ORCHIDS OF THE CLOUD FORESTS OF SOUTHWESTERN COLOMBIA AND OPPORTUNITIES FOR THEIR CONSERVATION

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ABSTRACT

Between Colombia and Ecuador, the two richest countries in the world in orchids, 9000 species are found or thirty percent of all known species. However, in both countries the number of orchid species threatened with extinction may well add up 3000 species, a figure quite worrying when you consider that the main cause of this extinction is the deforestation of Andean forests. These forests provide most of the water resources for the large cities, agriculture lands and industries of these nations. One could say that where there are still forests rich in orchid populations there will also be healthy human populations. The La Planada, Farallones de Cali and La Mesenia natural areas in the Guiza, Cali-Jamundí and San Juan river basins respectively represent examples where the richness and endemism of their more than 400 species registered thus far coincide with the importance of the ecosystem services provided to the cities of Ricaurte and Tumaco in the department of Nariño, Cali-Jamundí in Cauca Valley and Jardín/Andes in Antioquia, where some critical areas of cloud forests have been identified for conservation. Images are presented of endemic, threatened and newly described orchid species of Colombia's Western Andes.

Keywords: biodiversity, orchids, endemic, threatened species, watershed, environmental service

Introduction

Two areas of South America, the Ecuador-Colombia border and Southeastern Brazil share the honour and responsibility of having one of the highest levels of concentration of endemic life forms in the world. These two areas also boast enormous biological diversity in almost all plant and animal groups.

Although in Colombia, orchids are found in abundance in virtually all natural ecosystems, the highest numbers of individuals and species are found in the Western part of the country (Fig. 1). In spite of the large number of species and the singularities of their life cycles, many are scarce or rare, and a good number are in danger of extinction. Orchids with small geographic ranges, even though locally abundant, may be particularly endangered.

In Colombia, orchids are notorious for being the plant family with the highest number of endangered species (Calderón-Sáenz 2007). The nation's cloud forest species share twice the risk, due to high levels of endemism and the speed at which many ecosystems are being changed to other usage such as for agriculture and livestock (Dixon and Phillips 2007). It is anticipated that an already difficult situation will worsen as a result of global warming (Jarvis 2009).

Fig. 1 Map of Colombia with the study areas.

Fig. 2 Panoramic of La Planada nature reserve, Nariño department.

Fig. 3 La Mesenia reserve, Antioquia department.

Threats to Orchids

Undoubtedly, the greatest threat to Colombia's orchids lies in the destruction of their habitat within the cloud forest. It is estimated that only about 18% to 25% of original Andean forest remains in the country today (Etter and Wyngaarden 1998). In general, mountain forests in Colombia have become seriously threatened environments, since most have already been cut down, and those remaining exist only as various different-sized fragments at differing degrees of isolation (Kattán and Álvarez 1996). Despite the enormous changes to Colombia's natural ecosystems, there is as yet no reliable data on the annual rate of deforestation, either in the nation's various macro-regions, or overall. Past estimates for the magnitude of timber extraction and forest conversion to crops and cattle ranching, range between 200,000 and 500,000 hectares annually (FAO 1999; Instituto von Humboldt 1999). Fandiño-Lozano and Wyngaarden (2005) indicate that up to 56.6% of the national territory has been substantially transformed and that in the face of such high levels of disturbance, the present system of conservation is insufficient.

The impact of human action has been most significant in the western half of the country, where about 70% of the population live. According to a report by the von Humboldt Institute (1999), and studies by Cavelier and Etter (1995) and Fandiño and Wyngaarden (2005), degradation of the Andean region represents approximately 70% (45,000 km). In particular, subtropical forests have virtually disappeared while mountain forests are undergoing high rates of transformation.

The fragmented natural habitats of the Andean zone now resemble a series of islands lying in a sea of pasture and agricultural usage. This degradation of Andean landscapes causes serious problems to human welfare by reducing ecosystem goods and services, particularly water and soil protection.

The effect of this destruction on orchid plant populations in general, are of particular concern. Based on the analysis of 18 genera, Calderón-Sáenz (2007) estimated that 371 species (10%) of Colombian orchids are threatened with extinction. Assuming there are 180 genera of Colombian orchids, the total number of threatened species must be extremely high. This data and its consequent projection are a worrying indication of a widespread problem for orchids, particularly on the central slopes of the Andes and in the middle sections of the outward-facing slopes (Pacific and Amazon).

The subsequent transformation of the valleys and slopes for agriculture and livestock increased pressure on the country's orchid flora. There is no doubt that, with the disappearance of the valley forests, many species had become extinct before they could even be recorded or described!

The extraction of wild orchids with economic value and for exhibition, although illegal today, still continues to reduce many species to local extinction. These activities have significantly diminished natural populations of species from the genera *Cattleya*, *Coryanthes*, *Anguloa*, *Dracula*, *Stanhopea*, *Oncidium,* and *Masdevallia*. In some cases, species have been exploited almost to local extinction. Contrary to the belief that CITES (the Convention on International Trade in Endangered Species of Wild Fauna

Fig. 4 Cloud forest in the Farallones de Cali National Park. Cali. Photo: Carlos Mario Wagner.

and Flora), controls the extraction of all natural species, it only focuses on reducing illegal trafficking in wildlife.

Urban growth, road construction and large development projects aggravate existing conditions for many orchid species. Other factors include: environmental insensitivity or illiteracy on the part of business and government leaders, lack of environmental education and organization of local communities and non-compliance with established norms. In general in Colombia, the conservation of biodiversity still has low status when compared to production industries such as mining, agriculture, livestock and trade (Instituto von Humboldt 1999).

Medium and Long Term Threats

Global warming may alter mist flow circulation patterns causing mists to bypass forested hillsides, and thereby impair their function as water cycle regulators. Jarvis has recently raised this issue based on projections of global warming and the impact of rising temperatures and increased rainfall in the tropical Andes. It is likely that moisture provided by mists will decrease markedly within the cloud forests, a situation which may irreversibly alter the functioning of these habitats, thus affecting all dependent plant and animal species (Jarvis 2009). It is to be hoped that in the immediate future this will be the focus of worldwide attention, because of its consequent impact on the water supply for major Andean urban centers (Jarvis 2009; Orejuela 2009; Pimm 2009).

