A SYNOPSIS OF POLYGALACEAE IN INDIAN SUBCONTINENT: ITS DISTRIBUTION AND ENDEMISM

Una sinopsis de Polygalaceae en el subcontinente indio: su distribución y endemismo

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RESUMEN

Una revisión preliminar de Polygalaceae en el subcontinente indio ha sido preparada sobre la base de la observación de diferentes especies pertenecientes a esta familia en un hábitat natural y el análisis de especímenes de herbario y de literatura taxonómica. En el subcontinente indio (Bangladesh, Bhutan, Myanmar, Nepal, Pakistan, Sri Lanka e India) la familia Polygalaceae está pobremente representada (6,37% de la distribución global). Este artículo trata la distribución, fitoendemismo, posibles fósiles ancestrales, potencial económico y riesgos de supervivencia de especies existentes. El estado actual de fitoendemismo en Polygalaceae en el subcontinente indio (35,29% en 2002-2007) ha sido comparado con la información de investigaciones anteriores (21,87% en 1939-1940) finalizadas en el siglo XX. El aumento de la tasa de endemismo indica un incremento en el número de especies endémicas o un lapso de decrecimiento de especies pan-endémicas pertenecientes a esta familia. Para una mejor comprensión de los aspectos funcionales del porcentaje dinámico de las especies, la tasa de endemismo de un grupo determinado ha sido usada aquí como un indicador clave. El crecimiento en una misma zona geográfica ha sido registrado en intervalos de tiempo diferente y posteriormente es considerado para narrar los estudios académicos en la forma de presupuestos económicos de recursos renovables para asegurar su conservación y uso sostenible.

Palabras clave: Endemismo, Polygalaceae, subcontinente indio

ABSTRACT

A preliminary checklist of Polygalaceae in Indian subcontinent has been prepared on the basis of primary observations of different taxa belonging to this family in wild habitats and on secondary observations based on examined herbarium specimens and taxonomic literature. On the Indian subcontinent (comprising Bangladesh, Bhutan, Myanmar, Nepal, Pakistan, Sri Lanka and India), the family Polygalaceae is poorly represented (6.37% of global distribution). The present paper deals with a brief review of distribution, phytoendemism, possible fossil ancestry, economic potential and survival threat on existing taxa. The present status of phytoendemism of Polygalaceae in Indian subcontinent (35.29% in 2002-2007) has been compared to the data of previous investigations (21.87% in 1939-1940) done in the XX century. The increasing rate of endemism either indicates towards increasing number of endemic taxa or decreasing span of distribution of pan-endemic taxa belonging to this family. For a better understanding of the functional aspects of species dynamics the percentage of rate of endemism of a particular group of plants has been used as key index here. The growing

ISSN 0084-5906
Depósito Legal 196902DF68

on same geographical location has been recorded in different time intervals and has further been considered to narrate the academic studies in form of qualitative economic appraisal of renewable resources for ensuring its conservation sustainable utilization.

Key Words: Endemism, Indian subcontinent, Polygalaceae

INTRODUCTION

Polygalaceae, with tree, herbs, shrubs and woody climbers comprise *ca*. 21 genera and about 900 species (Chadat 1980; Banerjee 1993; Eriksen 1993; Eriksen & Persson 2006) and is a sub cosmopolitan family diversely distributed over American and African tropics. Apart from ethnobotanical importance, the underexploited genetic resources belonging to this family deserve conservation on the face of threat of depletion of wild habitats. Apparently, the family Polygalaceae is a minor floristic element in the Indian subcontinent, yet the phytogeographical analysis of Indian subcontinent would remain incomplete due to lack of any recent studies on this group of plants.

