, Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Zambia and Zimbabwe). The aims of these workshops were to determine what products and services the end-users of botanical information in southern Africa required from herbaria and what herbaria needed to fulfil their obligations.

Participants in the workshops came from various disciplines, including: herbarium staff, biodiversity specialists, government officials, conservation agencies, non-governmental organisations (NGOs), universities, ecologists, environmental consultants, traditional plant users, botanical organisations and amateur botanists. A total of 252 participants attended one or more of the SABONET end-user workshops.

Some of the envisioned outputs of these workshops were:

- Who exactly are the end-users of botanical information and the products and services provided by herbaria?
- What types of information do they require?
- In what format would they prefer to receive the information?
- What were the top priorities for the end-users?

WHO ARE THE END-USERS OF BOTANICAL INFORMATION?

The following groups were found to be the major users of botanical information and other herbarium services:

- Taxonomists
- Ecologists
- Ethnobotanists
- Other researchers
- Botanic gardens and museums
- Government
- Tertiary educators (universities)
- Secondary educators (schools)
- Applied educators (training centres)
- Environmental consultants
- Agricultural institutions
- Farmers
- International NGOs
- National NGOs
- Traditional plant users
- The eco-tourism industry
- Amateur botanical societies/organisations
- Environmental lawyers
- The media

WHAT INFORMATION DO THE END-USERS REQUIRE?

End-users of botanical information require the following types of products and services from herbaria:

- Species lists
- Plant Identifications
- Up-to-date, correct plant names
- Library facilities with relevant, up-to-date literature
- Smaller herbaria require that large national herbaria provide training of taxonomists, support staff, and data capturers
- Lists of plants that are endemic, medicinal, threatened, alien, poisonous etc. plants
- Information on conservation status
- Red Data List production
- Plant distribution data/maps
- Plant ecological information
- Field guides, brochures and other general information
- Interpretative signage in and at botanical gardens
- A help desk / information service on plants
- An outreach education programme targeting especially learners
- An integrated botanical information system/database (preferably accessible through the Web)

To provide these products and services, herbaria require the following:

- Active and targeted expansion of herbarium collections
- Efficient curation
- An effective computerised herbarium management system

- Funding for plant biodiversity research
- Funding for plant taxonomic research

IN WHAT FORMAT IS THE INFORMATION REQUIRED?

Generally, the format in which the information was required depended on facilities, particularly access to computer and Internet facilities, available within each country. In South Africa the end-users indicated that the majority of the information should be accessible through the Internet and on CD ROM. In other countries, hard copy format was preferred.

PRIORITIES

The priorities indicated by end-users differed from country to country, however, the top-five priorities included: plant identification services, species lists/inventories, outreach education programmes, library facilities, training for herbarium staff from smaller herbaria, and the provision of information on the Internet through an integrated botanical information system.

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TAXONOMIE MARINE AU MAROC: ÉTAT DES LIEUX ET PROBLÉMATIQUES

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Keywords: taxonomie, milieu marin, et Maroc

INTÉRÊT DES CÔTES MAROCAINES EN TERME DE TAXONOMIE

Le Maroc est considéré comme un pays maritime par excellence disposant de près de 3500 kilomètres de côtes et jouissant de conditions océanographiques remarquables qui consistent en un mélange de courants froid (C. Canaries) et chaud (C. Ouest Africain), un mélange de deux grandes masses d'eau, atlantique et méditerranéenne; l'ensemble est brassé par des courants ascendants (Upwellings) comme il n'en existe que rarement dans le monde (cinq régions principales dont celle marocaine). Ces derniers enrichissant les eaux en sels nutritifs en font, en terme de biomasse, certaines des plus riches au monde. Ces particularités hydrologiques y ont généré une richesse spécifique remarquable ayant suscité l'intérêt de nombreux naturalistes et taxonomistes ayant exploré les eaux marocaines à bord de navires océanographiques dont «Porcupine» (1870), «Challenger» (1873), «Valdivia» (1893), «Goldf Inch» (1905), «Michael Sars» (1910), «Dana» (1920, 1922, 1928), «Xauen» (1946), «Discovery» (1957), etc. qui ne sont que certaines des dizaines de ces expéditions qui s'y continuent jusqu'à nos jours et qui y ont permis la découverte d'un grand nombre de taxa dont certaines portent encore et toujours le nom latinisé du Maroc ou de certaines de ses régions (*Natica marrocana, Nereis marrocensis, Diopatra marrocensis, Fusus marrocanus, Styela marocanense, Eudistoma rabati,* etc.).

PRINCIPAUX GROUPES TAXONOMIQUES DES EAUX MARINES MAROCAINES

La figure 1, traduisant l'organisation par groupes taxonomiques de la biodiversité marocaine, montre que les groupes taxonomiques les plus représentés et, par la même occasion, les mieux étudiés sont les Arthropodes (principalement les crustacés), les vertébrés (surtout les poissons) et les mollusques. L'Etude Nationale sur la Biodiversité (Menioui, 1998, Riadi, 1998) a permis de mettre en évidence également que la richesse spécifique marine des eaux marocaines, dépasserait de loin toute celle recensée en Méditerranée et en mer noire.

TAXONOMIE ET TAXONOMISTES MARINS AU MAROC

L'analyse de la figure 1 laisse également supposer la présence au Maroc d'un arsenal taxonomique (matériel, systématiciens, etc.) conséquent ayant permis d'établir ces inventaires et cette structure. Mais, la situation est toute autre puisque, à l'exception de quelques mises au points taxonomiques réalisées par de rares scientifiques nationaux (souvent en collaboration avec des spécialistes étrangers), la majorité des inventaires établis provient de travaux de coopérants européens ou encore de matériel biologique de campagnes océanographiques internationales étudié par des scientifiques étrangers dont Lutz pour les Foraminifères (1980), Herubel (1924–1925) pour les Sipunculides, Fauvel, Rullier, Bellan, Amoureux, etc. (entre 1928 et 1976) pour les annélides, Monterosato, Chaster Pallary, Bellon-Humbert, Gofas, etc. (1889–1975) pour les mollusques, Loman, Stock, Krapp (1925–1983) pour les pygnogonides, Monod, Forest, Gantes, Daguerre de Hureaux, Menioui et Ruffo, Menioui et Menioui et Myers (1923–2004) pour les crustacés, etc.

C'est ainsi que, quand on se pose la question sur la situation de l'enseignement, la formation ou la recherche scientifique taxonomiques marines au Maroc, on se heurte à l'énorme «abysse» qui sépare, d'une part, les formidables potentialités des côtes marocaines en ressources spécifiques et, d'autre part, le nombre extrêmement réduit de scientifiques taxonomistes nationaux susceptibles de subvenir aux besoins du pays en matière d'identification (pour une meilleure compréhension et une meilleure valorisation) de la biodiversité nationale, surtout que la très grande majorité de ses eaux demeure encore inexplorée. Force est de constater également que la très grande majorité des composantes de l'inventaire établi dans l'ENB proviennent de listes anciennes qui nécessitent des mises aux points, des actualisations, des vérifications, etc.

L'analyse des figures 2 et 3 montre que, à priori, les groupes taxonomiques les plus étudiés et qui, par conséquent, suscitent le plus d'intérêt auprès des instances chargées de la recherche et de formation (intérêt traduit par le nombre de «systématiciens», Fig. 3) sont ceux ayant un intérêt socio-économique (Fig. 2). C'est une conclusion qui aurait été très intéressante s'elle correspondait à la réalité «sur le terrain», car ça prouverait qu'il y a un certain intérêt pour la systématique de certains groupes même si cet intérêt est accommodé par le «côté commercial» de la chose. Or, si on considère par exemple le groupe le mieux étudié (arthropodes), dominés par les crustacés, on se rend compte que la majorité des études «systématiques» réalisées sur ce groupe ne concerne pas spécialement les crevettes «d'intérêt commercial», mais plutôt d'autres groupes tels que les amphipodes, les isopodes, les crabes, etc. qui n'ont aucun intérêt commercial direct. Il est également important de remarquer de cette analyse, l'écart entre le nombre de «généralistes», souvent des bionomistes, (bleu) et de «spécialistes» (jaune); ce qui sous entend automatiquement moins de rigueur, moins de précision dans l'identification des espèces et, par conséquent, des inventaires souvent sujets à discordes. C'est une situation qui est, donc, tout à fait inconfortable quand on cherche à élaborer une stratégie de conservation, un plan de gestion ou un plan d'action; approches toutes basées sur des données scientifiques suffisantes et fiables.

Le Développement mal maîtrisé des «généralistes» et le «plein» qu'ils font sur la «scène scientifique» taxonomique n'encouragent évidemment pas les responsables à s'engager dans des formations de spécialistes systématiciens, d'autant plus que la systématique est considérée de nos jours comme une recherche fondamentale n'apportant rien sur le plan socio-économique. Ceci instaure à l'échelle nationale, un environnement idéal pour une insuffisance cruelle et chronique de spécialistes et, par conséquent, de pouvoir d'action dans ce domaine.

IMPACT DE L'INSUFFISANCE DE TAXONOMISTES SUR LA CONSERVATION DE LA BIODIVERSITY ET LE DÉVELOPPEMENT DURABLE

Au Maroc, la forêt, l'agriculture et la pêche maritime constituent les principales ressources biologiques renouvelables ainsi que des élément stratégiques dans le développement économique et surtout social du pays; développement qui ne peut être assuré et soutenu que si ces ressources sont caractérisées (identifiées, hiérarchisées selon leur intérêt, leurs potentialités de valorisation, les menaces qui pèsent sur elles, etc.), sachant que celles-ci assurent non seulement des sources de revenus et de subsistance et de «bien-être matériel» pour des populations de plus en plus exigeantes, mais des conditions environnementales (qualité des eaux et de l'air, biomasse, etc.) améliorant amplement ce «bien-être». Cette caractérisation suggère un minimum de moyens humains et matériels dont l'insuffisance cruelle ressentie dans le pays ne fait que différer à l'infini toute initiative de mise en place de programmes scientifiques intégrés ayant pour finalité une meilleure connaissance du patrimoine national, pour une meilleure valorisation et capitalisation des potentialités non-utilisées ou peu utilisées, une meilleure compréhension des structures, des organisations faunistiques et floristiques, des mécanismes de fonctionnement de divers écosystèmes

marins et côtiers, un meilleur développement des secteurs socio-économiques basés sur ces ressources, etc. La situation est d'autant plus préoccupante que les facteurs de dégradation de l'environnement, en général, et de la biodiversité, en particulier, ne font que s'aggraver au fil du temps. C'est ainsi que les changements globaux, tels que la désertification, périodes de plus en plus fréquentes de sécheresse, croissance démographique, urbanisation, le tourisme de masse et l'industrialisation tronqués dans la zone côtière, la pollution, l'introduction délibérée (mariculture) ou accidentelle (transport maritime) d'espèces exotiques, etc. , sont les principaux facteurs qui exercent sur le milieu une pression telle qu'on perd de nombreux éléments de notre biodiversité marine sans même les avoir explorés ou identifiées et sans même avoir su quel rôle précis jouent-ils dans le fonctionnement de nos écosystèmes.

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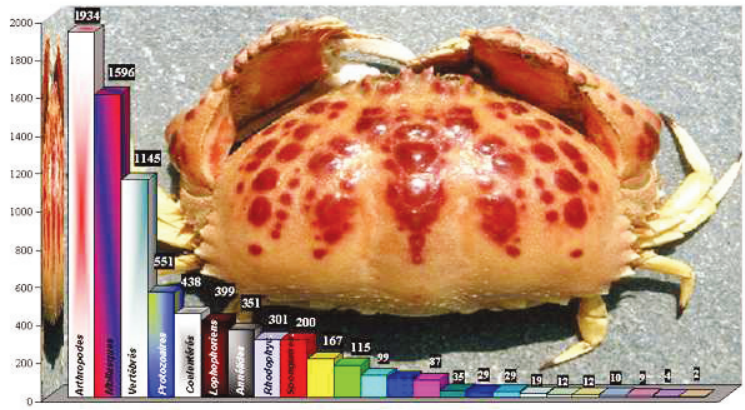
FIGURE 1: Structure, par groupes taxonomiques de la biodiversité marine du Maroc



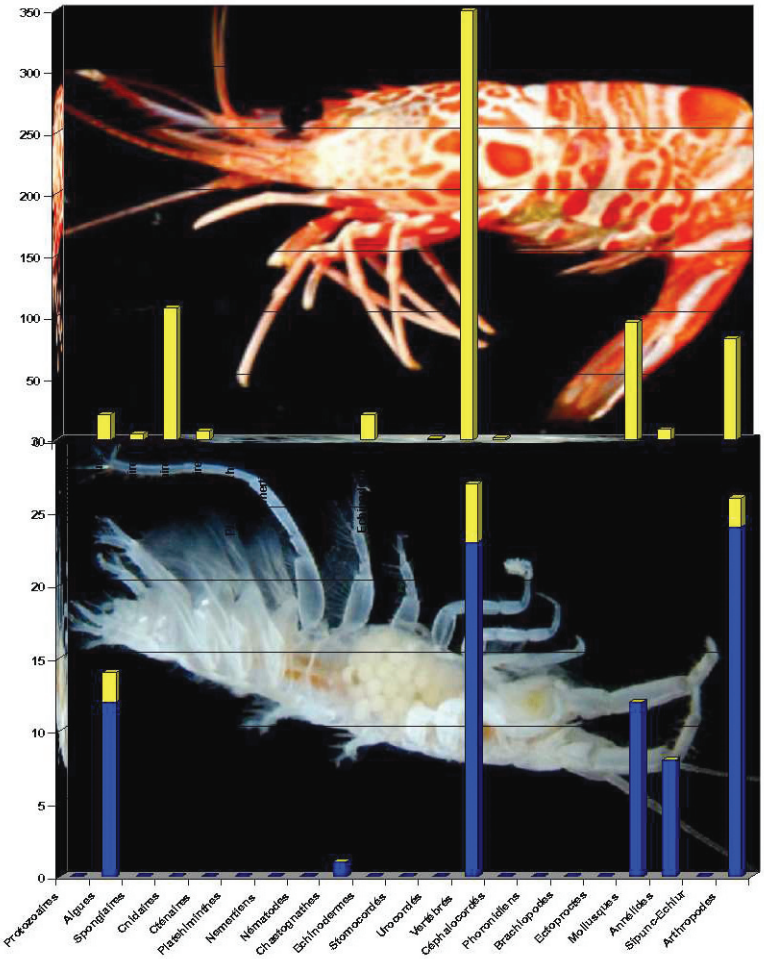


FIGURE 2: Structure, par groupes taxonomiques de la biodiversité d'intérêt socio-économique

FIGURE 3: Nombre de taxonomistes «généralistes (bleu) et spécialiste (jaune) dans divers groupes taxonomiques marins au Maroc

PARTNERSHIPS FOR THE GLOBAL TAXONOMY INITIATIVE

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Keywords: Taxonomy, capacity building, partnerships, regional networks

INTRODUCTION

Since its inception in 1993, BioNET-INTERNATIONAL (hereafter BioNET) has been dedicated to promoting taxonomy to meet sustainable development and conservation needs, particularly in less industrialised countries. Recognising the urgency and variety of taxonomic needs, BioNET supports the meeting of locally defined taxonomic priorities via capacity building, technology transfer and technical partnerships amongst taxonomists and between the taxonomic sector and other users of taxonomy.

BioNET has aligned its programme to support the Global Taxonomy Initiative (GTI), in particular the GTI work programme adopted in 2002 as decision VI/8, the importance of which was recognised in the Plan of Implementation agreed at the 2002 World Summit on Sustainable Development. While the GTI provides the context for taxonomic work in support of the Convention on Biological Diversity (CBD), BioNET recognises that other high-level developments since 2002 also have significant implications for the taxonomic sector. Taxonomic expertise, resources, research, information and services are vitally important for meeting the 2010 biodiversity target and a number of the Millennium Development Goals (Table 1).

SUCESSES OF THE PARTNERSHIP APPROACH

BioNET's support to Parties in implementing the GTI programme of work has included successes in each area of the programme where the potential of BioNET is recognised: needs assessments, awareness raising, regional cooperation and the coordination and delivery of capacity building. Underpinning BioNET's contributions to the GTI are its affiliated sub-regional Locally Owned and Operated Partnerships (LOOPs), comprising institutions and individuals in government-endorsed partnerships that implement donor and government-supported activities, providing a cost-effective mechanism for meeting user needs by building, strengthening and sharing taxonomic resources regionally.

Strengthening regional partnerships

Significant progress has been made with establishing five more LOOPs since 2002. Of these five, three LOOPs have been formally established with governmental endorsements — ANDINONET (Andean countries), EASIANET (East Asia) and NAFRINET (North Africa) — bringing the total to nine LOOPs established since 1993. The governments of two further sub-regions — South Asia and Mesoamerica — are formally considering LOOP establishment. Each of the five recently initiated LOOPs has been specifically designed to meet CBD and GTI needs. National GTI and/or CBD focal points have had leading roles in designing the LOOP strategies and work programmes.

Needs assessments

BioNET has contributed to the assessment of taxonomic priorities and capabilities at the national, regional and global levels. While not equivalent to a detailed assessment of the needs of the many users of taxonomy, the establishment of each LOOP involves the presentation and regional synthesis of national statements on taxonomic priorities. Once established, LOOPs provide a mechanism to deliver assessments of the taxonomic needs of particular users. In examples of user-needs assessed at the regional scale, BioNET-ASEANET and Australian partners undertook and published in 2002 assessments of the taxonomic needs of Southeast Asia in relation to Plant Pathogenic Organisms and Arthropod Pests. Globally, BioNET's Third Global Taxonomy Workshop (2002), organised in collaboration with the CBD Secretariat, UNESCO and the Secretariat of the International Plant Protection Convention, included presentations on user needs in taxonomy from leading organisations in the conservation, agriculture and trade sectors.

Building taxonomic capacity

Recent coordination and implementation of capacity-building activities has included: (a) providing fellowships and arranging short-term training (e.g., for an East African insect curator) and doctorate studies (e.g., a West African biocontrol expert and East Asian mycologist); (b) organising and delivering technology transfer workshops in Southeast Asia and Southern Africa on the use of new technologies and tools (e.g., Lucid keys and Discover Life guides); (c) establishing a group to further the conservation, study and sustainable use of palms of the Andean countries; (d) delivering a short course to public health entomologists from the Andean countries in taxonomy and the identification of problem insect groups; and (e) establishing and organizing technical support for a pest and invasive species alert, advice and information service in the Caribbean.

Public awareness, communication and networking

In 2004, BioNET published a series of case studies — Why Taxonomy Matters — that illustrate the societal and economic impacts of taxonomy across many sectors. In a special focus on the critical role of taxonomy in preventing, controlling and mitigating the impact of invasive alien species, BioNET also published a set of case studies — Taxonomy targeting invasives — in collaboration with the Global Invasive Species Programme and the Invasive Species Specialist Group of IUCN, the World Conservation Union. BioNET's monthly electronic bulletin and website serve as popular mechanisms for disseminating and exchanging information, news and announcements relevant to the GTI, including information on training courses, funding opportunities and relevant strategic initiatives.

CONSTRAINTS

Despite the achievements of many actors, the taxonomic needs of the GTI, 2010 target and MDG remain significant. LOOP establishment, capacity building and other BioNET achievements demonstrate a proof-of-concept of the BioNET model, i.e. taxonomic institutions / technology providers / technical partners / end-users / funders working in partnership to meet national taxonomic needs through capacity building and cooperation regionally and internationally. With committed partners, the sharing of taxonomic resources, expertise and information across borders is both possible and practical. Fuller realisation of BioNET's potential to support the GTI is constrained by the need for new and continuing resources and capacity to strengthen our existing regional networks (GTI Planned activity 6, decision VI/8). The 2004 External Review of BioNET, led by renowned experts in biodiversity and the

Convention, and commissioned by the Swiss Agency for Development and Cooperation, emphasised this need and the potential to realise significant further benefits from the previous investments in BioNET. Assessing its position and the needs of the GTI, BioNET has refocused its programme with the aim of addressing the acute and continuing need of the taxonomic sector, particularly in developing countries, for project development support and empowerment. With a large Global Network of LOOPs in place and with extensive global level partnerships and recognition, BioNET will strive to further mobilise its partnership in support of the GTI.

TABLE 1: Linkages between taxonomy and the Millennium Development Goals

DEVELOPMENT GOALS		VALUE OF TAXONOMY
GOAL 1: eradicate extreme poverty and hunger	1.1	Agriculture, forestry, fisheries and horticulture need the taxonomic sector and its products. Many different organisms have beneficial roles e.g., in soil fertility and pollination; others are pests that decrease productivity. The taxonomic sector provides the basis for knowing and hence better managing species that can enhance or protect productivity.
	1.2	Taxonomists are the first line of defence, providing expertise needed to maximize productivity, ensure ecological sustainability and minimize production losses. Crop pest management is of particular importance due to continuing high losses to production, and resulting food shortages, increased poverty and malnutrition.
GOAL 6: Combat HIV/AIDS, malaria and other diseases [and indirectly Goal 4: reduce child mortality; Goal 5: improve maternal health]	6.1	Having the capacity to identify, understand disease vectors and reservoirs is increasingly important and is central to attempts to reduce the frequency of outbreaks of human and animal illness that result from the greater mobility of diseases and pests globally.
	6.2	Taxonomy is key to: ◆ The identification of pathogens that cause infectious diseases ◆ Understanding and curbing disease-causing and carrying vectors ◆ Identifying taxa with medicinal properties
GOAL 7: Ensure environmental sustainability	7.1	Taxonomy is central to the aims of the Convention on Biological Diversity (CBD). Taxonomists underpin biodiversity monitoring and use. They contribute to conservation strategies by identifying areas of high species diversity; listing species under threat of extinction; identifying species that may be of value (or harmful) to humankind; and improving understanding of ecosystem function.

