Plan of Action of the African Pollinator Initiative

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Food and Agriculture Organization of the United Nations
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Contents

Mission statement of the African Pollinator Initiative:

To promote pollination as an essential ecosystem service for sustainable livelihoods and the conservation of biological diversity in Africa

Words from a Patron:

"Concern for the conservation of biological diversity for the survival of mankind, has been a central point of action by countries and institutions. Conservation of plant diversity depends on the protection of forests, woodlands, grasslands and wetlands, and on a number of environmental services, such as pollination. In particular, flowering plants benefit from pollination. The vast majority is pollinated by insects, birds and other animals. Conservation of the pollinators is fundamental to plant diversity and their absence means serious threats to food security, cash-crop economies and the long-term survival of plant species in natural ecosystems. This calls for great attention to the study and conservation of pollinators.

Understanding the taxonomy of pollinators and pollinator/plant relationships are both needed for conservation and restoration. The introduction of the oil palm pollinator was successful in Malaysia, but one wishes the same solution could be found for vanilla growers in Africa who spend many hours hand-pollinating the crop. The importance of pollinators requires publicity and awareness. Pollinators are affected by extensive habitat clearing for monocultures and indiscriminate spraying of pesticides. Re-examination of agricultural and land use policies may be needed, while indigenous agricultural systems that allowed for alternative forage and breeding sites for pollinators are encouraged.

Traditional knowledge could offer guidance to the study, conservation and monitoring of pollinators. The local communities will also need to be involved in training and conservation. A farmer in Kitui District, a semi-arid part of Kenya, noticed flowers of pigeon peas dropping off without pod formation. The solution was to smear a few plants in the field with honey. This shows the perception of pollination and attracting pollinators in traditional knowledge.

Pollinators are essential for the conservation of biological diversity and sustenance of agrobiodiversity that support livelihoods in Africa. The African Pollinator Initiative needs all the support it can get to realize its plan of action in the study and conservation of pollinators."

Christine Kabuye
Patron of the African Pollinator Initiative
Curator-Emeritus
East African Herbarium, National Museums of Kenya

Executive summary

Informed by increasing recognition worldwide that pollinators play a key role in ecosystem health, both in farmers' fields and in wild landscapes, an Africa-wide group of people formulated the African Pollinator Initiative. This group is interested in and committed to protecting, understanding and promoting the essential process of pollination for sustainable livelihoods. We realise that pollination is a service nature provides that we have tended to take for granted, and that we often do little to encourage until we start to lose it. An estimated two-thirds of all flowering plants depend on animals, largely insects, for pollination. For these plants, the pollinator may be as critical as light and water. Pollination is a vital link in natural communities, connecting plants and animals in key and essential ways. Pollination is a service that is key to agriculture as well. Insect pollinators are essential for many fruit and vegetable crops, and the demand for pollinators grows as the need for agricultural productivity increases. Pollinators have real commercial value, although this is not always appreciated, as is evidenced by the US$150 million-plus per year service that West African beetles provide to oil palm plantations in Southeast Asia. The contribution of pollinators to food security in Africa may have both tangible and intangible values in reducing wide disparities in production levels and dependence on imported foods.

As wild ecosystems are increasingly converted to more human-dominated uses to meet the compelling demands of food security, it is critical to understand how we can preserve the basic ecosystem functions that fostered tremendous diversity in the first place, such as pollination. Pollination precedes fertilization in plants, and fertilization results directly in seed and fruit production. As a part of reproduction, seeds comprise the dormancy and dispersal phase of many plants. Seeds and fruit are also food for many people and animals. The loss in biodiversity and the adverse ecological effect that would follow a broad-spectrum loss of pollinators is inconceivable.

Yet remarkably little is known about pollinators in Africa. Virtually nothing is known about the effectiveness of pollinators of wild plant species. The bulk of research on both crop plants and wild ecosystems resides in South African studies, while the rest of the continent has been unevenly covered in the scientific literature. We risk losing not just particular pollinators or plants with fragile pollination systems but also critical ecosystem interactions and long-evolved links that underpin African ecosystems.

This document outlines the steps that API believes must be taken to secure the future of pollinators in Africa, for the benefit of this and future generations. The inaugural meeting of the initiative in February 2002 identified four components of an action plan, which has been further elaborated as the plan was developed. These four components: public awareness and education; placing pollination in the mainstream; conservation and restoration; and capacity building, have been designed to interact and reinforce each other, and to be applicable both regionally and nationally.

The action plan of the African Pollinator Initiative has benefited from a wide circle of supporters and friends, not the least of which has been the United Nations Food and Agriculture Organization and members in other regions of the International Pollinator Initiative who have contributed enthusiasm and ideas. But it remains at heart a locally developed solution to conserving what nature has provided, and the members of the initiative thoroughly endorse it.

Preface

When the Fifth Conference of the Parties to the Convention Biological Diversity established an International Initiative for the Conservation and Sustainable Use of Pollinators (also known as the International Pollinators Initiative-IPI) in 2000 (COP decision V/5, section II), FAO was requested to facilitate and co-ordinate the Initiative in close co-operation with other relevant organisations. A Plan of Action for the IPI was adopted at COP 6 (decision VI/5), providing an overall structure to the initiative, with four elements of assessment, adaptive management, capacity building and mainstreaming.

FAO, through the FAO/Netherlands Partnership Programme, supported the initial establishment of a regional African Pollinator Initiative, and the development and publication of its Plan of Action in 2003. With this initial publication now out of print, support from the Government of Norway has permitted the translation of the Plan of Action into French, and the publication of both documents in 2007.

We hope that the information contained in this Plan of Action will inspire others to establish and implement similar initiatives in their countries or regions as appropriate. We would encourage those that are developing initiatives and materials on conservation and sustainable use of pollinators to share these with FAO for wider dissemination, through the following address: pollination@fao.org).

Linda Collette
FAO Responsible Officer for the IPI and FAO's Global Action on Pollination Services for Sustainable Agriculture Rome, Italy

Introduction

Four years after the initial publication of the Plan of Action of the African Pollinator Initiative, we are grateful to FAO for supporting the republication of the English version of the Plan and for its translation into French. We are also pleased to note that, while we have no formal secretariat, the Initiative continues to attain a number of its objectives through the hard work and enthusiasm of its committed supporters. Since the Plan of Action was published, among other accomplishments, we note that: a stocktaking of the status of crops, browse and pollinators has been completed; a special issue featuring African pollination research was published in the inaugural volume of the International Journal of Tropical Insect Science; the initiative published a book and CD entitled, "Pollinators and Pollination: A Resource Book for Policy and Practice"; capacity building courses in bee identification have been held in two countries; post-graduate students are pursuing higher level degrees in bee taxonomy, pollination and pollinator biodiversity surveys; several countries from Africa have worked with the Food and Agriculture Organization of the United Nations to design a global pollinator project that will showcase good pollinator practices for sustainable agriculture, through an ecosystem approach; an innovative project to work with communities around Kakum Forest in Ghana to conserve and utilize stingless bees has been initiated; and pilot work in demonstration sites focused on coffee, curcurbits, chili peppers and eggplant has begun in both Ghana and Kenya. There are many more pollinator and pollination projects being undertaken in Africa and many of these are not well publicized. Therefore we need to remodel API into a better mechanism for people interest in pollination and pollinator biodiversity conservation to communicate and learn from one another, and to improve awareness of the importance of pollination for agriculture and biodiversity conservation. The initiative is developing a new website (http://www.arc.agric.za/home.asp?pid=3493), and strongly encourages people with an interest in pollination in Africa to both join and contribute. Working together, we will succeed to promote pollination as an essential ecosystem service for sustainable livelihoods and biodiversity conservation in Africa.

Connal Eardley,
ARC/PPRI
South Africa

Background

The African Pollinator Initiative (API) is an Africa-wide group of people interested in and committed to protecting, understanding and promoting the essential process of pollination for sustaining livelihoods and conserving biological diversity in Africa. Informed by increasing worldwide recognition that pollinators play a key role in ecosystem health, both in farmers' fields and in wild landscapes, a group of biologists, extension agents, educators and conservationists met in Kenya in early 2002 to formulate a continent-wide initiative to conserve pollinators in Africa. The meeting endorsed a declaration (below), identified four components of an action plan, and appointed an initial steering committee. This document outlines the steps that API believes must be taken to secure the future of pollinators in Africa, for the benefit of this and future generations.

The Kasarani Declaration

We, the participants of the first African Pollinator Initiative workshop, met at Kasarani in Nairobi, Kenya, during 18–22 February 2002 and—

• Agreed on a common purpose: to promote pollination as an essential ecosystem service for sustainable livelihoods and the conservation of biological diversity in Africa.

• Developed a plan of action to realize this purpose.