The lack of contemporary phytogeographical analysis of Polygalaceae in the South Asian region, which is pre-requisite criteria to adopt conservation strategies on a national level as well as regional level, lead to undertake the present studies. The last phytogeographical review of this family on the Indian subcontinent was done in 1939-1940 (Chatterjee 1939). Thus a review is necessary to monitor the species dynamics of Polygalaceae in the same geographical location after a period of time. Species dynamics is a key indicator in predicting whether a particular group of plants is in a mode of expansion or extinction (Ahmedullah & Nayar 1986) apparently, the present study is an academic study where economic potential of a group of plants has been overlooked. Hence, "species dynamics" has been used as a key tool to determine sustainable utilization pattern as well as planning of conservation strategies, based on its mode of expansion, diversification or extinction by recommending its commercial exploitation and scientific regeneration process. For a developing country, sustainable utilization of overexploited as well as underexploited plant resource would be considered as a potential indigenous, renewable, natural resource, which could play an important role in socio-economic development. But, most of the time it has been found that the conservation initiative, strategies, and ethics is much more pro-active in developed countries than in developing countries, enriched with tropical and subtropical floristic resources.

MATERIALS AND METHODS

To prepare a preliminary checklist of Polygalaceae in Indian subcontinent, available floristic works of Indian subcontinent and other major regions have been

consulted, starting with Index Kewensis (Hooker & Jackson 1895) and its supplements. The list of endemic taxa has been prepared from Dar (1973), Trimen (1974), Hara (1979), Sumithraachari (1987), Tan (1991) and Chen *et al*. (2007), and subsequently confirmed by studying the exsiccata of six Indian herbaria: viz. BSIS (Industrial Section of Indian Museum, Botanical Survey of India), CAL (Central National Herbarium, Botanical Survey of India), FRC (Herbarium, Division of Genetics and Tree Breeding, Institute of Forest Genetics and Tree Breeding, Coimbatore), MH (Herbarium of Botanical Survey of India, Southern Circle, Coimbatore), RRCBL (Medicinal Plant Herbarium, Regional Research Laboratory, Bangalore), RBGT (Herbarium, Tropical Botanic Garden, Research Institute, Trivandrum, Kerala) and from the Herbarium of Royal Botanic Gardens, Kew (K). The microfiches of C. Linnaeus's collection from two European Herbaria have also been studied, viz. Herbarium, Linnean Society of London, U.K. (LINN) and Herbarium of Naturhistoriska Riksmuseet, Stockholm, Sweden (S). In search of endemic and threatened taxa, field surveys have been undertaken in Central and Southern Western Ghat regions of India. The required data on threatened taxa of Polygalaceae were partially accumulated from World Conservation Monitoring Centre, Cambridge, U.K. The assortment of endemic taxa of Polygalaceae in different phytocorias has been made following the phytocorial classification of Kundu (2001).

The percentage of endemism of Polygalaceae has been calculated by Chatterjee in 1939-1940 as follows: 100y/x, where the number of taxa belonging to Polygalaceae in the Indian subcontinent (comprising of British India, Burma, Ceylon, Royal British Nepal and Royal Bhutan) and other parts of the world are "x" and the taxa exclusively belonging to the family Polygalaceae in Indian subcontinent are "y".

In 2002-2006, replication of entire process has been repeated on the same matrix to witness the changing index of "Species dynamics" of Polygalaceae under influence of changing factors, viz. climatic, edaphic, topographic, ecological, anthropological and biological, etc. Though area and locations of the study remains the same, the intra-political boundaries have been changed in 2002-2006: British India has been divided in India, Bangladesh and Pakistan; Burma has been newly recognized as Myanmar; Royal British Nepal became Nepal Republic and Royal Bhutan became Bhutan as well as Druk now.

RESULTS AND DISCUSSION

Distribution of Polygalaceae in Indian subcontinent

Banerjee (1993) enlisted four genera and *ca*. 32 species of Polygalaceae occurring in India. However, the present study reveals that 43 taxa (comprising 31 species and 12 subspecies) are represented here. The checklist of Polygalaceae distributed over Indian subcontinent and other places of the world is given in Table 1.

Table 1. Checklist of Polygalaceae chiefly distributed over Indian subcontinent and other places of the world.