Source: HMSO, 2002. What on Earth? The threat to the science underpinning conservation. *Report of the House of Lords Select Committee on Science and Technology, Session 2001-02*, 3rd Report. HL paper 118 (i).

See also the *Why Taxonomy Matters* case study series: http://www.bionet-intl.org/case_studies

GLOBAL TAXONOMY INITIATIVE PILOT PROJECT IN COLLABORATION WITH EXISTING NETWORKS IN ASIA AND THE PACIFIC

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Keywords: taxonomy, database, internet, capacity building

PROJECT OUTLINE

The Global Taxonomy Initiative (GTI) pilot project was carried out to find a cost effective way of establishing capacity in Asia and Oceania, through regional cooperation, to provide biodiversity information which meets the goals of the Convention on Biological Diversity. To identify strong champions, and the existing taxonomic impediment that prevented them from meeting the targets of the GTI, a taxonomic needs and capacity assessment was carried out and two GTI regional workshops were held. To develop a mechanism for effective succession of taxonomic knowledge, training and development of electronic tools was carried out, and a library for species identification in groups of organisms such as microalgae, nematodes, fishes and fungi created. For effective data sharing, a prototype data provider for the Global Biodiversity Information Facility (GBIF) was implemented as well as communication web sites for GTI in the region.

NEEDS AND CAPACITY

A survey of taxonomic needs and capacity was carried out through the existing networks and collaborators. The existing collections and experts that might collaborate to build capacity in Asia and Oceania were identified (Figures 1 and 2). The survey found that infrastructure and the number of experts in microbiology were less adequate than for botany and zoology in most organisations. The type specimens which were originally found in the region are kept in remote countries, and access to both specimens and the corresponding references is difficult for researchers and specialists involved in inventorying and monitoring of biodiversity in the region. It was stressed at the regional workshop in Asia (2002) and in Asia-Oceania (2004) that information on type specimens and location and images of those types would greatly help taxonomic studies in the region (Shimura et al. 2002, 2003).

PILOT COLLABORATION IN TAXONOMY AND INFORMATICS

Japanese researchers in taxonomy (vascular plants, coastal and marine organisms, fishes, microalgae, fungi) and young scientists from Thailand and Indonesia worked together at the observation/sampling sites in Asia. Specimens of 337 angiosperm species in 269 genera of 98 families were collected and identified. Among them, 196 genera (72%) and 293 species (87%) were newly record in Lombok, Indonesia. In Thailand, the 10,742 specimens of nematodes were mounted for microscope examination. Electronic versions of the field guide in the local language and in English were made accessible on the Internet (http://research.kahaku.go.jp/zoology/FishGuide/), which covers representative fishes found in coral reefs, mangroves, seagrass beds, and sandy beaches in Lombok in Indonesia, and Libong Island in Thailand. The electronic identification site (http://svrsh2.kahaku.go.jp/fishis/) for fishes was expanded to cover more than 4,000 species found in temperate and tropical waters in the western Pacific and

Indian Ocean. Through this project, eight divisions and 11 classes of microalgae were newly recorded for the checklist in Thailand. 440 fungal strains were isolated from mangroves in Indonesia. Data were compiled into an identification guidebook, *A Guidebook to Identification of Fungi Inhabiting Mangroves and Surrounding Area in Indonesia* available through the individual particpants. Information relevant to the GTI pilot project is presented in Table1.

FACILITATION FOR THE DEVELOPMENT OF RESEARCH AND INFORMATION NETWORKS

The East Asian Network for Taxonomic Capacity Building (EASIANET) and Pacific Biodiversity Information Forum (PBIF) were established. EASIANET covers 7 East Asian countries and economies, and PBIF covers Asia and Oceania, including island countries in the Pacific.

REGIONAL PROJECT DEVELOPMENT

The second GTI regional workshop in 2004 resulted in four large project proposals (for potential GEF funding) and 11 smaller project proposals (for funding by other bodies) (Colreavy et al. 2005). The workshop demonstrated that identifying high-priority regional and national biodiversity projects requiring taxonomic expertise is not difficult.

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FIGURE 1: The number of collections for different groups of organisms in Asia as reported in the 2002 survey.

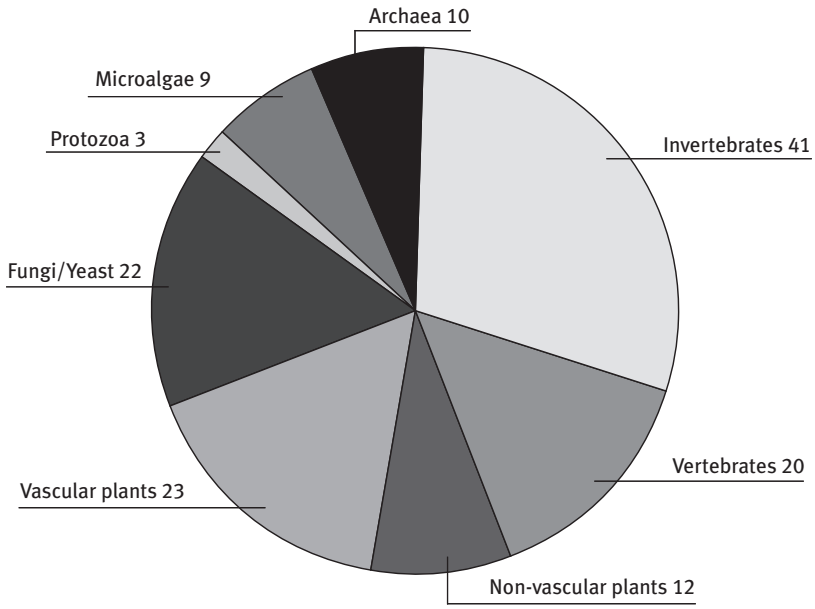

FIGURE 2: The number of experts for different groups of organisms in Asia as reported in the 2002 survey.

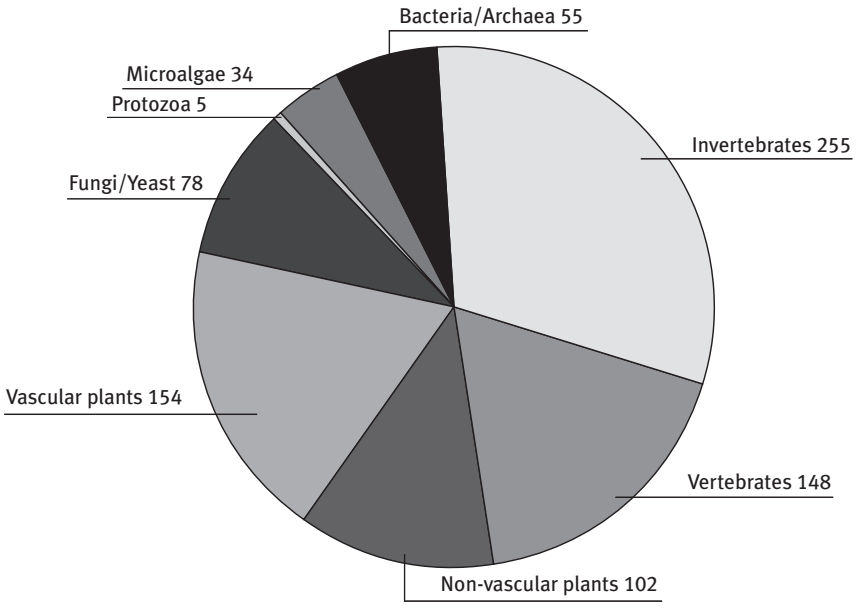

TABLE 1: Information-sharing web sites newly developed or updated through the GTI pilot project

URL	CONTENTS	RECORD NUMBER (in database only)	REMARKS
http://www.gti.nies.go.jp/	GTI Web pages		English and Japanese
http://www.gtijp.nies.go.jp/	GTI Japan data provider for GBIF	66,000 specimen and observational records	National Science Museum Fish Collection, JTYPES, Kyoto Univ. Museum, EASIANET Accessible from GBIF
http://www.bios.nies.go.jp/	Bacterial names	13,000 names	Accessible from GBIF
http://www.easianet.nies.go.jp/	EASIANET Web pages		English
http://www-gtiao.nies.go.jp/	Taxonomic literature for nematodes and microalgae	(1,100 taxa, PDF files searchable by taxon)	Password required to access

MEASURING SPECIES RICHNESS AT THE CORE OF THE INDO-PACIFIC HOTSPOT: THE PANGLAO MARINE BIODIVERSITY PROJECT

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Keywords: Crustacea, Mollusca, centre of richness, all-species inventory

SCIENTIFIC BACKGROUND

Coral reefs and the deep sea are recognized as the two major frontiers in marine biodiversity exploration. Coral reefs occupy only 0.1% of the planet, but concentrate as much as 5% of global biodiversity. Within the Indo-West Pacific marine biogeographic province, biologists have recognized a biodiversity gradient, with a species-rich "core" in South-East Asian seas, and fewer species as one moves towards the central Pacific. The Philippines and Indonesia present an exceptionally complex region where coral reefs, island margins and deep-sea basins are encountered within discrete geographical areas. This region is exceptionally rich in species, many of which are still undocumented and unnamed. Marine ecologists and conservationists are overwhelmed by the high biodiversity they want to study, promote, and protect. Because of the taxonomic impediment, the species-rich taxa (molluscs, crustaceans, polychaetes) are carefully avoided during most surveys because of problems with sampling, sorting and identifying them. Ironically, the simple question "How many species can coexist in a complex marine area?" remains unanswered.

CHALLENGES

Scientific Challenge

We wanted to develop a novel approach for evaluating the magnitude of marine biodiversity, superposing three levels of difficulty: (1) targeting the reputedly richest marine ecoregion: the core of the Indo-Pacific biogeographic province; (2) selecting a study area with maximal internal heterogeneity, from mangrove to coral walls, to deep basin; (3) focussing on two of the most diverse marine taxa: molluscs and decapod Crustacea.

Permit-Granting Process

Philippines biodiversity-access laws require research proposals to receive "Prior Informed Consent" from each Local Government Unit (municipalities) in the intended study area. Five municipalities and several dozen village units (barangays) were involved in our project. Under Philippine law, the Panglao Marine Biodiversity Project was the first academic marine research project to comply strictly with such regulations, to be evaluated positively by the national Committee on Bioprospecting, and to be granted an Academic Research Agreement.

PARTNERSHIP

The Panglao Marine Biodiversity Project 2004-2005 involved academic research scientists, technicians, students, and volunteers from the Philippines, other ASEAN countries, Europe and the U.S., with the following institutions acting as principal investigators: University of San Carlos (USC), Cebu City; Bureau of Fisheries and Aquatic Resources (BFAR), Manila; the National Museum of Natural History (MNHN), Paris; and the National University of Singapore (NUS). Philippe Bouchet and Peter Ng acted as Biodiversity Chairs for the project under the ASEAN Regional Center for Biodiversity Conservation (ARCBC). The project was supported by grants from the Total Foundation and the French Ministry of Foreign Affairs.

The study area is a renowned destination for scuba-diving tourism. It is also famous world wide for its fisheries of high quality deep-water seashells. The project involved local dive guides as well as tangle net operators.

THE PANGLAO SURVEY EFFORT

The study area is situated on the island of Panglao, province of Bohol, in the Visayas region of the Philippines. It consists of a coastal area of 15,000 hectares and a deep offshore basin reaching 2,000 metres deep within 20 km from the coast. The fauna of the coastal ecosystems was inventoried in 2004, based on intertidal collects, scuba diving, trawling, and deployment of tangle nets; the fauna from the deep-sea ecosystems was inventoried in 2005 from BFAR's oceanographic research vessel. Samples were processed immediately after their catch; small species were sorted under dissecting microscopes; specimens were photographed alive, then preserved for future reference, including molecular barcoding. With a total of 80 participants from 19 countries, the Panglao Marine Biodiversity Project was the most comprehensive survey of benthic invertebrates anywhere in the tropics.

RESULTS: SUCCESSES AND DIFFICULTIES

Scientific Results

The coastal part of the survey has inventoried in the order of 1,200 species of decapod Crustacea, and 4,000–6,000 species of molluscs. To put it in perspective, it should be remembered that the whole decapod crustacean fauna of Japan barely exceeds 1,600 species. The Mediterranean (300 million hectares) has 340 species of decapods and 2,024 species of molluscs. Numerous species were photographed alive, almost always for the first time, and it is estimated that 150–250 of the Crustacea and 1,500–2,500 of the molluscs are new species. Samples taken during the 2005 deep-sea survey are still being analyzed.

Outreach

A specially dedicated web site (www.panglao-hotspot.org) has been established; it contains a description of the project (in English and Cebuano). During the field work, representatives from municipalities of the study area and local NGOs visited the laboratory and expedition facilities. The Panglao Marine Biodiversity Project has been covered by popular media (TV, newspapers, magazines) in the Philippines, Singapore, Malaysia, and France. The findings of the project have been popularized through public lectures in Manila, Cebu City, and Tagbilaran.

Training and Capacity Building

Students and researchers from several developing countries (Indonesia, Vietnam, Philippines, Nicaragua) were involved in the field and laboratory work. As part of the Panglao Marine Biodiversity Project, Philippino scientists are receiving taxonomic and curatorial training in France and Singapore. Holotypes of new species and reference collections are being lodged at the Philippines National Museum. Local students trained during the project are now employed by the private sector for processing biological specimens for the shell trade. A biological sorting facility is being established to assist future surveys; it is also employing personnel trained during the project.

Difficulties

As an academic taxonomic survey, the Panglao has encountered difficulties that are probably shared by other such projects. First, we found it difficult to convey the notion of academic taxonomic research during grassroot meetings of the Prior Informed Consent process. Second, managers (from government as well as NGOs) have expectations that our research results should be immediately applicable to management plans. Finally, there is a rampant suspicion among many outsiders that any inventory of this kind is a smokescreen for bioprospecting and biopiracy.

THREE-DIMENSIONAL NETWORK APPROACH SOLUTION TO GTI AND CBD REQUIREMENTS

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Keywords: three-dimension, solution, interaction, information, Global Taxonomy Initiative

INTRODUCTION

Lessons from all the multilateral biodiversity-related agreements indicate that all stand-alone approaches to implementing the Global Taxonomy Initiative (GTI) and the Convention on Biological Diversity (CBD) are individually weak. The Ramsar Convention on Wetlands (1971), the World Heritage Convention (1972) for protected sites, the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES – 1973) and the Convention on Migratory Species (1979) have all failed to effectively achieve their intended goals. CBD (1992) wrapped up all the above approaches into an almost universal convention. The GTI, one of the major crosscutting issues under the CBD and considered the greatest challenge to achieving CBD and Millennium Development Goals, has its head stuck out thereby stimulating the proliferation of CBD-backed network programmes to combat the GTI challenges identified in various SBSTTA deliberations. The network programmes may have also been spawned in response to failure by national institutions to effectively deal with GTI requirements. The NET programmes, such as BioNET and LOOPS (see below), Barcode of Life, Pollinator Initiative, and the Global and Invasive Species Programme, are working towards either GTI activities or the CBD *per se*, but as opposed to national institutions, have regional participation from individuals and institutions.

GTI INFORMATION SOURCES SCENARIO

In Kenya, the slow pace of implementing the GTI and the CBD has been due to two main factors: meager resources and lack of functional linkage between and among the individual work on specific disciplines of government and private organizations. There is no bureau or centre for instance, where independent work from different institutions is collated and integrated to deliver national or international goals. Desperate to deliver CBD and GTI requirements, we discovered that different organizations have different GTI-relevant projects that, but if joined together, could readily provide required GTI outputs. The challenge was to form a functional bridge between them. It is this role that Locally Organised and Operated Partners (LOOP) have played.

DISJOINT OPERATIONS AMONG INSTITUTIONS

From our analysis, we recognize an unstructured weak network of government institutions, private institutions and the LOOPS. These three cadres form a functional, though still weak, linkage at a higher level above the most fundamental and vital three-dimensional interaction. While collating information for preparing the country GTI report, weobserved the existence of independence and disjointedness in the operations of institutions that hinder information flow at three levels. First, in individual institutions with many discipline-based departments or faculties, each has its own projects founded on an independent purpose, which proceeds virtually oblivious of the other departments' work. Second, each institution

has projects which are often independent and oblivious of valuable resourceful organizations such as LOOPs. Third, LOOPs fail to identify resourceful organizations to further their agenda, or vice versa. This means that someone has tovisit individual departments, institutions and network organizations to identify any complementarity and to get a full picture of the situation. As a result of this strenuous but worthwhile work, national focal point contacts came to the realization that three-dimensional interaction, though in its infancy, is a powerful means to achieve both GTI and CBD at relatively low costs.

PRODUCTS SO FAR

Good results are already evident in taxonomic training, identification of information sources, access and political goodwill. The implementation of the GTI and CBD in Kenya so far is a product of this kind of interaction rather than the intent of projects intended for the realization of conventions. Our passionate appeal is to strengthen, encourage and explore this linkage so as to realize its full potential in conserving biological diversity and sustainablly using its resources locally and regionally.

CONCLUSION

Our conclusion is that on a national and regional level, intra- and inter-institutional networking is the means to implement the GTI and CBD.

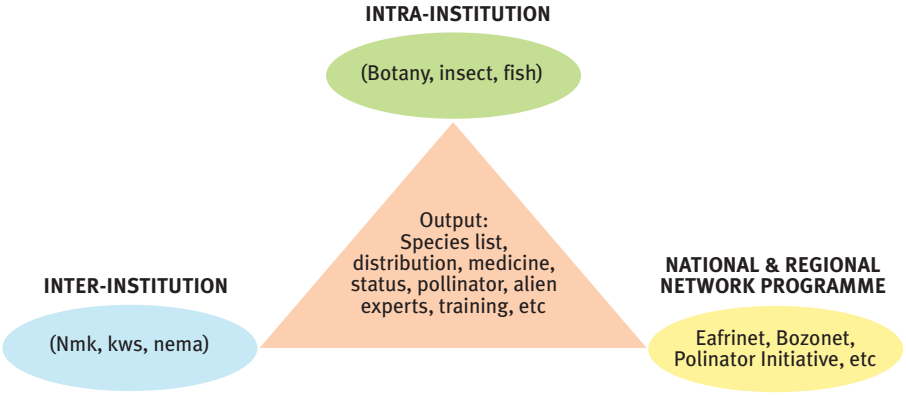
FUTURE PROSPECTS

The greatest lesson is that parties without resources can emphasize this interaction as an affordable vehicle to deliver national and goals as well as those of the conventions. The challenge here is to have a proactive and self-motivated team to collate, synthesize, classify and compile the fragmented information. Otherwise, a government-backed bureau, a centre where all information from different project activities from all institutions is deposited, is preferred.

The challenge in Kenya is the lack of resource base to set up a team to:

1. initiate structured collaboration;
2. collect, collate, synthesize and relay back and forth information on behalf of individual institutions and the government; and
3. based on information received, set priorities through consultation, on behalf of the government.

FIGURE 1: Structure of the three-dimensional approach to the implementation of the goals of the GTI in Kenya



GUIDE TO DIAGRAM

1st DIMENSION: INTRA-INSTITUTIONAL INTERACTION IN VARIOUS ACTIVITIES

- Species- and discipline-specific projects, e.g., herbarium and mammalogy studies from separate departments or projects
- Training in taxonomy, ecology, biotechnology, etc.

2nd DIMENSION: INTER-INSTITUTIONAL INTERACTION

- Joint projects between two or more institutions that deliver on the GTI
- Memoranda of Understanding for training and information sharing

3rd DIMENSION: INSTITUTION VS NETWORK PROGRAMMES

- National and regional network programmes interacting with national institutions to deliver on the GTI
- National and regional network programmes linking regional institutions into a working relationship to deliver on the GTI
- National and regional network programmes interacting to deliver on the GTI (EAFRINET vs BOZONET)

The regional network programmes involved in this integrated approach include EAFRINET, BOZONET, Pollinator Initiative, and the Global Invasive Species Programme. The powerhouse institutions include National Museums of Kenya, NMK, ICIPE, KWS, NEMA, FD and universities.

SENSE AND SENSIBILITY IN TAXONOMIC CAPACITY-BUILDING

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Keywords: taxonomy, capacity building, Global Taxonomy Initiative, developing countries, Belgium

INTRODUCTION

Belgium signed and ratified the Convention on Biological Diversity in 1992 and 1996 respectively. In implementing COP decision V/9, paragraph 4, Belgium designated in 2001 the Royal Belgian Institute of Natural Sciences (RBINS) in Brussels as its National Focal Point (NFP) to the GTI. This research institute and museum harbours a vast collection of recent zoological specimens (roughly 27 million), a library of global importance, well-equipped research facilities and well-trained scientific and curatorial staff. It is the largest of Belgium's high quality taxonomic research institutes. It works in partnership with the Royal Museum for Central Africa in Tervuren and the National Botanic Garden in Meise, as well as with universities and other relevant taxonomic research organisations. A complete list of Belgian actors in biodiversity research can be found at the following URL: http://bch-cbd.naturalsciences.be/belgium/biodiversity/actors/actors.htm.