• Committed ourselves to working together to carry out the plan of action.

• Called on the good office of the United Nations Food and Agriculture Organization (FAO) to support API in this endeavour.

Why conserve pollinators in Africa?

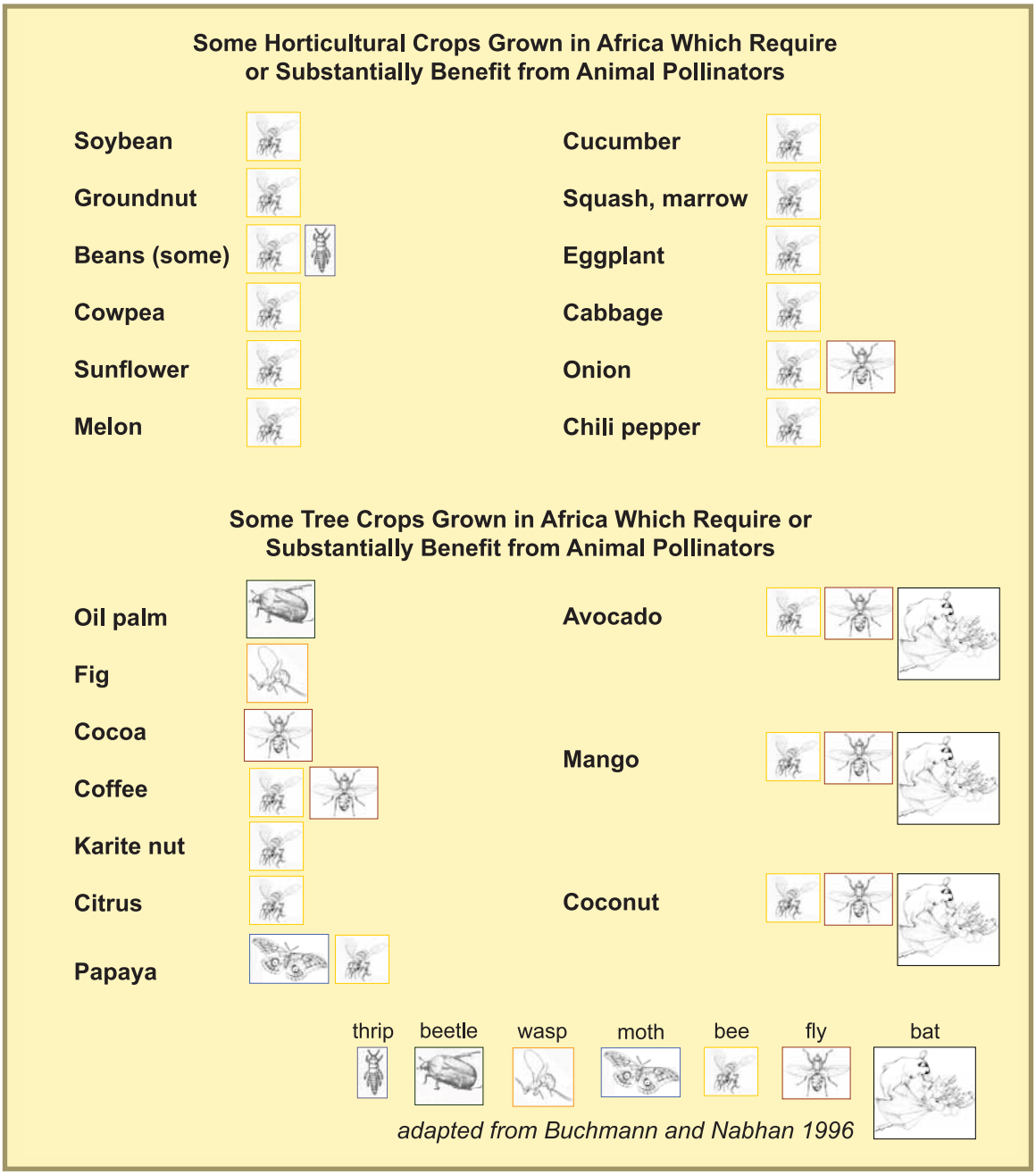
Conservation of pollinators is essential for food security and conservation of biodiversity in general. The continent of Africa is renowned for its biological diversity, from its bulldozer herbivores of elephants and rhinos to its equally spectacular bird life. Although less recognized, a highly diverse

fauna of insects also inhabits sub-Saharan Africa, and the African flora is stunning, though often only after close inspection. In the past, this diversity has persisted, and has even been encouraged by Africa's peoples, from nomadic pastoralists of the savannah to forest dwellers in the Congo Basin. Presently, however, the continent is under threat of widespread poverty and diseases such as HIV/AIDS that challenge people in the most productive periods of their lives. As wild ecosystems are increasingly converted to more human-dominated uses to meet the compelling demands of food security, it is critical for us to understand how we can preserve the basic ecosystem functions that fostered the tremendous diversity in the first place.

Pollination is the transportation of pollen from anther to receptive floral stigma. It takes place by means of animals (pollinators), wind and water. Pollination precedes fertilization, and fertilization results directly in the plant producing seeds and fruits. Seeds, of course, are the means by which plants manage to disperse to new sites. They are also a means by which a plant species can persist in a dormant phase, during times of drought or other stress. Seeds and fruits are also food for many people and animals. The loss in biodiversity and the adverse ecological effect that would follow a broad-spectrum loss of pollinators is inconceivable.

Thus pollination is a central service to all ecosystem functions. Worldwide we are realizing that pollination is a service nature provides that we have tended to take for granted, and that we often do little to encourage until we start to lose it. An estimated two-thirds of all flowering plants depend on animals, largely insects, for pollination. For these plants, the pollinator may be as critical as light and water. Pollination is a vital link in natural communities, connecting plants and animals in key and essential ways. Cross-pollination by insects has very likely been key to the radiation of flowering plants throughout the world—plants that are the cornerstones of most ecosystems. Because insects have become so adept at finding and identifying individual flowering plants, even rare plants may persist so long as pollination occurs. In other words, they need not be close together—as is rarely possible in the many marginal environments of Africa that experience recurrent drought. The wealth of types of pollinators—from butterflies to bees to birds and bats— and the wealth of variety within flowering plants have stimulated each other's evolution, leading to a remarkable diversity and often-beautiful adaptations between flowers and pollinators. Conserving pollinators in an ecosystem means preserving the finely tuned links between plants and animals that make it possible for plants to reproduce successfully. In turn, especially in the harsh environments found throughout Africa, plants offer a rich and critically vital resource to animals in the form of pollen, nectar, seed, fruit and foliage.

Pollination is a service that is key to agriculture as well. Insect pollinators are essential for many fruit and vegetable crops, and the demand for pollinators grows as the need for agricultural productivity increases. Unfortunately, by developing larger and larger fields and landscapes for agriculture, we also remove the habitat that pollinators may need. Pollinators have real commercial value, although this is not always appreciated. We need only to consider the US$150 million-plus per year service that West African beetles provide to oil palm plantations in southeast Asia (see box on West African oil palm pollination, *page 14*).



Studies on pollination have almost always shown that we should not rely on a single pollinator species. For many crops, the more pollinators, and the more different kinds of pollinators, the better. For example, with cucurbits such as watermelon, the weight of the fruit is directly linked to the number of pollinator visits. Moreover, certain pollinators such as most bees may fly only when it is warm and sunny while others such as hawk moths may fly in cooler and cloudier weather. It has become apparent that providing pollinator services involves far more wild species and far more habitat types than have been considered in most discussions of agriculture's dependence on biodiversity.

Estimated Global Value, Pollinator Services of Selected Crops

	FAO Production Year book Commodity "International Dollar" Price per ton	Annual Value World Production 1000s of "International Dollars	Southwick's % Crop Loss with No Replacement Pollinatoon	Value of Losses 1000s of "International Dollars"
TROPICAL TREE CROPS				
MANGOES (% From J. B. Free)	211.49	4,715,496	50%	2,357,748
COFFEE, GREEN (% from J. B. Free)	958.96	5,286,733	50%	2,643,367
COCOA BEANS (% from J. B. Free)	663.10	1,956,085	50%	978,042
PALM OIL (% from J. B. Free)	165.05	2,629,554	20%	525,911
	Sub-total	14,587,867	43%	6,505,067
VEGETABLE AND SEED CROPS				
ARTICHOKES	590.70	671,135	10%	67,114
ASPARAGUS	1440.85	5,607,111	21.87%	1,226,275
CABBAGES	100.24	4,502,052	0.63%	28,363
CARROTS	162.87	2,648,771	1.68%	44,499
CAULIFLOWER	183.92	2,333,767	3.87%	90,317
COTTONSEED	174.69	6,450,614	30%	1,935,184
CUCUMBERS AND GHERKINS	223.12	13,091,076	60%	7,854,646
SUNFLOWER SEED	292.45	7,771,635	80%	6,169,308
	Sub-total	43,076,161	26%	17,415,706

To illustrate this range of diversity in pollinators, we have depicted the key pollinators of horticultural crops and tree crops grown in Africa. As can be seen, bees feature very importantly in horticultural crops; a wider diversity of pollinators is important among tree crops. Recent estimates of potential yield loss of crops that could result from serious loss of pollinators are sobering.