A Pragmatic Strategy for the Conservation of Orchids

There is no doubt that orchids are one of the key elements of biodiversity conservation, in that they are a visible and fascinating example of the natural world and are seriously threatened by human activity (deforestation and fragmentation, illegal extraction and global warming).

However, there is still time to preserve the remaining high diversity of orchids, and these efforts could bring results with immediate action. There are many openings and opportunities. The task of orchid conservation is multi-faceted and should combine protection of habitat, increased knowledge about species and their distribution, coordination of efforts both *in situ* and *ex situ*, involvement of communities in species and ecosystem conservation projects, outreach activities and the creation of knowledge networks. Judicious investment of international and national resources, generated in conjunction with programs to prevent deforestation, such as Colombia's contribution to reducing carbon dioxide emissions, will all help orchid conservation of (Hágsater and Dumont 1996; Koopowitz 2001).

Orchids could play a key role in national conservation efforts, by virtue of their importance as a charismatic species, many of which have commercial value. They are also a flagship group whose conservation could help protect many other species and habitats (Hágsater and Dumont 1996). In some ways, orchids could be considered the plant species counterpart to bears, jaguars and primates – more traditionally associated with wildlife conservation. If hummingbirds are the winged jewels of the natural world, orchids are surely the treasures hidden in the mist.

The Convention on Biological Diversity (CBD 1992) has been the general framework for world conservation action. The Convention set out three objectives: conservation of biological diversity, sustainable use of its component parts and equitable sharing of benefits arising from genetic resources. It recommended that the strategy for ecosystem conservation should be adopted as a practical guide for action.

In 2001 a group of scientists, directors of botanic gardens and herbaria and members of Colombia's environmental sector met in Villa de Leyva and formulated the National Strategy for Plant Conservation (Alexander von Humboldt Institute and Ministery of the Environment 2001). Orchids of the genus *Cattleya* were identified as a priority group for action in implementation of the strategy.

This essay embraces the National Strategy for Plant Conservation as a guide for developing an integrated plan for orchid conservation in the cloud forests of southwestern Colombia. For this purpose, some fundamental questions need an adequate response: What should be done to protect both species and their habitats? How should these efforts be promoted? Where should conservation efforts be implemented and who should participate? Good management, to ensure both funding and cooperation at different levels, will be critical to the sustainability of conservation efforts.

Knowledge towards Conservation

It is important for science to serve the conservation of both orchid species and their habitats. In Colombia there is an urgent need to improve the orchid knowledge base. In comparison to its neighbors, particularly Ecuador, there have been few specialists in Colombia in the field of orchid natural history and distribution. For this and other reasons, advances in conservation have been limited. Progress must continue in the assessment of orchid floras in different regions, the development of databases and the generation of distribution maps. As a result, it should be possible to identify endangered species. The current state of systematics and taxonomy for Colombian orchids should also be reviewed.

Orchid ecology provides another interesting field for research, particularly orchid dependence on pollinators and the fungi associated with nutrient absorption. The key relationships between orchids and other wildlife needs to be recognized, along with the maintenance of forest goods and environmental services, especially water resources. Through local efforts and international cooperation it should be possible to increase both the number of studies and their scientific quality. The dissemination

of knowledge about orchids through technical publications and local outreach is key to broadening the base of community and institutional support for conservation.

Protection for both Species and Ecosystems

The Convention on Biological Diversity, the National Strategy for Plant Conservation, and the United Nations Millennium Development Goals (2010–2015), are calling for all nations to develop systems of protected or special management areas, showing a complete representation of overall diversity, both in terms of ecosystems and biotic provinces. For orchids, the system should include endemic species and also meet the needs of those species which have wide geographical range and discontinuous distribution.

Conservation *in situ*

It is recognized worldwide that one of the most effective strategies to promote biodiversity conservation is by strengthening systems of national parks and similar reserves at regional (departmental) and local levels, integrating protection of species and ecosystems with the promotion of community development (Miller 1980; MacKinnon and Thorsell 1986; McNeely et al. 1990; Sanchez et al. 1990; Fandino and Wyngaarden 2005; Ministry of Environment, Housing and Territorial Development 2009).

Nature reserve systems should also include civil society (private sector) along with territories that have traditional settlements, including indigenous reserves, afrocolombian communities and rural reserves.

Fig. 5 Endemic orchid species *Oncidium cirrhosum*.

Fig. 6 Endemic orchid *Dracula chimarca*.

In the Andean region it is particularly important to make progress in watershed management, integrating rural landscape maintenance with sustainable production systems, that are in harmony with the conservation of relict natural forest and environment restoration.

Considering that 60–73% of Colombia orchids grow in Andean cloud forests, which represent only 3–4% of the national territory, it makes sense to focus conservation efforts in these areas (Pimm 2009).

It is in this region, that floristic diversity is most concentrated (30–40,000 species in South America's north Andes, a 'hot spot' of the tropical Andes, north of the Huancabamba depression in Peru (Conservation International 2004; Rodriguez-Mahecha 2004). In addition, 50–70% of the nation's vertebrates are also found there, of which over 40% are endemic. Per unit area, the Andean regions contain a level of endemism and diversity five to six times higher than in regions like the Amazon and the Pacific province.

The Andean regions are also one of the essential elements in strategies to provide water for major conurbations throughout the country, as well as to key areas for crop and livestock production. The choice of appropriate conservation areas requires special attention and should be based on a practical system, such as by Van Velzen (1992), which integrates three principal criteria: biological diversity, biological vulnerability and management feasibility.

Biological criteria. It is desirable to protect natural ecosystems rich in species with high levels of endemism, The region of southwestern Colombia has several such 'hot spots' to which priority should be assigned.

Vulnerability Criteria. It is also necessary to consider threats to complete ecosystems as well as to their specific species of plants, together with the imminence or severity of those threats or disturbances. Areas under pressure but still relatively intact should receive priority attention.

