

PHYTOGEOGRAPHICAL NOTES ON INDIAN CONNARACEAE

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ABSTRACT

The family Connaraceae comprises of 24 genera and 385 species (Schellenberg, 1938) and is distributed exclusively in the tropics of the World. Africa is very well represented by 12 genera and 154 species. Asia and America are not so rich but having 9 genera and 142 species and 5 genera and 89 species respectively. The members of the family are largely restricted to lowland rain forests. Leenhouts (1958) led to a considerable reduction in the number of species and also substantial reduction of genera. His revision led to reduction of genera and species to 9 genera and 142 species for Asia and adjacent areas, 6 genera and 36 species for Malaysia, and 10 genera and 49 species for Africa. Forero (1983) estimated 101 species under 5 genera for America. Mabberley (1997) considers 180 species from 12 genera all over the world. India is represented by 4 genera, 15 species including 1 subspecies and 2 varieties (Mondal, 2000). The family was first designated by Robert Brown (1818) with 3 genera from Terebintaceae of de Jussieu (1789), a group of Genera Terebinaciacae affinia. Since then many more taxa have been added to this family and their distributional area have been revalued. Present paper deals with the distribution of Indian members of Connaraceae with latest nomenclature. The extension of Indian elements outside the country and the influence exerted by foreign taxa are presented. Fossil remains so far reported are also discussed. The paper will be very much helpful in better understanding of the world distribution pattern of the family and also to correlate the fossil remains and impressions.

INTRODUCTION

The family Connaraceae is distributed in the tropics and subtropics of the Old and New World. Van Steenis (1962) designated the family as a truly megatherm family from thermoeological concept of plant distribution. Leory (1978) put a special emphasis on the family for its phytogeographical interest. In a biogeographical survey of the Madagascan flora he estimated the family to comprise of 25 genera and 200 species which cover principally a palaeotropical area. It is evident from the world distribution pattern that the main centre of distribution of the family is the African -

Madagascan area where 16 genera occur of which 11 genera are endemic. It is, however, poorly represented in Malagasy with only 5 species from 5 genera including one endemic species.

Some aspects however call for special mention : African genus *BYRSOCARPUS* Schum. et Thonn. occurs in Malagasy with 1 endemic species and 1 species common to Africa. There are 3 palaeotropical genera *ELLIPANTHUS* Hook. f., *AGELAEA* Soland ex Planch. and *CNESTIS* JUSS., and a pantropical one *ROUREA* Aubl. [*Santaloides* (L.) Schellenb.].

Leenhouts (1958) revised the family for Flora Malesiana and estimated 16 genera with

about 300–350 species and he designated the family as circumtropical. Mabberley (1997) estimated 12 genera and 180 species.

Present authors while working on the family for 'Flora of India Project' - a thorough revision of the family was planned. Specimens deposited at different Indian herbaria were examined supplemented by field collections and their distributional patterns along with population ratio has been recorded. The data summed up here will be of immense help for future botanists and may throw much light on the family and also on its present day distribution in India and abroad. In this text the latest nomenclature of the genera and their species along with infraspecific taxa are taken into account. The extension of the Indian elements into foreign habitats and the influence of foreign taxa on the composition of the Indian Connaraceae are also analysed.

Regarding available fossil report there is only one disputed fossil amber species assigned as a flower of Connaraceae. Assam tertiary is probably rich in Connaraceous fossil pollen (Awasthi, BSIP, Personal communication, 1994).

For the correlation of fossil remains and impressions, and also for a more comprehensive appreciation of the global distribution of the family, this paper constitutes a valuable contribution