Remarkably little is known about pollinators in Africa. Virtually nothing is know bout the effectiveness of pollinators of wild plant species. The bulk of research in Africa on both crop plants and wild ecosystems resides in South African studies; the rest of the continent has been unevenly covered in scientific literature (Rodger, Balkwill and Gemmill, in press). When pollinators become increasingly rare in an ecosystem, other species will usually fulfill a similar role, even if less optimally. Thus the losses may be subtle and unnoticed at first, making any early warning system for pollinator loss quite complex. When losses start to take effect, reduced seed set is the first result. Then follows increased inbreeding within a crop or population—again, an effect not readily apparent to non-specialists. The primary threats to pollinators are alteration of their habitat, leading to loss of breeding sites and food resources, and the wide use of pesticides on crops in ways that kill beneficial insects as well as crop pests.

Formation and growth of the African Pollinator Initiative

The organisms responsible for pollination, and consequently pollination itself, are widely believed to be seriously threatened by a combination of habitat loss and indiscriminate use of agricultural pesticides. This threat has raised concern, and more or less simultaneously two different parties—the Convention on Biological Diversity and the Forgotten Pollinators campaign—recognized that a global approach to pollinator conservation was needed.

The Forgotten Pollinators campaign, which coincided with a book by the same name by Buchmann and Nabhan (1996), initiated a wide interest in pollinator conservation, mainly in the USA. In the same year, the Third Conference to the Parties (COP 3) of the Convention on Biological Diversity (CBD) gave pollinators priority for publishing case studies in its agro-biodiversity programme. This stimulated global interest in pollinator conservation, and the first subsequent major activity was an international symposium in São Paulo, Brazil. This resulted in the São Paulo Declaration, which called for an international pollinator initiative and documented many activities required for pollinator conservation (http://www.biodiv.org).

The consequence was the International Pollinator Initiative (IPI), formally known as the International Initiative for the Conservation and Sustainable Use of Pollinators, a cross-cutting issue within the CBD programme for Conservation and Sustainable Use of Agricultural Biological Diversity formed at CBD's Fifth Conference of the Parties (COP 5, Decision V/5). COP 5 requested that 'the United Nations Food and Agriculture Organization (FAO) facilitate and coordinate the initiative in close cooperation with other relevant organizations and . . . consider establishing a coordination mechanism' , and that it prepare a proposal for a plan of action to submit to the Subsidiary Body on Scientific, Technical and Technological Advice, to be considered by the Conference of Parties at its sixth meeting. The plan of action for the International Initiative for the Conservation and Sustainable Use of Pollinators was adopted at COP 6 (decision VI/5) in April 2002. Through these efforts, pollination has earned a place in the global environmental agenda. One member of the API steering committee (Barbara Gemmill) is the lead author in the 'Millennium Ecosystem assessment' chapter on 'Biodiversity regulation of ecosystem services', with respect to pollination services. The Millenium Ecosystem Assessment is assembling global evaluations of nature's services to human welfare and the trade-offs being made under current development patterns, and will be a powerful and effective tool to influence policy decisions.

But earlier in Africa, concern about pollinator conservation had stimulated a proactive approach, and the African Pollinator Initiative (API) was founded in 1999 at the first symposium of the Southern African Society for Systematic Biology, held in Stellenbosch, South Africa. API intends to increase capacity through strengthening institutions, not by creating new organizations. It has focused on using existing structures such as BioNET-International's east, west and southern African networks to achieve its objectives. API enjoys a strong if informal relationship with BioNET-International (http://www.bionet-intl.org/) in that BioNET has made its network structure available to API,

and our principal outreach to countries at this initial point is through SADC, East African, West African and North African BioNET focal points and frameworks. Networking is clearly an important tool for implementing a regional initiative such as API, yet implementing a network effectively must be both strategic and frugal. To make API an effective force among existing initiatives, some of which have overlapping fields of concern, it is prudent to create distinct nodes of activity, and to develop understanding between these nodes and other ongoing initiatives. Among those that will benefit from mutual agreements with API are the Global Taxonomy Initiative, the Global Biodiversity Information Facility (both of which are under discussion with BioNET nodes in Africa) and the Global Invasive Species Programme.

API is a major African regional network whose work contributes to the implementation of IPI, and it can be a good model of a regional entity working towards IPI implementation. API also maintains a particularly strong link with FAO by working in partnership to undertake activities that assist in implementing IPI activities and objectives. FAO funded the first API workshop, to enable API to create a more formal, coordinated approach to pollinator conservation and sustainable use, and to establish specific regional activities but also to collaborate with other international and regional partners.

Public Education and Awareness

The continent of Africa is graced with a wealth of unique pollinator syndromes and a healthy level of pollinator diversity represented not just by insects and birds, but also by reptiles and mammals as well.

Focus on . . . Ceropegia

The diverse genus *Ceropegia*, a member of the milkweed family with over 160 species distributed throughout the Old World tropics, is well represented in Africa. Ceropegias are both strange and lovely. They are mostly climbing, succulent herbs, with distinctive flowers. The complex flowers are highly variable but consist of a chamber formed of fused petals with limited access, a fringe of hairs to the corolla (a typical trait of many fly-pollinated succulents) and a delightfully involved and complex pollination mechanism. Flies, drawn to the colours and foetid smells of the *Ceropegia* blossom, are led through its gaps and folds until they are tricked into entering the chamber. Here they are duly trapped and find themselves drawn once again to the flower's reproductive structures. While searching for food, their mouthparts will encounter small packages of pollen, called "pollinia" that adhere to the fly's mouth. The fly is released as the flower wilts, and loaded with the very securely attached pollinia eventually visits another blossom. As an educational poster, this case study with its bright colours and interesting processes could go a long way in fostering awareness among primary and secondary science students, amateur naturalists and other nature enthusiasts.

from Masinde 2004

The suite of organisms in Africa providing pollination services to crop plants alone is estimated to increase productivity of outcrossing crop plants by an average of 31%, with a return to agricultural productivity of 23 billion dollars per year. Yet public awareness of this essential ecosystem service remains virtually nonexistent. Even farmers, who understand that bees provide honey, are often not aware of their beneficial role as pollinators.

When a workshop primarily of biologists met in Kasarani, Kenya, in February 2002 to mobilize the African Pollinator Initiative, they recognized that while research to identify pollinators and document their roles is critically needed, no amount of scientific work will retain its value unless a campaign to increase public awareness of pollinator importance is placed at the highest level of priority.

Fortunately, pollination can sell itself, with a little help from its friends and advocates. The many intricate and fascinating systems of plant-pollinator interactions throughout the continent are our best source of tools for capturing the popular imagination and communicating the value of pollination as a service to be protected.

Public Education and Awareness: Plan of Action

Who?	How or What?	Why?
Public	Media campaigns, including targeting the general public, and specialized publics through newsletters/brochures.	To inform the public, both general and specialized.
Schools, Universities	Lectures,posters	To interest younger generations and current science managers in the importance of pollination
Farmers, land managers	Information, demonstration “pollinator gardens”, simple management guides, posters	To increase the specific understanding of those most close to the resource
NGOs	Workshops, documents	To provide advocacy materials for modifying land management practices to support pollinator conservation
Consumers	Media campaigns, public information	To inform and influence consumer choices
Policy makers, Government ministries	Information, policy analysis	To inform and influence policy decisions

Focus on . . . West African oil palm pollination

Consider the oil palm plantations of Malaysia and how an African pollinator has benefited them. Oil palm trees, native to West Africa, were taken to Southeast Asia and planted in vast plantations to satisfy the global demand for cheap, versatile palm oil. Production was disappointing until the plantation managers realized that it could be enhanced by hand pollinating the palm flowers. Yet hand pollination was laborious and inefficient. Plantation owners began to ask how the oil palm got itself pollinated in its native habitat of West Africa's forests. Researchers studied the oil palm in Cameroon, where they found that a tiny weevil, *Elaeidobius kamerunicus,* travels from male to female flower parts and pollinates the flowers effectively while feeding on the pollen. Start-up stocks of the weevil were taken back to Malaysia, where they were released into the plantations. (There was no problem of ecological complications with other species, since the weevil confined its attentions to the oil palm.) The weevil now accomplishes all the pollination, bringing savings that were amounting to $150 million per year by the early 1980s (Greathead 1983). Figures such as these should help to convince policy-makers of the importance of pollinator conservation.