Management Feasibility. A conservation strategy needs to take into account the responsiveness and cooperation of local communities along with their level of organizational development. Potential fields for education, recreation, research, community environmental services, and the protection of water resources, soil and landscape, also need to be assessed.

Priority Areas in the Southwestern Cloud Forests

The National System of Protected Areas, which currently has fifty-six units, covers approximately 12% of the national territory (www.parquesnacionalesdecolombia.com). These are outstanding areas, but are not enough to ensure adequate protection of orchid species and ecosystems throughout the country in general, and the southwest in particular. There is probably better coverage of protected wilderness areas in the Amazon region, as the National Parks are complemented by Indigenous Reservations.

Besides these macro-regions, the other surviving macro-habitats face problems of representation and ecological amplitude. The Andean region, for example, has a number of protected areas, which are either not large enough or do not have broad ranges of altitude. The highest concentrations of species both in number and singularities are in the subtropics (premontane) and temperate (montane) zones of the Andean slopes, and in particular on the Pacific slopes of the Western Andes in the departments of Nariño, Cauca and Valle del Cauca. Significant levels of biodiversity are found along this same stretch at medium elevations, along the Pacific slopes of the departments of Risaralda and Antioquia (Orejuela 2011).

As in the adjacent nation of Ecuador (Endara and Yañez 2006), the number of orchid species endemic to Colombia is assumed to be between one quarter and one third of the total species for the country. This represents between 1000 and 1500 species concentrated in altitudinal belts from 1500 m to 3500 m. It is also assumed that the majority of these orchids are endemic members of the Pleurothalidinae subfamily (50–60%), followed (not too closely) by members of the Laelinae and Oncidinae subfamilies with approximately 10% in each. Likewise, in Ecuador, it is thought that endemic species figure highly the IUCN Red Book 'threatened' categories, with between 50% and 80% of endemic species likely to be found in the 'Vulnerable' category, and those in the most precarious situations classified as either Endangered or Critically Endangered. In most of the tropical American countries the epiphytic orchids comprise around 70% of the total count and they comprise a large proportion of the endemic species of the region (Bertolini et al. 2011; Ortega-Loeza et al. 2011).

On the Pacific slope of the Cordillera Occidental in Nariño, approximately 150–250 species are possibly endemic. Several of these species have been described as new species and were highlighted by Calderón (2007) in the Red Book of Orchids of Colombia. On the same slope in Risaralda, orchid studies by De Wilde (1998) showed a high diversity of species and remarkable levels of endemism.

Endemic species are often either rare or scarce within their own natural distribution sites. But a significant group of orchid endemic species are still relatively abundant in the places where they are found, even though the area itself may be very small. Generally, these species are found in habitat fragments or isolated patches on mountain peaks or arid enclaves on high Andean plains, or their distribution is discontinuous, particularly within the complex mosaic of habitats in the Andean region (Escobar 1983; De Wilde 1998; Orejuela 2005). Since many areas rich in orchids are outside the system of protected areas, conservation efforts need to consider other types of alternative systems, such as indigenous lands, watersheds, buffer areas of national parks, and private reserves. Orejuela (2005) recommends a strategy of establishing a system made up of a few large conservation areas with many small reserves. For the conservation of orchids with broad geographic ranges, usually shared with other groups of organism, the strategy of a few large national parks with wide altitudinal ranges should be supplemented by protected watersheds and indigenous community territories.The development of Departmental Systems of Protected Areas should be governed by principles of effective citizen involvement, and they therefore need to create conditions that encourage the participation of civil society by strengthening community organizations and environmental non governmental organizations, promoting their ability to plan, act and implement conservation efforts. One goal is for the community itself to play a key part in the control of many conservation project activities. People get involved and active when they experience a friendly relationship with staff, and when the project directly meets the community's perceived needs in a relatively short time. Equally, the conditions that generate enthusiasm and commitment are the most powerful reinforcements for community development.

These systems should pay particular attention to the interconnections between forest fragments through ecological corridors, whether horizontal (along the main axis of the Andean mountain ranges), or vertical, following the dendritic pattern of watersheds. An obvious strategy to preserve biodiversity in optimal sites for orchid conservation would be to protect areas adjacent to national parks in the Southwest (Galeras, Munchique, Farallones

de Cali, Tatamá and Las Orquídeas in the Cordillera Occidental, Puracé, Huila, Las Hermosas, Los Nevados in Cordillera Central).

The altitudinal expansion of these parks contributes significantly to the conservation of high biodiversity ecosystems and environmental services vital to the big cities in the Andes. The Otún river basin is a good example of this type of management, with conservation action at a national level (Parque Los Nevados), regional level (Otún-Quimbaya Wildlife Sanctuary) and municipal level (Ucumari Park) insuring water resources to the city of Pereira. Something similar is also happening in the Cali river basin between the Farallones de Cali National Park, the San Antonio Forest Area of Interest for Bird Conservation, and Cali Botanical Garden with a conservation corridor project to link these conservation units which benefit the inhabitants of the city of Cali.

In western Nariño it will be crucial to establish national parks for the Cumbal-Chiles-Azufral volcanoes and to connect these with existing conservation areas such as the La Planada Nature Reserve, the Nembi community conservation project and El Pangán private reserve, and especially the Awa indigenous territory. It would be of particularly interest to establish an orchid inventory for these altitudinal transects. Private nature reserves and civil society in these regions can be connected by corridors with the above parks, and conservation corridors between the different parks in the three ranges would provide interesting mechanisms for global conservation.

Conservation *ex situ*

Ex situ conservation efforts have played and will continue to play a major role in orchid conservation, but its efforts should only be seen as a complementary measure supporting *in situ* conservation and not aiming to replace it. In the cloud forests of western Nariño, contiguous to the La Planada nature reserve, around 2000 plant species and innumerable animals could be preserved, along with its remarkable collection of orchids.

