

CONTRIBUTION TO THE RED LIST OF PAKISTAN: A CASE STUDY OF *DELPHINIUM NORDHAGENII* (RANUNCULACEAE)

Haidar Ali¹, M. Qaiser² and K.B. Marwat³

¹Centre of Botany and Biodiversity Conservation, University of Swat, Khyber Pakhtunkhwa, Pakistan

²Federal Urdu University for Arts, Science and Technology, Karachi / Islamabad, Pakistan

³Agricultural University Peshawar, Khyber Pakhtunkhwa, Pakistan

Abstract

Delphinium nordhagenii Wendelbo (Ranunculaceae) is endemic to District Chitral, Pakistan. This taxon was previously known from 2 localities of Barum Gol and Sher Ghora. After three years of continuous field studies during 2005-2007, five new localities were discovered. According to its population size and number of localities reported, 624 mature individuals were found in 5 localities in 2005, 275 mature individuals were found in 2006 and 184 mature individuals were found in 2007. The main threat posed to the existence of the taxon is its habitat destruction. In 3 localities i.e., Torikhoo-Chato Doke Ghari, Mastooj-Shandoor Top and Torikhoo-Khoot Ghari, 28.57%, 10.12% and 36.12% decrease has been observed in its population size, respectively, caused by grazing, soil erosion resulted from deforestation and agricultural land extensions. In view of its extent of occurrence of 293.77km², area of occupancy of 20 km² and population size of 184 mature individuals, the taxon is placed under the category of critically endangered (CR).

Introduction

Wild plants are rapidly disappearing due to tremendous increase in human population, urbanization, habitat fragmentation and the increased dependency of the poor on the limited natural resources (Western, 2001; Woodruff, 2001). As a result of these anthropogenic activities, the rate of plant extinction has reached to one species per day. This rate is considered to be 1000-10000 times faster than could naturally occur (Hilton-Taylor, 2000) and if the trend remains constant, 60,000 to 100,000 plant species would disappear during the next 50 years (Pujol *et al.*, 2006). It is expected that as many as half of the world's plant species would be threatened by extinction if assessment is made according to the categories and criteria of IUCN (Pitman & Jørgensen, 2002).

For Pakistan a total of 1572 genera and 5521 species of flowering plants are identified (Ali, 2008) but no comprehensive field research based Red List is present for the country (Ali & Qaiser, 2010a). On the other hand, Pakistan is under tremendous pressure concerning its population explosion, unplanned urbanization, deforestation and over-exploitation of natural resources (Ali, 2000). Unfortunately, no critical work has been done on threatened plants of Pakistan and very little information is available on this subject (Alam & Ali, 2009). Though herbarium based studies were conducted by Nasir (1991) who estimated 580-650 flowering plant species (i.e. 12%) were threatened at national level. But this assessment was not based on any criteria. Similarly 14 flowering plant species are listed as threatened from Pakistan by Walter & Gillet (1998) in IUCN Red Data List. Among which 2 are considered as extinct, 2 endangered, 2 vulnerable, 5 rare and 5 indeterminate. While in the current red list (Anon., 2009), 19 species are listed from Pakistan. Of these, 2 are vulnerable, 13 lower risks/least concern, 1 near threatened and the remaining 3 were classified as data deficient. But this seems to be underestimation as it is only 0.3% of the total number of

flowering plant species known from Pakistan. Beside this no comprehensive field data regarding the trends in population size and local threats are given (Ali & Qaiser, 2010b).

According to IUCN (Anon., 2001) for determining the conservation status of a taxon, it is necessary to monitor the fluctuation in the population size, the extent of occurrence (EOO), the area of occupancy (AOO) and the nature and extent of threats faced by the taxon. In this context, endemic taxa deserve special attention because of their limited geographic distribution and any unfavorable change in the habitat might hinder their whole population as a result the taxon may face the process of extinction (Callmender *et al.*, 2005). However, these populations are under the fundamental evolutionary processes that give birth to new species or relict taxa (Mauchamp *et al.*, 1998). Hence, endemic and rare species, particularly narrow endemic species deserve our immediate attention.

Most of the flowering plant diversity is confined to the mountainous areas in Pakistan (Ali & Qaiser, 1986). Therefore, there is dire need of extensive plant collection in these biodiversity rich mountain areas of Pakistan. About 80% of the endemic flowering plants are confined to the northern and western mountains of Pakistan and Kashmir (Ali, 2008). Beside N. Baluchistan and Sino-Japanese region of Kashmir, Chitral is at third position regarding the number of endemic taxa with 34 species (9.1%) and is recognized as the centre of radiation (Ali & Qaiser, 1986).