Taxa	Place of occurrence
Epirixanthes elongata Blume, Cat. Gew. Buitenz. 25. 1823.	India, Bhutan, Bangladesh, Myanmar, Malaysia, Thailand, Indonesia, China, Vietnam
Polygala abyssinica Fresen., Mus. Seuck. 2: 273. 1837.	India, Pakistan, Nepal, Afghanistan, West Asia, Africa
P. arillata D.Don var. *arillata,* Prodr. Fl. Nep. 199. 1825.	India, Nepal, Bhutan, Myanmar, Sri Lanka, Vietnam, China, Malaysia, Philippines
P. arillata D.Don var. *chartacea* (Mukherjee) Giri, Bull. Bot. Surv. India 26: 5. 1984 (1985).	India
P. arillata D.Don var. *laevicarpa* R. N. Banerjee & Giri, Candollea 42: 555. 1987.	India, Nepal
P. arillata D.Don var. *purpurescens* Clarke ex Mukherjee, Bull. But. Soc. Bengal 12: 32. 1958.	India, Bhutan
P. arillata D.Don var. *revoluta* (Mukherjee) Giri, Bull. Bot. Surv. India 25: 5. 1984 (1985).	India
P. arvensis Willd., Sp. Pl. 3(2): 876. 1803.	India, Nepal, Bangladesh, Myanmar, S. E. Asia, N-Australia
P. bulbothrix Dunn. var. *bulbothrix*, Fl. Pres. Madras 1: 58. 1915.	India
P. bulbothrix Dunn. var. *devicolamensis* (Mukherjee) R.N.Banerjee, Fl. Ind. 2: 463. 1993.	India
P. bulbothrix Dunn. var. *pulniensis* (Mukherjee) R.N.Banerjee, Fl. Ind. 2: 463. 1993.	India
P. buxiformis Hassk., Ann. Mus. Lugd. Bat. 1: 161. 1864.	India, Pakistan, Bangladesh, Myanmar, Sri Lanka, China, Malysia, Philippines
P. cardiocarpa Kurz, J. Asiat. Soc. Bengal, pt. 2, Nat. Hist. 41: 293. 1872.	Myanmar, Thailand, China
P. chinensis L., Sp. Pl. 2: 704. 1753.	India, Pakistan, Bhutan, Myanmar, Sri Lanka, China, Vietnam, Thailand, Malaysia, Philippines, New Guinea, Australia
P. crotalarioides Buch.- Ham. ex DC., Prodr. 1: 327. 1824.	India, Pakistan, Nepal, Bhutan, Myanmar, China, Vietnam, Thailand, Laos
P. elegans Wall. ex Royle, Illus. Bot. Himal. Mts. 76. 1834.	India, Pakistan, Nepal, Bhutan, China
P. elongata Willd., Sp. Pl. 3(2): 879. 1802.	India
P. erioptera DC., Prodr. 1: 326. 1824.	India, Pakistan, Myanmar, West Asia, Africa
P. furcata Royle, Illus. Bot. Himal. 3: 78. 1834.	India, Pakistan, Nepal, Bhutan, Bangladesh, Myanmar, China, Vietnam.

Table 1. Continuation...