We recognize that we need to relay and disseminate information on pollinators through a number of avenues, each one especially tailored for the targeted audience. Among the critical target audiences to reach will be children, farmers, extension workers and government policy-makers, as well as the general public.

Following are strategic interventions we intend to use in promoting public education and awareness of pollination.

Produce stimulating documentaries and informational material. API, like many other bodies approaching the general public and exploiting media time and space, will be competing for attention with a wide range of causes and ideas. While it would be wonderful if everyone stopped and read a whole book on pollinators, most people don't have the time or inclination to do so. However, by using colourful images, a catchy slogan, logo and branding, Web sites, and similar methods, API can become part of the wider societal conscience. Other groups have managed to do this—the WWF logo of a panda bear, despite it being an obscure and rare animal, is as familiar and recognizable as Coca-Cola the world over. With pollinators we have the advantage that everyone already knows bees, and all societies have stories and proverbs that value and honour them. API should use this as

a starting point. Moreover, pollinators visiting colourful flowers is a visually appealing image, and the ways pollinators and plants have evolved to manipulate each other's performance are full of surprises and twists. Pollination biology in an African context includes the prehistoric-era stories of *Cycad* pollination, *Ceropegia* flowers and their imprisoned flies, sunbirds sipping at aloes, and bats

Provisional Budget: Public Education and Awareness

Activity	Level	Unit Cost	No. of Units
1. Production of pollination documentaries for radio and television.	Regional	$50,000 Television, $20,000 Radio	2 Television, 5 Radio
2. Production of quarterly newsletters/brochures with network of pollination biologists, botanical garden managers, farmer groups, other specialists.	Regional	$500	12, over 3 years
3. Demonstration "pollinator gardens" in national research centres and botanical gardens.	National	$3000	per participating countries
4. Extension materials for agents and farmers.	National	$3000	per participating countries
5. Civil society awareness raising workshops on pollinator conservation in sustainable agriculture and rural development.	National	$3000	per participating countries
6. Consumer campaigns for "pollinator friendly" commodities	Regional	$100,000	3 commodities

hanging from *Parkia* flowers. The subject can be a door for children and adults alike to learn about the broader ideas of science and conservation. The science of pollination is dynamic and interesting, and many new and interesting mechanisms are discovered every year. Telling this story to the general public, through radio, television and the print media, presents a great opportunity to convey the beauty of subtle ecological interactions to the general public. Our present API coordinator, Dino Martins, was awarded the Peter Jenkins Conservation Journalism award of 2002 for just such reportage: a series of articles in *Swara* magazine, which focused on pollinators, insect mimicry, and other insect-related stories.

Foster information exchange among key stakeholders. Active networking and exchange of information among practitioners in the field of pollination and those interested in pollination services (including farmer groups and sustainable-agriculture groups) will lead to stakeholders who are more informed and engaged on pollination issues in Africa. Exchange of preliminary research information and experiences to conserve pollinators will build informal capacity among a wide range of stakeholders interested in pollination services.

Information exchange between API and global initiatives is important too. Pollination biologists are well placed to assess harmful trends in the environment, as pollinators have been identified as 'canaries in the mine'—giving early warning of the breakdown in critical environmental services. The African Pollinator Initiative will seek to inform initiatives such as the Millennium Ecosystem Assessment of its observations on pollinator declines within Africa, keeping conservation and ecosystem services sufficiently prominent on the global agenda.

Create demonstration gardens. Seeing is believing, and pollination is a process that is a pleasure to observe. Establishment of demonstration pollinator gardens in existing public spaces such as arboretums, museums, botanical gardens and national agricultural research stations will provide places where the public can see, first hand, an ecosystem service that they may never have focused on before. Pollinator conservation may hinge on establishing just such small reserves. Demonstration gardens can serve both to educate people and to promote pollinator conservation. API will also work to draw people's attention to their private flower and vegetable 'kitchen' gardens, and the pollination that occurs there.

Inform community groups and extension officers. These groups need specific, practical information on how their management decisions can serve to conserve pollinators. Crop yield loss and fragile pollination relationships in wild ecosystems need to be pinpointed and highlighted. Scientific information on threats to pollinators—from disease, land degradation, pesticide use and habitat loss—must be made relevant and accessible to resource managers. Specific interventions, such as when best to spray pesticides and how to conserve alternate resources for pollinators, need to be conveyed to farmers and land managers.

Actively engage support groups and communities working on the nexus of sustainable livelihoods and conservation of biological diversity. API recognizes and seeks to establish memoranda of understanding with other public interest institutions and bodies that are actively engaged in

community-based conservation and sustainable agriculture. These societies, such as Nature Kenya, or PELUM (a network of sustainable-agriculture non-governmental organizations in southern and eastern Africa), should also be educated as to how important pollinators are and the necessity to include pollinators as part of any campaign on conserving biodiversity or making agriculture sustainable.

Inform consumers. Interesting possibilities for valuing ecosystem services are opening up with new ecolabelling schemes, such as 'bird-friendly' shade-grown coffees produced in Latin America and marketed through coffee shops in the United States. Such schemes can provide farmers with premium prices for producing with environmentally friendly practices, benefit the local ecosystem, inform consumers about how their food is produced, and assure them that the food is safe and healthy. 'Pollinator-friendly' coffee from the highlands of Ethiopia or cocoa from Ghana may ultimately be a marketing force to harness in support of pollinator conservation. Stingless bees produce a very special honey, highly valued in Ethiopia and Tanzania for its medicinal values, whose commercial potential has not yet fully been explored in Africa. Indigenous bees often nest in, and make use of the resin, from trees that produce myrhh, a commodity valued by green marketers such as the Body Shop. It is not inconceivable that consumers might like to know that their purchases support a web of interactions, if API can present this information in an attractive way for distant purchasers.

Placing Pollination in the Mainstream

Pollinators are small, industrious animals that rarely manage to get onto the agenda of policymakers, yet we need a policy environment that recognises the quiet, fundamental role that pollination plays in food security and biodiversity conservation. The African Pollinator Initiative must find strategic ways to promote "pro-pollinator" policies. We recognise that it is unlikely that any government will soon develop a high-level department devoted to pollination; rather, we need to mainstream pollination concerns into the relevant sectors. Some of the ways we propose to do this are:

Ensure that pollination is addressed in environmental planning. Every country that is signatory to the Convention on Conservation of Biological Diversity is obligated to develop a national biodiversity strategy and action plan. Only Brazil, and the Philippines, so far as we know, have included pollination in these plans. Signatory countries have also agreed to develop means of sharing biodiversity data with the public on a national basis, through a clearinghouse. Often countries have found it difficult to identify and produce such data readily. The African Pollinator Initiative will be well placed to share the data it generates with a national clearinghouse and to help governments make the first steps toward proffering such data in a Web-based interface.

Many countries have developed fairly detailed regulations for biodiversity conservation, yet none as yet address needs specific to pollination, such as conserving small areas of nesting sites in agricultural landscapes. Impacts of development projects on birds, mammals and rare plants are routinely considered in environmental impact assessment procedures, but as yet, planners have

little information on how to include pollinators in impact assessment. Some countries, such as Australia, have means by which citizens can identify perceived threats to their governments, such as declining pollinator numbers or the presence of alien invasive pollinators. As we note, pollination is rarely likely to receive direct attention from government bodies, and finding ways such as this, to involve citizens in conservation policy, will benefit both governments and communities.

Bring pollination into agricultural policy. Again, pollination has not yet earned a mention in most agricultural policies in Africa, but countries can learn from each other: China officially recognises pollination as an agricultural input, along with other agricultural inputs such as seeds, fertilisers and pesticides. The Moroccan national agricultural extension service recognises that pollination, rather than honey, is the most valuable output of the apiculture sector in Morocco, and orients its extension services in this direction. The EU, much criticised for its agricultural subsidies, has developed an alternative subsidy scheme which rewards farmers not for over-producing, but for conserving biodiversity on-farm, including specific provision for offering good quality pollinator forage, and leaving farm margins unploughed so that pollinators may

Placing Pollination in the Mainstream: Plan of Action

Who?	How or What?	Why?
National Biodiversity Planners, NGOs	Introducing pollination into environmental planning, through national biodiversity plans, regulations and environmental impact assessment screening criteria	To estalish a policy environment for pollinator conservation
Ministries of Agriculture, national agricultural research centers	Bringing pollination into agricultural policy.	To have pollination recognised as an important agricultural input
Ministries of Finance	Introduce green accounting for the contribution of ecosystem services to national budgets	To recognise the economic value of ecosystem services to poverty alleviation and sustainable development

find nesting sites. Some new certification systems for export crops from Africa are requiring on-farm biodiversity plans as part of "Good Agricultural Practices", which could well include pollination considerations. On a more specific but equally important level, few countries require pesticide labels to include information about pollinators. Information generated by this initiative will be translated directly into such policy considerations.