IMPLEMENTING THE GTI PROGRAMME OF WORK

The Belgian tactic to tackle the taxonomic impediment generally is a pragmatic implementation of the GTI objectives as expressed in the operational programme of work for the GTI (figures 1A & B).

The Belgian GTI NFP intercepts taxonomic needs through expert and needs-driven calls for proposals (Belgian GTI National Focal Point, 2004; Samyn *et al.* 2004, 2005a, b). After two years of activity and five calls for proposals, 110 individuals from 18 developing countries have expressed their taxonomic needs. We have installed three separate research-based projects with taxonomic capacity building components (entomology in Cambodia, herpetology in Guyana and mammalogy in DR Congo). Nearly one quarter of the individual taxonomic needs were satisfied through training in Belgian taxonomic research institutes. In addition, one subregional workshop in S.E. Asia has provided training to a further 30 individuals from four different countries (Thailand, Laos, Vietnam & Cambodia).

Wherever possible, this build-up of human capacity is complemented with the installation of taxonomic infrastructure, either directly through the Belgian GTI NFP or indirectly through cooperation with other, independently funded, projects.

Through its training programme, especially if provided in the partner country, the Belgian GTI NFP further succeeds in generating novel taxonomic data. Finally, we facilitate access to taxonomic information through networking and linkage with digitisation projects. Moreover, wherever possible the Belgian GTI NFP assists with the building of reference collections in developing nation institutions.

SENSE AND SENSIBILITY IN TAXONOMIC CAPACITY-BUILDING...

Increasing taxonomic capacity is not a simple endeavour, particularly in those countries that are most wanting: the megadiverse developing countries of the South. The success of our project undoubtedly resides with the sense and sensibility with which we operate. By employing our two types of calls for proposals we not only ensure that individual, institutional and thematic taxonomic impediments are attended to, but also that resources are attributed to projects that are likely to augment standing taxonomic capacity. In order to evaluate the latter we ask trainees to report on how the gained taxonomic capacity will aid them in their future taxonomic endeavours. This not only gives us direct feedback on our programme, but also allows us to evaluate what type of further follow-up candidates need to become fully autonomous.

...BUT EATEN BREAD IS SOON FORGOTTEN

Even though we believe our capacity-building efforts to be quite successful, we are fully aware that on their own they are not sufficient to ensure durable taxonomic capacity in the South. To attain such durability we couple our training programme to the liberation of historical biodiversity data as stored in the archives of the Royal Belgian Institute of Natural Sciences (Figure 2), underpin the value of taxonomic research by organising awareness initiatives (Figure 3) and plan the elaboration of a series of manuals devoted to capacity-building in taxonomy.

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Acknowledgment

A project made possible thanks to the financial support of the Belgian Directorate-General for Development Cooperation.

FIGURE 1: Through linkage with the Belgian CHM, implementation of the CBD is achieved. (Figure A reproduced with permission of the CBD Secretariat)

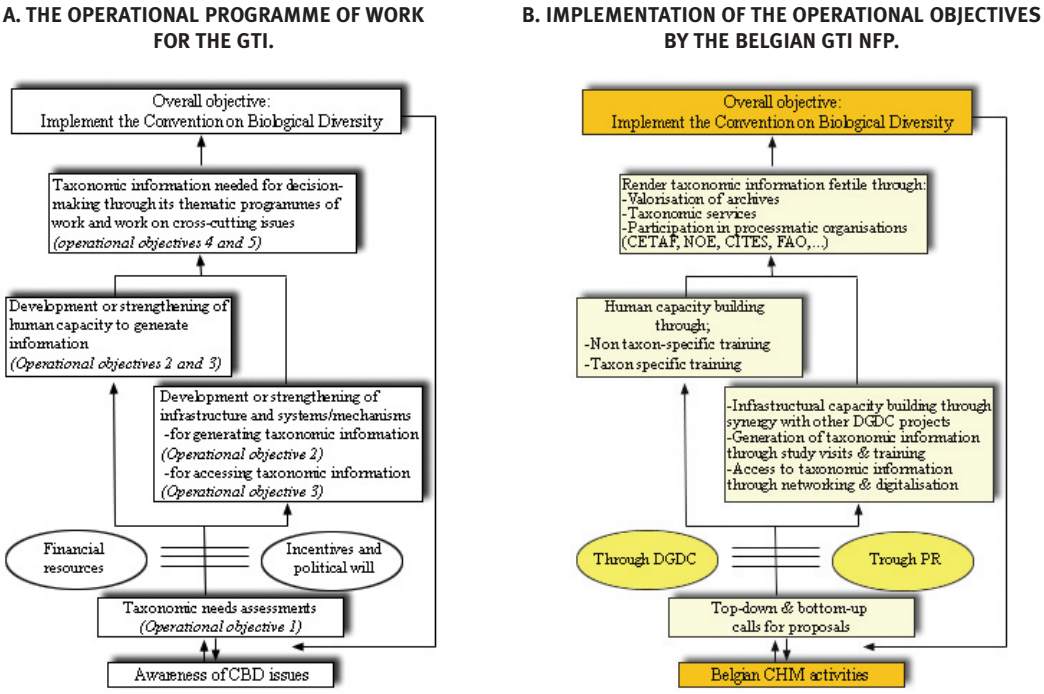

FIGURE 2: Some hits from the Royal Belgian Institute of Natural Sciences archives on the biodiversity of the Democratic Republic of the Congo.

FIGURE 3: Public awareness and education initiatives.

A.

B.

C.

A. Poster with the herpetofauna of Kaieteur falls (Guyana)
B. Training workshop on the taxonomy of rotifers (Thailand)
C. Didactic panels utilised by youth in Cambodia
(Photo credits: A, Ph. Kok, RBINS; B, Y. Samyn, RBINS; C, P. Grootaert, RBINS)

GENERATING TAXONOMIC CAPACITY TO SUPPORT THE SUSTAINABILITY OF SHADE-COFFEE PRODUCTION IN EL SALVADOR

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Keywords: El Salvador, biological collections, Global Taxonomy Initiative, identification guides, shade coffee

INTRODUCTION

With continuing deforestation in Latin America, the biodiversity challenges currently faced by El Salvador will be faced by much of the region in the future.

El Salvador has only 4.3% of its original cover of natural forest remaining. The loss of so much natural forest suggests that a large proportion of El Salvador's biodiversity and a number of ecosystem services are at risk. However, 11% of the country's land area supports shade forest for coffee production, and this has become the major forest resource for the country. Studies elsewhere in the world indicate that shade forest has levels of biological diversity of the same order of magnitude to that of natural forest. Shade forest for coffee should therefore play a central role in the conservation of biological diversity in El Salvador but the capacity to monitor and assess this diversity is lacking.

There is significant overlap between the taxonomic capacity needed to meet El Salvador's Biodiversity Action Plan and that required to conserve biological diversity in shade coffee farms. Developing the taxonomic capacity required to underpin the monitoring and inventory of biological diversity in shade coffee farms could also exploit a synergy between the biodiversity/environmental value and the economic sustainability of shade coffee production. Biological diversity inventory data would not only support El Salvador's Biodiversity Action Plan but also generate added value to the coffee price through 'Biodiversity-friendly' and 'Migratory bird-friendly' premium payments from the specialist coffee market, thereby providing some insurance against the volatility of the open market.

This work addresses the work programmes of the Agricultural Biodiversity, Forest Biodiversity, Mountain Biodiversity and Dry and Sub-humid Lands Thematic Programmes of the CBD and contributes to implementation of the work programme of the Global Taxonomy Initiative (GTI), the Global Initiative on Communication, Education and Public Awareness (CEPA), and is consistent with the principles and guidelines for incentive measures, adopted by COP VI. The work also addresses targets VI, XII, XIII, XIV, and XV of the Global Strategy for Plant Conservation, the Millennium Development Goal of ensuring environmental sustainability, as well as contributing to efforts to achieve the 2010 Biodiversity Target.

PROJECT OBJECTIVES, ACTIVITIES AND OUTCOMES

Develop taxonomic capacity within El Salvador

Salvadoran scientists were trained at the Natural History Museum (NHM) in London and in the field in El Salvador. Training at the NHM enabled access to world-class collections and library facilities and contact with other researchers in their discipline.

Two-week training courses were held in San Salvador. The course was aimed at coffee farmers, resource managers, governmental bodies, NGOs, policy makers, and students. The aim of this course was to generate awareness of the uses and importance of taxonomic capacity to the conservation of biological diversity as well as to provide basic training in collection, identification and monitoring techniques.

Generate baseline biodiversity data for shade coffee farms in El Salvador

The project generated a significant volume of high quality, verifiable data on the biological diversity of shade coffee farms for trees, ferns and Pimplinae (Ichneumonidae) wasps. The results indicated high levels of tree (data on 261 species) and Pimplinae (data on 59 species, one third of the total diversity of Costa Rica) diversity encountered in shade coffee farms. The Pimplinae collections included four new species to science. In all, the project made over 2,080 tree and fern collections and 1,100 Pimplinae wasp collections.

Identification tools and disseminated biodiversity data

User-friendly identification guides were produced for all of the trees, ferns and Pimplinae (Ichneumonid) wasps. These were targeted at non-scientists, through the use of common names and field characters, and all were linked to verifiable biodiversity data in the form of biological collections housed in El Salvador.

Duplicate sets of all collections were returned, with labels, to the relevant Salvadoran institutions. A duplicate set was kept at the NHM. Databases for trees, ferns and Pimplinae wasps were generated from these collections and an inventory of the national collections in El Salvador. These were deposited with national institutions and available on line via the project website.

A two-day symposium 'Café y biodiversidad' was held in October 2001, as a side-event at the annual congress of the Sociedad Mesoamericana para la Biología y la Conservación. In attendance were 74 participants from eleven countries.

Promote awareness of the biodiversity value of shade coffee farms

Posters promoting the value of shade coffee farms
One thousand high quality posters were produced within El Salvador by our network of project partners and distributed to schools, coffee farmers and NGO offices.

News media
News media coverage included a series of newspaper articles in El Salvador, an article in *BBC Wildlife Magazine*, an interview on the project objectives and rationale broadcast on the BBC World Service and on the Australian National Broadcasting Corporation.

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POLLINATOR BIODIVERSITY CONSERVATION IN AFRICA STIMULATES INTEREST IN BEE TAXONOMY

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Keywords: Afrotropical, bees, taxonomy, pollination and livelihoods

INTRODUCTION

Bees are the world's most important pollinators of agricultural crops and natural vegetation, yet their populations appear to be declining. Quite simply, without pollination the world would be a completely different place and one that could not sustain anything other than a very small human population; conserving pollination services are critical to realising several of the Millenium Development Goals, including the eradication of hunger and environmental sustainability targets. To do so, tools and capacities are needed for rapid identification to facilitate sustainable management of wild pollination services. The taxonomic impediment poses a major barrier to pollination management. In Africa a number of steps are being taken to address these challenges.

THE AFRICAN POLLINATOR INITIATIVE

The African Pollinator Initiative (API) was formed in 1999, after a decision was taken in Sao Paulo, Brazil, in 1998, to form an International Pollinator Initiative (IPI). As a result, the International Initiative for the Conservation and Sustainable Use of Pollinators was established in 2000 at the Fifth Meeting of the Conference of Parties (COP) of the Convention on Biological Diversity (CBD) (COP decision V/5: http://www.biodiv.org/decisions/). Africans then felt that because of a lack of capacity in Africa a network was needed to maximise Africa's potential in IPI. Because of a dearth of taxonomic capacity on invertebrate pollinators in Africa, and to avoid duplication in the creation of a network structure, API worked closely with BioNET-International and used its networking structure.

API organized itself quickly and in February 2002 the First API Workshop, sponsored by the United National Food and Agriculture Organization (FAO), was held in Nairobi, Kenya. A main purpose of this workshop was to develop an API Plan of Action (Martins et al, 2003). In this Plan of Action awareness was considered to be the primary focus — a prerequisite from which conservation and restoration, capacity-building and mainstreaming would follow.

Since 2002 API has undertaken several projects. They have mostly involved awareness, capacity-building and assessment, and a number of project proposals are in the pipeline. API has also networked with all the other continents, which has resulted in Africa's participation in a number of international pollination and/or biodiversity conservation Workshops.

THE GLOBAL TAXONOMY INITIATIVE AND THE AFRICAN POLLINATORS INITIATIVE

Bees are the most important groups of pollinators, both in natural and agro-ecosystems. In sub-Saharan Africa 2,919 bee species have been described; 2,607 of these were recorded in South Africa alone. This

disparity between South Africa and the rest of Africa is probably due to an historic concentration of effort in the subcontinents and unlikely reflects the true distribution of bee diversity in Africa. This situation is, however, being addressed. Three young African scientists are training to become bee taxonomists; one each in South Africa, Kenya and Ghana. They will be the first African bee taxonomists in East and West Africa.

The upsurge in bee taxonomy at a time when taxonomy, as a discipline, is not growing is apparently due to a number of reasons.

- API's momentum has attracted people interested in different aspects of pollinator biodiversity conservation. Scientists interested in taxonomy have gravitated towards this momentum.
- The BioNET-International taxonomy capacity-building networks (SAFRINET, EAFRINET and WAFRINET) have created awareness of the need for taxonomic capacity, and have provided training in bee identification in Kenya and Ghana. The model for the training was the American Museum of Natural History's bee course.
- Afrotropical bees are catalogued and all the literature is electronically available. This resource will save future bee taxonomists years of work and enable revisions and keys to be published quicker than were it not available.
- The higher classification of bees was recently revised by C.D. Michener (2000); *The Bees of the World*, John Hopkins University Press, giving an overall reference point for bee identifications and taxonomy

CONCLUSION

Taxonomy capacity-building is stimulated by scientific co-operation in joint research projects and through communication networks. Instead of the all-too-frequent gatherings to decide how to stimulate capacity in taxonomy, which have not provided the desired results, there should instead be a creation of initiatives focused around a central issue, such as the IPI focus on the maintenance of an essential ecosystems service, namely pollination, and the conservation of the diversity of species that provide the service. Funding for such initiatives should include taxonomic revisions and the development of species identification tools.

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THE EUROPEAN GTI TOOLKIT: CAPACITY-BUILDING FOR THE GLOBAL TAXONOMY INITIATIVE

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Keywords: taxonomy, toolkit, implementing the GTI, Internet, National Focal Points

INTRODUCTION

In June 2004, a workshop was held at the International Academy for Nature Conservation (INA) on the Isle of Vilm, Germany on the topic of Building Capacity for the Global Taxonomy Initiative (GTI) in a larger Europe. This workshop brought together 16 representatives from 13 countries and two international organisations to report on the current state of taxonomy and taxonomic institutions in their countries, and to discuss further steps in implementing the GTI in Europe (find the workshop materials under: http://www.gti-kontaktstelle.de/toolkit/workshop.html).

A specific outcome of the workshop was the call for a European GTI-Toolkit, in which relevant CBD documents and reports, information about funding mechanisms, opportunities for taxonomists, and sources of taxonomic data and relevant information, such as directories of taxonomic experts, tools for taxonomic identifications, maps and gazetteers, etc. should be collected. The main purpose of this toolkit would be to assist new and upcoming GTI National Focal Points (NFPs) and other stakeholders to become involved in the GTI with an easy and efficient start-up phase. Furthermore, both scientists and the public could be provided with a single source of information to learn about taxonomy and the GTI process.

A second workshop was held from 6-8 June 2005 in Stuttgart, Germany, entitled Creating the European GTI Toolkit — Capacity Building for the Global Taxonomy Initiative which was attended by 14 scientists from 11 European countries. Over the course of two days, participants tirelessly collected and arranged documents, websites, and other relevant information items. The resulting first European GTI toolkit will be made available both on CD and freely accessible over the Internet.

CONTENTS

The workshop results were structured into the following four clusters and 14 chapters, for which different specialists took charge as managing editors and/or authors.

Cluster I: Official Texts, Documents, and Reports

Chapter 1: Relevant CBD and other documents
Chapter 2: National legislation on biodiversity
Chapter 3: National workshops and activities
Chapter 4: Taxonomic needs assessments

Cluster II: Science and Language

Chapter 5: Taxonomy as a science
Chapter 6: Technical terms in non-UN languages
Chapter 7: Abbreviations and acronyms

Cluster III: Organisations, Case Studies and Support

Chapter 8: Applications of taxonomy and case studies
Chapter 9: Funding sources for taxonomy
Chapter 10: Taxonomic organisations and initiatives
Chapter 11: Lists and databases on taxonomic experts

Cluster IV: Taxonomic Tools and Services

Chapter 12: Identification of organisms
Chapter 13: Taxonomic software
Chapter 14: Search engines and strategies

RESULTS

The surprising quantity and range of texts and materials compiled by the workshop participants address both specialists and the general public. The toolkit contains introductory texts in several European languages, describing the goals of the Global Taxonomy Initiative and how they relate to the CBD. Furthermore, the texts explain in a nutshell what taxonomy is and why detailed taxonomic data and information are essential for successfully conserving and sustainably using biodiversity. The relevance and relationship of the GTI to other CBD programs and initiatives are also addressed, none of which can be implemented without detailed taxonomic information about the elements of biodiversity concerned. Case studies demonstrating the relevance and application of taxonomic information for solving wide-ranging environmental and other specific problems are also included.

Special emphasis was put on a compilation of links to web pages and open-access databases helpful for the identification of organisms, and directories of taxonomic experts. An efficient and reliable identification of organisms is key not only for assessing and monitoring biodiversity for conservation, but also for many applied areas such as pest management, dealing with alien invasive species, human health, and areas from most other specific CBD programs. Furthermore, the European GTI-Toolkit contains an extensive database of biodiversity-related abbreviations and lists over 2,500 acronyms plus short explanations and links to the web pages of the respective organisations, institutions, projects, and initiatives.

The European GTI-Toolkit is hosted on the website of the German GTI NFP (http://www.gti-kontaktstelle.de/toolkit/toolkit_June.html). The toolkit is constantly updated and also open to contributions with relevance beyond Europe. For several sections, the information offered is structured into global, regional, and national (European) levels, with entries present especially for many groups of organisms from regions other than Europe.

CONTRIBUTIONS AND ACQUISITIONS

As the website is a dynamic way to present information, contributions are added at any time and improvements are easily made. *So, please send us your relevant links and information to share with others!* A CD version of the workshop material is available and will be "freshly burnt" at the time of request.

Acknowledgments

We would like to thank the workshop participants for their valuable contributions and outstanding support. For financial and institutional support, we would like to acknowledge the Federal Agency for Nature Conservation (BfN), Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), and State Museum for Natural History Stuttgart (SMNS).

FIGURE 1: Screenshots of the European GTI-Toolkit website http://www.gti-kontaktstelle.de

"BOZONET": BOTANICAL AND ZOOLOGICAL TAXONOMIC NETWORKS SUPPORTING THE CONSERVATION OF BIODIVERSITY IN AFRICA

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Keywords: taxonomy, biodiversity, conservation, Global Environment Facility, East Africa

INTRODUCTION

The Botanical and Zoological Taxonomic Networks in East Africa Project (BOZONET) is a developing Global Environment Facility (GEF) Project designed to address the Global Taxonomy Initiative (GTI). BOZONET builds on the lessons learned from an earlier GEF supported project Southern African Botanical Network (SABONET), from 1998 to mid 2005.

The Eastern Africa Region (Ethiopia, Kenya, Tanzania, Uganda) is exceptionally rich in biodiversity. It features five global hotspots for plant biodiversity, high levels of endemism and diversity in several financial groups, e.g., 200 endemic fish species and even more mollusks in each of East Africa's Great Lakes.

The Global Taxonomy Initiative defines the taxonomic impediment as "the gaps in knowledge of taxonomic systems, and the reduced conservation impact by not using that knowledge in the management and sustainable use of biodiversity". The GEF has agreed to fund a limited number of regional networks to seek innovative ways to overcome this impediment. BOZONET is one such initiative, now in the detailed planning phase.

LINKING TAXONOMY TO CONSERVATION

Modern conservation practice, seeking to maintain the great majority of the world's species both within both protected landscapes, and within sustainable use regimes in productive landscapes is dependent on a certain level of taxonomic knowledge. Three essential questions for conservation planners are: Which species? Of which rarity status? Where do they occur?

Taxonomic tools or products (species names and distribution maps, keys, floras, faunas, species guides, red data lists, area checklists) are necessary building blocks for biodiversity planners. Such planners feed a second generation of knowledge into the conservation agencies.

BOZONET will bring together those who develop taxonomic tools (the taxonomists) and the end users of that information (the conservationists). But this is not as easy as it sounds. SABONET was developed on the premise that if botanists provide good taxonomic tools, then conservationists would rush to pick them up and use them. Experience showed it needed more than that — national conservation agencies (wildlife, forest departments) needed the capacity to understand and use these tools. Taxonomists write in Latin, and field wardens deal in practical issues: taxonomy is rarely a priority. (The Terminal Evaluation of SABONET highlighted the need to support end-users — Simiyu and Timberlake 2005, see also discussions on conservation- taxonomy linkages in Rodgers 2005.)