Taxa	Place of occurrence
P. glaucoides L., Sp. Pl. 2: 705. 1753.	Sri Lanka
P. globulifera Dunn. var. *globulifera,* J. Linn. Soc. Bot. 35: 486. 1903.	India, Nepal, Myanmar, China
P. globulifera Dunn. var. *kachinensis* (Mukherjee) R.N.Banerjee, Bull. Bot. Surv. India 26: 6. 1985.	India, Myanmar
P. glomerata Lour., Fl. Cochinch. 2: 426. 1790.	India, Sri Lanka
P. hirsutula Arn., Nova Acta Phys.- Med. Acad. Caes. Leop.- Carol. Nat. Cur. 18(1): 322. 1836.	Sri Lanka
P. hohenackeriana Fisch. & Mey., Ind. Sem. Hot. Petrop. 4: 42. 1838.	Pakistan, Afghanistan, Iran, Turkey, Yugoslavia
P. irregularis Boiss., Diagn. Ser. 1(1): 8. 1842.	India, Pakistan, Iran, West Asia, N.E. Africa
P. jacobii Chandrab., Bull. Bot. Surv. India 9: 288. 1967.	India, Sri Lanka
P. japonica Houtt., Handl. 10: 1. 1979.	India, Myanmar, Sri Lanka, China, Vietnam, Taiwan, Japan, Korea, Malaysia, Philippines, New Guinea, Russia, Australia
P. javana DC., Prodr. 1: 324. 1824.	India, Sri Lanka, Malaysia, Indonesia
P. karensium Kurz. var. *karensium,* J. Asiat. Soc. Bengal 41: 292. 1872.	India, Bhutan, Myanmar, Vietnam
P. lacei Craib., Bull. Misc. Inform. Kew 1916: 260. 1916.	Myanmar, China, Thailand
P. leptalea DC., Prodr. 1: 325. 1824.	Sri Lanka
P. linarifolia Willd., Sp. Pl. 3: 877. 1803.	India, Nepal, China, Thailand, Vietnam, Malaysia, Vietnam, Australia
P. longifolia Poiret, Encycl. 5: 501. 1804.	India, Nepal, Bhutan, Myanmar, Sri Lanka, China, Vietnam, Thailand, Malaysia, Cambodia, Indonesia, Laos, Philippines, New Guinea, Australia
P. macrolophos Hassk., Ann. Mus. Bot. Lugd.1: 167. 1864.	Sri Lanka
P. mariesii Hemsley, J. Linn. Soc., Bot. 23: 61. 1886.	India, Bhutan, China
P. persicariifolia DC., Prodr. 1 : 326. 1824.	India, Nepal, Bhutan, Myanmar, China, Vietnam, Malaysia, Cambodia, Indonesia, Philippines, Australia, New Guinea, East Africa
P. polifolia C. Presl., Rel. Haenk. 2: 101. 1835.	India, Pakistan, Bangladesh, Sri Lanka, Malaysia, Thailand, Indonesia, Cambodia, Laos, Philippines, China, Taiwan, Vietnam, New Guinea
P. rosmarinifolia Wight & Arn., Prodr. 1: 37. 1834.	India, Sri Lanka

Table 1. Continuation...

Taxa	Place of occurrence
P. sibirica L. var. *sibirica,* Sp. Pl. 2: 702. 1753.	India, Pakistan, Nepal, Bhutan, Myanmar, Sri Lanka, China, Japan, Korea, Mongolia, Russia, Europe
P. tartarinowii Regal, Bull. Soc. Nat. Moscou 34: 523.1861.	India, Pakistan, Nepal, Bhutan, Myanmar, China, Japan, Malaysia, Philippines
P. telephioides Willd., Sp. Pl. 3: 876. 1802.	India, Sri Lanka, China, Malaysia, Philippines
P. tricholopha Chadat, Mem. Soc. Phys. Geneva 316: 98. 1898.	India, Bhutan, Myanmar, China, Vietnam, Laos, Thailand, Malaysia, Indonesia
P. triflora L., Sp. Pl. 2: 705. 1753.	India, Nepal, Myanmar, Sri Lanka, China, Malaysia, Laos, Thailand, Cambodia, Philippines, New Guinea, Australia
P. umbonata Craib, Bull. Misc. Inf. Kew. 1916: 260. 1916.	India, Myanmar, Vietnam, Laos, Thailand, Cambodia
P. wightiana Wight & Arn., Prodr. 38. 1834.	India, Malaysia, Australia
Salomonia cantoniensis Lour. var. *cantoniensis*, Fl. Cochinch. 1: 14. 1790.	India, Nepal, Bangladesh, Myanmar, Malaysia, Thailand, Cambodia, Laos, Indonesia, Philippines, Vietnam, China
S. cantoniensis Lour. var. *edeutula* (DC.) R.N.Banerjee, Fl. Ind. 2: 490. 1993.	India, Nepal, Bhutan
S. ciliata (L.) DC., Prodr. 1: 334. 1824.	India, Nepal, Myanmar, Sri Lanka, Malaysia, Philippines, Indonesia, Laos, Philippines, Cambodia, China, Taiwan, Vietnam, Japan, New Guinea, Australia, Europe
S. cordata Arn., Nova Acta Phys.- Med. Acad. Caes. Leop.- Carol. Nat. Cur. 18: 322. 1936.	Sri Lanka
Securidaca inappendicula Hassk., Pl. Jav. Rar. 295. 1848.	India, Nepal, Bhutan, Bangladesh, Myanmar, Vietnam, China, Malaysia, Thailand, Indonesia, Cambodia, Laos, Philippines