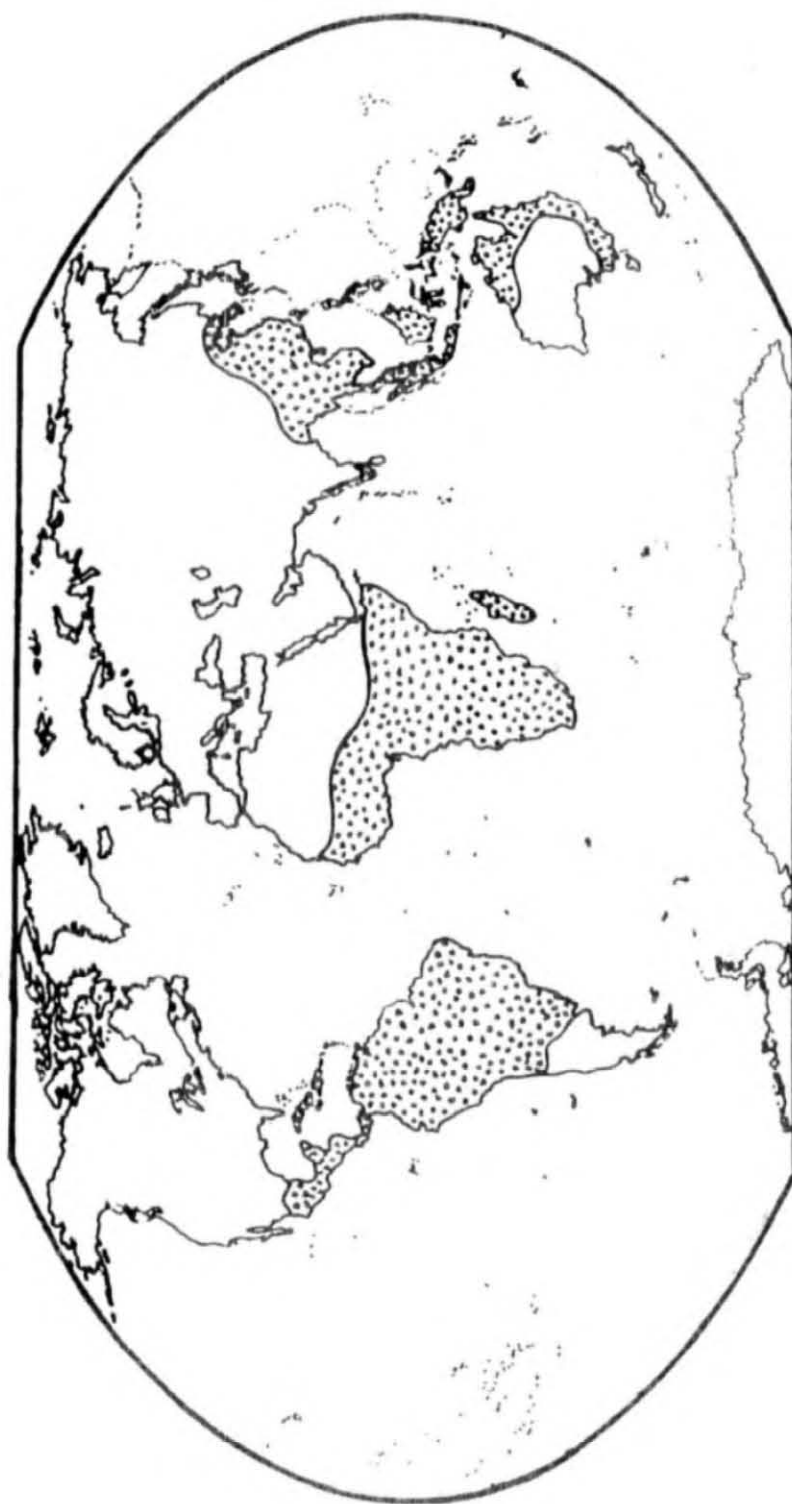
DISCUSSION

Map - 1 shows world distribution of the family Connaraceae and Map 2 shows the distribution of species in India. It is evident from the world distributional record that the family is largely restricted to lowland rain forest and very rarely found in mountain or Savanna vegetation where they grow in thickets or in remnants of forests. It is also apparent that rarely a few