Professor Crane, opening the 2004 Congress of the Association of African Plant Taxonomy in Ethiopia, said that the computerised plant distribution databases of SABONET is the most significant and innovative conservation tool developed for African plants for a decade.

The principles of both SABONET and BOZONET link closely to those of the Global Strategy for Plant Conservation (GSPC). For southern Africa a retrofitting of GSPC outputs to those of SABONET showed that SABONET fulfilled almost half of the reporting requirements for southern Africa countries. BOZONET is poised to do the same.

BOZONET: PROJECT OBJECTIVES AND ACTIVITIES

The Overall Goal of BOZONET is to "support the countries of East Africa to remove barriers to the flow of relevant taxonomic information, from networked centres of expertise, to the end-users of such information, and to assist the end-users of the information for the conservation of biodiversity through processes of inventory, planning and resource management."

To achieve this goal, BOZONET, will work in three phases over six years:

1. Building capacity in East African taxonomic institutions (universities, museums, collections) will allow the generation of modern products, such as computerized distribution maps and floras/faunas for key taxa, and computerised keys. End users will be encouraged to help prioritise these key taxa and key areas for conservation.
2. Taxonomic tools will be used by biodiversity surveyors/planners to develop red data lists, identify threatened species and the areas they inhabit. Site lists can identify hotspots for conservation. Sustainable use strategies can be developed for threatened species. Computerised distribution maps on a GIS platform can transform conservation planning.
3. Conservation agencies put into practice these plans and strategies; building them into Protected Area Management Plans and into Monitoring Programmes and Sustainable Use Regulations etc. New Protected Areas may have to be gazetted, conserving key sites.

It is only if this last step is put into place that conservation impact will take place. Preparing keys and floras is the first but necessary step of a long journey.

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THE EUROPEAN DISTRIBUTED INSTITUTE OF TAXONOMY (EDIT): A NETWORK FOR INTEGRATION OF TAXONOMY SUPPORTED BY THE EUROPEAN COMMISSION

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Keywords: Global Taxonomy Initiative, collections, expertise, infrastructure, Information Technology, capacity building

INTRODUCTION

Taxonomy provides the basis for understanding biodiversity. Overcoming the taxonomic impediment involves both having enough trained taxonomists and having taxonomic information available to those who need to use it. The European Distributed Institute of Taxonomy project (EDIT) is a European Commission–sponsored Network of Excellence aimed at starting to overcome the taxonomic impediment through collaboration and a joint work programme. Through EDIT we hope to build capacity globally and provide information and tools for use by all. The EDIT proposal is an initiative of the Consortium of European Taxonomic Facilities (CETAF) which since 1996 has been working for better integration of the taxonomic effort in Europe.

OBJECTIVES

The project's objectives are to help to reduce the fragmentation in European taxonomic research and expertise and to co-ordinate the European contribution to the global taxonomic effort, in particular the Global Taxonomy Initiative, through an integrated initiative aimed at improving society's capacity for biodiversity conservation. EDIT, which is led by the Muséum National d'Histoire Naturelle in Paris, focuses on improving of both production and delivery of taxonomy through (1) coordination of the research policies of its member institutions, which employ altogether some 1,500 researchers and doctoral students in taxonomy; (2) progression toward integration of their scientific expertise and infrastructures to improve both production and access to taxonomic knowledge and information, within the network as well as in the framework of international structures and initiatives, such as the GBIF and the GTI; and (3) inducing cultural change that improves the production of taxonomic results by building an internet platform for elaboration and publication of collaborative revisions on the web, and making this platform freely available to all taxonomists worldwide. A work package is dedicated specifically to training, aiming at developing capacities beyond the consortium in accordance with GTI objectives.

CONTENTS

The EDIT project consists of eight workpackages:

EDIT coordination and management	Simon Tillier
Integrating the expert and expertise basis	Henrik Enghoff
Integrating the infrastructure basis	Wouter Los
Coordinating research	Marian Ramos
Internet Platform for Cybertaxonomy	Walter Berendsohn
Unifying Revisionary taxonomy	Malcolm Scoble
Applying taxonomy to conservation	Christoph Häuser
Training and public awareness	Jackie van Goethem

These work packages address infrastructural, scientific and cultural impediments which hamper both development and availability of taxonomic knowledge. Addressing these challenges will increase the availability of taxonomic data, facilitate the acquisition of new taxonomic knowledge and will help taxonomic capacity building far beyond members of the EDIT consortium, in particular in developing countries.

NEXT STEPS

The EDIT contract is presently under negotiation with the European Commission and is expected to start in 2006. For five years, the network will build up durable integration to improve both production and delivery of taxonomic knowledge for biodiversity sciences. The EDIT network holds the most comprehensive body of literature, specimens, research and expertise in the world. EDIT wants to integrate this body not only inside the initial network, but also over the whole taxonomic community and beyond to create a virtual centre of excellence widely available to users and potentially expandable worldwide.

THE EDIT CONSORTIUM

Muséum national d'Histoire naturelle — Project Leader (FR); Natural History Museum of Denmark, University of Copenhagen (DK); Consejo Superior de Investigaciones Científicas (ES); University of Amsterdam (NL); National Herbarium Netherlands (NL); Natural History Museum Naturalis (NL); Centraalbureau Schimmelcultures (NL); Freie Universitaet Berlin — Botanical Garden and Botanical Museum (DE); Natural History Museum, London (UK); Royal Botanical Gardens Kew (UK); Staatliches Museum für Naturkunde, Stuttgart (DE); Royal Belgian Institute of Natural Sciences (BE); Royal Museum for Central Africa, Tervuren (BE); National Botanic Garden of Belgium (BE); Museum and Institute of Zoology, Polish Academy of Sciences (PL); Institute of Botany, Polish academy of sciences (PL); Hungarian Museum of Natural History (H); Comenius University, Bratislava (SL); Institute of Botany, Slovakian Academy of Sciences (SL); Institut National de la Recherche Agronomique (FR); Society for management of European biodiversity data (IR); Species 2000 (UK); Komarov Botanical Institute of the Russian Academy of Sciences (RU); Zoological Institute of the Russian Academy of Sciences (RU); Missouri Botanical Garden, St Louis (USA); US National Museum of Natural History, Smithsonian Institution, Washington (USA)

SOUTHERN AFRICAN BOTANICAL DIVERSITY NETWORK (SABONET): HAS IT DEVELOPED THE REGIONAL BOTANICAL EXPERTISE IT PROMISED?

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Keywords: SABONET, regional capacity building project, herbaria, botanic gardens

INTRODUCTION

The Southern African Botanical Diversity Network (SABONET) is a Global Environment Facility – United Nations Development Project (GEF–UNDP) regional donor-funded project involved in building the institutional capacity of southern African herbaria and botanical gardens. It is often asked whether SABONET developed the regional botanical expertise it promised; did it enable these institutions to address the needs of stakeholders involved with plant conservation actions in the region?

Incorporating the 10 countries of southern Africa, the Project has involved 17 herbaria and 22 botanical gardens in the preparation of botanical inventories, national plant checklists, national and regional plant collecting expeditions, computerisation of herbaria, post-graduate support for herbarium staff, national and regional training courses, internships for in-service training, production of Red Data Lists, Threatened Plants Programmes in botanical gardens, and workshops for the end-users of taxonomic information.

SABONET has made a significant contribution towards providing a strong base of capable and equipped herbaria and botanical gardens to overcome obstacles in systematic and conservation science in Africa.

ACHIEVEMENTS OF THE PROJECT

1. Established an intra-continental information network between herbaria and botanical gardens.
2. Created a demand for existing African expertise by promoting and marketing plant systematics.
3. Developed communication tools and training for capacity-building in plant systematics.
4. Strengthened existing centres of expertise.
5. Trained personnel in science-based applications such as studies of phylogenetic and species-level diversity.
6. Exchanged staff to build skills and international liaison.
7. Compiled a roster of regional taxonomic expertise, directories of botanical information and checklists.
8. Held thematic workshops to address priority topics.
9. Exchanged complementary skills with the developed world.
10. Contributed to the conservation of large, open systems through plant collecting programmes in under-collected areas.
11. Attended to areas of high endemism and diversity by assessing the conservation status of threatened species.

CONCLUSION

During the years that SABONET was active in southern Africa, it has achieved significant impact in the region as an established and functional botanical network. Capacity has been built and infrastructure been put in place to meet most international recommendations concerning systematics and conservation.

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IABIN: SHARING BIODIVERSITY KNOWLEDGE ACROSS INTERNATIONAL BORDERS

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Keywords: biodiversity information systems, conservation, Inter-American

INTRODUCTION

Biodiversity conservation requires adequate, scientifically sound, biodiversity information that is available in a timely manner. Although there is a real need to generate biodiversity information and to promote this through support to scientific research across the region, often the information gathered at the country level is not available or accessible or is not comparable among countries. An ecosystem approach to biodiversity conservation and strategic environmental planning requires that biodiversity information be integrated and analyzed based on ecoregions across boundaries in a regional context rather than a country level analysis.

With urgent need for regional cooperation, Western Hemisphere countries have created Inter-American Biodiversity Information Network (IABIN) to develop an Internet-based forum for technical and scientific cooperation that seeks to promote greater coordination among countries in collection, sharing, and use of biodiversity information relevant to decision-making and education.

IABIN GOALS

- Support exchange of biodiversity information and expertise across political, linguistic, and institutional boundaries
- Provide access to biodiversity information useful to decision-makers to improve biodiversity conservation
- Enhance capacity to collect, store, and use scientifically credible biodiversity information

IABIN STRATEGIC ACTIONS

These goals are made operational through:

1. Developing an Internet-based, decentralized managed network to provide access to scientifically credible biodiversity information currently existing in individual institutions and agencies in the Americas, in part through the development of Thematic Networks (TNs);
2. Providing the tools necessary to draw knowledge from that wealth of resources, which in turn will support sound decision-making concerning the conservation of biodiversity; and
3. Providing a mechanism in the Americas to exchange information relevant to conservation and sustainable use of biological diversity, thus promoting and facilitating technical and scientific cooperation to help fulfill the mandate of the Clearing-House Mechanism (CHM) of the Convention on Biological Diversity (CBD).

In order to achieve its goals and objectives IABIN is focusing its actions in six TNs, which were prioritized based on countries' interest, existence of regional and sub-regional data in the area of interest, and relevance to regional and global programs and to the Convention on Biological Diversity (CBD), availability of infrastructure, and possibilities to leverage other funding resources.

These TNs include:

- Specimen Network
- Species Network
- Ecosystems Network
- Invasive Species Network
- Pollinators Network
- Protected Areas

IABIN TNs provide access to information, coordinate technology, build capacity for information exchange, and facilitate inclusion of biodiversity themes in national agendas.

IABIN supports and complements the Global Taxonomic Initiative (GTI) efforts to provide taxonomic information and expertise as well as to fill in taxonomic acknowledge gaps through the species and specimen TNs. In addition, a formal collaboration has been established with the CHM to develop synergies among these initiatives. This is also operationalized through the participation of IABIN within the Global Biodiversity Information Facility (GBIF) providing taxonomic and biodiversity data, as well as adopting its standards and protocols to support development of innovative decision-making processes for the sustainable management and conservation of biodiversity.

CONCLUSION

Currently, there are 34 countries and more than 70 institutions and organizations actively participating and supporting IABIN. Additionally, GEF support has been obtained to implement the network and coordination with national, regional, and global initiatives is being carried out.

The Invasive Species Network and a geospatial informal network are already operational. It is expected that by the end of 2005 four other TNs will be operational. Among these, IABIN species and specimen TNs will integrate and make available Western Hemisphere data that will be critical to GTI, CHM, and GBIF efforts in the region.

FISHBASE: CONSTANT EFFORTS AND ACHIEVEMENTS TO MAKE COUNTRY-RELATED INFORMATION ON FISH AVAILABLE TO ALL USERS

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Keywords: Biodiversity information system, fish, web, country related information, check-list

INTRODUCTION

FishBase is a global public resource on all the finfishes of the world, developed as a decision-support information system for natural resource management of aquatic biodiversity. Its development started in 1988 at the International Center for Living Aquatic Resources Management (ICLARM), today the WorldFish Center, member of the Consultative Group for International Agricultural Research (CGIAR), where the encoding team is still hosted. The information system is piloted by the FishBase Consortium, comprising eight national and international research institutions. It is freely accessible on the web (www.fishbase.org) and some versions are distributed on CDROMs and DVDs. It covers a vast range of information on biology, physiology, food, (trophic) ecology, reproduction, life history, population dynamics, diseases, distribution and taxonomy, among other areas.

Knowledge of biodiversity in a country starts with taxonomic knowledge for two reasons:

- the necessity to have an inventory of species occurring in the territories of responsibility (and this is a requirement of the CBD for countries that signed the convention); and
- all the information on species is linked to names of taxa.

Firstly, FishBase was aware of these issues at a very early stage of the project (figure 1). In contrast, other global species databases do not give distribution or only biogeographic information. The latter is interesting for academic purposes (or regional ones in some cases), but does not help countries and their administration to manage their biodiversity. Secondly, since all species cannot be studied for all their biological and ecological features in each country, FishBase collects global data to make available all the information collected on a given species in all countries where this species occurs. Thirdly, we try, as far as possible, to collect "local" studies, mainly those that are documented in technical reports with limited availability in the rest of the world, and even within the country.

DATABASE STRUCTURE AND DATA ENCODING EFFORTS

CountRef table

This table contains all the details on countries in some 200 fields, including: country names (in nine languages), ISO codes, socio-economic and geographic data (also for mapping purposes), summary of information on fish and references used. FishBase has extended the concept of countries to archipelagos and other overseas territories that are far from the mainland of the country, such as the Portuguese Azores Islands and Madeira Island, which constitute two additional entities. Conversely, the Balearic Islands and Corsica are not separated from Spain and France, respectively. Thus, the table contains 301 geopolitical entities (each referred to as a "country" in the following).

Country table (and Occurrence table)

This table provides access to global information on the species occurring in a country. It contains 161,605 records documenting the occurrence status of a species in a particular country. The statuses are: native / endemic / introduced / reintroduced; stray / questionable / extirpated / not established / misidentification / error. The first set of statuses corresponds to the current ichthyofauna, the presence of the species in the country, whereas the second set denotes the presumed absence of the species in the country (see figure 1 for some data encoding details).

In addition, it is indicated whether the species lives in fresh, brackish or salt water, and if it is commercially important, threatened, used in aquaculture, in live trade, as bait, as a game fish, or subject to regulations. The comment field may indicate a precise distribution within the country, and other remarks.

The country occurrence information is not only entered from published national checklists and ichthyofaunas. The encoding process takes into account more general distribution statements at regional, continental, biogeographic region, and large ecosystem levels: the statement "this species is present in North-East Atlantic from France to Morocco" also gives country records for Spain and Portugal, although not explicitely mentioned. The encoding process uses the same type of inference from distribution maps (like those in FAO catalogues). In addition, FishBase provide access to 2 million occurrence records from 43 museum database collections and some surveys on the FishBase website or through the Global Biodiversity Information Facility (GBIF) portal. All these points show how the global information helps countries to have access to information on their own diversity published elsewhere.

Common names

Another important piece of information, linked to traditional knowledge, is common names, sometimes what is only known of a fish by the public at large. Of users who query the FishBase using a name, two thirds use only the common name and only one third a scientific name. Thus 209,817 common names in 264 languages from 243 countries are recorded. Moreover, the non-roman scripts are stored as well as their transliteration. A record of a common name is at minimum the name, the language and the country. Some additional information includes a more precise location in the country, development stage, size, sex, type of name (market, trade), and qualification of name lexemes (color, eponym, shape, etc.).

Other tables

Many other tables include those indicating the country where the study was done (in the case of the photos and checklists).

Searching information by country on the website

On the web site, the section dedicated to country-related data is **Information by Country/Island**. As shown in figure 2, 40 topics can be requested (a gap analysis for missing information on the species of the country will be added soon). Note that the Identification topic gives a quick and simple means to identify species by displaying all the photos available in FishBase of the species of the country. Information by country was the third most frequently accessed topic of the 1.6 million sessions in August 2005.

VALIDATION AND CALL FOR COLLABORATION

One of the difficulties is to know when the information for a country is complete, especially the species lists (but see Figure 1 where the number of records created per year and of countries with records reach a plateau), except when a complete ichthyofauna was recently published and used in FishBase. We also link to national websites. We are seeking national collaborators who could check the national data at regular intervals to validate the information in FishBase. In addition, we have developed generic tools and portals that can be provided to national agencies making possible other collaborations.

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FIGURE 1: Number of record entered and modified in the table country, and number of countries with records per year.

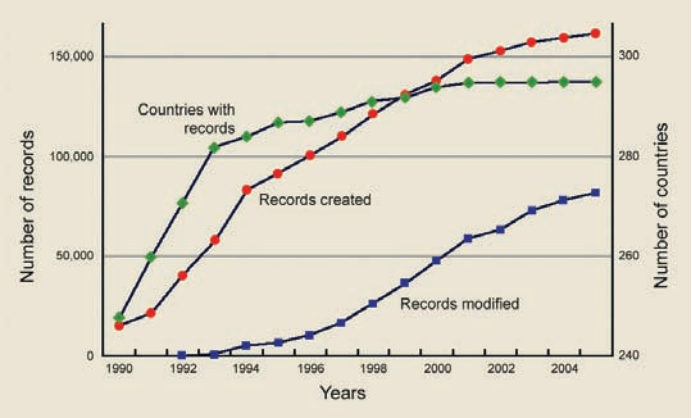
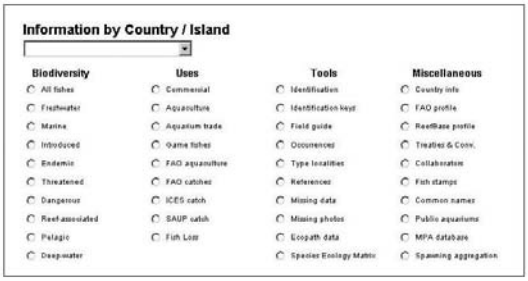


FIGURE 2: Query interface for countries on the FishBase website (www.fishbase.org).



BIODIVERSITY INFORMATION SHARING SERVICE (BISS) FOCUSES ON PROTECTED AREAS OF THE ASSOCIATION OF SOUTH EASTERN ASIAN NATIONS (ASEAN)

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Keywords: information sharing, protected areas, data sharing, biodiversity information systems, ASEAN data

The Association of South Eastern Asian Nations (ASEAN) Regional Centre for Biodiversity Conservation (ARCBC) is a network of institutions designed to strengthen biodiversity conservation in the ASEAN. The Centre is located in Los Banos, Philippines and linked to focal agencies working on conservation of biodiversity among the ASEAN Member Countries. It started operation in 1999 and was jointly funded by the European Union and the ASEAN. Funding from the EU ended on 16 December 2004.

The success and gains of the ARCBC were recognized and paved the way for the establishment of the ASEAN Centre for Biodiversity (ACB), including the Biodiversity Information Service (BISS).

Through the BISS, ARCBC manages and maintains web-based metadatabases consisting of protected areas and species of flora and fauna of the ASEAN and biodiversity institutions, experts and training resources data. The ARCBC metadatabase is accessible through a website (www.arcbc.org).

BISS is a state-of-the-art web-based data management system that is easily transferable to its National Biodiversity Reference Units (NBRUs) or biodiversity focal agencies in each ASEAN country. The database is web-ready and could be used as an effective database platform suitable to the needs of the NBRUs and the ARCBC.

BISS includes the following software products for making on-line databases:

1. ABISS Web-database module: full biodiversity data search and retrieval engine on any number or type of items stored in the database. It has a mapping feature which can show a map of a region showing point data from the database with any number of zoom levels. Individual points can be querried to have access to the underlying data (e.g. distribution of species)
2. GenSQL: data transfer utility which uses Borland Database Engine (installed with it)
3. Remote Datapump: enables the transfer of data tables between two different databases, or to update data from another table in a remote or local server (web-based)
4. BISS Editor: provides easy access to records and datasets in a SQL database
5. BISS Mapper: displays a map of a region showing point data from the database with any number of zoom levels. Individual points can be queried to have access to the underlying data (e.g. distribution of species).

The website shows the searchable database of plants, butterflies, amphibians, birds, reptiles, and freshwater fish. On-line species data includes 2,396 birds, 945 mammals, 655 amphibians, 1,995 freshwater fish, 1,652 reptiles, and 33,411 plants. The database for plants is linked to the website of Leiden Herbarium; the amphibian database is linked to the American Museum of Natural History; the mammal database is linked to the Smithsonian Institutions website; and the freshwater fish databases is linked to the FishBase website. A total of 1,518 protected areas are currently on-line.

All these software products were produced with free software and given for free to NBRUs to be used in managing their country data sets. Even maintenance use is free of charge.

The ASEAN Centre for Biodiversity continues to maintain and develop the BISS for further development and in follow-up of BISS training for the counterparts in the ASEAN region.