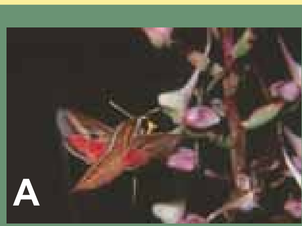
Introduce economic valuations of pollinator services. API recognizes that policy-makers and legislators are extremely busy and under pressure from many sectors. As part of the broader conservation strategies, a special subset of relevant, current and critical information must be made available to educate the policy-makers. Documents produced for this audience need to be terse but accurate. Specific policy interventions that can help conserve pollinators should be developed and presented to policy-makers, to guide their decisions appropriately. One means is to promote the incorporation of ecosystem services—such as watershed values and pollination services—into national accounting practices, so that these functions are given a visible economic value.

Provisional Budget: Placing Pollination in the Mainstream

Activity	Level	Unit Cost	No. of Units
1. Guidebooks developed for policy makers on pollinator- supportive policy frameworks, including mainstreaming into environmental planning, the agricultural sector, and national accounting.	Regional	$50,000	1
2. Support for national campaigns to introduce pollination into biodiversity and environmental planning regulations, including creating an agro-biodiversity web site, in collaboration with the CBD focal point in each country	National	$3000	per participating countries
3. Support for national campaigns to introduce pollination into agricultural policy,	National	$3000	per participating countries
4. Support for national campaigns to introduce pollination into national accounting.	National	$3000	per participating countries

*Focus on...*Unique Pollination Systems of Southern Africa

Southern Africa, with a tenth of the world's plant species, has the richest flora of any region of equivalent size in the world. This diversity is matched by a remarkable range of pollination systems, many of which have been discovered only in the past few decades. Some of these are described below.



Flies: Long-tongued flies (Nemestrinidae, Tabanidae, Bombyliidae) are known to be flower specialists and feed mostly on nectar (Fig. A). Particularly long probosces have evolved in the Nemestrinidae and Tabanidae, with the nemestrinid *Moegistorhynchus longirostris* having the longest proboscis (6–10 cm) of any fly worldwide. The long proboscis of these flies serves to extract nectar from deep tubular flowers, and research in the past decade has shown that dozens, if not hundreds, of plant species in southern Africa rely exclusively on these flies for pollination. Within any particular geographical region, there are guilds of plants that, in some cases, rely on a single long-tongued fly species for pollination. Such specialization by plants is rare worldwide and was hitherto known only in plants such as figs and yuccas that offer specific brood sites for pollinators.

Moths: Moth pollination is well developed in the African flora. Some 50% of African orchids, for example, are pollinated by moths. Data on moth pollination are hard to acquire because of the difficulty in making nocturnal observations. However, in the past decade several studies have been made of pollination by both settling moths (Noctuidae and Geometridae) and hawk moths (Sphingidae). Interestingly, moth pollination is rare in the Cape floral region where nutrient-poor soils render vegetation unpalatable to most moth larvae, but it is relatively common in the summer rainfall region.

Beetles: The classical beetle-pollinated flower has long been characterized as bowl shaped and pale in colour, with a strong fruity odour. This description applies mainly to plants pollinated by fruit-chafer beetles (Cetoniinae). In South Africa, most documented beetle-pollination systems involve plants with bright (red, orange or yellow) odourless flowers visited by monkey beetles (Scarabaeidae: Rutelinae: Hopliini) (Fig. B).

Pollen wasps: Southern Africa has the richest fauna of masarid wasps worldwide. These wasps feed their larvae on pollen and nectar, like bees, and not on insects and arachnids like other wasps. They appear to play a particularly important role in pollinating plants in the semi-arid Karoo region. Sexual deception of male wasps by Cape *Disa* orchids has recently been recorded.

Vertebrates: Bird pollination is well known in Africa, with sunbirds, sugarbirds and several other bird species visiting flowers regularly. But there are other vertebrate pollinators, as well, some of which are known only on the continent to serve this function. Pollination by rodents is an oddity that was first discovered in Cape proteas in the 1970s and later found to occur also in Cape lilies (Fig. C). Flowers adapted for rodent pollination blossom close to the ground, are dull coloured and produce a yeasty scent during the evening, timed in tune with the nocturnal activities of rodents. Flowering usually occurs in winter when rodents are short of food and alternative pollinators, such as insects, are less active. Bats are also pollinators—the baobab tree, which provides shelter and food for an abundance of animals, is bat pollinated.

adapted from Johnson 2004

Conservation and Restoration

The campaign to conserve pollinators globally arose from greater attention paid to monitoring information, and the realization that wild plant reproductive failures and agricultural loss through insufficient pollination were both becoming more common. Yet we have little of this type of information for Africa. While Africa has had a long history of agricultural and botanical research, and some groundwork has been laid with respect to pollination, overall the scientific understanding of pollination in Africa is weak and uneven.

Pollinator conservation provides a tremendous opportunity to put into operation the ever-elusive 'ecosystem approach' in fine-grained, human-scaled landscapes such as farm and field edges. With appropriate research, we must develop simple specific recommendations to land managers to conserve pollinator habitat, and publicize and lobby against bad agricultural and land-use practices. We must systematically identify key pollinator interactions and population dynamics in natural

Focus on . . . Bottle gourd pollination in Kenya

The use as a container of the cucurbit fruit known as 'bottle gourd' straddles many African cultures. The classic African bottle gourd, *Lagenaria* spp., comes from strong-growing annual climbers with ancient pan-tropical distribution. It is believed that the gene centre of the bottle gourd is Africa but wild species have not been confirmed. The plants seem to grow naturally around human settlements. What is remarkable about bottle gourds is their amazingly high diversity of fruit size and shape as well as shell colour, texture and thickness. The diversity is different between ethnic groups with some forms being found only in certain community groups where the cultivars are maintained by local custom. It is now known that culture has played a significant role in maintaining this diversity. The bottle gourd is, however, grown in traditional systems where pollination is left to natural factors. As the species is dependent on insects for pollination it makes sense to believe that insects are also crucial in maintaining this diversity. Unfortunately very little is documented about the plant's biological diversity and little is known about its reproduction mechanisms in Africa. A recent study in Kenya looked at the mechanism of pollen transfer in several species of bottle gourd. Four groups of flower visitors comprising hawk moths (*Hippotion celerio*, *Agrius convolvuli*), noctuid moths (*Noctuidae* spp.), skipper butterflies (*Gorgyra johnstoni*) and honey bees (*Apis mellifera*) were considered active flower visitors. Night-visiting hawk moths were suspected to be the major pollinators of this plant in the locations surveyed.

from Morimoto et al. 2004

Conservation and Restoration: Plan of Action

Who?	How or What?	Why?
1. A network of insect ecologists, research site directors and specialists in long-term monitoring, databasing, and taxonomy.	Develop and implement standardized monitoring methodology in a network of sites, to monitor pollinator trends in diverse and threatened ecosystems.	To develop both an early-warning system to detect pollinator trends, and simple reference guides to pollinators and their distribution patterns.
2. African universities and research institutions	Create a database on important crops and biomes in Africa dependent on pollination; assess existing knowledge on pollination biology and taxonomy; carry out focused case studies on major gaps.	Compilaiton of existing knowledge will guide targeted research designed to fill in the major gaps.
3. Network of national universities and NARCS, backed up by regional research institutions	Carry out case studies of pollinator decline for pollinator conservation and restoration interventions.	Management interventions should be based on knowledge, both scientific and traditional.
4. Specialists in environmental economics	Assess the economic value of pollination, with evaluations of the economic impact of the decline of pollination services in agriculture, and in natural ecosystems	Critical and compelling information for public education and awareness, and policy decisions will be provided.
5. NGO partners with restoration capacity, backstopped by research institutions	Carry out pollinator conservation interventions, based on knowledge of causes of pollinator decline and of pollinator habitat requirements, monitor and document effects of interventions and identify and publicise best practices in pollinator conservation and restoration, through application of the Ecosystem Approach of the Convention of Biological Diversity.	Successful strategies must be identified and documented for replication in other areas. Pollination services are a good application of the ecosystem approach and can illustrate its value to a wide constituency modifying land management practices to support pollinator conservation
6. Regional and national research institutions.	Develop specific recommendations to land managers to conserve pollinator habitat, and Publicise and lobby against bad agricultural and land use practices which are detrimental to pollinators.	Pollination conservation must be translated into clear management terms for farmers and wild land managers.

and agro-ecosystems, and give priority to those for which explicit pollinator management practices will have the most beneficial effect.