Another notable example is the conservation work carried out for threatened plant species including orchids, by the network of Colombian Botanic Gardens with support from the Whitley Fund for Nature (England). We should also mention the Orchid Seed Stores for Sustainable Use conservation project promoted worldwide with support from the Darwin Initiative and coordination from the Royal Botanical Garden, Kew, England (Seaton 2007; Seaton and Pritchard 2003). As part of this global project, the Cali Botanical Garden in association with the Dapa Orchid Nursery and the Valle del Cauca Orchid Association have initiated a project to conserve the endemic *Cattleya quadricolor*, threatened with extinction in the region. The goal is to propagate seeds and to raise plants in nurseries to a stage when they can be reintroduced to private and public wildlife areas within the range of their original distribution (Seaton and Orejuela-Gartner 2009).

To this effect, groups of enthusiasts have collected fruits, placed seeds in cold storage, propagated plants in laboratories, grown plants in nurseries and even reintroduced some plants onto native host trees in the region.

Sustainable use and equitable distribution of benefits

Conservation measures both *in situ* and *ex situ* should not be considered as total conservation mechanisms alone. It is also necessary to promote a comprehensive conservation strategy protecting habitats, managed by local people, whereby their communities become obvious beneficiaries. This strategy is based on clear identification of educational activities and community involvement in projects. 'Sustainable use' is a principle from the Convention on Biological Diversity defined as follows: 'The use of components of biological diversity in such a way that its rate of use does not lead to long-term decline in biological diversity, and therefore maintains its potential to meet the needs and aspirations of present and future generations. While writers such as Sarmiento (2006) have developed an excellent prognosis for the conservation and sustainable use of orchid species within the country, many within the conservation community are still far from consciously adopting concepts of sustainable development and equitable distribution of benefits.

Conservation on Private Lands

A point of increasing concern to the wildlife conservation community is how to define the minimum area required to achieve lasting preservation. The answer depends on the group of organisms you wish to preserve. For example, large territory species need large areas to ensure permanent survival. However, a relatively small nature reserve can achieve significant levels of conservation for orchids on the slopes of the tropical Andes, because of their high number of species and concentration of endemics. A network of private reserves can reach surprisingly high levels of conservation for many species and especially a number of high value endemic species. This is the case concerning orchids from the tropical Andean hillsides (Meisel and Woodward 2005; Seaton 2005; www.Loujost.com).

In Colombia, Resnatur, the Colombian Network of Civil Society Private Reserves (www.resnatur.org.co) has over two hundred registered private reserves, and has been leading the social process for biodiversity conservation for over twenty years. In other countries like Ecuador (El Pahuma, Bellavista, Maquipucuna, Mindo, Los Cedros), Perú (Machu Picchu), and Costa Rica (Monteverde) private nature reserves have also been established with the emphasis on observation and study of orchids. One strategy for the acquisition and management of reserves, Conservation Easements, is of special interest, as modeled by the Rainforest Foundation in The Pahuma Orchid Reserve, on the Pacific slope near Quito, Ecuador. Reynolds