THE TREE OF LIFE WEB PROJECT: A DIGITAL LIBRARY OF BIODIVERSITY INFORMATION

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Keywords: biodiversity, phylogeny, digital library, database, diverse user communities

INTRODUCTION

The Tree of Life Web Project (ToL, http://tolweb.org, Figure 1) is a collaborative effort of more than 400 biologists from over 20 different countries. The ToL web site currently offers more than 4,000 web pages providing synopses of the characteristics of different groups of organisms as well as discussions of their phylogenetic relationships. In order to illustrate the genetic connections between organisms, ToL pages are linked to one another hierarchically, in the form of the evolutionary tree of life.

Administration of the project follows a hierarchical, community-based model, with authors for different parts of the **ToL** chosen by the scientists working in that particular field. The audience of the **ToL** project ranges from professional scientists to teachers, students of all grade levels, and lifelong learners. The website currently serves approximately 150,000 unique visitors each month, from about 150 different countries.

The main goals of the project are to:

1. document the world's organisms and our knowledge of their phylogenetic relationships.
2. encourage and facilitate research about biodiversity and phylogeny.
3. increase knowledge about all kinds of organisms, familiar and obscure, among the public as a whole, and thus to inspire a greater appreciation for biodiversity.
4. portray the tree-like interconnectedness of all of life, and the importance of this organizational structure to the understanding of biological knowledge.

The **ToL** website provides open access to a large collection of detailed, expert content. Taxonomists and phylogenetic biologists use the project as an efficient, user-friendly platform for the dissemination of their research results to a diverse, global audience. Interdisciplinary and international collaborations are encouraged by a community-oriented administration model, and the system is designed to facilitate the sharing of content and software tools with other, related projects.

While most of the current ToL content consists of technical contributions from expert scientists, the project also collects materials specifically aimed at learners of all levels, including exercises, stories, scientists' biographies, instructional games, and teacher resources. ToL materials designed for children and the young at heart are presented on special webpages called *treehouses* (Figure 2), which are attached to scientist-generated *branch* and *leaf pages* (Figure 3) providing the project's scientific core content. The juxtaposition of contributions by young amateur scientists with content provided by professional researchers is intended to encourage ToL treehouse builders in their pursuit of scientific investigations and their documentation; furthermore, we hope that some of our young contributors will thus be motivated to choose careers in biodiversity, taxonomy, and phylogenetics.

Another notable merit of the ToL is its presentation of the evolutionary tree of life as an integrated whole. The architecture and navigational structure of the project is in one-to-one correspondence with

the basic structure of evolutionary history. In navigating across ToL, pages, users are thus instilled with a vision of the genetic connectedness of all life, the cornerstone of modern biological knowledge and its organization. Facilitating the casual or systematic exploration of broad-scale patterns, this approach encourages both learners and researchers to trace the distribution of characteristics across the branches of the tree and to ponder the forces that may have shaped the observed diversity of living things.

TECHNICAL IMPLEMENTATION & INFORMATION ARCHITECTURE

The **ToL** website relies on a dynamic system backed by a relational *MySQL* database. Requests for webpages are received by an *Apache* web server running on *Linux* OS, and pages are created dynamically from the database using the *Jakarta Tapestry* web development framework along with *Hibernate*'s object/relational mapping.

The structure of the ToL database and website is based upon the phylogenetic relationships between the organisms the project sets out to catalogue and describe. This structure is achieved via a node-based information architecture. Nodes are branching points in the phylogenetic hierarchy of life. Each node represents a particular group of organisms, including all descendents of a common ancestor, and descendent nodes correspond to subgroups of the group represented by the parent node.

Materials contained in the ToL databases (e.g., text, images, sounds, movies, maps, numerical data) are treated as objects that are attached to individual nodes following a nested hierarchical schema: nodes deep in the tree of life have objects attached that apply to large, more inclusive groups of organisms (or their ancestors), while nodes higher up in the tree own objects that apply to less inclusive groups, up to the level of individual species and subspecies.

Attaching objects to relevant nodes in the tree automatically organizes them hierarchically, according to phylogenetic hypotheses; the ToL system is, therefore, able to act as a source of phylogenetically structured data about organisms. Currently ToL data are used primarily to create ToL webpages, which are themselves objects attached to the nodes of the organisms they describe. In the future, these data will also be made available to other projects with an interest in phylogenetically structured data about organisms. In addition, we envision the integration of analytical programs (e.g., *Mesquite,*), so that ToL data can be used for *in situ* analyses of patterns of biological diversity across the phylogeny.

FIGURE 1: The ToL home page: http://tolweb.org

FIGURE 2: ToL treehouses: http://tolweb.org/tree/home.pages/treehouses.html

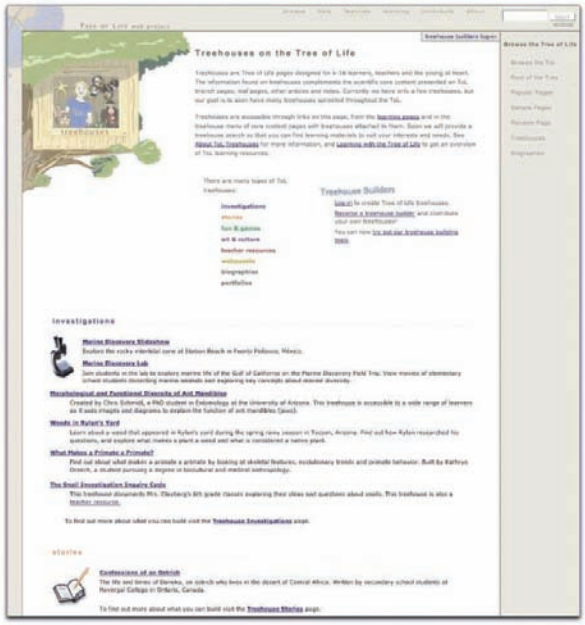

FIGURE 3: ToL scientific core content, e. g., a branch page: http://tolweb.org/tree?group=angiosperms

TAXONOMY AND BIOINFORMATICS ON THE FRONT LINE: BATTLING ALIEN INSECTS IN CANADIAN FORESTS

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Keywords: alien species, insect taxonomy, biological collections, Canadian Biodiversity Information Facility

CANADA: AN INVADED LAND

- Since European colonization, thousands of alien species have been introduced into Canada. The rate of introductions is increasing, in step with global trade.
- Biotic invasion is most evident in urban and agricultural areas but some introduced species successfully invade natural habitats, causing significant economic and environmental impact (Scudder, 2002).
- Management or eradication of invaders necessitates their early and reliable identification. This requires taxonomic expertise and facilities;
- Bioinformatics — mining existing specimen collections and taxonomic literature — will help make taxonomic information more widely and quickly accessible.

TAXONOMY AND EARLY INTERVENTION

- Rapid and correct identification of alien species permits effective management responses by distinguishing alien invaders from native species and allowing the scientific community to rapidly access existing information on them.
- Species identification is challenging and depends on availability of expert taxonomists, collections of authoritatively identified specimens, and specialized literature.
- Taxonomic expertise develops through active research and accumulated knowledge on the global diversity of various groups of organisms.
- Taxonomists publish information, e.g., identification keys, species descriptions and illustrations, used by non-experts to identify specimens. Up-to-date keys exist for only a fraction of North American species, let alone related species elsewhere.

BIOINFORMATICS: ACCESSING AN INFORMATION TREASURY

- Biological collections contain specimens with associated information, which objectively records the occurrence of species in space and time (Wheeler et al., 2001), and from which inferences about phenology, habitats, hosts and rate of spread are obtained.
- Such data are increasingly available globally through on-line databases. Alien insects and fungi on Canadian trees, represented by about 35,000 of the 16 million specimens in the Canadian National Collection of Insects and Arachnids and the six, smaller collections of the Canadian Forest Service (CFS), are being databased as part of a national project to develop and distribute an interconnected network of information on accurately identified and geo-referenced specimens. The information will be distributed through the Canadian Biodiversity Information Facility (http://www.cbif.ca), Canada's node in the Global Biodiversity Information Facility.

TAXONOMY AND BIOINFORMATICS: BOLSTERING THE ARSENAL

- Despite society's increasing need for taxonomic knowledge and products, investment in taxonomic research has not kept pace with demand (Huber and Dang 2003; Huber and Langor, 2004). Mere re-packaging of old and often-outdated taxonomic information is not good enough. Significant new investment in taxonomic research is essential to "hold the line" against biotic invasions and to meet other current and unforeseen environmental challenges.
- Investment in mining the largely untapped information lode in biological collections will be repaid many-fold through i) increased understanding of the spread of alien species and ii) more effective control.
- The scientific and economic value of collections grows with time as increasing information is archived in the form of voucher specimens (Wheeler, 2003). Such collections require continued attention and investment to maximize their use. Critical areas for investment are in research taxonomists, managers (curators) with identification expertise, and infrastructure.

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DNA BARCODING AND THE CONSORTIUM FOR THE BARCODE OF LIFE

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Keywords: Taxonomy, species identification, molecular biomarkers, DNA barcoding, biodiversity

INTRODUCTION

Approximately three years ago, "DNA barcoding" was proposed as a rapid and cost-effective method for identifying species using a very short gene sequence from a standardized position in the genome (Hebert et al., 2003). The "barcode region" would have to evolve at a rate that would distinguish species from each other while remaining more or less identical for all members of the same species. It would also have to be flanked by conserved regions so as to make polymerase chain reaction (PCR) amplification practical, and would have to be relatively free of insertions and deletions for easy alignment. The mitochondrial gene cytochrome c oxidase 1 (COI) seems to meet these criteria extremely well for most eukaryotic animals. Kress et al., (2005) have proposed two barcode regions for plants, and there are efforts underway to find a barcode region (or regions) that will work across all land plants.

DNA BARCODING IN TAXONOMIC RESEARCH AND BIODIVERSITY STUDIES

DNA barcodes is proving to be a valuable tool that complements and enhances traditional taxonomic research in three ways. First, most species descriptions rely on adult morphology. Diagnoses can be extremely difficult for immature life stages. In highly dimorphic species it is difficult to associate the males and females of the same species. Since DNA barcoding requires only a small amount of DNA, all the life stages and sexual morphs of a species can be united under a comprehensive species concept.

Second, DNA barcoding provides a lens through which hidden variation is being found. Barcode data is uncovering new and cryptic species that were overlooked or were only suspected on the basis of morphological characters. Using COI data, Hebert et al. (2004a) found suggestions of 10 cryptic species within what had been considered a single widespread species of skipper butterfly. Caterpillar coloration, host plant preferences and other ecological data proved to be consistent with the species delimitations suggested by DNA barcode data. Hebert et al. (2004b) used COI data to uncover previously overlooked cryptic species of North American birds.

Third, barcode data are proving useful in the search for new species in poorly known taxonomic groups, especially those that lack distinctive morphological traits (Blaxter et al., 2005). By using barcode data for the preliminary sorting of specimens, taxonomists can begin to make sense of difficult groups. Taxonomists are using different data types sequentially, in different orders, with the goal of constructing integrative species descriptions that rely on a variety of data types (e.g., genetic, morphologic, ecologic).

APPLYING DNA BARCODING TO SOCIETAL PROBLEMS

DNA barcodes can be invaluable in situations where rapid, accurate and cost-effective specimen identification is needed for regulatory or legal reasons. Border control agents often encounter eggs, larvae, damaged or incomplete specimens, and processed products which are difficult or impossible to identify using traditional taxonomic procedures. For example, barcoding can support efforts to protect endangered species (e.g., primates and other protected species endangered by bushmeat hunting), and control invasive and pest species (Armstrong and Ball 2005) and disease vectors.

THE CONSORTIUM FOR THE BARCODE OF LIFE

The Alfred P. Sloan Foundation has granted $669,000 to the Smithsonian Institution to establish the Consortium for the Barcode of Life (CBOL), an international initiative devoted to promoting the growth and use of DNA barcoding. CBOL's Secretariat is located in the National Museum of Natural History in Washington, DC. Since CBOL's launch in May 2004, more than 80 institutions have become Member Organizations by signing a Memorandum of Cooperation and agreeing to deposit their barcode data in a public repository. The members include museums, herbaria, zoos, biodiversity research institutes, universities, conservation organizations, government agencies and private companies. CBOL has held one international conference and supports several Working Groups that improve the scientific and technological basis for barcoding. Several regional meetings in South America, Africa and Asia are being planned to increase the participation of developing countries in DNA barcoding activities.

SUMMARY: THE DEMOCRATIZATION OF TAXONOMY THROUGH DNA BARCODING

The Global Taxonomy Initiative works to overcome "the taxonomic impediment" — the lack of data concerning Earth's biodiversity which limits our ability to manage living resources in a sustainable and responsible manner. The shortage of trained taxonomists and access to the essential information resources (especially museum and herbarium collections, taxonomic publications, databases on the Web) are most acute in developing countries where biodiversity is highest. DNA barcoding has the potential to increase access to taxonomic knowledge in all regions of the world. Databases of reference barcodes are connecting specimens to their correct species names, providing a direct route to species information associated with those names. CBOL is working with GenBank and its partner DNA repositories (European Molecular Biology Laboratory (EMBL) and DNA Data Bank of Japan (DDBJ)) to construct a global library of reference barcode sequences. Each barcode record is linked to a voucher specimen in a collection, a valid species name, and the associated taxonomic literature. Connections are being built to the Global Biodiversity Information Facility (GBIF) and other biodiversity data portals. Through these efforts, an integrated information infrastructure for taxonomy is growing rapidly.

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TAXONOMY IN ZIMS

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Keywords: Taxonomy, ISIS, ZIMS, mapped taxonomies, taxon subsets

INTRODUCTION

The International Species Information System (ISIS), which represents more than 650 zoological institutions in more than 70 countries, has worked with the worldwide zoological community to create the Zoological Information Management System (ZIMS). ZIMS is a web-based, real-time, global database of information on 2 million zoo animals and their environments. Figure 1 shows the reach of ISIS membership.

ZIMS will allow ISIS member institutions to share a comprehensive, integrated and current collection of animal, veterinary, husbandry, group and environmental data. Through ZIMS, zoo and aquarium staff can track their animal collections pre-birth (eggs or pregnancy) through post-death (autopsy and pathology), and keep all staff up-to-date as the collection changes.

By working together to enhance and fully use the ZIMS application, we will provide groundwork for international communication in the zoological community on a level never before imagined. The deployment of ZIMS within ISIS member institutions will begin in May 2006.

TAXONOMY IN ZIMS

All ISIS software to date has included a single taxonomic list, which is amalgamated from a number of published and unpublished taxonomic references. Exact synonyms are included and for the most part limits are deducible, but such lists are hard to update and occasionally ambiguous. There is a great need for clear communication between zoological institutions reliant on data originating halfway around the world.

ISIS will continue to maintain a unitary taxonomy but all names in ZIMS will be referenced so that the sense in which they are used is explicit. This is needed because the same name does not necessarily mean the same thing in different taxonomies, and yet it is critical that the global ISIS community can communicate unambiguously. By providing every name with a reference, anyone anywhere can look up what is meant by the name with regard to limits. Accurate taxonomy is important in conservation, and its interpretation must be at least as accurate.

Further, in ZIMS, the ISIS unitary taxonomy will be updated when crucial taxonomic revisions are published. Because data are attached to names and an update requires the transfer of information from one taxon to another, taxonomies in ZIMS are mapped through the species-group name. This allows for the constant evaluation of the limits of a name in one taxonomy with the limits of the same name in another taxonomy. Such relational taxonomies are universal translators for scientific names (see Andrew and McAllan, 1998).

The use of mapped taxonomies not only allows the maintenance of a contemporary unitary taxonomy, it also offers ISIS institutions choice in the taxonomies they use. Institutions, and regions, should be able, but not be obliged, to rapidly react to changes in taxonomic opinion. The Australasian Species Management Program might reasonably track marsupial classification more diligently than other regions. The use of multiple mapped taxonomies allows flexibility with no loss of precision, and allows for the transfer of taxonomically arranged data within ZIMS and between ZIMS and other biological databases.

ISIS is very interested in being able to exchange data with other external taxonomic databases, and since ZIMS is a .NET, web-based application, the possibilities of data exchange will now be available.

NON-TAXONOMIC GROUPS IN ZIMS

There is also a need to be able to group specimens according to non-taxonomic criteria. Taxonomies might remain the primary arrangements used to catalogue the natural world, but categorisation based on smaller, non-taxonomic units referred to in ZIMS as 'taxon subsets' is sometimes useful. Taxon subsets are subsets of taxa that are used to cluster specimens according to non-taxonomic criteria. There are two types of taxon subsets: provenance subsets and breed subsets.

Provenance subsets are groups of specimens from a prescribed geographical area. Location coordinates (GPS, polygons, etc.) are required to define the boundaries of the geographical area. Provenance subsets might be used to group specimens into management units that are administratively based rather than taxonomically based (nested under species or subspecies), or groups of specimens of uncertain species or subspecies that await taxonomic appraisal (nested under genus or species).

Breed subsets are groups of specimens clustered according to some pedigree of goal-oriented selection. They are not related to geographical boundaries. The numerous breeds currently in the ISIS list will become breed subsets, nested under the taxon from which they have been derived. 400 breeds of ancestral *Bos primigenius* are not taxa but should be available to, for example, rare breed societies and agricultural and veterinary institutions.

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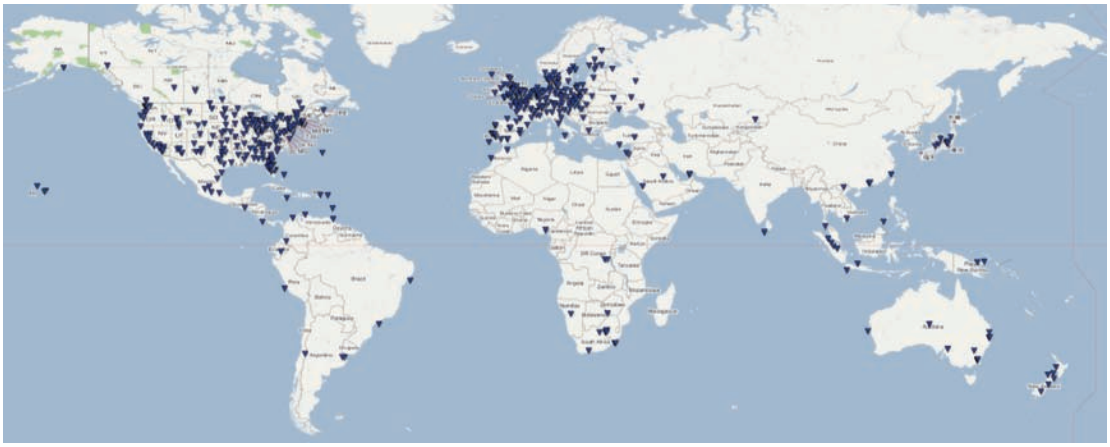
FIGURE 1: ISIS membership (October 2005).



SABONET: LEARNING BY DOING

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Keywords: SABONET, regional capacity building project, herbaria, botanic gardens, Southern Africa

INTRODUCTION

SABONET (Southern African Botanical Diversity Network), formally called "Inventory, Evaluation and Monitoring of Botanical Diversity in Southern Africa: a Regional Capacity and Institution Building Network" is a Global Environment Facility (GEF) project implemented by the United Nations Development Programme (UNDP) and executed by the South African National Biodiversity Institute (SANBI) — previously called the National Botanical Institute (NBI). It was co-funded by the United States Agency for International Development/The World Conservation Union's Regional Office for Southern Africa (USAID/IUCN-ROSA) through the Networking and Capacity Building Initiative for Southern Africa (NETCAB) programme.

The SABONET Project started in 1996 and officially ends on 31 December 2005. The project aimed at developing human capacity in southern Africa, and targeted southern African national and university herbaria and botanical gardens. Its immediate objective was to "develop a strong core of professional botanists, taxonomists, horticulturists, and plant diversity specialists within the 10 countries of southern Africa, competent to inventory, monitor, evaluate, and conserve the botanical diversity of the region in the face of specific developmental challenges, and to respond to the technical and scientific needs of the Convention on Biological Diversity". The 10 southern African countries that participated in the SABONET Project are Angola, Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Zambia, and Zimbabwe.

OUTPUTS OF THE PROJECT

Training courses, postgraduate studies and workshops

SABONET has sponsored the training of 26 students (at least one from each participating country, 13 male/13 female) to obtain a total of 36 degrees (14 BSc Hons, 1 B.Tech and 21 MSc degrees), has conducted numerous workshops and training courses, and has participated in several international workshops and conferences. Training courses developed and presented by SABONET include courses in plant identification, herbarium management, botanical garden management, database management, environmental impact assessment, botanical art drawing, and cycad conservation. SABONET has also instituted a very successful internship programme that further encouraged co-operation amongst the 10 participating countries and contributed to the continuing education of staff associated with the participating institutions.

Publications

From March 1996 to October 2005, SABONET has published nine volumes (24 issues) of the SABONET News, and 38 numbers in the SABONET Report Series. Another five numbers are in the final stages of being published in the SABONET Report Series. Amongst the publications produced by SABONET are seven national checklists of vascular plants, five national Poaceae checklists, one national bryophyte checklist, two publications on ferns and fern allies (one regional and one national), one field guide to *Trees of Botswana*, a conservation checklist of the Nyika Plateau, Plant Red Data Lists for nine countries (in one volume), *Seed Plants of South Tropical Africa*, two publications detailing end-user needs, two *Index Herbariorum* supplements for southern Africa, herbarium and botanic garden needs assessments, and an environmental interpretation guide for use in botanic gardens.