Chitral is the largest district of Khyber Pakhtunkhwa with a total of 14850 km² covering 20% of the provincial landscape. It lies between 35°15' 00" to 36°55' 32" N and 71°11' 32" to 73°51' 03" E (Anon., 1998). It is located in the extreme north-east, parallel to the pan-handle shaped Wakhan corridor of Afghanistan.

The aim of the present study was to study the geographic distribution, evaluate the conservation status and identify threats to the population and recommend measures for steady conservation of *Delphinium nordhagenii*.

Materials and Methods

Comprehensive field studies were conducted from 19th May 2005 to 30th September 2005; from 1st May to 30th September 2006 and from 1st June to 30th September, 2007. Studies were conducted in lower Chitral in May and June while upper Chitral was studied from July till the end of September, because of the inaccessibility (snow bound area) and also the lack of flowering period. Special attention was paid to those localities from where the taxon was previously collected and to the inaccessible and previously non-visited localities during long excursions of 7-10 days campaign in these areas. These excursions were conducted with the help of local guides and porters, using horses or sometimes yak for transportation of plant specimens. The routes followed were localized by using GPS (Lowrance, iFinder), altimeter and a topographic map (scale, 1:50,000, provided by survey of Pakistan). In addition to this the taxon was also searched in other localities containing the same altitudinal range and habitat in order to get the whole range of its distribution. When a population was located an additional 1-2 days were spent to determine the extent of the population by walking extensively in an area of at least 1-2 km² around each population. For population size, mature individuals were counted in each locality. Those individuals were considered as mature which contained fruits or flowers. Comprehensive field notes like, habit, habitat, life form, phenological status and altitudinal range was studied in

the field. Various anthropogenic threats like grazing, agricultural land extension and deforestation were also studied. Grazed individuals were counted and tabulated for each locality. Plant specimens collected were deposited at Karachi University Herbarium (KUH). For EOO the geographical coordinates were plotted on a georeferenced imagery obtained from Google (2009) in ArcView v.9.3 and a polygon was prepared by encompassing line through all the known localities of the taxon, excluding the localities which come inside the boundary of the polygon. Similarly the AOO was calculated by the presence of the taxon in a grid of 4km² area. All the data collected were analyzed in view of IUCN Red List Categories and Criteria (Anon., 2001).

Results and Discussion

Delphinium nordhagenii is a perennial herb, growing in steep rock slopes. This taxon was previously known from two localities: Chitral, Barum Gol, 12,000 feet, I.I. Chaudhri 164 (RAW); Sher Ghora, Ras Gul 10451 (KUH) (from Riedl & Nasir, 1991: 56). Although we could not find the taxon in these reported localities but have been able to find it from 5 more localities (Table 1). *Delphinium nordhagenii* is a Hemicryphyte (following Raunkier, 1934) plant height ranges up to 30 cm. Its altitudinal range varies between 3471 to 4230 m (Table 1). Flowering and fruiting was observed in July-August.

Table 1. *Delphinium nordhagenii*: locality, GPS value, altitude, habitat, population size and number of grazed individuals.

Locality No.	Locality	Alti. (m)	GPS value (UTM) E-N	Population size			Grazed individuals		
				2005	2006	2007	2005	2006	2007
1.	Molikhoo-Attahk Terich	3471	43-230941, 4022581	5	14	87	4	10	70
2.	Torikhoo-Chato Doke Ghari	3733	43-286873, 4045492	7	44	2	-	-	-
3.	Mastooj-Shandoor Top	4223	43-280916, 3994105	79	41	8	50	32	-
4.	Torikhoo-Shekhlasht Khote	3914	43-288135, 4046066	36	65	44	9	5	-
5.	Torikhoo-Khote Ghari	4230	43-287765, 4046947	191	111	69	45	7	3
Total				624	275	184	108	54	73
Average							361	78.33	

As the Extent of Occurrence of the taxon is 293.77 km² (i.e., less than 5000km²), Area of Occupancy is 20 km² (i.e. less than 500km²) therefore it should be placed under the Endangered Category. A total of 624 mature individual plants were observed in 2005, 275 in 2006 and 184 in 2007, with an average of 361 mature individual plants per year. Fluctuation is observed in the population size, with decrease of 349 mature individual plants (55.92%) in the second year, while further decrease of only 91 mature individual plants (33.09%) during the third year. Hence, a total decrease of 440 mature individual plants (70.51%) was observed during the three years of study. Therefore, it is a rare species with extreme fluctuation in population size in all the localities (Table 1).