Endemism of Polygalaceae in India

Analysis of species distribution pattern of Polygalaceae revealed that out of fifty-one taxa, six are strictly confined and endemic to India (Table 2). Among six taxa, four are restricted in Southern Western Ghat (P-14), one taxon is spatially distributed in Southern Eastern Ghat (P-11), Central Western Ghat (P-13) and Southern Western Ghat (P-14) and the rest one is extended over from Indian Peninsular region to Western Ghat regions. It has been found that Himalayan regions, mainly Eastern Himalayas (P-4) and Northern Eastern India (P-5) contain fewer endemic Polygalaceae taxa than Western Ghat regions, particularly, Southern Western Ghat. Hence the Southern Western Ghat region should be regarded as endemic matrix for Polygalaceae of India. Among the four genera, *Polygala* is solely represented with *ca*. 6 endemic taxa.

Table 2. Checklist of endemic taxa of Polygalaceae in India.

Name of taxon	Phytogeographic zones of India																	
	P-1	P-2	P-3	P-4	P-5	P-6	P-7	P-8	P-9	P-10	P-11	P-12	P-13	P-14	P-15	P-16	P-17	P-18
Polygala arillata D.Don var. *chartacea* (Mukherjee) Giri	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-
Polygala arillata D.Don var. *revoluta* (Mukherjee) Giri	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-
Polygala bulbothrix Dunn. var. *bulbothrix* Dunn.	-	-	-	-	-	-	-	-	-	-	+	-	+	+	-	-	-	-
Polygala bulbothrix Dunn. var. *devicolamensis* (Mukherjee) R.N.Banerjee	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-
Polygala bulbothrix Dunn. var. *pulniensis* (Mukherjee) R.N.Banerjee	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-
Polygala elongata Klein	-	-	-	-	-	-	+	+	+	-	-	+	+	+	-	-	-	-

(+) Presence, (-) Absence

Phytocorial divisions: North-West Himalayas (P-1), Western Himalayas (P-2), Central Himalayas (P-3), Eastern Himalayas (P-4), North East India (P-5), Indian Desert (P-6), Semi Arid Region (P-7), Gangetic Plain (P-8), Central Deccan Plateau (P-9), Northern Eastern Ghat (P-10), Southern Eastern Ghat (P-11), North Western Ghat (P-12), Central Western Ghat (P-13), Southern Western Ghat (P-14), Coromandel Coast (P-15), Malabar Coast (P-16), Andaman & Nicobar Islands (P-17) and Laccadive & Minicoy Islands (P-18) (Kundu 2001).

Endemism of Polygalaceae in Indian subcontinent

In the broader aspect, extent of endemism of Polygalaceae in Indian subcontinent is given in Table 3. The investigation revealed that there are twelve taxa belonging to Polygalaceae confined in the Indian subcontinent. Among twelve taxa, three are restricted to Indo-Nepal-Bhutan Himalayas (out of three, two belong to *Polygala* and one belongs to *Salomonia* genus). One taxon of *Polygala* is confined to Indo-Myanmar region and rest of the eight taxa (comprising seven taxa belonging to *Polygala* and one taxon that belongs to *Salomonia* genus) are restricted to Indo-Sri Lankan region. These *ca*. 12 taxa should be categorized as "Broad Range Endemics" (B.R.E.) (Kundu 2005); on the other hand the *ca*. 6 taxa, which are absolutely confined to India, should be regarded as "Narrow Range Endemics" (N.R.E.) (Kundu 2005). Among 18 taxa (comprising of six narrow range endemics and twelve broad range endemics), 12 taxa (which are endemic in subcontinent i.e. E.I.S.) i.e. 66.6% endemic taxa are restricted to Indo-Sri Lankan region, hence, this region should be considered as "endemic resort" (Kundu 2007), which is functionally recognized as either "refugium" or "centre of diversity" for Polygalaceae in Indian subcontinent (Fig.1).