Capital equipment

To increase the participating institutions' ability to conduct plant taxonomic and biodiversity research, SABONET purchased the following kinds of equipment for the institutions: computers, digital cameras, film cameras, guillotines, light microscopes, off-road vehicles, UPSs, camping equipment, deep freezers, drying ovens, fax machines, global positioning systems (GPSs), herbarium cabinets, microwave ovens, printers, stereo microscopes, and air conditioners. It also funded Internet and email facilities for some of the institutions.

Plant collecting, computerisation and contract staff

SABONET has organised and participated in two regional expeditions (to the Nyika Plateau in Malawi and Zambia, and to southern Mozambique) and numerous national collecting trips within each of the 10 countries. Collection trips targeted under-collected areas and aimed at increasing herbarium collections.

The participating herbaria have computerised almost half-a-million herbarium specimens under the auspices of SABONET, which increased these institutions' ability to access botanical information and produce distribution maps.

SABONET employed more than 70 people in the region as research officers, herbarium technical assistants, data entry clerks, and horticulturists.

CONCLUSION

Having been very successful in its primary objective of building a strong core of professional botanists, taxonomists, horticulturists, and plant diversity specialists within the 10 countries of southern Africa, the SABONET project's exit strategy included hosting Important Plant Areas (IPAs) workshops (one regional and two national), and sponsoring one national IPA desktop analysis. The Terminal Evaluation of the Project took place in February and March 2005, and resulted in a very positive report from the evaluators.

THE CONSERVATION COMMONS: ADVOCATING A NEW KNOWLEDGE MANAGEMENT PARADIGM IN THE CONSERVATION COMMUNITY

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Keywords: data integration, knowledge management

Comprehensive data, information and knowledge resources are essential for the conservation and sustainable use of biodiversity. Difficulties in accessing information, and in particular intelligently linking disparate data and information assets together often limit our ability to plan and implement successful conservation strategies.

The Conservation Commons is a cooperative effort amongst like-minded conservation organizations and research institutions which is responding to this challenge by seeking to ensure — wherever possible — open access and responsible use of data, information, and expertise on the conservation of biodiversity for the benefit of the global conservation community and beyond. Along with similar initiatives in the environmental field, the Conservation Commons seeks to broaden the base of access to emerging data, information, and knowledge resources on biodiversity conservation from the greater conservation community, and to effectively integrate and leverage these assets in support of best practice, effective policy development and decision-making. Web-enabled geographic information management and visualization tools, linking vast quantities of distributed data and information, are rapidly emerging as an important standard to improve interoperability in this field.

PRINCIPLES OF THE CONSERVATION COMMONS

Open access

The Conservation Commons promotes free and open access to data, information and knowledge for all conservation purposes.

Mutual benefit

The Conservation Commons welcomes and encourages participants to both use resources and to contribute data, information and knowledge.

Rights and responsibilities

Contributors to the Conservation Commons have full right to attribution for any use of their data, information, or knowledge, and the right to ensure that the original integrity of their contribution to the Commons is preserved. Users of the Conservation Commons are expected to comply, in good faith, with terms of uses specified by contributors.

The following organizations are among a growing number that recognize the need to change the way we store and disseminate conservation data and information, and who have endorsed the Principles of the

Conservation Commons:

- American Museum of Natural History; London Natural History Museum
- BirdLife International
- Chevron Texaco Corporation
- Center for International Forestry Research
- Centro de Referência em Informação Ambiental (CRIA), Brazil
- CONABIO – Mexico
- Conservation International
- CRIA - Brazil*
- Environmental Education Center – Russia "Zapoveniks"
- Fauna & Flora International
- Friends of Nature Foundation, Bolivia
- Global Biodiversity Information Facility (GBIF)
- Global Invasive Species Database (GISD)
- Global Invasive Species Programme (GISP)
- GreenFacts
- Information Center for the Environment (ICE), U. of California, Davis
- INSnet, Internetwork for Sustainability
- Instituto de Investigacion de Recursos Biologicos Alexander von Humboldt (Colombia)
- International Center for Himalayan Biodiversity
- International Commission on Zoological Nomenclature
- Invasice Species Specialist Group of IUCN/SSC (Species Survival Commission)
- IUCN – The World Conservation Union
- NASA, United States
- Nature Protection Trust of Seychelles
- Nature Serve*
- PALNet – Protected Areas Learning Network (from WCPA of IUCN)
- Rio Tinto
- Shell Exploration
- Social Insects Specialist Group SISG of SSC*
- Society for Conservation GIS
- South African National Biodiversity Institute – SANBI*
- The African Conservation Foundation
- The Natural History Museum, London
- The Nature Conservancy*
- The Rainforest Alliance
- The Smithsonian Institution
- The Zoological Society of London
- TRAFFIC International
- UNDP
- UNEP WCMC
- University of Maryland – Global Land Cover Facility*
- World Commission on Protected Areas (WCPA of IUCN)
- WWF Brazil
- WWF International

AUSTRALIA AND THE GLOBAL TAXONOMY INITIATIVE: THE CONTRIBUTION OF THE AUSTRALIAN BIOLOGICAL RESOURCES STUDY

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Keywords: Australia, biodiversity, online, reliability, biota, taxa, identification tools

INTRODUCTION

The mission of the Australian Biological Resources Study (ABRS), a program of the Australian Government, is to foster national taxonomic capability and to deliver high quality information on Australia's flora and fauna. ABRS offers funding for taxonomic research, and for projects to develop identification tools and collate and disseminate information on Australia's biota, as well as for PhD scholarships and student bursaries. We emphasise that all our projects involve collaboration with the national and international community of taxonomists and their institutions and, while delivery of reliable taxonomic information on Australia's biota is our core work, we also collaborate on projects to develop biodiversity informatics facilities and tools.

For maximum benefit within Australia and internationally, we increasingly emphasize free electronic delivery through the ABRS website. Our online databases (see ABRS 2005, Online Resources) include the *Flora of Australia Online* and the *Australian Faunal Directory,* and we provide links to other ABRS-supported databases. The international biodiversity informatics projects in which ABRS is involved include the *Australian Biodiversity Information Facility* (ABIF), Australia's node of the *Global Biodiversity Information Facility* (GBIF); and the *Biodiversity Analysis Tool* (BAT), a GBIF demonstration project to develop a simple on-line tool that enables users to query data from biodiversity collections to derive maps of species richness, endemism and taxonomic diversity. Being available to users worldwide, these products all contribute to the Global Taxonomy Initiative (GTI).

MAGNITUDE OF THE TASK

The biota of Australia is currently estimated to include 7,558 described vertebrates (i.e. about 90% of the estimated total species); 114,600 described invertebrates (about 46% of the estimated total species); 20,000 described vascular plants (about 87% of the estimated total species); and 30,000 described species belonging to groups such as lichens, fungi, algae and bacteria (about 1 to 8% of the estimated total species) (Chapman, in prep.).

ABRS CORE BUSINESS CONTRIBUTES ACROSS ALL THEMATIC AREAS

ABRS, working in collaboration with herbaria, natural history museums and universities, nationally and internationally, contributes to all seven major thematic areas identified by the GTI. The following ABRS key projects cut across all seven GTI thematic areas (see ABRS 2005, Publications):

- the *Flora of Australia* series, including vascular plants, lichens and bryophytes
- the *Fungi of Australia* series

- the *Australian Faunal Directory*

Each of these projects focus on documenting all described species recorded in Australia and its island territories.

Progress on the *Flora of Australia* to date includes publication of 29 of an expected 65 volumes; 11 of these are now freely accessible online. Preparation for a further five volumes of the *Flora* is well advanced, and more of the published volumes will be online shortly. Five volumes of the *Fungi of Australia* are now published. The *Australian Faunal Directory* now lists around 60% of the described fauna. Checklists of lichens, and liverworts and hornworts are freely available on the ABRS website and are updated regularly.

Another core role of ABRS is in training of taxonomists, and this takes the form of financial support for four PhD students, and provision each year of bursaries that assist 10 to 15 postgraduate students to attend conferences.

SPECIFIC FOCUS ON THEMATIC AREAS

ABRS also focuses on development and delivery of products that contribute to specific thematic areas of the GTI, often aimed at broader client groups.

In relation to the GTI target area *Forest Biological Diversity,* the ABRS *Flora of Australia* series, *Fungi of Australia* and works on Lichens and Bryophytes provide the basic information for development of forest biodiversity inventories. Tools such as the interactive CDRom keys *Mites in Soil* (Walter & Proctor 2001) and *Spiders of Australia* (Raven *et al.* 2002) enable identification of taxa, leading to recognition of biodiversity indicator groups.

A number of ABRS products target *Marine and Coastal Biological Diversity*, cataloguing the species recorded from Australia, and providing identification tools to enable early detection of alien species and monitoring of the health of coastal systems such as mangroves. These products include the online interactive key to identification of Polychaete worms *POLiKEY* (Glasby & Fauchald 2003); *Fabulous Flatworms, a guide to marine polyclads* (Newman & Cannon 2005); the texts *Marine Benthic Flora of Southern Australia* (Womersley *et al.* 1994-2003); and online fauna catalogues for groups such as Tunicates, Sponges and Echinoderms. *Antarctic Marine Protists* (Scott & Marchant 2005) was published recently by ABRS and the Australian Antarctic Division, and texts on Echinodermata and Bryozoa, in preparation, include specific sections on ballast and fouling organisms.

Particularly significant in Australia is the development of identification tools that enable assessments to be undertaken in the GTI thematic area of *Dry and Sub-Humid Lands Biodiversity*. Australia has a pressing problem with dryland salinity, and interactive keys such as *Wattle, Acacias of Australia* (Maslin 2001), *AusGrass — Grasses of Australia* (Sharp & Simon 2002), and *Key to the Genera of Australian Macrolichens* (Glenny & Malcolm 2005) enable assessments of biodiversity of these areas and identification of specific indicators.

Similarly, *Inland Waters* are of critical importance to Australia, and ABRS provides baseline data in the form of catalogues of the species occurring in these systems. For example, all the major aquatic macroinvertebrate groups are catalogued in the online *Australian Faunal Directory* (ABRS 2005, Online Resources). The *Bibliographic Checklist of Non-Marine Algae in Australia* (Day *et al.* 1995) provides the starting point for studies on groups such as diatoms and green algae, and for the far north of the coun-

try, *Floodplain Flora: a flora of coastal floodplains of the Northern Territory, Australia* (Cowie *et al.* 2000) is an aid for conservation management of these habitats. Available soon will be a web-based tool, *Habitat Profiles of Selected Aquatic Insects* (Suter, in prep.), that characterizes habitats of selected aquatic invertebrates, enabling better assessment of indicator groups used in rapid biodiversity assessment of inland waters.

Australia is renowned for its geology, being an old, heavily eroded continent. A mountain chain delineates the east of the continent, extending into Tasmania where the mountains are home to an unique *Mountain Biological Diversity*. Aspects of this are documented in collaborative works such as *Lichens of Rainforest in Tasmania and South-eastern Australia* (Kantvilas & Jarman 1999), *Vegetation of Tasmania* (Reid *et al.* 1999) and *Tasmanian Lichens: Identification, Distribution and Conservation Status* (Kantvilas *et al.* 2002).

As a large island nation, Australia is particularly concerned with aspects of *Agricultural Biological Diversity*, especially in relation to biosecurity. Knowing what we have is critical to early detection of alien species. Thus the ABRS catalogues, checklists, and volumes inform on component species of the native flora and fauna. For crop protection the databases of Thysanoptera (thrips), Psyllidae (jumping plant lice and lerps), Coccoidea (soft and hard scales), Aleyerodoidea (white fly) are valuable basic tools, each including names of associated plant species. The Aphidoidea (aphids) will also be online soon. The online catalogue of Australian Apoidea provides information on this important group of pollinators and the interactive keys *AusGrass — Grasses of Australia* (Sharp & Simon 2002) and *Mites in Soil* (Walter & Proctor 2001) are tools that aid assessment and inventory of agricultural biological diversity.

Australia's states and territories include a number of small islands, and ABRS has collaborated on a number of projects to document and disseminate information on their *Island Biodiversity*. Among these are the *Flora of Australia* volumes 49 and 50 (see ABRS 2005, Publications) which cover Australia's oceanic islands including Norfolk Is., Lord Howe Is., Christmas Is., Cocos (Keeling) Is., Ashmore Reef, Cartier Is., the Coral Sea Islands, Macquarie Is., Heard Is. and McDonald Is. Both these volumes are now also available in *Flora of Australia Online* (see ABRS 2005, Online Resources). Separately, ABRS has collaborated in publication of the *Mosses of Norfolk Island* (Streimann 2002) and the *Native Plants of Christmas Island* (Claussen 2005); most of the fauna databases in the *Australian Faunal Directory* include the faunas of Australia's island territories (see ABRS 2005, Online Resources).

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A PRELIMINARY CHECKLIST OF THREATENED PLANTS IN THAILAND

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Keywords: *Threatened plants, protected areas, Thailand, check-list*

INTRODUCTION

A checklist has been compiled at the Forest Herbarium (BKF), Bangkok, as a preliminary investigation of the potentially threatened vascular plants of Thailand. It may serve in the future as a basis for comprehensive assessments using the World Conservation Union — Species Survival Commission (IUCN-SSC) Categories and Criteria of threat. The data for the checklist originated from the various sources of information i.e. specimens kept in the Forest Herbarium as BKF specimens database, Flora of Thailand, relevant publications, new and not yet published data by BKF staff and foreign collaborators, books on endemic and rare plants in Thailand by T. Santisuk (2000, 2004). The list includes endemic and rare taxa, the main criteria used so far for rarity being restricted distribution ranges and paucity of specimens collected.

Biogeographically, Thailand lies between the Indochinese and Sundaic (Indomalayan) regions, and is considered a collective centre of botanical diversity from three regional elements: Indo-Burmese, Indo-Chinese and Malesian. As a result, Thailand shares its flora with many neighbouring countries, therefore limiting the number of true endemics. However, the BKF database and flora publications showed that many taxa have been found within restricted areas, including true cases of endemism for the country. It is considered that the endemic and rare plants in Thailand are mainly determined by climatic and topographic factors including limestone hills and high mountainous areas.

This work is only a first step in the process of cataloguing plant species for which conservation is a concern in the country. It is hoped that it will serve its role as a basis for a thorough assessment of all vascular plants in Thailand using the IUCN Categories and Criteria of threat. It is also hoped that it will help the country implement the UN Convention on Biodiversity, especially in regard to the programme on protected areas.

CHECKLIST OF THREATENED PLANTS IN THAILAND

Only one volume has so far been published (Pooma et al., 2005). It covers 1,131 taxa within 394 genera and 48 families, 456 of the species being illustrated with photographs. Notes on habitats and distribution ranges are given for all taxa. Sixteen species are newly recorded for the country and four are most probably new to science (three in Aristolochiaceae and one in Labiatae). IUCN Categories and Criteria were indicated only in the Dipterocarpaceae (ver 2.3, 1994) and Cycadaceae (ver 3.1, 2001), data obtained from the IUCN Red List of Threatened Species at . The second volume, to be published by 2007, will include most remaining taxa. This second checklist will contain about 1200 taxa, more than 500 illustrated with photographs.

More than 90% of taxa from both volumes occur in protected areas such as national parks and wildlife sanctuaries. More importantly, they are mostly confined to specific habitats, especially fragmented limestone hills and high mountains. About 35% of threatened species can be found in high mountains over 1,000 m altitude, and about 20% of threatened species can be found on limestone. High mountains include Doi Inthanon (2,565 m) and Doi Phahom Pok (2,285 m) in the north, and Doi Luang (1,835 m) in the south. Limestone hills include Doi Chiang Dao (2,175 m), a massive fragmented forest, the highest in the country, and Doi Hua Mot, an open limestone hill bothin the north, and Khao Sok in the south. Other specific habitats of great richness for endemic and rare plants are numerous hills in the southernmost part of peninsular Thailand, next to the Malaysian border, Kaeng Krachan on the Burmese border, a connective range between the Indo-Himalayan and Malaysian elements, and Phu Wua in the upper north-east, between the Korat, Vientiane and Suvanakhet basins.

Most habitats of threatened plants are in protected areas under the auspices of the National Park, Wildlife and Plant Conservation Department. Their future is relatively safe but restricted distribution ranges remain very fragile, making habitat loss still the prime cause of threat for species included in this checklist.

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INBIPS: THE INTERNATIONAL NETWORK FOR THE BARCODING OF INVASIVE AND PEST SPECIES

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WHAT IS INBIPS?

The International Network for the Barcoding of Invasive and Pest Species (INBIPS, www.barcoding.si.edu/INBIPS.htm) is an informal international network of researchers, research institutes and government agencies concerned with the recognition of invasive and pest species. INBIPS's goal is to provide information about applying DNA barcoding to invasive and pest species identification and to facilitate new barcoding activities in this area.

DNA BARCODING

DNA barcoding is a technique that uses short DNA sequences from standardized regions of the genome as a species identifier. A ~ 650 base-pair region of a mitochondrial gene (COI) has been shown to be an effective barcode region for many animals, (Hebert et al. 2003a,b; Hebert et al. 2004a,b; Hogg and Hebert 2004; Armstrong and Ball 2005; Ball et al. 2005; Barrett and Hebert 2005).

HOW CAN DNA BARCODING BE USED FOR INVASIVE AND PEST SPECIES PROBLEMS?

DNA barcoding can play an important role in the identification of invasive and pest species that may otherwise be difficult or impossible to achieve. When new and unfamiliar invaders are initially detected, the search for expertise may be time-consuming and 'off-shore'. In the case of invertebrates, invaders are frequently discovered as eggs or larvae. These commonly lack distinguishing morphological characters, for which taxonomic keys are generally unavailable.

DNA barcoding of invasive and pest species can provide a valuable diagnostic method for biosecurity and quarantine, where rapid and accurate species identification is critical but may not be possible by current means. For example, rearing immature life stages through to the adults that can be readily identified is often unsuccessful, and at best it is far too slow. However, their genetic makeup remains constant throughout their life cycle. Even so, development of molecular tools customised for all but the most obvious high risk species has been considered impractical. In addition, corroboration of species identifications required for policy or management decisions can be complicated if different molecular tools are employed by different laboratories. DNA barcoding, however, offers rapid and accurate species identifications, and is based on standardized methods that can be easily developed from existing datasets.

The DNA barcoding method can be easily integrated into existing systems for the identification of alien species ranging from forestry and agricultural pests to human disease vectors (e.g., mosquitoes carrying

West Nile virus), to those that may be intercepted at a country's borders or in shipments held in quarantine, or as hitchhikers on ship's hulls or in ballast water. Combined with other tools, such as LUCID keys, taxonomic literature, on-line databases of biological and geographical species information (e.g., host plant, phenology, species range) it can contribute towards a highly effective and holistic means of identification. DNA barcode data may also provide the basis for development of new technologies, such as DNA micro- and macro-arrays for identification of species in mixed samples such as ballast water.

DNA BARCODING AND TAXONOMY

DNA barcoding can also contribute to the categorization of many invasive and pest groups by identifying genetically distinct individuals or populations, flagging potentially new species (Hebert et al. 2004b) and unveiling cryptic species complexes (Hebert et al. 2004a). For invasive and pest species, understanding the taxonomy and associating other biological information is critical to preventing their establishment and could play a role in predicting the invasiveness of species.

THE ROLE OF INBIPS

INBIPS can make DNA barcoding more accessible as a global, standardised tool for invasive and pest species identification, addressing the needs of both the developed and developing nations.

- catalyst for the formation of new barcoding projects on invasive and pest species,
- 'noticeboard' for increasing the taxonomic breadth of invasive and pest species barcodes and minimising redundancy of effort,
- source of information on DNA barcoding and its use in addressing invasive and pest species problems,
- forum for interactions among invasive alien species (IAS) initiatives that are interested in exploring the use of DNA barcoding, and
- clearinghouse of information on organizations, initiatives, and species lists concerned with invasive and pest species.

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CANADA'S NATIONAL IDENTIFICATION SERVICES

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Protecting Canada's borders against possible importation of invasive alien species requires the ability to identify foreign plant, fungal and arthropod species in whatever form they arrive. The National Identification Services of Agriculture and Agri-Food Canada are the primary resources available to do so. Timely identification of foreign organisms can help prevent the introduction or establishment of pests and can save millions, even billions of dollars. Correct scientific names are also key to communication and information retrieval.

Our teams of specialists use the most advanced techniques for systematics research in modern lab facilities and have expertise in identifying, describing and classifying the major groups of plants, fungi, insects, mites, spiders and nematodes of relevance to Canadian agriculture and forestry. The National Identification Services is the first line of defence against invasive alien species. The expertise and advice of our scientists provides an essential service to the Canadian Food Inspection Agency and other departments responsible for our border security. The enforcement of such federal regulations as the narcotics control act, customs regulations, and drug control regulations, as well as international regulations such as the Convention on International Trade in Endangered Species depends on the capability to accurately identify organisms. The National Identification Services are also readily available to the general public, as well as private industry, other government agencies, and scientific researchers.