It's population size is 184 (i.e. less than 250 mature individuals). In addition, the subpopulations are also severely fragmented i.e. distributed in 5 small localities (Figs. 1, 2 & 3). Furthermore, due to continuing decline in number of mature individuals i.e., 329 mature individual plants (70.50%) decreased from 624 in 2005 to 184 in 2007 (Table 1), this taxon is placed under Critically Endangered Category. These results of low population size with continuing decline and extreme fluctuation collectively suggest the category of Critically Endangered according to the IUCN Red List Categories and Criteria (Anon., 2001).

Hierarchical Alpha Numeric Numbering System is as:

CR C 1 2 b

where:

CR = Critically Endangered

C = Population size estimated to number fewer than 2500 mature individuals and either:

1 = An estimated continuing decline of at least 25% within three years

2 = a= Continuing decline observed in number of mature individuals

b= Extreme fluctuation in number of mature individuals



Fig. 1. *Delphinium nordhagenii*: A, habit; B, flower close up.

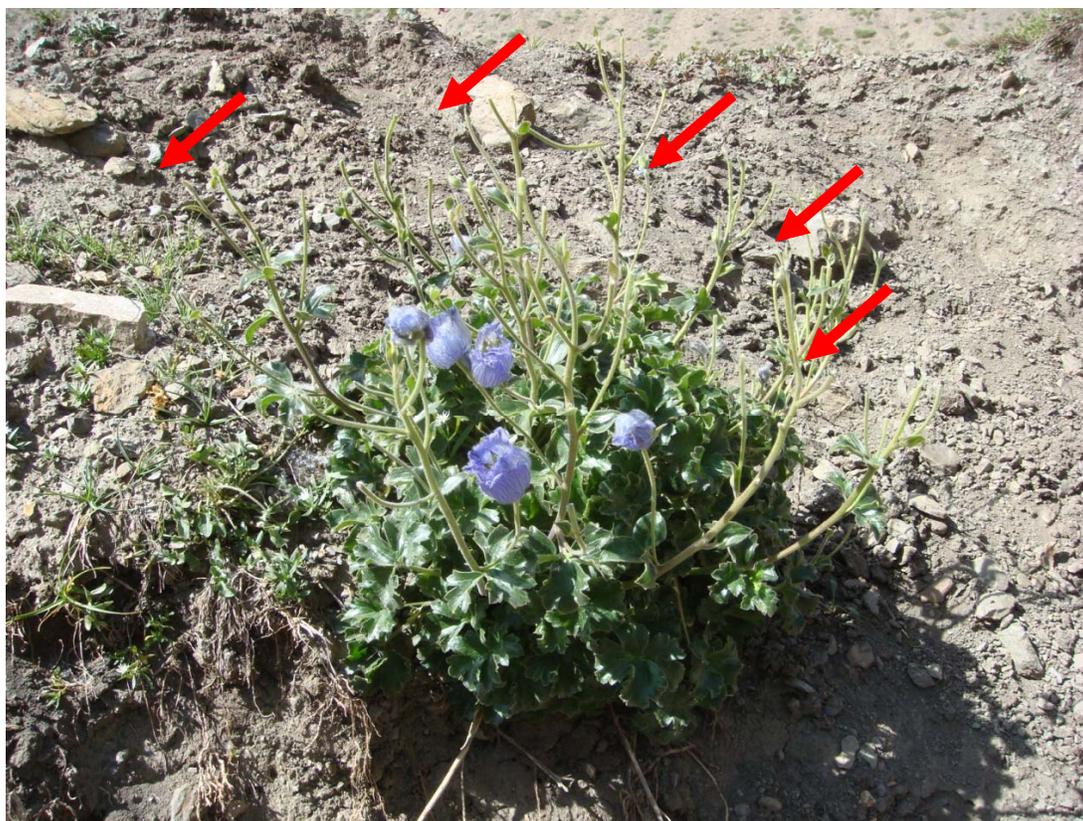


Fig. 2. *Delphinium nordhagenii*: extensively grazed individual.