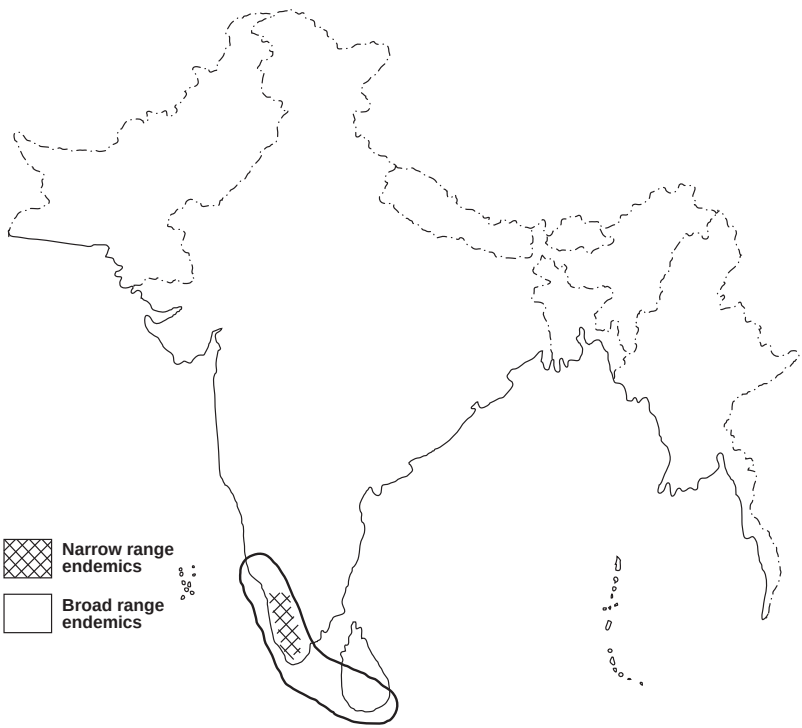

Fig. 1. An outline of endemism of Polygalaceae in Indian subcontinent.

Table 3. Checklist of endemic taxa of Polygalaceae in Indian subcontinent.

Name of taxon	India	Pakistan	Nepal	Bhutan	Bangladesh	Myanmar	Sri Lanka	Altitude (m asl)	Flowering time
Polygala ariillata D.Don var. *laevicarpa* R.N. Banerjee & Giri	+	-	+	-	-	-	-	300-2000	June-Dec.
Polygala arillata D.Don var. *purpurascens* Clarke ex Mukherjee	+	-	-	+	-	-	-	1000-2500	Feb.-Aug.
Polygala glaucoides L.	-	-	-	-	-	-	+	#	#
Polygala globulifera Dunn. var. *kachinensis* (Mukherjee) R.N.Banerjee	+	-	-	-	-	+	-	#	Feb.-Apr.
Polygala glomerata Lour.	+	-	-	-	-	-	+	#	June-Jan.
Polygala hirsutala Arn.	-	-	-	-	-	-	+	#	Jan.-Dec.
Polygala jacobii Chandrabose	+	-	-	-	-	-	+	#	May-Dec.
Poygala leptalea DC.	-	-	-	-	-	-	+	#	Jan.-Mar.
Polygala macrolophos Hassk.	-	-	-	-	-	-	+	#	Dec.-Mar.
Polygala rosmarinifolia Wight & Arn.	+	-	-	-	-	-	+	500-2000	Jan.-Dec.
Salomonia cantonensis Lour. var. *edeutula* (DC.) R.N.Banerjee	+	-	+	+	-	-	-	#	Feb.-May
Salomonia cordata Arn.	-	-	-	-	-	-	-	#	Aug.-Dec.

(+) Presence, (-) Absence, (#) Data is not available

It has been found that the total number of taxa belonging to Polygalaceae on the Indian subcontinent is *ca*. 51, whereas the total number of taxa in India is 43 (84.31%). The number of endemic taxa in the Indian subcontinent is not so impressive: *ca*. 18 taxa (35.29%). The number of narrow range endemics is *ca*. 6 taxa (11.76%) and the number of broad range endemics is *ca*. 12 taxa (23.52%). From the viewpoint of "Species Dynamics", the percentage of endemism of Polygalaceae on the Indian subcontinent in 1939-1940 (Chatterjee 1939) was 21.87%, whereas in 2002-2004, it has become 35.29%. The positive index of phytoendemism could be defined as either an increasing number (numerical increase) of endemic taxa or further shrinkage of distributional area of pan-endemic taxa (virtual increasing) or a combination of both. Apparently, the interpretation of an increased rate of endemism depends upon the discovery of new endemic species and reduction of previously widespread taxa in a particular matrix. But it is logical to argument that new endemic taxa would be a maiden discovery or it might be recognition of new varieties from existing mother-stock. So the rate of endemism is an index of species dynamics, the key tool to track the evolutionary process of a plant group, in a particular matrix.