The National Identification Services and the team of taxonomic specialists that comprise them are supported by The Canadian National Collection of Insects, Arachnids and Nematodes (CNC), the National Vascular Plant Herbarium (DAO), the National Mycological Herbarium (DAOM), and the Canadian Collection of Fungal Cultures (CCFC/DAOM). These National Collections and associated specialized libraries are maintained and developed by Agriculture and Agri-Food Canada as part of its systematics research program and are housed in the K.W. Neatby and L.G. Saunders buildings on the Central Experimental Farm in Ottawa. The collections are essential as sources of correctly identified comparative material for authoritative identifications of native and foreign plants and their products, pathogens, insects, arachnids and nematodes. With the globalization of trade, specimens from all areas of the world are increasingly critical and world class collections are necessary for the National Identification Services. Our National Collections have existed for over a century, are the largest of their kind in Canada and are among the finest worldwide.

BIODIVERSITY ASSESSMENT OF A HYPERDIVERSE ARTHROPOD GROUP: DNA BARCODING THE ANTS OF MADAGASCAR

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Keywords: CO1, Madagascar, collaborative taxonomy, DNA barcode, biodiversity

INTRODUCTION

The increasing loss of biodiversity presents a daunting challenge to taxonomists and requires the discovery and analysis of biodiversity at a greatly accelerated pace. To truly consider "zero biodiversity loss" in Madagascar and elsewhere, conservation planning needs to be based more fundamentally on biodiversity data, and this requires taxonomic knowledge. However, if nothing is done to change the slow pace of current taxonomic efforts and practice, it will take centuries to complete even a preliminary "encyclopedia of life" on Earth. It is clear that if systematics is going to play a practical role in directing the preservation and development of natural systems, changes need to occur throughout the entire taxonomic process, from collection to description, from publication to dissemination, and from public outreach to advocacy.

In this paper, we show how DNA barcoding (using cytochrome oxydase 1 (CO1) – Hebert et al 2003a; Hebert et al. 2003b), enables taxonomic data on hyperdiverse arthropods to be gathered, analyzed, and synthesized into useful products in a timeframe that meets the challenge presented by the rate of biodiversity loss. We test a model for accelerating the taxonomic process with the aims of providing the necessary data for effective taxonomy, and — most importantly — the tools for making data accessible and applicable to the conservation agenda. The model is tested on a key taxonomic group, ants, and in an especially threatened area, Madagascar. We describe how CO1 DNA barcoding enables rapid identification of Molecular Operational Taxonomic Units (MOTU – Blaxter 2004) for the assessment of richness and turnover across landscapes.

The ant fauna of Madagascar is currently estimated to include approximately 1,000 species, of which 96% are endemic (Fisher 1996a). An estimated 75% of the ant fauna in Madagascar, however, remain undescribed (Fisher 1996b). For example, of the 71 species of the genus *Strumigenys* described in a recent revision, 70 were endemic and newly described (Fisher 2000). Although ants dominate the biomass of most terrestrial communities, are critical pollinators and seed dispersers, and are critical to nutrient cycling and ecosystem function, there is a global lack of studies of ant diversity or community structure. This may be largely because of the difficulty of species-level identifications (Bolton 2003).

A DNA-based system of species identification using a single gene was proposed by Hebert et al. (2003a; 2003b) who coined the term "DNA barcoding". Since then, the utility of DNA barcodes for species identification has been successfully demonstrated with several taxonomic groups. The potential for such a system is evident to many who study biodiversity, especially in smaller, understudied, or hyperdiverse groups or in areas where the estimates of diversity lag well behind what is actually there.

In our analysis we test whether a diversity estimate based on DNA barcode MOTU is significantly different from estimates based on traditional morphological taxonomy using an understudied taxa from a part of the world where established taxonomic frameworks are only now emerging. We demonstrate that DNA barcode functional units are an effective surrogate for traditional morphological species and discover the same relative patterns of diversity within and between collection sites.

FINDINGS

There was no significant difference between richness (number of morphospecies or MOTU) using the molecular approach or morphological taxonomy. There was a significant difference between sites using the different methodologies to assign individuals to morphospecies or MOTU. Molecular similarity thresholds tended to emphasize the uniqueness of each site while morphological taxonomy tended to find more overlap between sites. Generally, morphological taxonomy "lumped" MOTU separated using the threshold approach. The average molecular divergence of morphospecies which contained multiple MOTU was 16.27%.

RECOMMENDATIONS

DNA barcoding proved an effective surrogate for morphospecies diversity patterns across localities in northern Madagascar. We demonstrated how inventories of hyperdiverse taxa such as ants can provide rapid analyses of diversity for conservation assessment. Sequence data generated during the inventory process will also provide an alternative set of characters to assist in inferring species boundaries during future taxonomic studies. Thus, the application of DNA tools during diversity assessment will facilitate and complement taxonomic study. The combination of DNA sequencing data coupled with inventory and traditional taxonomy is a model that can be applied across disciplines and will allow analytical needs to scale to the enormity of the biodiversity crisis. It will help to identify and conserve the evolutionary processes that generate and preserve biodiversity.

Our analysis is unique in that it has compared diversity measures at four sites in Madagascar using both the morphologically defined species units and MOTU based on two different threshold values for DNA barcode sequence divergence. Patterns of richness and turnover of MOTU and morphospecies were not significantly different. The take-home message is not that the values are the same (although for the most case they are remarkably similar), but rather that the patterns of richness within sites and turnover between sites were so similar. Thus, richness and turnover assessments determined using DNA barcode variability, *accrued within less than three weeks of preparatory analysis*, provided an effective surrogate for species determined through time-consuming intensive detailed morphological analyses.

DNA barcodes allow the rapid identification of functional units of diversity that can scale to the magnitude of hyperdiverse arthropod assemblages at a timeframe needed by conservation groups responding to habitat destruction and degradation. Measuring diversity, using MOTU in collaboration with taxonomists should provide the essential fine-scale maps for assessing biodiversity at a scale at which conservation decisions are made. Little time remains for the documentation of global biodiversity. Taxonomists, equipped with modern tools and collaborations, have a chance to move systematics to the forefront of conservation and the public's attention. With increased taxonomic output and improved public access and visibility, public support for the discovery of life on this planet should follow.

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Further Information

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CONTRIBUTIONS OF THE DARWIN INITIATIVE TO THE GLOBAL TAXONOMY INITIATIVE

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Keywords: Darwin Initiative, training, taxonomy, capacity, information

INTRODUCTION

This report[1] was commissioned by the UK's Department for Environment Food and Rural Affairs (Defra) to examine the contribution of the UK Darwin Initiative (DI), through its funded projects, to the Global Taxonomy Initiative (GTI) of the Convention on Biological Diversity (CBD). The full report can be found on the Darwin Initiative's website www.darwin.gov.uk

The DI aims to promote biodiversity conservation and the sustainable use of natural resources in countries that are rich in biodiversity but poor in resources, and has so far supported over 400 projects towards achieving this aim. Fifty of these projects have made significant reference to taxonomy and were the subject of a detailed review, in liaison with staff of UK and host country institutions. All project documentation was examined with respect to the five Operational Objectives of the GTI. This enabled the review to determine the clustered projects' contribution to the GTI in terms of best practice, lasting legacy, and lessons learned, and to draw attention to valuable case studies.

ASSESSING TAXONOMIC CAPACITY

The GTI Operational Objective 1 recognises the need to assess taxonomic capacity at national, regional and global levels. DI project leaders have a good understanding of national taxonomic needs, which were successfully addressed in projects throughout the world — from terrestrial invertebrate biodiversity in the Galapagos to deep-sea fish communities in the Maldives. Through improving knowledge of species taxonomy, DI projects also implicitly highlighted taxonomic capabilities. These assessments will have a lasting impact through national biodiversity strategies and action plans.

TRAINING

The majority of DI projects reviewed had an enormous impact upon GTI Operational Objective 2 — building and maintaining the resources to obtain and manage taxonomic collections. DI impacts range from establishing and developing both local and national collections (such as local herbaria through the project Conservation of Plant Diversity in Western Cameroon and the National Borneensis [Lepidoptera] collection developed by the Project Biodiversity of Butterflies in Tropical Rainforests in Sabah; technology transfer (e.g., methodologies for culturing fungal collections transferred by the Microbial Genetic Resource Programme); infrastructural provi-

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sion (for collections such as the Insect National Collection, Thailand, through the project Taxonomic Capacity Building in Support of Biodiversity Conservation; training motivated students (such as exciting new team at Sucre herbarium, Bolivia, by the project Plant Endemism of the Central Andean Valleys; and employment of trained staff post-project (See Box 1). A combination of "on-the-job" training and formal qualifications increased the skills base of a large number of trainees, while enabling them to play an important ongoing role in maintaining collections, developing policy and training subsequent generations of taxonomists.

ACCESS TO INFORMATION

Operational Objective 3 highlights the need to make taxonomic collections accessible, particularly in their country of origin. Many DI projects have contributed to strengthening in-country taxonomic collections. Examples include: developing databases, including web-based systems such as the Darwin Nematode Virtual Collection; Repatriating specimens from the UK (Repatriation of Herbarium Data for the Flora of Bahia, Brazil; and publishing field guides and manuals, such as the two local-language manuals produced by the Marine Benthic Invertebrate Study in Coastal Waters of Ecuador.

GENERATING NEW TAXONOMIC INFORMATION

DI projects have been involved in generating the taxonomic information needed for decision-making in conservation in all of the major thematic work programmes of the CBD (GTI Operational Objective 4), through discovering new species, records and populations, and identifying key areas and taxa for conservation. Some projects (e.g., Conservation of Plant Diversity in Western Cameroon) discovered as many as 30 new species (See Box 2).

CBD CROSS-CUTTING ISSUES

Through the activities described above, DI projects contributed to most of the cross-cutting issues of the CBD (Operational Objective 5). Particular contributions were made in, among others, public education and awareness, sustainable use of biodiversity, and technology transfer and cooperation. A DI project in West Africa trained taxonomists to engage in genetic level conservation, in partnership with the primary international body tackling this, the International Plant Genetic Resources Institute (IPGRI). Molecular taxonomic techniques and assumed correlations with habitat or eco-geographic features were used to sample populations of endangered wild relatives of cultivated crops, generating a geographic profile to preserve genetic diversity. Taxonomic data then enabled conservation through monitoring, preventing genetic pollution by cultivated species and maintaining a gene pool for the future.

Overall, this review found that the Darwin Initiative delivers good value for money as it has an overall significant impact on GTI objectives for a modest investment of funds. The Darwin Initiative is an important, unique source of funding for biodiversity science and conservation that ensures taxonomic research gets to the people and places that need it most. Having highlighted examples of best practice and drawing attention to the constraints taxonomic Darwin Initiative projects may face, the report concludes by making recommendations to the Darwin Initiative for consideration by the DEFRA, which, if adopted, should further enhance its contribution to the GTI.

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BOX 1: A legacy of training: Ecuador

In Ecuador, a DI marine invertebrate study delivered a strong legacy of taxonomists working in their home country. They are now transferring their expertise to a second generation while maintaining useful contact with their UK partner.

- Elba Mora, a university teacher has remained in her post, making increased use of the collections and publications generated by the project;
- Manuel Cruz, a professor and navy marine biologist, has continued in these roles, registered for a part-time PhD through Heriot-Watt University in the UK and is heavily involved in Ecuador's marine biodiversity working group;
- Three project trainees secured new posts: Daisi Merino, now a teacher in marine biodiversity; Maria Fernanda Arroyo, employed as a researcher at the university with responsibility for maintaining the collection set up by the project; and Alba Calle, now working in polychaete taxonomy at another university in Guayaquil and also working on a PhD.

(Project 6-029: *Marine Benthic Invertebrate Study in Coastal Waters of Ecuador.* Based on discussions with Dr. James Mair, Heriot-Watt University and Professor Manuel Cruz, Oceanographic Institute, Guayaquil, Ecuador).

Ecuadorian Darwin project team members with Guayaquil University students on a shore sampling survey (image courtesy Elba Mora, University of Guayaquil, Ecuador).

BOX 2: Discovering new species: Mimosa in Bolivia

One DI project discovered new species in Bolivia. As part of the project, Margoth Atahuachi, studied collections at many institutions including Oxford, New York and Missouri, whilst in Bolivia, she made field trips to Mimosa-rich areas and visits to Bolivian herbaria to select specimens. Intensive study of this one particular genus, facilitated by a DI project, has revealed at least three species new to science, and generated a key to Bolivian Mimosa.

(Project 11-010: Plant Endemism of the Central Andean Valleys, Bolivia. Based on discussion with J.R.I. Wood, University of Oxford).

STATE OF THE IMPLEMENTATION OF THE GLOBAL TAXONOMY INITIATIVE IN ARGENTINA

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Keywords: Argentina, Global Taxonomy Initiative

INTRODUCTION

In 2004, the Secretariat of Environment and Sustainable Development of Argentina began the actions for the implementation of the Global Taxonomy Initiative in Argentina. In 2005 the Departamento de Biodiversidad y Biología Experimental of the Facultad de Ciencias Exactas y Naturales of the University of Buenos Aires and the Instituto de Botánica Darwinion were appointed as focal points. A strategic plan with the purpose to implement the programme of work for the Global Taxonomy in Argentina is presented.

ARGENTINEAN STRATEGIC PLAN FOR THE GLOBAL TAXONOMY INITIATIVE

- To compile information about the taxonomic groups studied so far and the research groups involved in these studies;
- To individualize geographic explored regions for each taxonomic group;
- To evaluate the state of the situation taking into account the obtained information;
- To estimate the grade of knowledge for each taxon;
- To conform a net of Sub-regional Centers for the GTI coordinated by the Argentinean focal points, for a better access to the information;
- To try to get financial support for the activities of the GTI in Argentina;
- To create a National Taxonomic Net, with national experts in taxonomy.

Medium-term operational objectives

- To identify taxonomic groups with scanty development in Argentina;
- To obtain taxonomic maps showing the more and less studied areas;
- To compile information about the taxonomic research groups;
- To generate a list of experts;
- To spread out the GTI objectives;
- To identify financial mechanisms for the development of taxonomic research;
- To develop the National Taxonomic Net;
- To identify the knowledge gaps in Argentina;
- To help to build and to maintain the human resources, systems and infrastructure for the development of taxonomic disciplines.

Long-term operational objectives

- To facilitate the implementation of the programmes of work of the Convention on thematic and cross cutting issues;
- To improve public education about the importance of taxonomy;
- To provide necessary information to improve the current legislation and rules for sustainable use of biological diversity and its components;
- To strengthen the relationship between the government and the taxonomic expert community.

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GLOBAL TAXONOMY INITIATIVE IN ITALY: SUPPORTING THE 2010 GOAL

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Keywords: taxonomy, Italy, check-list, databases

INTRODUCTION

Since the 1990s the Nature Protection Directorate of the Italian Ministry for Environment and Territory Protection has carried out a number of initiatives that allowed the collection of standardized data and the compilation of checklists. Among the first initiatives of the Directorate as National Focal Point for the Global Taxonomy Initiative (GTI) was the proposal of a GTI portal under COP VII of the Convention on Biological Diversity (CBD) website (Kuala Lumpur, 2004) and the compilation of the thematic report on the GTI. A second activity was the organization of the Side Event on GTI during the Ad Hoc Open-Ended Working Group on Protected Areas (Montecatini, June 2005). The main result of the Side Event was the establishment of collaboration between the International Commission for Zoological Nomenclature and the Global Biodiversity Information Facility, which puts taxonomy at the basis of biodiversity database assemblages. This important result focuses on the need for a major role of taxonomy in structuring the initiatives of the Convention of Biological Diversity in assembling information and planning the tools supporting the 2010 goal. Italy, which launched the National Countdown 2010 program during the Montecatini meeting, is carrying out several initiatives in the field of taxonomy with the support of a number of scientific institutions. Moreover, the National Focal Point promoted the GTI as a point of agenda at the regional, pan-European Fourth Intergovernmental Biodiversity in Europe Conference (initiative of the Council of Europe, scheduled to be held in Dubrovnik, Croatia, in February 2006).

ITALIAN FOCAL POINT ACTIVITIES TO IMPLEMENT THE GTI PROGRAMME OF WORK

The main activities of the Italian Focal Point on GTI deal with assembling pre-existing taxonomic information in terms of: identification keys, digitized checklists, digitized collection and distributional data, thematic atlases, improving their updates and contributing to filling the gaps (Figure 1). The main taxonomic initiatives lie in the field of database construction, including directories of taxonomists and checklists. Further steps deal with the screening of the available checklist (implemented in a hierarchical structure) to assemble distributional data sets of selected species obtaining thematic maps using GIS software. At present, the following products are publicly available:

- Volumes of the "Fauna d'Italia" series. Thus far, 40 volumes with identification keys and general information on all the species of the considered taxa have been published.
- *Field guides of the Italian flora and fauna* (within the "Quaderni di Conservazione della Natura" series 21 issues published so far).
- *Checklist of the Italian fauna* (Minelli et al., 1993-95; on-line version: http://checklist.faunaitalia.it), including all the 57,468 species up to now reported from Italy. Recently updated for marine species by the Italian Society for Marine Biology (Relini et al., unpublished)
- CKmap (Ruffo and Stoch, 2005). A distributional database of 10,000 terrestrial and freshwater animal species including over 537,000 distribution records (see Figure 2 for an example of application to thematic maps dealing with the richness of endemic species in Italy).
- *Checklist of the Italian vascular flora* (Conti et al., 2005), including over 6,700 species with admin-

istrative regional distribution (Figure 3).

- Assessment of knowledge of Italian vascular flora (Scoppola and Blasi, 2005)
- Checklist of basidiomycetes (Onofri, 2001), including over 4,000 species.
- Checklist of planktonic microphytes of the Italian seas (Italian Society of Marine Biology). Including over 1,200 species.
- Checklist and distribution of marine macrophytes (Furnari et al., 2003), including over 900 species with administrative regional distribution.

A more recent initiative was the dissemination, at international and national levels, of available taxonomic information on Italian biodiversity through the Clearing-House Mechanism (CHM) website (www.minambiente.it/Sito/settori_azioni/scn/chm/gti.htm).

Obviously, the huge amount of data contained in these datasets and the continuous evolution of scientific knowledge require an incessant effort to update the databases.

GTI IN ITALY: FULFILLING THE OBJECTIVES TOWARDS THE 2010 TARGET

The creation, implementation and maintenance of such resources will allow current gaps in Italian taxonomic production and capacities to be identified in terms of: (1) taxonomic groups, (2) geographic areas and/or (3) taxonomic toolkits. Further work is required in relation to operational objective 4 (link to thematic areas) and in the identification of gaps which will allow the Focal Point to suggest and support the most efficient activities to increase GTI toolkits in Italy, activating capacity-building initiatives to create new taxonomic competences and to repatriate to the countries of provenance taxonomic knowledge based in Italy. The integration of national database experience with international initiatives, like *Fauna Europaea* and Important Plant Areas programme by *Plant Europa*, is in progress. Moreover, additional activities are essential to raise the level of recognition for the applied nature of much taxonomic work, to popularize the GTI among taxonomists and to support the sustainable use of biodiversity for the effective implementation of the Convention. All these activities will contribute to overcoming the taxonomic impediment stated by the Darwin Declaration at the national and international levels. Further steps include taxonomic support for the identification of national priority areas for conservation and providing an interface between taxonomy and the end-users of taxonomy for fulfilling the objectives of the 2010 target.

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Ruffo, S., and Stoch, F. (2005). Checklist e distribuzione della fauna italiana. *Memorie del Museo Civico di Storia Naturale di Verona, 2.serie, Sezione Scienze della Vita* 16: 307 pp.

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FIGURE 1: Implementation of operational objective 3 of the GTI Programme of Work in Italy: a network of information including databases of taxonomists, species checklists, identification keys, distributional data and validation of biodiversity conservation strategies (under construction by the Italian Focal Point).