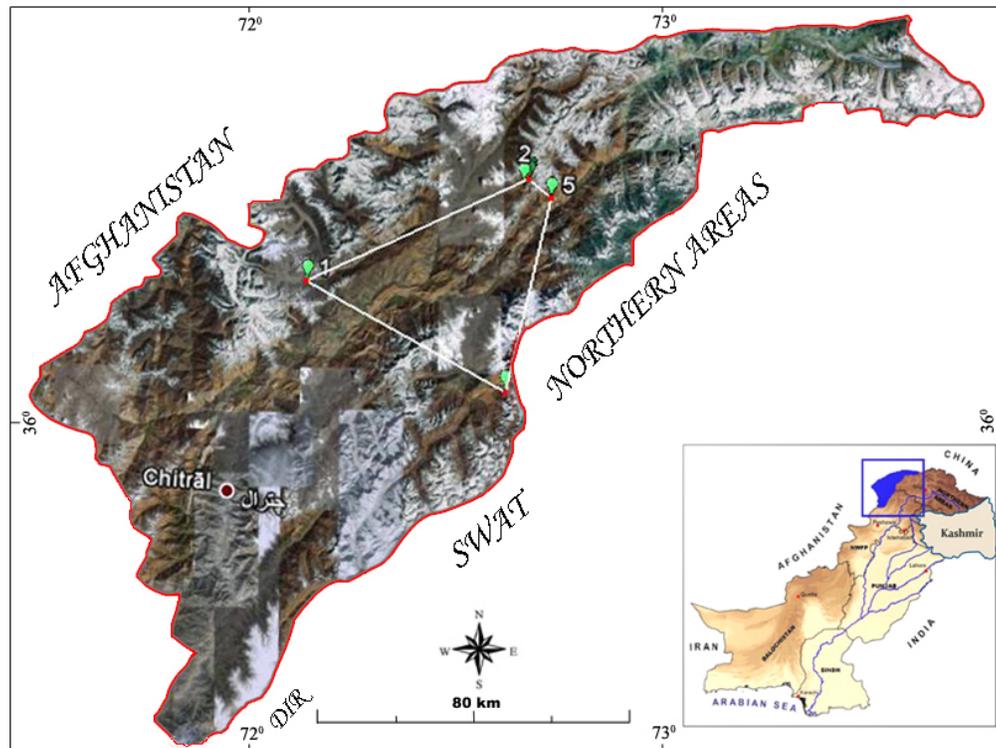


Fig. 3. Distribution of *Delphinium nordhagenii* during 2005-2007, number corresponds with the localities in the table.

Adequate plant collections with good field observation notes may play a critical role in assessing conservation status, conservation priorities, or changes over time in species frequency (Burgman *et al.*, 1995; MacDougall *et al.*, 1998; Funk *et al.*, 1999; Steege *et al.*, 2000; Golding, 2001; Hedenas *et al.*, 2002; Schatz, 2002; Willis *et al.*, 2003; Ungricht *et al.*, 2005), but various collection biases may hamper its basic goal and lead to various misconceptions. In addition, it is also possible that the previously documented populations might no longer exist in nature. Since the number of available collections and the evenness of collecting localities across ecological zones further hinder the problem of assessing conservation status. Based solely on the Herbarium specimens data using the IUCN categories and criteria can be misleading if proper field knowledge is not taken into account (Randrianasolo *et al.*, 2002), especially for the areas like Chitral which is very hard to reach and plant collection from the remote localities sometimes seems almost impossible. Therefore, the evaluation of conservation status based on herbarium specimens must be accompanied with the field observations taken continuously for at least three years in order to confirm the existence of the taxon in the wild (Ali & Qaiser, 2011). Otherwise the evaluation will be misleading.

According to the IUCN Red Data List Categories and Criteria (Anon., 2001) a taxon should be assessed throughout its whole range of distribution, but due to the security situation and political constraints the national level assessment are also given due consideration (Anon., 2003).

The extreme fragmentation of species distribution appears to be the characteristic of areas of high endemics, poses a grave dilemma for conservation (Ashton, 1981). Narrow endemics are susceptible to extinction for a

variety of reasons, one among the most important being the destruction of their habitat (Lende, 1988; Schemske *et al.*, 1994; Romeo *et al.*, 1994; Sala, *et al.*, 2000, Bernardes *et al.*, 2006).

In Chitral valley, habitat loss is a serious problem, mainly due to agricultural land expansions, deforestations, grazing pressure, developmental activities and environmental degradation. If these circumstances continue, an irreversible loss of many species would occur, mainly of those which are found in Alpine and Subalpine regions. Earlier measures for the conservation of these plant resources are urgently needed. *Delphinium nordhagenii* is endemic to Chitral (Riedl & Nasir, 1991) and is categorized as Critically Endangered.