The following strategic interventions are foreseen:

Monitor the status and trends of pollinators in selected areas of Africa. From research that has already been conducted in Africa, we know that African pollination systems are often unique, and their components need careful documentation. The African Pollinator Initiative has recognized that we must systematically identify key pollinator interactions and population dynamics in both natural and agro-ecosystems, including forests, savannahs, grasslands, arid and semi-arid lands, wetlands and afromontane ecosystems. Establishing the status and trends of pollinators in Africa is among the most important activities of this initiative, as we need to understand the status of pollinators in Africa to plan for conserving them. In agricultural systems, we need to assemble all existing information on crops that depend upon pollinators—including indigenous knowledge—and identify the key pollinators in crop systems with high priority. From an assessment exercise, we should be able to identify and prioritize vulnerable systems, and those in which explicit pollinator management practices can have the most beneficial effect.

Assess the state of knowledge of pollination biology and taxonomy. The African Pollinator Initiative does not start from zero; in fact the initiative has begun to compile a respectable body of information on pollination in Africa. Making known information on pollination biology and taxonomy of pollinators readily available to researchers and the interested public ensures that the initiative builds on past efforts.

Identify key pollinator interactions and population dynamics in natural and agro-ecosystems. Plant dependence on pollinators can be determined by simple exclusion and inclusion studies. Such research does not require sophisticated equipment, can be completed in a growing period, and is easily (but necessarily) replicated to determine local requirements. A valuable synergy of the initiative occurs when researchers share their protocols and procedures, allowing work to be replicated in many different sites. This sharing has already begun as the result of the first API workshop. The information that API will require can also focus African university students on pollinator studies.

Develop credible assessments of the economic value of pollination. Pollination is an ecosystem service that is clearly and directly related to human livelihoods and food security, yet a credible assessment of the economic value of pollination has yet to be carried out. Developing such an assessment within Africa, with compelling demands for food production and security, could be a major contribution of the African Pollinator Initiative to global development goals. Economic assessments of pollinator services in Africa can be an important input into the agenda of the New Economic Partnership for African Development (NEPAD), to identify ways that development and environmental conservation can work together.

Identify and implement key pollinator conservation and restoration activities in natural and agro-ecosystems. To conserve pollinators means that we must find ways to modify the management

Focus on ..Stingless bees of Bwindi Impenetrable Forest

The Bwindi Impenetrable forest is located in western Uganda along the border with the Democratic Republic of Congo. The forest survives as an 'island' in the midst of dense agricultural settlement. Traditionally, local peoples including the Batwa (Abayanda) pygmies live in and use the forest. Batwa knowledge and exploitation of stingless bees is extensive and complex. Two genera occur in the forest: *Meliponula* and *Hypotrigona.*

Batwa peoples harvest stingless bee nests from the forest, using the honey and other hive products for a range of purposes including food and medicine. The Batwa classify the stingless bees of Bwindi into six distinct categories: maranga, obuganza, obugashu, obuhumbamba, obuzagali and obwiza. Characteristics such as body size and colouring are carefully observed in determining the kinds of stingless bee. The shape of the nests as well as the taste and qualities of the honey are also important factors. Batwa knowledge of forest ecology extends to recognizing ant associations with stingless bees; the bees engage in a mutualistic nesting within some ant colonies.

Stingless bees are important pollinators of a range of forest plants throughout the tropics. The six different types of stingless bee that the Batwa recognize are also scientifically classified as distinct species. Batwa names for the stingless bees reflect their various characteristics, such as 'obuhumbamba', meaning 'likes to nest in people's homes'. Traditional folk taxonomic systems are vital indicators of forest use, and they can be adapted to sustainable methods of harvesting, thus protecting local enterprise and conserving pollinators.

from Byarugaba 2004

of natural resources to permit pollinators to persist. This may not be difficult; long-term studies in mid-western United States have shown that small areas of natural habitat in an agricultural landscape (such as road verges and uncultivated fence lines) have permitted a remarkable persistence of wild bees over a 75-year period of agricultural development (Marlin and LaBerge 2001). For systems most under threat, we need to know the critical specifics of habitat size, shape and plant resource distribution needed to conserve pollinators. We also need to better understand 'adaptive' management for pollinator conservation: what are the tools and principles that land managers need to internalize, so that they can make appropriate decisions that incorporate pollinator conservation with other day-to-day practices? In formulating adaptive management recommendations, we must

begin by recognizing existing information and knowledge, including indigenous knowledge, on how to manage pollinators in landscapes.

Introduce meliponiculture. Possibilities for harnessing African pollinators for generating income must be underlain by appropriate research and experience sharing. Unique opportunities are possible

Provisional Budget: Conservation and Restoration

Activity	Level	Unit Cost	No. of Units
1. Development and implemention of standardized monitoring methodology.	Regional	$100,000	1
2. Creation of database on important crops and biomes in Africa dependent on pollination; assessment of state of knowledge on pollination biology and taxonomy.	Regional	$30,000	1
3. Focused case studies on major gaps.	National	$30,000	per participating countries
4. Assessment of economic value of pollination, with evaluations of the economic impact of the decline of pollination services in agriculture, and in natural ecosystems.	National	$30,000	per participating countries
5. Case studies on pollinator restoration interventions.	National	$30,00	per participating countries
6. Development of science-based African meliponiculture, with reference to traditional knowledge.	Regional	$250,000	1
6. Implementation of pollinator conservation interventions, monitoring and documention of effects of interventions	National	$50,000	per participating countries
7. Dissemination of best practices in pollinator conservation and restoration, including development and dissemination of specific recommendations to land managers to conserve pollinator habitat, and development of publicity and lobbying material against bad agricultural and land use practices which are detrimental to pollinators.	Regional	$60,000	1

in South–South sharing expertise such as in meliponiculture, the culturing of stingless bees. Traditional knowledge of meliponiculture most likely exists in Ethiopia, Kenya and probably several other countries, but the culture seems to be little practised today and risks being lost. Brazil has developed a scientific basis to meliponiculture and is willing to assist African researchers to adapt this technology to local conditions and species. As Varroa mite extends across Africa now that it is firmly established in South Africa, alternatives to honeybee apiculture need to be developed to help farmers withstand the losses in production that the initial infestations will bring.

Focus on.... The Bee Course

About 80 people have subscribed to the African Pollinator Initiative, with taxonomists comprising only a few. Pollinator identification has been diagnosed as a major limitation in understanding pollinator biology and pollination systems. Two constraints merge to create this problem:

- Insufficient taxonomic research
- Inadequate functional identification tools

The American Museum of Natural History has since 1999 been holding a yearly course to teach people from a variety of biological disciplines (pollination biology, faunal survey, conservation, teaching, and so on) how to identify North American (Mexico, USA, Canada) bee genera. Each course accommodates about 20 candidates. Every course has been oversubscribed, attracting people from beyond the intended geographical range for the course, such as from Africa and South America. The Bee Course has become a model for other courses, such as an Ant Course.
Among African pollinator researchers and teachers the frustration caused by a lack of expertise in bee identification has motivated scientists in Africa to travel to the USA to study North American bees, as there is a degree of similarity (for example, *Anthophora* and *Megachile* occur on both continents). However, many North American bee genera do not occur in Africa (form example, many eucerine genera). Five Africans and one European who studies pollination in Africa have attended the Bee Course (T. Beldorf, B. Gemmill, M. Gikungu, P. Kwapong, W. Kinuthia and A. Ochieng), and more would have attended if funding had been available. C. Eardley, the only resident African bee taxonomist, attended as a visiting scientist. All reported the Bee Course to have been very helpful in understanding the higher classification of bees, recognizing cosmopolitan genera and using identification keys. But they found the training incomplete for them and urge that an African Bee Course be developed.

Lessons learned

From discussion with many African pollinator and pollination biologists, both candidates who attended the Bee Course and those who would like to attend, it is clearly evident that—

- African pollinator and pollination biologists are aware of the taxonomic impediment that must be overcome in pollinator conservation.
- Scientists in Africa go to great lengths to acquire additional skills to achieve their goals.
- The American Museum of Natural History's Bee Course is useful, but an African bee course is preferable.
- Customized keys and descriptions are needed.

Develop sustainable strategies and policies for maintaining pollinator habitats and ecosystem services. As with any resource, we can exploit pollination services in ways that may degrade the service, or we can develop sustainable strategies that benefit ecosystems. As an example, it has been proposed to import bumblebees to the African continent to buzz-pollinate greenhouse tomatoes, as they are used in Europe. But Africa has its own buzz-pollinating insects. If we can learn to use these instead, we will not only avoid an alien introduction but also increase the economic value of indigenous species.