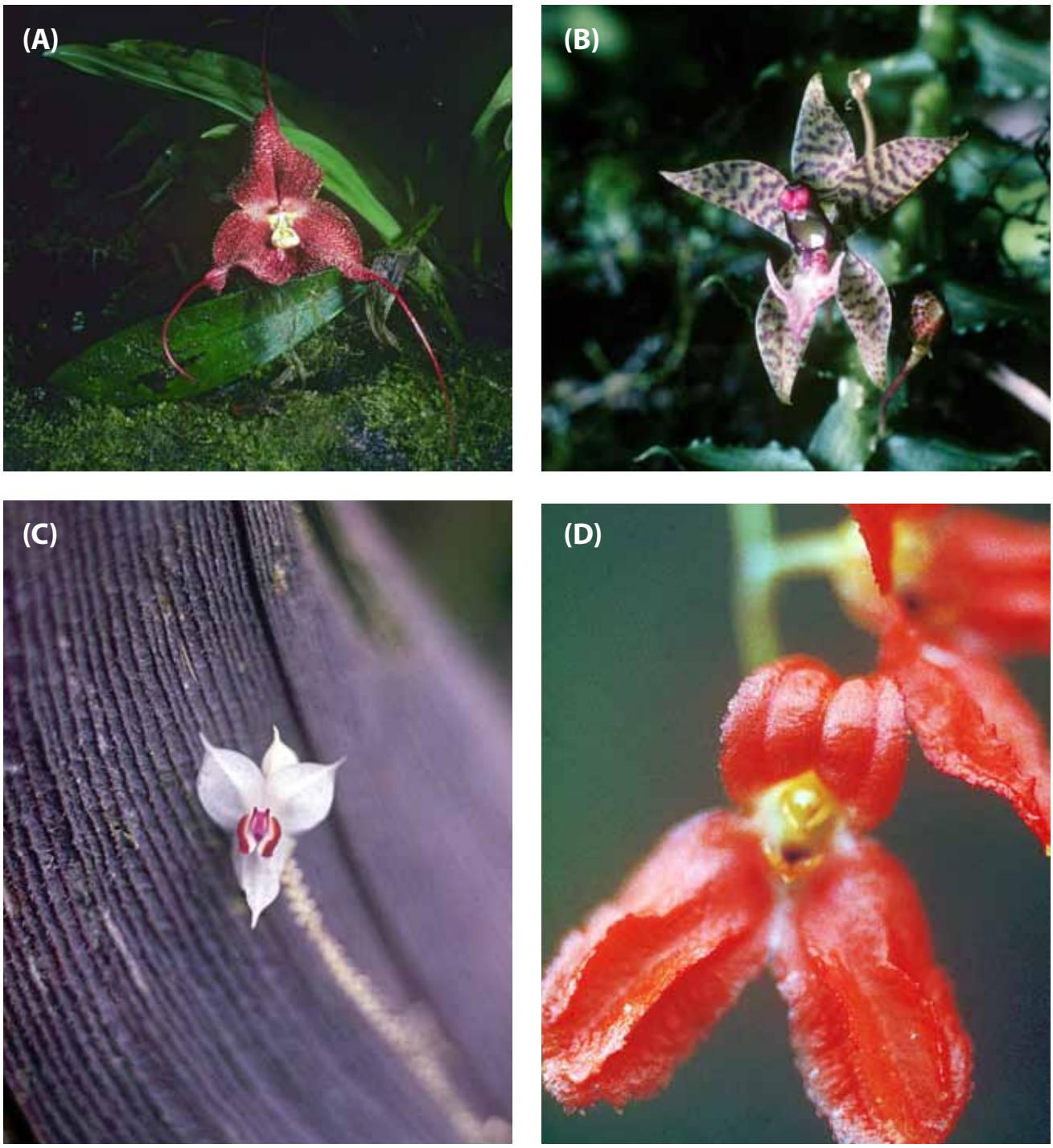

Fig. 7 Examples of endemic and endangered orchids of the cloud forests of the Western Andes: (A) *Dracula wallisii*, (B) *Dichaea hystricina*, (C) *Lepanthes magnifica*, (D) *Porroglossum eduardii*.

(2004) has published a magnificent catalog of the orchids from Maquipucuna Nature Reserve in Pichincha, Ecuador.

The work carried out at La Planada, Nariño (Fig. 2), has resulted in a remarkable collection of native orchids from the region which visitors can appreciate in the orchidarium, part of La Planada's interpretive nature trail. We would also like to draw attention to the efforts of individuals and organizations who hold important collections of native orchids in various regions. *In situ* collections in the Western Cordillera include: the Nature Reserve of Yotoco Forest, Valle del Cauca, CVC, administered by the National University of Palmira; the La Mesenia private reserve (Fig. 3), part of the Tatamá-Caramanta Biological Corridor (running through Antioquia, Risaralda, Caldas and Chocó); the La Irlanda-Clavellinas private reserves, just outside the southern part of the Farallones de Cali National Park (Fig. 4) in the municipality of Jamundí, and the Orquídeas National Park (Antioquia)

In the Central Cordillera region, there are collections in the Los Nevados National Natural Park; in Acaime

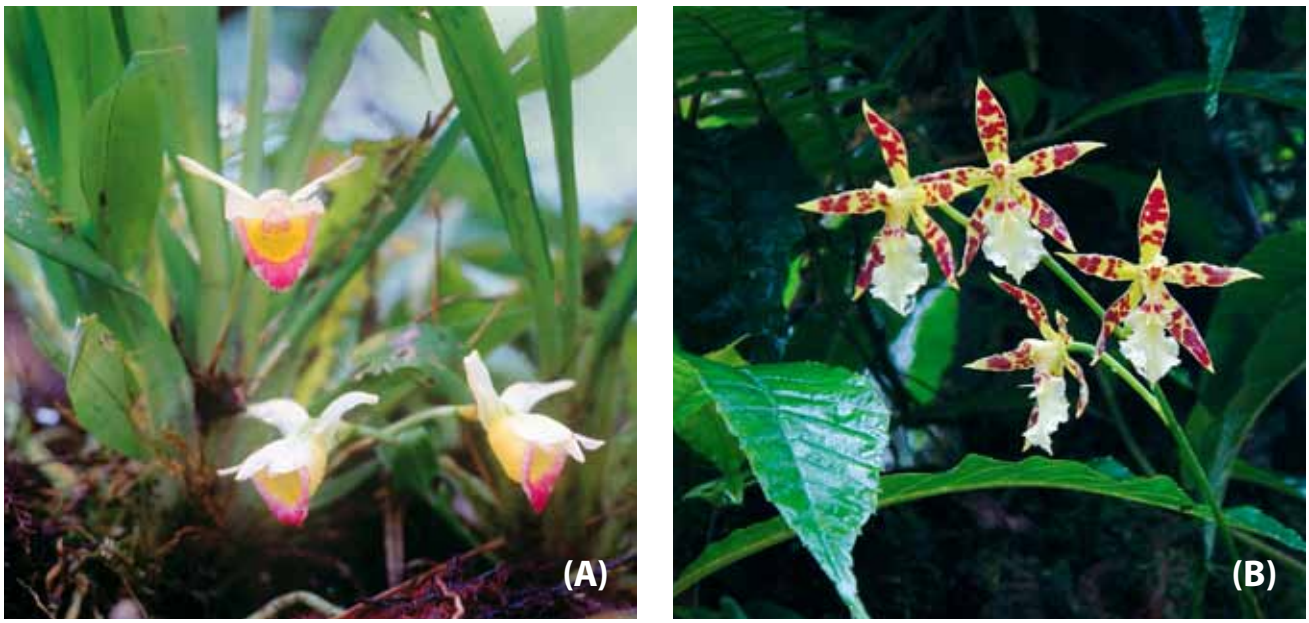

Fig. 8 Examples of endemic and endangered orchids of the cloud forests of the Western Andes: (A) *Echinorhyncha vollesii*, (B) *Oncidium aspidorhinum*.

private nature reserve, managed by the Herencia Verde Foundation; and in Popayán, orchid enthusiast Roberto Angulo holds a collection with numerous species from the Popayan-Paramo Puracé transect. In the Otún-Quimbaya sanctuary, at Pereira, Risaralda, the Autonomous Regional Corporation of Risaralda (CARDER) runs a research program and education resources in the Otún river basin. The Posada family in La Ceja, Antioquia has a large Collection of native colombian orchids. In the Taquihuaila reserve in Gigante, Huila, the Ospina Hernandez family researches native orchids and maintains a seed bank of *Cattleya trianae*, the national flower of Colombia.

In the eastern highlands, the Bogotá Botanical Garden and orchidologist Ortiz Valdivieso study the orchid flora of the Bogotá River basin. An interesting program combining bird watching with orchids is being developed by the Cali River Association (a Mapalina ecotourism initiative) and Cali Botanical Garden. It is situated on the eastern slopes of the Cordillera Occidental, in the cloud forest of San Antonio, at km 18 on the Cali-Buenaventura road at the Morobia property, and in the Piedras Blancas area in the Pichinde section of the Farallones de Cali National Park, where a group of community residents work on conservation projects and welcome visitors into their homes to study orchids and birds. On a nature trail passing through the montane forest (2000–2300 m) local guides help visitors see over one hundred species of orchid in their natural sites and watch spectacular birds such as the Andean Cock-of-the-Rock, the Golden-headed Quetzal, mountain toucans and hummingbirds, amongst many others.