In order to obtain the benefits in a sustainable manner not only at local level but also at global level, it is the responsibility of the state to conserve their biodiversity. Hence, it is necessary to identify important components of biodiversity and identify priorities which may need special conservation measures (Glowka *et al.*, 1994). Pakistan became signatory of CBD in 1992 and ratified by the cabinet in 1994. In order to meet the objectives of CBD, Pakistan has developed Biodiversity Action Plan (BAP) in 2000 but up till now Pakistan has not yet approached biodiversity planning and implementation in the comprehensive and integrated manner was required by the convention (Anon., 2000).

These results obtained from the study area may well depict the conditions prevailing over most other parts of the country and can be used as a baseline study for the future biodiversity management.

References

- Alam, J. and S.I. Ali. 2009. Conservation status of *Astragalus gilgitensis* Ali: a critically endangered species in Gilgit district, Pakistan. *Phyton* (Horn, Austria), 48: 211-223.
- Ali, H. and M. Qaiser, 2010b. Contribution to the Red List of Pakistan: a case study of *Gaillonia chitralensis* (Rubiaceae). *Pak. J. Bot., Special Issue (S.I. Ali Festschrift)* 42: 205-212.
- Ali, H. and M. Qaiser. 2010a. Contribution to the Red List of Pakistan: a case study of *Astragalus gahiratensis* Ali (Fabaceae-Papilionaceae). *Pak. J. Bot.*, 42(3): 1523-1528.
- Ali, H. and M. Qaiser. 2011. Contribution to the Red List of Pakistan: a case study of *Silene longisepala* (Caryophyllaceae). *Oryx*, 45(4): 522-527. DOI: 10.1017/S003060531000102x.
- Ali, S.I. 2000. Impact of environmental degradation on biodiversity. In: *Proceedings Pakistan Academy of Science*. 37(1): pp. 93-97.
- Ali, S.I. 2008. Significance of Flora with special reference to Pakistan. *Pakistan Journal of Botany*, 40(3): 967-971.
- Ali, S.I. and M. Qaiser. 1986. A phytogeographical Analysis of Phanerogams of Pakistan and Kashmir. In: *Proceedings of Royle Society Edinburgh*, 89B: 89-101.
- Anonymous. 1998. *District Census Report of Chitral*. PCO, Govt. of Pakistan.
- Anonymous. 2000. Government of Pakistan, World Wide Fund for Nature, Pakistan and International Union for Conservation of Nature and Natural Resources, Pakistan.
- Anonymous. 2001. 2001 IUCN Red List Categories and Criteria (Version 3.1) IUCN Species Survival Commission, IUCN Gland, Switzerland and Cambridge UK. [http://www.redlist.org/info/categories_criteria2001.html, accessed 13 April 2009].
- Anonymous. 2009. *2009 IUCN Red List of Threatened Species*. IUCN, Gland, Switzerland. <http://www.iucnredlist.org> [accessed 17 September 2009].
- Ashton. 1981. Techniques for the identification and conservation of threatened species in tropical forests. In: *The Biological Aspects of Rare Plant Conservation*. (Ed.): H. Synge. John Wiley & Sons Ltd. pp. 155-164.
- Bernardos, S., A. Amado and F. Amich. 2006. The narrow endemic *Scrophularia valdesii* Ortega-Olivencia & Devesa (Scrophulariaceae) in the Iberian Peninsula: an evaluation of its conservation status. *Biodiversity and Conservation*. 15: 4027-4043.
- Burgman, M.A., R.C. Grimson and S. Ferson. 1995. Inferring threat from scientific collections. *Conservation Biology*. 9: 923-928.
- Callmander, M.W., G.E. Schatz and P.P. Lowry II. 2005. IUCN Red List assessment and the Global Strategy for Plant Conservation: taxonomists must act now. *Taxon*, 54 (4): 1047-1050.
- Funk, V.A., M.F. Zermaglio and N. Nasir. 1999. Testing the use of specimen collection data and GIS in biodiversity exploration and conservation decision making in Guyana. *Biodiversity and Conservation*, 8: 727-752.