Threatened taxa belonging to Polygalaceae in India

Phytoendemism is an interdisciplinary study which bridges between phytogeographical and floristic studies. Apparently, it deals with academic and theoretical studies of evolutionary sciences. The contemporary changes of perception helps to narrate academic and theoretical aspects of "endemic floristic elements" under a political boundary, in terms of socio-economic appraisal of renewable, indigenous, natural resources deserving conservation. Identification of indigenous resources is a primary socio-economic concern of a developing country, but sustainable use (scientific cultivation and commercial exploitation from the field) and trading of it beyond the regional territory is the ultimate goal. As commercial demand of market could only be met by commercial growth of indigenous resource and it would be the ultimate responsibilities of indigenous resource based industries and market to ensure the existence of "indigenous resources" by following sustainable utilization policy.

From an economic perspective, the increasing rate of phytoendemism is an important index for national economy of any developing state but shrinkage of a particular germplasm due to habitat destruction and anthropogenic interference is a key negative gradient from conservation as well as economic viewpoint (Myers 1980). If the potential resource is overexploited the loss is irreversible to the society. Though species like *Polygala chinensis*, *Polygala japonica* are neither endemic nor threatened taxa, yet leaves of first one has been cooked as vegetable in Western parts of India (Gammie 1902) and the second one is consumed as staple food (leaves, shoot, root) in China (Read 1946). The endemics of Polygalaceae and locally confined pan-endemics with isolated small patches are the outfall of habitat disturbance and anthropogenic interference (e.g. ethno botanical exploitation, con-

version of wild habitat to cultivation field, urbanization, etc.). Overall, it has been estimated that there are three taxa facing various degrees of survival threat (Table 4), like habitat disturbance coupled with narrow gene pool which accelerates the genetic erosion of *Epirixanthes elongata* (during field survey it has been observed that it flowers normally on the habitat, under anthropogenic pressure but fruit setting of it is very low: 25-35% and population distribution is disjunctive type) and the rest two taxa, *Polygala tricholopha* and *Polygala telephioides* which have ethno-medicinal importance as well as local uses as food and alcohol fermentation (Bannerjee 1993) and it could be done at a commercial level by involving "Research & Development" of pharmaceutical industries and breweries.

Table 4. Plants facing survival threat belonging to the family Polygalaceae in India.

Taxa	Frequency index	Biotic pressure	Parts used	Flowering season	Altitude (m asl)
Polygala telephioides Willd.	Indeterminate	Medicine Economic	Leaves (curing asthma, chronic bronchitis, famine food) Root (antiseptic cream, expectorant)	August-January	1000
Polygala tricholopha Chadat	Indeterminate	Medicine Economic	Root (beverage, purgative, febrifuge, headache relief)	June-August	1000-2000
Epiririxanthes elongata Blume	Indeterminate	Isolated small population	Data is not available	September-December	1200

Possible fossil evidence in relation to endemics of Polygalaceae in India

Searching of fossiliferous ancestors of the living endemics (endemic taxon) of a taxonomic group (e.g. family) is an endeavor to understand the evolutionary history through a geological time scale. The result gives a putative perception about origin and dispersal of ancestors of living representatives in ancient time. When fossil history combined with the important characters of living groups viz. habit (e.g. herb, tree, liana, etc.), habitat (e.g. desert, mountain top, sea shore), ecological traits (e.g. altitude, rainfall, substratum with varied pH level, type of succession, etc.), reproductive biology (Faverger & Contandriopoulos 1961), etc., it is easy to predict whether the particular group of endemics would be treated as Palaeo-endemics (Carlquist1965), Neo-endemics or Holo-endemics (Herzog 1926; Richardson 1978). As conservation and sustainable utilization strategies for Palaeo-endemics are invariably different than Neo-endemics. It is interesting to focus on phylogenetic relationship by studying the fossil remains of the ancestors of the modern taxa, which are referable to the endemic taxa of the family Polygalaceae now-a-days. The fossil pollens representatives of Polygalaceae, *Poly-*