This work might well be replicated in other regions, in the sure knowledge that orchid conservation will be progressed. In addition to the preservation of individual species and ecosystems, the financial potential for conservation-based tourism at these sites is relatively high. Complementing the beauty and variety of cloud forest landscapes, there is clearly a future for economic development.

Education

Environmental education is a key component for all elements of conservation strategy. A wise Chinese proverb says: "If you're thinking one year ahead, plant rice. If you're thinking ten years ahead, plant trees. If you're looking at the next hundred years, educate people." Education, training and outreach are essential elements of all integrated conservation and development efforts. Training helps people achieve their full potential. Education helps people increase their access to available information and thus make better decisions. It also helps local leaders emerge.

Education is vital for people to understand the relationship between conservation and development and for them to acquire skills to promote their own welfare. If communities are to solve their own long-term environmental problems in sound fashion, they need information, skills and new perspectives.

Conservation education should complement and improve the practical understanding people have of their environment, and its relationship to their quality of life and wellbeing, so they can then incorporate this knowledge in all their future decisions (Light et al. 2003).

The roles of botanical gardens, orchid associations, autonomous regional development corporations, universities and the media are all essential to orchid conservation strategy. Equally important are communication networks and

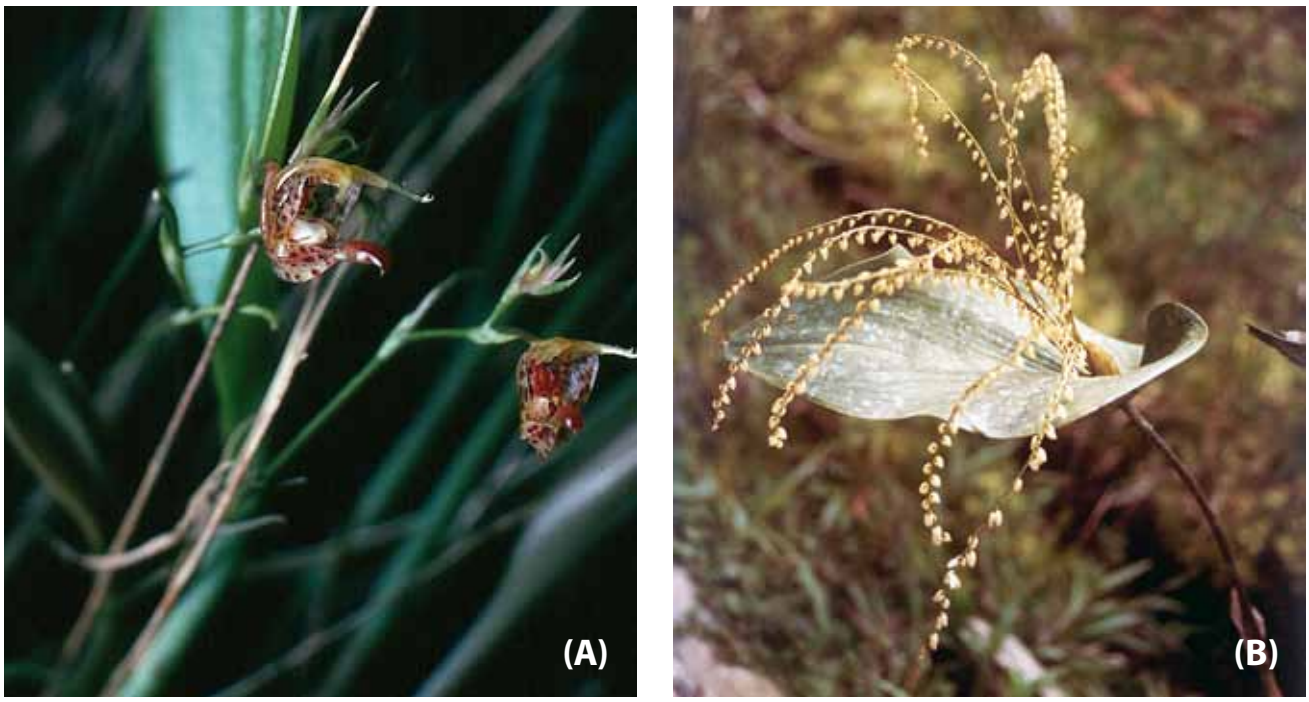

Fig. 9 Examples of endemic and endangered orchid of the cloud forests of the Western Andes: (A) *Scaphosepalum ophidion*, (B) *Pleurothallis colossus*.

Fig. 10 Some species recently described or waiting description from the Western Andes of Colombia: (A) *Pleurothallis perryii*, (B) *Lepanthes lycocephala*.

support for conservation projects. Two key organizations are Conservation International and the World Conservation Union (IUCN), which has a group of orchid specialists and an orchid conservation education panel. There are several other institutions such as the American Orchid Society, the Orchid Society of San Diego (USA), Orchid Conservation International, the Royal Botanical Gardens at Kew, England and the Orchid Conservation Alliance who support research projects, conservation and education with resources available for a variety of orchid projects.

Fig. 11 Some species recently described or waiting description from the Western Andes of Colombia: (A) *Lepanthes planadensis*, (B) *Pleurothallis titan*, (C) *Masdevallia hortensis*, (D) *Dracula levii*.

A Strategy for Success

The ecosystem approach to sustainable biodiversity conservation also includes the human dimensions: social, cultural and economic (Seaton 2007). The approach requires: (1) an open dialogue between both scientific and traditional knowledges, (2) making knowledge accessible to decision-makers and those who produce knowledge relevant to resource users, and (3) creating a greater appreciation and reverence for nature in all its forms through a sense of being part of the landscape and local region.