Disseminate best practices. To assure that conservation research and practice are available to end users, best-practice guidance will be needed in pollinator conservation and restoration. Land managers will need specific recommendations on how to conserve pollinator habitat. Compelling publicity and lobbying material must be prepared to advocate against deleterious agricultural and land-use practices. Both the public awareness and the capacity-building components of this proposal will serve to extend this information to the public and to integrate it into training curricula, but we must assure that research and experience are codified into specific recommendations that can then form the message we want to convey.

Capacity building

Pollinators occupy keystone positions in both natural and agro-ecosystem functions. They are therefore an important natural resource. But the skills to conserve them and to manage many aspects of sustainable pollination do not exist in Africa, except for honey bees. Some of these skills can be imported, but mostly they must be adapted locally to suite unique African conditions. This point was strongly emphasized during the African Pollinator Initiative's workshop to develop a plan of action.

Capacity is needed to conserve pollinators, use them sustainably, work on their taxonomy and biology, and develop the technology for managing pollination. Training programmes for farmers, scientists, technicians, extension officers, conservationists and naturalists are essential. Different stakeholder groups require their own specialized training and customized support. The yellow box on the next page suggests possible providers and recipients of training.

Little is known about the biology of most pollinators and which plants, including crops, they pollinate. Pollination, as an essential process for reproduction in wild plants and food for wild animals, is left to chance. Similarly, much pollination for commercial crop production is fortuitous, its management confined to honey bees. This is a case of 'all of one's eggs in one basket', and African honey bees face serious new pest and disease problems. Also, they are not good pollinators of many crops and do not visit many wildflower types. The situation must therefore change if African countries are serious about food security and about development based on sustainable use of natural resources.

As with all natural resources, monitoring is necessary to determine what change occurs in the diversity and abundance of pollinators. This requires inventories, distribution maps and identification tools,

Capacity Building: Plan of Action

Who?	How or What?	Why?
1. Academic, conservation and government commun ity	National capacity assessments	To establish a committed community for pollinator conservation
2. Universities and other training and research organizations.	Research	To train professional personnel to implement pollinator identification and document customized conservation strategies for Africa, pollinator biology, pollination mechanisms, taxonomic monographs and keys.
3.Land-use planners, national agricultural researchers, extension personnel, non-governmental conservation organizations	Short courses	To introduce pollination conservation concepts to people in positions to ensure their implementation through on-the-job training.
4. Research institutes, including museums and conservation agencies, including government and non-government agencies	Institutional strengthening	To provide national focal point institutions with basic equipment for processing and databsing of specimens, and resources to formulate strategic plans for pollinator conservation.
5. Educators researchers and conservationists	Facilitate information dissemination	To develop means to rapidly dessimiate information on pollinator taxonomy, biology and conservation within Africa.
6. Educators and researchers	Information and curricula	To support inclusion of pollinator/ pollination conservation in school curricula and to publish (in hard & soft copy) guides, hand books and posters, teaching materials, inventories of pollinators and their host plants, including crops.
7. Educators researchers and conservationists	Travel to professional meetings, and skillshare workshops	To enhance insect and plant identification, monitoring methodologies, pollinator-friendly land management, understanding of plant breeding systems, writing case studies, experimental design, culturing of non-honey bee pollinators.

Capacity Building: Plan of Action, ... *continued*

Who?	How or What?	Why?
8. Concerned public	Development of user-friendly pollinator identification and information materials.	To make pollination information accessible to the concerned public, by providing information and identification services that can be used by non-specialists
9. Technical experts within Africa	Development of an African network of expertise in sustainable pollination.	To share African and international experience in pollination research to establish fruitful continental and international collaborations.
10. Farmers. land managers and conservationists	Training, institutional strengthening, agricultural extension.	To improve agricultural production and food security, preferably using indigenous pollinators, and to maintain the diversity of indigenous pollinators in natural areas.

for which capacity is needed to develop these. The International Pollinators Plan of Action (element 3) highlights a global taxonomic deficit—the unacceptably high numbers of bee genera for which identification keys are not available. More specifically, the plan of action stresses the need to build taxonomic capacity to carry out inventories of pollinator diversity and distribution to optimize their management. This is to be done in part by training taxonomists and parataxonomists of bees and other pollinators. IPI also promotes training postgraduates to carry out applied research on pollination in agricultural ecosystems. The capacity-building focus of API will seek to address these needs within Africa.

Capacity must be built to be able to maintain natural pollinator populations, including recognizing impending disaster and how to avoid it. This requires knowledge of pollen and nectar flowers, nesting materials and substrate, periods of activity, parasites and diseases. Further, capacity in developing marketable by-products should be promoted, such as the medicinal properties of the honey of stingless bees and edible larvae of moths.

Conserving the nature, diversity and abundance of pollinators is essential for maintaining a functioning ecosystem. Seeds and fruit are more than food for humans and animals; they enable plants to adapt to new environmental conditions, and to disperse. These basic functions are also important to farmers: generic diversity in farmers' seed stock helps to assure that they will have a crop when unusual weather conditions prevail, and a quiescent period as seed enables farmers overcome dry or cold seasons. All farmers depend on natural vegetation because it consolidates soil, reduces soil erosion, maintains watersheds, and encourages natural enemies of crop pests.

Provisional Budget: Capacity Building

Activity	Level	Unit Cost	No. of Units
1. Country-level assessment	National	$30,000	per participating countries
2a Taxonomic training	Regional	$30,000	3
2b. Pollination biology training	National	$30,000	per participating countries
3. Short courses	National	$10,000	per participating countries
4. Institutional strengthening	National	$25,000	per participating countries
5. Information provision	Regional	$10,000	per participating countries
6. Curriculum (at primary, secondary and teriary levels)and publication development	Regional and National	$5,000	1, and per participating countries
7. Travel, skillshare meetings	Regional	$50,000	3
8. Develop tools for identifying pollinators.	Regional	$100,000	1
9. Networking: Development of an African Network for Expertise in Sustainable Pollination	Regional	$50,000	1
10. Farmer and Land Manager Field Schools	Regional National	$10,000 $5,000	1 per particpating countries

Alternative wild food plants are needed to sustain pollinators when crops are not in flower. Understanding and managing this complexity of the processes that enable pollination requires knowledge and a combination of skills. Developing these skills is the objective of this programme.

We recognize that building capacity must be wide in scope, including the following:

- Training is needed at all levels, both formal and informal, and should be adapted for trainers (teachers), conservationists, extension services and farmers. The general public needs to be made aware of the benefits of conserving pollinators.

- Partnerships and networks must be built within Africa and abroad. It is important to involve teachers and to transfer technology from regions with more experience in pollinator conservation.

- Institutions that build capacity (such as research institutes, museums, universities, natural history societies) must be strengthened.

- Mechanisms must be put in place to enable and encourage feedback from stakeholders.

- The level of success in training and capacity building must be measured, to assess effectiveness.

Thus, capacity building must occur at different levels—from the field level to the policy-making level. The main objective of this component is to ensure that people have the intellectual and institutional resources available to empower them to make their own decisions and be in a position to implement them, therefore moving towards long-term sustainability of pollination conservation in Africa. Additionally, building capacity will help implement country obligations to the Convention on Biological Diversity by providing people and institutions with the means with which to do so. This objective will be achieved through a number of activities, as discussed below.

API will promote appreciation of the value of pollinator diversity and promote the multiple goods and services it provides for sustainable productivity among farmers, producer organizations, agricultural cooperatives and enterprises, and consumers and decision-makers with a view to promoting and supporting responsible practices. Training will be provided to a wide range of stakeholders, including taxonomists, policy-makers, children, farmers, farmer-led organizations and local communities. Strengthening institutional capacity through supplying equipment and specimen collections, and promoting self-organization for participatory research and learning are preferred over creating new organizations. Sharing experiences through participating in conferences and through publication of research results and capacity-building case studies also increases institutional capacity. Stakeholders will be encouraged to carry on constructive dialogue among themselves during all stages of developing and implementing the project.

Specific activities to be supported include:

Country-level interest and capacity assessment. The African Pollinator Initiative is a regional initiative that will operate at both national and regional levels. It will, of course, be essential that there is a strong locus of interest in pollination services within a country for an initative to take root there. Each country wishing to participate in the African Pollinator Initiative should undertake to assess the current level of capacity within the country to implement the activities of API, and develop a profile of actors with an interest to be trained and build capacity in pollination conservation.

Training. Over a three-year period API will aim to train at least three specialists in the continent in pollinator taxonomy, assuring one specialist in each of the three regions of Eastern, Western and

Southern Africa who can identify, at a minimum, the known species from those regions. We will also seek to train one postgraduate student in pollination biology per participating country. This training may be degree-related, but could also be additional training for entomologists or botanists to extend their research capabilities to include pollination questions. We also propose to offer or arrange a number of short courses and attachments for personnel in positions to place pollinator conservation in the mainstream (land-use planners, national agricultural researchers, extension personnel, non-governmental conservation organizations, and others in related positions).