galacidetes clasus Sah & Dutta has been found in Assam and Shillong plateau, Meghalaya of Palaeocene period, Tertiary era (Sah & Dutta 1968) and it has resemblance to the living endemic representative of Polygalaceae: *Polygala globulifera* var. *kachinensis*. The fossil pollen of *Polygala* has also been found in Haigam lake, evidenced from palaeo-stratigraphic deposition of Quaternary era (Vishnu Mittre & Sharma 1966). Though, there are a number of living representatives of Polygalaceae found in North-Western Himalaya and North-Eastern India, there is no living endemic taxon of Polygalaceae so far reported from those matrices and it has been noticed that all endemic taxa of Polygalaceae are distributed in Southern part of India, which left a space for further inquiry about Palaeo-Spatio-Temporal movement of Polygalaceae in the background of palaeo-climatic change. However, it helps to predict the geological age and distributional pattern of predecessor of living Polygalaceae in India. Over viewing the characteristics like habit, habitat, ecological features, fossil histories (mostly Tertiary-Quaternary representatives), etc., of Polygalaceae in India, the endemics belonging to this family would not be categorized under Palaeoendemics and which does not support further that "endemic resort" is of relict habitat like "refugium". As the living endemic taxa of Polygalaceae do not show high level of ploidy and infraspecific representation is not high either, hence it could not be categorized under Neoendemics either. Rather, it might be considered under Holoendemics (somewhere between Palaeoendemics and Neoendemics) and which further helps to recognize the "endemic resort" as "centre of diversity".

CONCLUSION

The species occupancy in a particular habitat (P) in a particular geographical matrix is not static forever and "Species Dynamics" is the key indicator of the changes of "Species Occupancy" in spatio-temporal scale. If (P), the proportion of the available habitat to species occupancy become less than one ($P<1$), the species would generally be considered in the mode of extinction (Wimberly 2006), if the proportion is greater than one the species would naturally be considered in the mode of expansion or diversification. If evolutionary process has been considered as legitimate ongoing process of expansion, diversification as well as extinction of plant kingdom inception of geological time scale, "Species Dynamics" would be considered as "functional index" of the changing phase. The change of number of living taxa in a particular matrix varies from one climatic regime to another climatic regime. Likewise, the representation of endemic component of a taxonomic group (e.g. percentage of endemism of a family) varies on the same matrix from time to time. The observation on rate of endemism of a taxonomic group could help to undertake short-term use and utilization measure as well as instant conservation strategies in the local level. Without any comparative studies of endemism of a taxonomic group in a particular matrix, it is almost impossible to understand that whether the group of plants is in the mode of diversification as well as expan-

sion or extinction. For undertaking the long-term strategies for conservation and sustainable utilization of a group of plants in a regional level and global level, changing of "functional index" needs to be considered.

After studying the fossil evidences related to endemic living representatives of Polygalaceae, it has been noticed that they are mostly Tertiary-Quaternary representatives so those would not be categorized under "Palaeoendemics". After phytogeographical analysis as well as reviewing species dynamics of the living representatives it has been noticed that rate of endemism has been increased in passage of time and this increase is not due to numerical increasing of neo-endemic taxa rather considered to be virtual increasing of endemic taxa (shrinkage of area of distribution of panendemic taxa) belonging to Polygalaceae; hence it should be positioned between Palaeo and Neoendemics, when overall changing variables e.g. edaphic, climatic, anthropogenic, stochastic and biological, etc. don't drive this group of plants in the mode of diversification. After considering the following factors like: high rate of endemism (which is virtual in nature), nature of endemic resort (which is centre of diversity), the rate of diversity (which is very low or negative) and the endemic taxa belonging to Polygalaceae should be considered as "Holoendemics". Logically, the confinement of endemic taxa of Polygalaceae on physically alike "Island habitat", an isolated refugium with Holoendemics and Epibiotics make these "Holoendemics" considered to be "Island Endemics" (Carlquist 1965; Gentry 1986).

ACKNOWLEDGEMENTS

I wish to thank my friend Ms. Catalina Bernal, Richmond Hill, ON, Canada, for her sincere effort to go through the article and translate the abstract and key words in Spanish without which this work would remain incomplete.

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