Within an ecosystem approach, people are able to channel a fair share of nature's bounty towards themselves. Many ancestral inhabitants understand how to do this without harming the quality of the environment or significantly reducing critical resources. The process helps promote cooperation at all levels and among all audiences.

Three concrete orchid conservation examples

La Planada Nature Reserve, municipality of Ricaurte, Nariño Department

Richness. At La Planada Nature Reserve (Fig. 2), where orchids comprise a large percentage of the total plant spe-

cies richness in the cloud forest, about 350 species are concentrated in less than 50 km^2. A total of 80 genera were recorded, of which five were dominant: *Pleurothallis*, with 45 species; *Epidendrum*, 28; *Stelis*, 14; *Lepanthes*, 21; *Maxillaria*, 21 which included 38.8% of the total recorded species. Riofrio et al. (2007) reported a similar spatial distribution for the same genera in the cloud forests of southern Ecuador.

The orchid flora of La Planada also includes a large number of singularities. That is, species whose characteristics merit special mention, either by their restricted geographical distributions, because they are endemic, or because their populations may be threatened to some degree. Many have been recognized nationally as being in particular danger of extinction, others have just been noted with a caution of early warning signs, but should still be considered in any conservation plans (Orejuela 2011).

Endemic Species. Despite locally being relatively abundant, restricted geographical distribution puts a significant number of species at risk, as they are found only in limited areas. Given the overall threat of deforestation in the Andean mountains, these species may easily enter higher risk categories.

Lacking complete data on geographic distributions for many species in La Planada, it is likely that the number of endemic species is as high as in areas of similar ecological conditions in nearby Ecuador, where at least one third of all orchids have restricted or endemic status.

A number of species endemic to the region are on the endangered list. The following are endemic to La Planada: *Anguloa virginalis, Brachionidium* sp., *Chondroscaphe chestertonii, Echinorhyncha vollesii* (Fig. 8A), *Cybebus grandis, Dichaea hystricina* (Fig. 7B), *Dichaea rubroviolacea, Dracula andreettae, Dracula wallisii* (Fig. 7B), *Dracula dodsonii, Dracula radio-syndactyla, Dracula levii* (Fig. 11D), *Elleanthus petrogeiton, Epidendrum schlimii, Epidendrum brachystele, Epidendrum gentryi, Lepanthes magnifica* (Fig. 7C), *Lepanthes ribes, Lepanthes pecunialis, Lepanthes planadensis* (Fig. 11A), *Masdevallia planadensis, Masdevallia ophioglossa, Maxillaria jamesonii, Oncidium aspidorhinum* (Fig. 8B), *Oncidium cirrhosum, Pleurothallis crossota, Pleurothallis* sp., *Pleurothallis crucifera, Pleurothallis lacera, Porroglossum eduardii* (Fig. 7G), *Scaphosepalum ophidion* (Fig. 9A), *Sertifera lehmannii, Sobralia* sp., *Stelis* sp., *Stellilabium* sp., and *Trichosalpinx chamaelepanthes.*

Endangered Species. The recently published study on Colombian endangered orchids (Calderón, 2007), with an analysis of 18 of the 180 genera recorded nationally, included 25 species found at La Planada. Of these there are three, *Dracula bellerophon*, *Dracula levii,* and *Anguloa cliftonii*, in the Endangered (EN) category, at high risk of extinction in the near future. Five are in the Vulnerable (VU) category (*Dracula andreettae*, *Dracula gigas*, *Dracula syndactyla*, *Miltoniopsis vexillaria,* and *Oncidium aspidorrhinum*), with moderate risk of extinction or population decline over the medium term. Seven are listed as Near Threatened (NT) (*Dracula dodsonii*, *Dracula felix*, *Dracula mantissa*, *Masdevallia planadensis*, *Oncidium cirrhossum*, *Phragmipedium schlimii*, and *Rodriguezia lehmanni*), and could fall into the VU category in the near future.

Eleven species from La Planada were identified as Least Concern (LC). These were: *Comparettia falcata*, *Masdevallia anachaete*, *Masdevallia cucullata*, *Masdevallia peristeria*, *Masdevallia picturata*, *Dracula radiosa*, *Dracula wallisii*, *Oncidium lehmannii*, and *Cyrtochilum ramosissimum*.

Newly recorded species for Colombia. It is important to highlight that the following seventeen species have been registered for the first time in Colombia: *Brachionidium ballatrix, Dichaea angustisegmenta, Dracula lotax, Lepanthes magnifica, Malaxis nidiae, Maxillaria jamesonii, Pleurothallis crossota, Pleurothallis epiglottis, Pleurothallis flaveola, Pleurothallis troglodytes, Pleurothallis prolaticollaris, Porroglossum aureum, Scaphosepalum beluosum, Sobralia ecuadorana, Sobralia gentryi, Stelis columnaris, Stelis guatemalensis.* Additionally, the species listed in the catalog only with the generic name may also be new additions to the country.

The Peñas Blancas/San Antonio/Morobia natural areas in the Cali river basin, Municipality of Cali, Cauca Valley Department

Richness. The forests above the city of Cali include the Farallones de Cali National Park (Fig. 4), municipal reserves as San Antonio and private reserves like the Cali Botanical Garden and Morobia, where orchids comprise a large percentage of the total plant diversity of their forest formations. Over 200 species are presumed to exist in the forested areas of the Eastern slopes of the Western cordillera. Although complete inventories are lacking, the dominant genera include *Pleurothallis*, *Epidendrum*, *Stelis*, *Lepanthes*, *Maxillaria,* and *Cyrtochilum,* which comprise between 46.2% of the total recorded species.

New Species. Four new species have been recently reported from the area (*Lepanthes dapaensis*, *Lepanthes ortiziana*, *Acianthera adeodata,* and *Epidendrum noramesae*) by members of Dapaviva, a local conservation organization (Ortiz et al. 2010).

Endemic Species. Several species of the Rio Cali basin have restricted geographical distributions. The following endemics were registered: *Brachionidium* sp., *Masdevallia caesia, Masdevallia strumosa, Epidendrum summerhayayesii, Oncidium lehmannii, Penduncella pseudocaulescesns,* and *Lepanthes* sp.