Institutional strengthening. In many participating countries, appropriate institutions to foster pollinator conservation already exist, such as national museums, botanical gardens and agricultural research institutions. But they lack the equipment to serve adequately as repositories of specimens and information. Rather than create any new institutions, API will strengthen these that exist, both with equipment and with resources to formulate strategic plans for pollinator conservation. For focal institutions seeking to implement national programmes of pollinator conservation, modest budgets for microscopes, insect cabinets,key literature, scanners and digital cameras will be made available.

Access to information. The API has so far accumulated a database of almost four hundred publications relating to pollination in Africa. Many other key publications, such as those related to bee identification in Africa or South African pollination systems, have been authored by API participants. We will obtain the relevant literature, request journals to permit us to distribute electronic copies of African pollination literature, and will prepare a repository of such scanned documents for distribution upon request. A bibliography and searchable index of abstracts will be made available on the API website.

Curriculum and publication development. Pollination is still a poorly understood ecological function, and we need to undertake some dramatic awareness-raising activities to have it register in public awareness. Linking it with existing structures will help, such as school biology curricula. Pollination biology is eminently suitable for both secondary and tertiary curricula. All API participants will be invited to submit case studies and localised examples of pollination services for use in biology curricula. API will assist national-level participants to develop and adapt pollinator conservation material for the curricula at several levels within formal schooling. It will support production of simple guides and handbooks on pollinator conservation practices, technical publications, and pollinator catalogues, including researcher time, technical support, and costs of publishing in hardcopy and CD and on the Internet.

Networking/Travel. A limited travel budget to permit API participants to attend international meetings, and to permit annual API skill-sharing meetings will build networking and capacity mutually within the initiative. Since capacity for offering both degree and short-term courses is limited within the continent, a skill-sharing workshop itself offers an excellent opportunity for sharing expertise across borders. The workshops will also provide an opportunity for structured feedback and measurement of effectiveness.

Develop tools for identifying pollinators. Capacity can be built far faster within Africa if we successfully network with experts and adopt or adapt the cutting-edge technologies being developed in other regions. In the area of taxonomy, networks and initiatives are currently in existence that can immediately assist API to build capacity. API will build on existing institutions such as the Global Taxonomy Initiative (GTI), the Expert Centre for Taxonomic Information (ETI), Discover Life, Ecoport, Automated Bee Identification Systems (ABIS) and DAISY. Brief descriptions of each of these and how they might contribute to API follow.

The Global Taxonomy Initiative, which is also an activity of the Convention on Biological Diversity, seeks to build capacity in taxonomic expertise in relation to the implementation of the Convention. We will seek a working collaboration with the GTI, which is based at the Convention Secretariat and can help to promote the taxonomic needs of pollinator conservation.

ETI is a non-governmental organization operating in conjunction with the United Nations Educational and Scientific Organization (UNESCO). Its mission is to develop and produce scientific and educational computer-aided information systems, to improve general access to taxonomic and biodiversity knowledge and promote its broad use worldwide. Gathering and disseminating taxonomic knowledge, ETI has developed special computer software tools that make it possible for anyone, regardless of background, to identify species and find species-related information, by employing user-friendly.interactive keys.

A similar initiative is Discover Life, which works to develop interactive keys that are posted and maintained on the internet. Discover Life also distinguishes itself in developing products targeted for users at a secondary school level, and thus avoids the use of scientific terminology which may turn away amateurs. Thus the identifying characteristics of bee "toes" may be mentioned, instead of tarsi.

Ecoport is a web-based portal of scientific and taxonomic information, which is easily updated and maintained by contributors. It can serve as a repository of identification keys, images and literature databases.

In addressing the taxonomic impediment that is a major barrier to pollinator conservation, the initiative will make collection information more broadly available by creating a database with photographic illustrations. With these images, it is possible to build an Automated Bee Identification System (ABIS) that uses image recognition to identify bees from images of their wings. We will maintain computerized bee identification information and will process requests for identification from researchers working on the continent. A similar system for other taxa is available through the DAISY program.

Working in partnership with the institutions mentioned here, API will seek to establish an taxonomic identifcation service, which can produce easily accessible electronic identification keys and information on crop and plant pollinators within Africa as scientific products published in hardcopy, on CD and on the interet. Procedures for providing taxonomic services, by sharing of images and automated systems, will be established.

Networking with continental and international expertise. Numerous international experts in pollination conservation are willing to offer advice and expertise to inititiatves such as API, and structures are in place to facilitate the dissemination of such advice. For example, the International Network for Expertise in Sustainable Pollination (INESP) is an initiative of Guelph University in Canada. It is an Internet-based network that makes a global arena of expertise available to support sustainable pollination, for both agriculture and natural resources. INESP pulls together interdisciplinary scientific expertise from the fields of botany, zoology, ecology, ethology, environmental sciences, economics and social sciences in synthesizing and appraising information relevant to pollinator conservation. It seeks to make this in-depth expertise available to practitioners in the field working in extension and policy development to provide them with the scientific capacity to achieve sustainability of pollination systems. Expertise in pollination already exists among several individuals within Africa. The INESP model can be expanded by developing an African node of INESP, making use of the expertise that INESP can marshal, and sharing African experience in pollination research to establish fruitful continental and international collaborations.

Structure of the African Pollinator Initiative network

Participants at the first regional workshop identified regional representatives and an interim steering committee, as given below.

Members of the interim steering committee of the African Pollinator Initiative

West Africa	Dr Peter Kofi Kwapong Lecturer, Department of Zoology University of Cape Coast, Cape Coast, Ghana
East and Central Africa	Dr Wanja Kinuthia Entomologist, Head, Department of Invertebrate Zoology National Museums of Kenya, and EAFRINET Coordinator
Southern Africa	Dr Connal Desmond Eardley Specialist Scientist Agricultural Research Council, South Africa
Northern Africa	We are currently searching for a North African representative. Please direct all enquiries to the address on the back cover. If you are interested in filling this post, please contact us.
Scientific Adviser	Dr Barbara Gemmill-Herren Executive Director, Environment Liaison Centre International*

While the steering committee was identified by participants at the workshop, few activities on pollinator conservation in Africa have yet been undertaken in a coordinated manner. Thus identifying steering committee members should be regarded as an evolving process, which stakeholders will have opportunity to review as the initiative gets under way. Committee composition should be reviewed every two years to endorse or select new regional representatives and co-opted members.

** currently, Global Pollination Project Coordinator, Food and Agriculture Organization of the United Nations*

One mandate of the steering committee has been to review appropriate network structures. It has found that the most appropriate network model for the initiative at this time is a collaborative network with flexible action and channels for information exchange, rather than any rigid institutional formulation. As support for the network is developed, memoranda of understanding will need to be developed between institutions carrying out activities.

The governance structure of the African Pollinator Initiative is designed to facilitate coordinated networking within and between participatory countries, and with the global International Pollinator Initiative and other networks such as the International Network in Sustainable Pollination and the IUCN Specialist Group on Declining Pollinators. Its procedural principles are aimed at promoting vertical and horizontal consultation, accountability, efficiency, transparency and harmony of purpose. The structure is deliberately designed to strengthen country-initiated endeavours while at the same time providing for regional responsibilities. The structure is oriented towards national-level action and allows for flexibility on national entry point as is deemed appropriate.

The focal point for the initiative at present is the regional steering group, in which regional representatives have taken guidance from the first workshop to design a plan of action with both national and regional activities. This plan of action has been reviewed and endorsed by workshop participants and other network members.

As this API plan of action identifies a number of desirable national-level activities, network members from different countries will be encouraged to develop their own plans and proposals to take up these activities. Both the regional steering committee and national network members should seek resources for national activities. Country members applying for funds through the regional structure should undertake assessments of capacity, and set up national steering committees to guide national-level activities.

At the regional level, funds permitting, an API coordinator will be engaged to operate in any one of the host steering committee institutions, under the guidance of the regional steering committee.

Conclusion

The four components of the action plan: education and awareness; placing pollination in the mainstream; conservation and restoration; and capacity building, are each important in their own right, but also have been designed to interact and reinforce each other, and to be applicable at both national and regional levels. We believe that undertaking the steps outlined here will secure the future of pollinators in Africa, for the benefit of this and future generations.

The action plan of the African Pollinator Initiative has benefited from a wide circle of supporters and friends, not the least of which have been FAO and members in other regions of the International Pollinator Initiative, who have contributed enthusiasm and ideas. Others that should be mentioned include the International Centre of Insect Physiology and Ecology (ICIPE), which provided the venue and logistics for the inaugural meeting, and Dino Martins, who has ably served as the first API coordinator.

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