- Glowka, L., F. Burhenne-Guilmin, H. Synge, J.A. McNeely and L. Gündling. 1994. A guide to the Convention on Biological Diversity. Environmental Policy and Law Paper 30. Gland, IUCN, p. 15-51.
- Golding, J.S. and P.P. Smith. 2001. A 13-point flora strategy to meet conservation challenges. *Taxon*, 50: 475-478.
- Google, 2009. ©2009 Google Inc. 1600 *Amphitheatre Parkway Mountain view*, CA 94042.
- Hedenas, L., I. Bisang, A. Tehler, M. Hammene, K. Jaederfelt and G. Odelvik. 2002. A herbarium based method for estimates of temporal frequency changes: Mosses in Sweden. *Biological Conservation*, 105: 321-331.
- Hilton-Taylor, C. 2000. 2000 IUCN Red List of Threatened Species. IUCN, Gland, Switzerland and Cambridge, UK.
- Lende, R. 1988. Genetic and demography in biogeography in biological conservation. *Science*, 241: 1455-1460.
- Maddougall, A.S., J.A. Loo, S.R. Clayden, J.G. Goltz and H.R. Hinds, 1998. Defining conservation priorities for plant taxa in southern New Brunswick, Canada using herbarium records. *Biol. Conserv.*, 86: 325-338.
- Mauchamp, A., I. Aldaz, E. Ortiz and H. Valdebenito. 1998. Threatened species, re-evaluation of the status of eight endemic plants of the Galapagos. *Biodiversity and Conservation*, 7: 97-107.
- Nasir, Y.J. 1991. Threatened plants of Pakistan. In: *Plant Life of South Asia. Proceeding of International Symposium*. (Eds.): S.I. Ali & A. Ghaffar. University of Karachi, Karachi.
- Pitman, N.C.A. and P.M. Jorgensen. 2002. Estimating the size of the world's threatened flora. *Science*, 298(1): 989.
- Pujol, J.L.P., F. Zhang and G. Song. 2006. Plant biodiversity in China: richly varied, endangered, and in need of conservation. *Biodiversity and Conservation*, 15: 3983-4026.
- Randrianasolo, A., J.S. Miller and T.K. Consiglio. 2002. Application of IUCN criteria and Red list categories to species of five Anacardiaceae genera in Madagascar. *Biodiversity and Conservation*, 11: 1289-1300.
- Raunkiaer, C. 1934. *The Life from Plants and Statistical Plant Geography* Clarendon Press, Oxford.
- Riedl, H. and Y.J. Nasir. 1991. Ranunculaceae, In: *Flora of Pakistan*. (Eds.): S.I. Ali and Y.J. Nasir. Islamabad & Karachi.
- Romeo, M.I., P. Ramil and M. Rubinos. 1994. Conservation status of *Eryngium viviparum* Gay. *Acta Bot. Gallica.*, 151: 55-64.
- Sala, O.E., F.S. Chapin, III 2000. Global Biodiversity Scenarios for the Year 2100. *Science*, 287: 1770-1774.
- Schatz, G.E. 2002. Taxonomy and herbaria in service of plant conservation: lessons from Madagascar's endemic families. *Ann. Mo. Bot. Gard.*, 89: 145-152.
- Schemske, D.W., B.C. Husband, M.H. Ruckelshaus, C. Goodwillie, I.M. Parker and J.G. Bishop. 1994. Evaluating approaches to the conservation of rare and endangered plants. *Ecology*, 75: 584-606.
- Steege, H., M.J. Jansen-Jacobs and V.K. Datadin. 2000. Can botanical collections assist in a National Protected Area Strategy in Guyana? *Biodiversity and Conservation*, 9: 215-240.
- Ungrecht, S., J.-Y. and F. Kjellberg. 2005. Extinction threat evaluation of endemic fig trees on new Caledonia: priority assessment for taxonomy and conservation with herbarium collections. *Biodivers. Conserv.*, 14: 205-232.
- Walter, K.S. and H.J. Gillet, (Eds.) 1998. 1997 IUCN Red List of Threatened Plants. Compiled by the World Conservation Monitoring Centre. IUCN, The World Conservation Union, Gland, Switzerland & Cambridge UK.
- Western, D. 2001. Human-modified ecosystems and future evolution. *PNAS*, 98(10): 5458-5465.
- Willis, F., J. Moat and A. Paton. 2003. Defining a role for herbarium data in Red List assessments: a case study of *Plectranthus* from eastern and southern tropical Africa. *Biodiversity Conservation*, 12: 1537-1552.
- Woodruff, D.S. 2001. Declines of Biomes and Biotas and the future of evolution. *Colloquium*, 98: 5471-5476.