Endangered Species. The following species are described as endangered by Calderón (2007): Two spe-

cies *Masdevallia caesia* and *Masdevallia strumosa* are in the vulnerable category (VU). With moderate risk of extinction or population decline the species *Lycaste microphylla* was listed as Near Threatened (NT). Other seven species of the region were given the Least Concern (LC) category. These species were: *Comparettia falcata, Masdevallia amanda, Masdevallia picturata, Dracula chimaera, Oncidium lehmannii* (previously *Odontoglossum cristatellum*), *Cyrtochilum ramosissimum,* and *Rodriguezia granadensis.*

La Mesenia nature reserve, Jardín, Antioquia

Richness. The forests above the cities of Jardín and Andes, Antioquia include the wilderness corridor that connects the Tatamá National Park in the department of Risaralda with the El Paramillo ridge where the departments of Chocó, Risaralda, Caldas and Antioquia come together. The access entrance from the East to this wilderness is the La Mesenia private nature reserve (Fig. 4), established witht the purpose of conserving both the outstanding orchid assemblage and birdlife of this region. During the first preliminary visit an orchid inventory of some 70 species was registered. Over 200 species are presumed to exist in the forested areas of the Eastern slopes of the Western Cordillera in this region. As in other localities in the Eastern slopes of the Western Andes, the dominant genera include *Pleurothallis*, *Epidendrum*, *Stelis*, *Lepanthes*, *Maxillaria,* and *Cyrtochilum*.

Endemic Species. Several species of La Mesenia have restricted geographical distributions. The following endemics were registered: *Masdevallia hortensis* (Fig. 11C), *Dracula gorgona, Dracula iricolor, Porroglossum mordax.*

Endangered Species. The following species from La Mesenia were described as endangered by Calderón (2007): *Masdevallia hortensis, Dracula gorgona, Dracula iricolor* are in the Vulnerable category (VU). Other seven species of the region were given the Least Concern (LC) category. These species were: *Comparettia falcata*, *Cyrtochilum funis*, *Cyrtochilum ramosissimum, Masdevallia amanda*, *Masdevallia cucullata*, *Masdevallia picturata,* and *Oncidium hallii*.

Issues confronting cloud forests due to global warming

Perhaps the most critical situation facing Andean biota in the near future is the decline of humidity from mists. Because of global warming, moisture-saturated air from the Pacific becomes even warmer, raising it up and over the cloud forests of the middle and upper-levels of the Western Andes. The most obvious and easiest cloud forest feature to record, is the loss of what has been called horizontal rain or the mist-humidifier effect (Jarvis, pers. com.). With decreasing humidity, cloud forests lose one of their principal features, the main element which favors the accumulation and diversification of many life forms. The cloud forest or 'kingdom of the epiphytes' as Gentry called it, would lose much of its exuberant wildlife, especially the orchids.

Final Recommendations

Conservation strategies for both ecosystems and species are based on four criteria: 1) that the richness of both living species and human cultural wealth should be seen as interrelated and essential to human development, 2) that the links between ecological systems and human economy are a common thread linking human destiny with local regions, 3) that the maintenance of human social and cultural vitality, in relation to a globalized economy, represents a major challenge to ecosystem programs, and 4) that organizational and social participation are the mechanisms which will help communities anticipate and deal with coming change, maintain their cultural integrity and economic viability, and the quality of their natural resources and environment.

Orchids are among the most outstanding, charismatic and diverse of all plant groups in Colombia, but the complexities of their reproduction and survival also put them amongst the most vulnerable and threatened from the duress of human activity. Orchids are, at least in the tropical world, important indicators of environmental quality and priority areas for conservation. They have keystone features which make them essential for the survival of bees, flies and butterflies, which in turn play important roles in plant pollination and the biological control of natural ecosystems. As a keystone species, orchids contribute significantly to the welfare and stability of ecosystems.

When these ecosystems work well, they provide important goods and services such as soil and watershed protection, essential to the sustainability of human welfare. The goal of conservation is not only to identify and protect orchids and their habitats, but to discover, develop and support the ability to use and manage sustainably the natural resources that exist in and around local communities.

Stuart Pimm (2009) summed up the challenge of conservation with the following statement: "We have a moral responsibility to protect the world's 'special places', those richest in biodiversity and most threatened by human advances."

The fundamental questions are how to reduce human pressure on natural ecosystems and how to encourage behavior which is more in harmony with nature. To answer these questions we must look for the root causes of our human behavior in relation to the environment. A culture of environmental awareness seems to be lacking. This environmental illiteracy manifests itself in competitive attitudes, in a wild desire to extract nature's resources and in an inadequate appreciation of the natural world. If current trends continue, many species that we now con-

sider safe are really in danger, and those that are currently threatened will probably become extinct.

It would be virtually impossible to save the wilderness areas of the tropical Andes, one of the world's largest reservoirs of biodiversity, simply through law enforcement and the use of rangers. What needs to be done is to direct our currently scattered efforts towards reaching a unified commitment between representatives of the scientific community (for example, a team of orchid specialists from the World Conservation Union) and organizations from civil society, communities of resource users and environmental authorities, in order to raise environmental and cultural awareness within the population as a whole, and particularly within children, for in our children lies our future.

Perhaps more urgent still is the influence that we can all exercise collectively on our decision-makers and those who produce the guidelines of environmental policies. While we cannot force the world to conserve nature and its resources, we can induce them to do so, through dissemination of information and emotional persuasion based on fact (Orejuela 2005). This article about orchids from the southwestern Colombia cloud forests, is a testimony that we hope is both eloquent and appealing, that might engage and inspire people everywhere, persuading us all to share in the wonderful and extraordinary world that is nature.

We trust that as a result, we can all share our understanding of these wonderful plants and in appreciation, commit to learning more about, preserving and enjoying these gems of nature.

Hopefully, most Colombians will be able to visit orchids in their wilderness areas, and also be alert to their presence in towns and cities, along with their pollinators and environment. Many hours of exploration and discovery await those who are open to amazement.

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