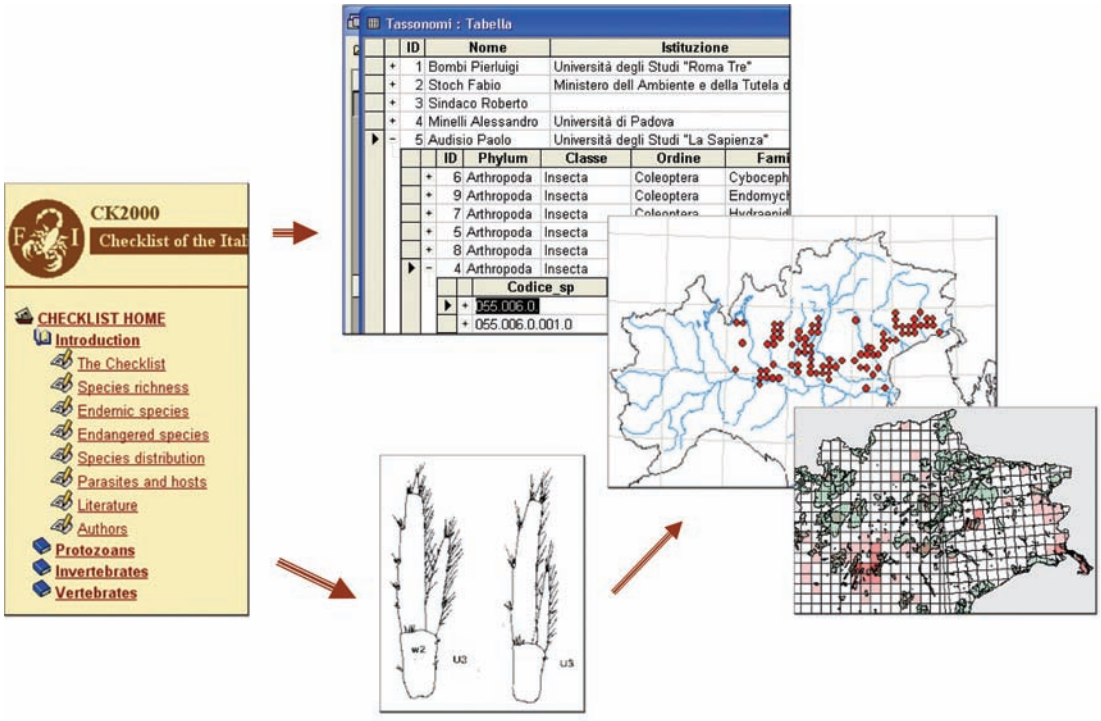


FIGURE 2: Distribution pattern of endemic species richness of terrestrial and freshwater animals in Italy (from the *Checklist and distribution of the Italian fauna* — 10,000 terrestrial and inland waters species).

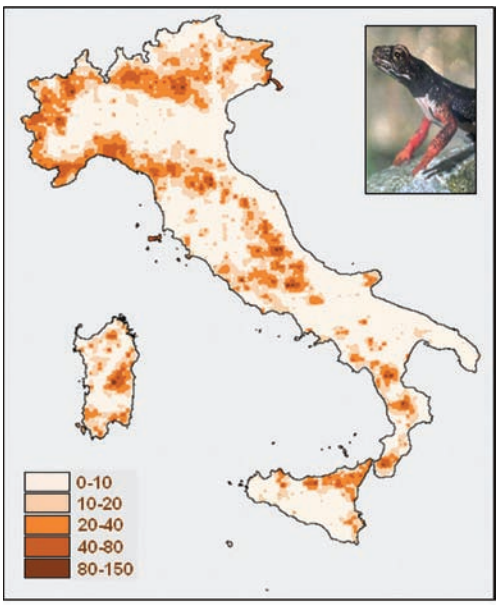
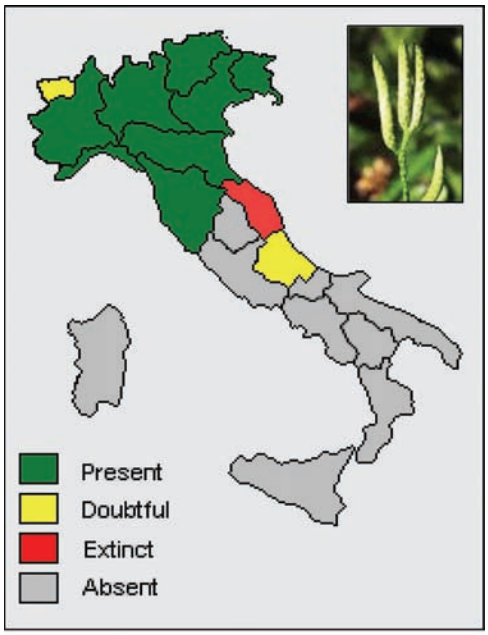


FIGURE 3: An example of the distribution data of a vascular plant (*Lycopodium clavatum*) in Italian administrative regions (from the *Checklist of the Italian vascular flora*)



UK IMPLEMENTATION OF THE GLOBAL TAXONOMY INITIATIVE

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Keywords: taxonomy, needs assessment, capacity building, GTI National Focal Points

INTRODUCTION

The Natural History Museum (NHM) was designated as the UK's National Focal Point for the Global Taxonomy Initiative (GTI) in 2001. In order to advance implementation of the Programme of Work for the GTI in the UK, the NHM created a GTI Steering Group in 2003.

Working in collaboration with this group, the NHM carried out a taxonomic needs assessment in the UK, focusing on the needs of biodiversity conservation organisations for taxonomic information. At the same time, the NHM and other members of the UK GTI Steering Group have been actively involved in a number of awareness-raising and capacity-building activities at both the national and international levels. As well as contributing to the implementation of the GTI Programme of Work, it is hoped that this work will serve as a useful example for other countries to follow.

GTI STEERING GROUP

The GTI Steering Group was convened in 2003 by the NHM and brought together representatives of taxonomic research institutions, governmental bodies responsible for biodiversity conservation, and representatives of the substantial amateur naturalist community in the UK. The following organisations are members of the UK GTI Steering Group:

Taxonomic Research Institutions

The Natural History Museum
Royal Botanic Garden, Edinburgh
Royal Botanic Gardens, Kew

Governmental organisations

Department for Environment, Food and Rural Affairs (DEFRA)
Joint Nature Conservation Committee
Centre for Ecology and Hydrology

Non-governmental Organisations

National Biodiversity Network (NBN)

Bringing together taxonomic research institutions with biodiversity conservation organisations has helped build a dialogue between these groups and contributed to the success of GTI implementation in the UK.

TAXONOMIC NEEDS ASSESSMENT

The UK taxonomic needs assessment was carried out in 2004 by the NHM and focused on the needs of UK biodiversity conservation organisations for taxonomic information relating to UK biodiversity. The assessment was carried out by questionnaire, and sought to gather information from conservation organisations while raising their awareness about the importance of accurate taxonomic information for many of the information tools used by conservationists.

The assessment provides a useful model for other countries to follow in that it was relatively low-tech, required little in the way of resources, and has generated results that taxonomic organisations in the UK can use to target their research and develop appropriate outputs.

CAPACITY-BUILDING

The UK is facing a growing need for taxonomic skills at the national level among organisations engaged in environmental management and biodiversity-monitoring activities. In particular there is a growing need for ecologists with species-identification skills to carry out water-quality monitoring. The NHM has been working with the University of Birmingham and the Field Studies Council to establish high level training courses linked to accreditation in order to help build these skills and address the taxonomic impediment. The new Identification Masterclasses have helped train ecologists to the level where they can pass an Identification Qualification exam, entitling them to a certificate of competence awarded by the NHM.

The Royal Botanic Gardens, Kew, has also been actively contributing to international awareness-raising about the GTI and Convention on Biodiversity through the development of an information pack titled "The CBD For Botanists". This presentation pack provides basic information on the CBD for botanical institutions. It focuses on the issue of "access to genetic resources and benefit-sharing", and its practical implications. The pack includes slides and suggested speaker's notes, and a resources section offering more detailed information, useful links and suggestions for further reading. It also includes the text of the CBD and the Bonn Guidelines. It is designed to be a flexible training tool, adaptable to different audiences, but can also be read for practical guidance on implementation. The pack is a product of a recent Darwin Initiative project.

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HALF A MILLION SPECIES: THE *SPECIES 2000 & ITIS CATALOGUE OF LIFE* AND THE GTI

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Keywords: Catalogue of Life, Global Taxonomy Initiative, Global Strategy for Plant Conservation, taxonomy, species, plants, animals, fungi, micro-organisms

SUMMARY

The goal of the Species 2000 and ITIS Catalogue of Life programme is to create a comprehensive, uniform, validated electronic Catalogue of species. The objective is to provide a synonymic species checklist and a taxonomic structure for all of the world's known species as a contribution to the Planned Activity 7 of the Global Taxonomy Initiative (GTI) Programme of Work. The intermediate targets for reaching critical mass in the first phase of a 10-year programme from 2001 to 2011 have been met. The current Catalogue of over half a million species is being widely used by a number of international agencies even while it is still seriously incomplete. The goal of the second phase of the programme is to create a ring of regional taxonomic database hubs to which regional and national databases may be connected over the Internet. This second phase will enable i) connections between species-based systems in any country and the regional and global taxonomic checklists, and ii) the completion of the global Catalogue's goal of 1.75 million known species by 2011.

THE GOALS OF THE CATALOGUE OF LIFE

The Catalogue of Life programme was established in 2001 as a partnership between two already extensive programmes. The North American Integrated Taxonomic Information System (ITIS) had started as a U.S. federal programme, expanded to include Mexican and Canadian partners, and enlarged to provide global coverage for many groups. Species 2000 launched its global distributed programme to link taxonomic databases in 1996. By working together to create a common product, the Catalogue of Life partnership has enabled the two organisations to reduce duplication of effort, make better use of resources, and accelerate the development of the Catalogue.

Creating a comprehensive, uniform and validated electronic checklist and index to the world's known species is a challenging and ambitious objective. The Catalogue includes all groups of organisms, (i.e., plants, animals, fungi and micro-organisms), species from all environments, including marine, terrestrial and freshwater, and the domesticated and exotic species in urban and agricultural landscapes. As examples, the partners are working closely with marine biodiversity organisations such as the Ocean Biogeographic Information System (OBIS), and with the botanical institutions preparing the working list of the world's plants, Target 1 of the Global Strategy for Plant Conservation (GSPC).

The Catalogue is intended for use as a practical tool in inventorying and monitoring biodiversity worldwide and as a global taxonomic architecture for the GTI Planned Activity 7. It should provide:

1. a comprehensive catalogue for checking the status, classification and naming of species;

2. electronic baseline lists of species for use in inventorying projects worldwide;
3. a basis for linking species-based systems worldwide;
4. the index for an Internet gateway to species databases worldwide; and
5. a reference system for comparison between inventories.

The programme is a distributed one, both at the level of its organisation, and in its information technology. In its organisation, checklists for different taxonomic groups are maintained by many different organisations around the world and supplied to the Catalogue. At the information technology level, the *Dynamic Checklist* uses a federated computer system that harvests the appropriate data from the array of supplier databases across the Internet. These databases are operated by different groups or networks of specialists around the world. After appropriate checks and peer reviews, database organisations are invited to supply their data to ITIS or to join Species 2000 and to become regular suppliers to the Catalogue. The rationale is a) to make rapid progress by using all suitable existing datasets, b) to involve as wide as possible a community of taxonomic experts through these member organisations, and c) to allow the taxonomic work to go ahead in many parallel projects, thus permitting a significant scaling up of activity.

PROGRESS SO FAR

Three products were launched earlier in 2005, although each is presently far from complete. All are free of charge and open to all users:

1. *Species 2000 & ITIS Catalogue of Life: 2005 Annual Checklist.* The *Annual Checklist* is a fixed edition issued once a year since 2001 on CD-ROM and on the web. The 2005 edition (Bisby et al., 2005a and b) covers 527,366 species in certain groups of plants, animals, fungi and micro-organisms.
2. *Species 2000 & ITIS Catalogue of Life: Dynamic Checklist.* The *Dynamic Checklist* is a dynamic Internet system that harvests taxonomic sectors from an array of taxonomic databases around the world (Bisby et al., 2005c). It provides direct access to current data from the providers. Although the system was launched in October 2005, it will take several months before the datasets included are as extensive as the *Annual Checklist.* It has an additional component, the Euro-Hub, the first of the planned regional hubs, containing the *Fauna Europaea Checklist* and to be followed by the *Euro+Med PlantBase* and the *European Register of Marine Species.* Other regional hubs planned for the second phase of the programme will be added.
3. *Species 2000 & ITIS Catalogue of Life: Web-service.* The *Web-service* is an electronic service that can be queried automatically by other electronic systems. The coverage is the same as that of the *Dynamic Checklist.*

In 2001 a timetable and milestones were set for completion of all 1.75 million species by 2011. The intermediate milestones for 2003 and 2005 have been met.

YEAR	MILESTONE	OUTCOME (*Annual Checklist*) (by April of the year)
2003	300,000 species	304,710 species
2005	500,000 species	527,366 species
2006		Estimate: 750,000 species
2011	1,750,000 species	–

THE SECOND PHASE

The present programme of linking or incorporating Global Species Databases to contribute to the Global Hub will continue. But a second phase of the programme will be added, to create and link a ring of regional taxonomic hubs. These will be like the present Euro Hub — several regional databases connected to a single Internet hub to provide a regional checklist. The objective is to link several existing regional hubs that are under development and to create new hubs for certain other regions. The regional hubs will provide a platform for linking regional and national taxonomic databases to the Catalogue of Life network and a means of completing the Catalogue by 2011.

Acknowledgments

The programme has been supported by federal programmes of the U.S., Mexican and Canadian governments, by grants from the European Commission and from the Japanese Government, by GBIF, by the UK BBSRC, CODATA, the US NSF, and the University of Reading Trust Fund. Very substantial in-kind support has come from a wide network of institutions, database projects and individuals.

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THE CANADIAN BARCODE OF LIFE NETWORK

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Keywords: DNA barcode, biodiversity, rapid identification

INTRODUCTION

The goal of the Canadian Barcode of Life Network, and of the large international consortium of which it is a part, is to develop an accurate, rapid, cost-effective and universally accessible DNA-based system for species identification. The DNA barcoding paradigm had its conceptual birth in Canada (Hebert et al., 2003a; Hebert et al., 2003b), which has become the first country to establish a national research network dedicated to the assembly of DNA barcodes on a large scale. The goal of the national network is to continue work on animals while extending the DNA barcode paradigm to the remainder of eukaryotic life, including fungi, plants and protists.

CANADA'S DNA BARCODING AGENDA

Following the coining of the term "DNA barcoding", a considerable amount of momentum has been generated for applying a standardized single-gene analytical approach to cataloguing biodiversity. In response to the emergence of this new global community, the Consortium for the Barcode of Life (CBOL) was established in 2004 and has since commissioned several working groups which address key issues in the development of DNA barcoding. This international movement now consists of members from over 80 organizations in 33 countries, across six continents.

The Canadian Barcode of Life Network represents the first network dedicated to barcoding all biodiversity within national boundaries and involves researchers and funding support from a broad range of institutions across the country (Table 1). Our previous work (e.g., Hebert et al., 2004; Hebert et al., 2003a; Hebert et al., 2003b; Hogg and Hebert, 2004; Lorenz et al., 2005; Smith et al., 2005) has demonstrated that a DNA barcode derived from a 648 base pair segment of the mitochondrial cytochrome *c* oxidase subunit I gene will enable a highly efficient system for the identification and discovery of animal life. This goal is now being pursued under four taxonomic themes:

- Animal Diversity — about 100K animal species will need to be barcoded to complete the national survey. At least10K species will be barcoded within 5 years.
- Protist Diversity — research will target macroalgae, microalgae, and ciliates, with some emphasis on their possible roles as bioindicators of ecosystem health.
- Plant Diversity — barcoding of the approximately 5,600 species of plants present in Canada will proceed with emphasis on optimizing protocols for identifying roots, pollen, seeds and spores.
- Fungi Diversity — research will proceed with initial emphasis on barcoding known pathogens within ecosystems.

While the ultimate objective is to barcode all species, our initial target is to establish a database of DNA barcodes for economically, socially, and environmentally important organisms from the Canadian biota. In addition to the pursuit of a national biodiversity research agenda, our researchers are playing lead roles in a number of international barcoding movements, including the Fish Barcode of Life Initiative (FISH-

BOL), and the All Birds Barcoding Initiative (ABBI). Through the pursuit of these goals, the Canadian Barcode of Life Network will make important contributions to global biodiversity research as a whole.

TAKING A LEAD ROLE ON THE GLOBAL STAGE

The logistical challenges of barcoding biodiversity at this scale are considerable, and a robust strategy is required to coordinate the flow and processing of both specimens and their data. Key areas requiring attention include laboratory processing, information management, and the coordination of the efforts of all stakeholders. In this regard, the Canadian Barcode of Life Network has lead development of protocols for large-scale DNA barcoding.

The refinement of laboratory protocols occupies a central role in the whole barcoding process, and is a primary focus for a fifth research theme (Analytical Platforms) in our Network. The core analytical facility for the Canadian Barcode of Life Network has pioneered the optimization of laboratory techniques for high-throughput DNA barcoding (Figure 1). Moreover, we have demonstrated that production targets of 100K barcode records are feasible for single analytical facilities (Hajibabaei et al. 2005). This production rate can be achieved in an environment with a multitude of specimen sources and other collaborative relationships, while delivering specimen information to a centralized database system. In order to facilitate and coordinate the rapid assembly of this database across a national (or international) research network, we have developed a suite of web-accessible tools to aid in the management and assembly of DNA barcodes. The Barcode of Life Database (BOLD) presents varied collaborative tools for data management, from specimen collection records, to taxonomy, to the DNA barcodes themselves. In addition, BOLD offers a universally accessible DNA-based system for species identifications. As an extension of this, we are pursuing the development of a portable, rapid identification instrument that can be used in biodiversity monitoring.

CONCLUSION

DNA barcoding offers a highly promising approach to resolve the 'taxonomic impediment' that constrains global biodiversity research. Through the efforts of a determined network of researchers, and support from diverse organizations, Canada will make important contributions to a biological research program whose goal is as ambitious as it is important: an understanding of the full diversity of life.

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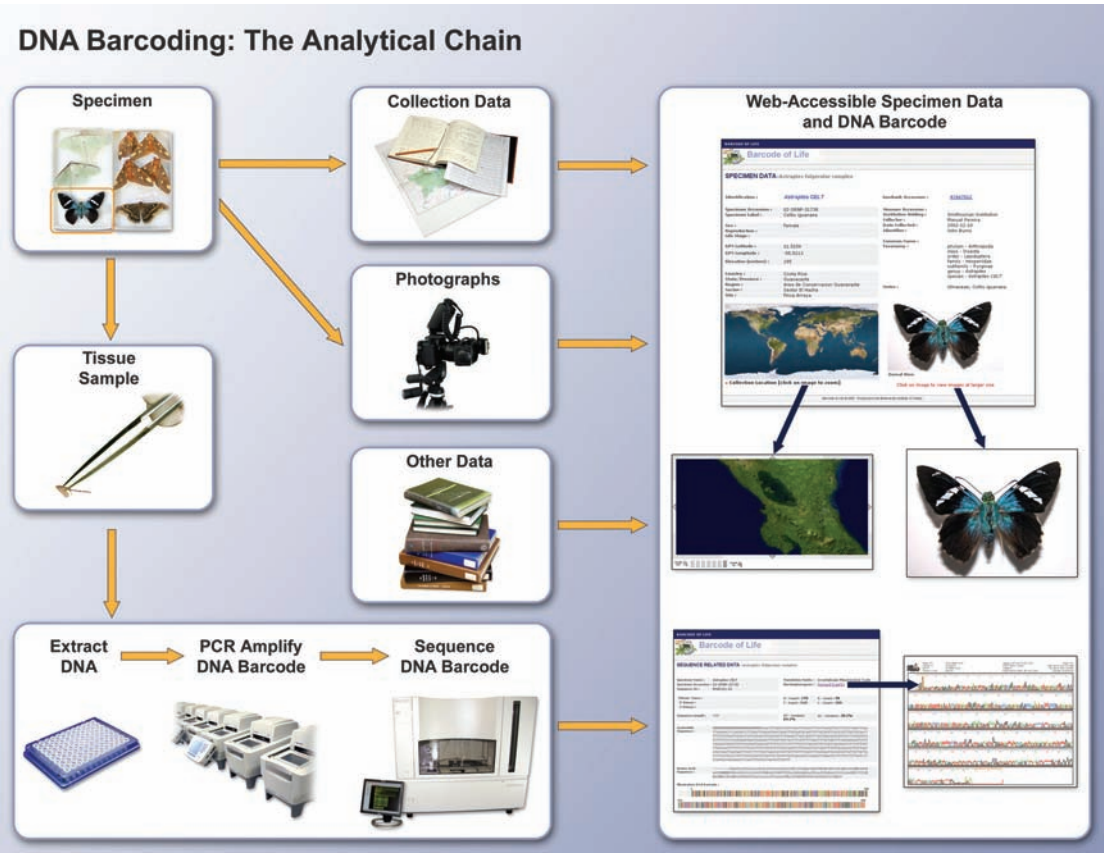
Further Information

Barcode of Life: www.barcodinglife.org
Canadian Barcode of Life Network: www.bolnet.ca
Fish Barcode of Life: www.fishbol.org

TABLE 1: Partners in research, funding and in-kind support.

CANADIAN BARCODE OF LIFE PARTNERSHIPS
Agriculture and Agri-Food Canada, Applied Biosystems, Bio-Rad Laboratories, Beckman-Coulter Canada, Brock University, Canada Foundation for Innovation, Concordia University, Dalhousie University, Department of Fisheries and Oceans, Environment Canada, Genome Canada, Laurentian Forestry Centre, McGill University, McMaster University, Mount Allison University, Natural Resources Canada, NSERC, Ontario Genomics Institute, Parks Canada, The Alfred P. Sloan Foundation, The Biodiversity Institute of Ontario, The Gordon and Betty Moore Foundation, The Royal Ontario Museum, Université du Québec à Rimouski, University of British Columbia, University of Guelph, University of Laval, University of Lethbridge, University of New Brunswick, University of Toronto, University of Western Ontario, University of Windsor, VWR International, York University

FIGURE 1: Conceptual diagram of the high throughput flow of specimens and data into a universally accessible database.



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