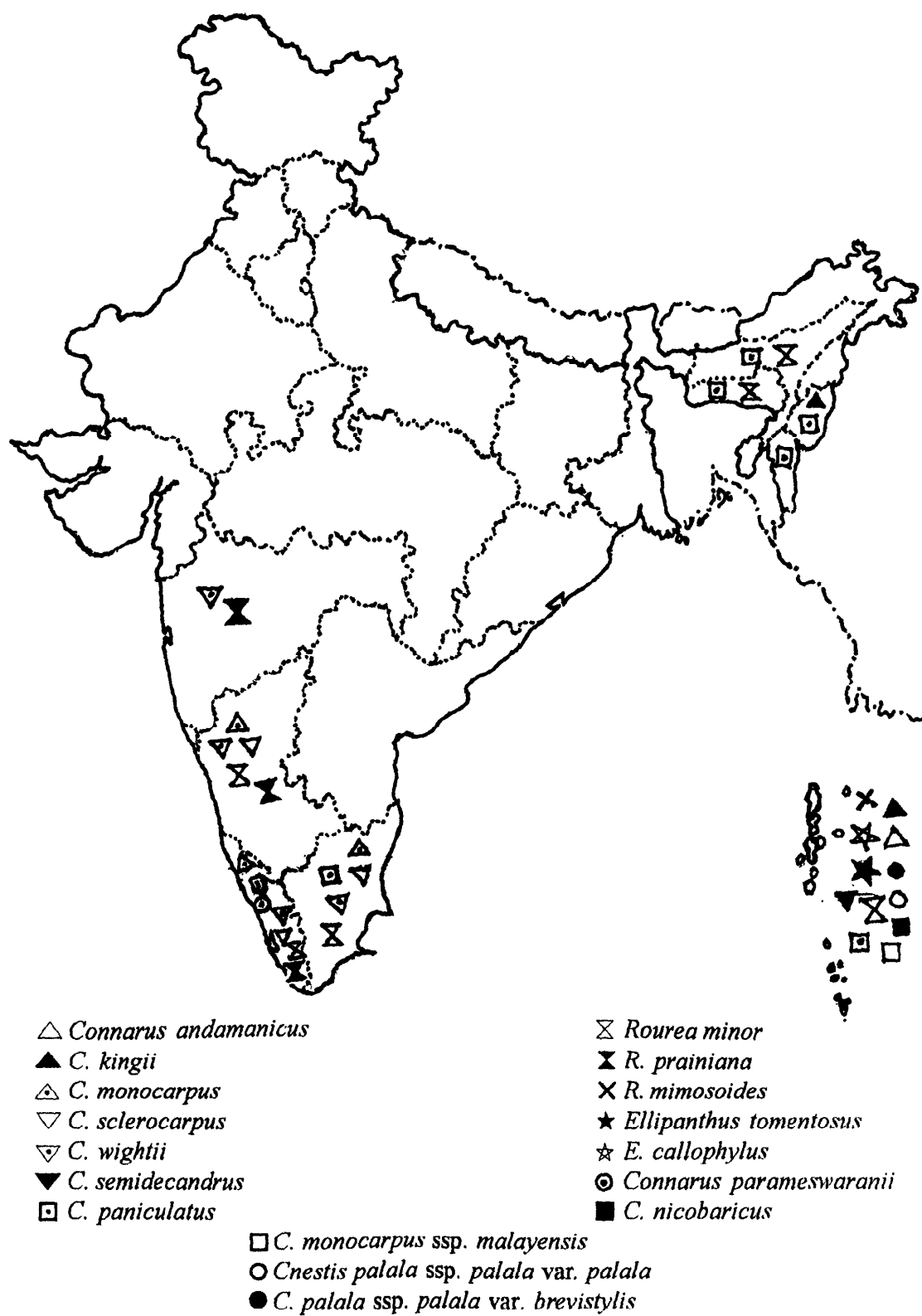
species e.g. *Cnestis polyphylla* Lam. and a few species of *CONNARUS* L. and *ROUREA* Aubl. surpass the 20° of latitude. Table 1 shows that the largest number of genera are represented in Africa (10), followed by Asia (6) and America (4). It is interesting to note that only a few genera like *CONNARUS* L. and *ROUREA* Aubl. are distributed in Africa, America and Asia. The genera like *AGELAEA* Soland ex Planch., *CNESTIS* Juss., *ELLIPANTHUS* Hook. f. and *VISMIANTHUS* Mildbr. are found in Africa and Asia only, whereas *CNESTIDIUM* Planch. and *PSEUDOCONNARUS* Radlk. are strictly American genera. *BURTTIA* Baker. f. et. Exell. *HEMANDRADENIA* Stapf., *JOLLYDORA* Pierre ex Gilg. and *MANOTES* Soland ex Planch. are represented in Africa only.

It is also apparent that the main centre of distribution of the family is Africa, and further within the African countries the main centre of distribution is Central Africa. In West Africa 29 species belonging to 7 genera are found. East and South Africa have 12 species from 7 genera. In Central Africa 40 species from 7 genera are reported, of which 36 species are found in Cameroon and Gabon. When the part of Nigeria east of Niger river is added to Central Africa, the number of West African members is reduced to 20 species from 6 genera. In Central Africa representatives from all the tribes (sensu Schellenberg, 1938) are found (Gilg, 1897, Schellenberg, l.c., Leenhouts, 1958. Forero, 1983).

The family is represented by 5 species from 4 genera in Malagasy, of which only one species *Ellipanthus madagascarensis* (Schellenb.) Capuron ex Keraudren is endemic. According to Dietz and Holden (1970) and Wild (1975) Malagasy, prior to the fragmentation of Gondwanaland, is supported to have been



Map - I : World distribution of Connaraceous species (After Heywood, 1978)



Map - II : Distribution of Connaraceous species in India

joined to the Somalia - Kenya - Tanzania coast. This could explain the pattern of distribution of some Connaraceous members linked to its morphological variation, *i.e.* intermediate position of the materials between the distinct populations of Malagasy and those of South East Africa. At the separation of Malagasy from the African continent possibly a major part of the gene pool remained in this island, resulting in wide variations within the species.

Some Connaraceous members inhabit a very large area in Africa and Asia. *Rourea minor* (Gaertn.) Leenh. and *Cnestis palala* (Lour.) Merr. are even found outside Africa, in Malaysia and on islands in the Indian Ocean and in the Pacific. *Connarus andamanicus* Mondal, *Cnestis palala* (Lour.) Merr. ssp. *palala* var. *brevistylis* Mondal are the new taxa described recently from the Andaman and Nicobar Islands of which the latter one is related to African element. Some of the very closely related species from the genera AGELAEA Soland ex Planch., CONNARUS L., ELLIPANTHUS Hook. f., ROUREA Aubl. and VISMIANTHUS Mildbr. are found in Africa and Asia. From the above mentioned distributional pattern it is apparent that speciation is very slow since the separation of continents, as their large seeds are not likely to get dispersed over long distances and also they are not likely to have been distributed by man.

The affinity between the taxa of African and American tropics is less close in comparison to the Asiatic species. However, the interesting exception is that some American species of CONNARUS L. show remarkable resemblances with some African as well as Asiatic species. Moreover, some species of ROUREA Aubl. are distributed in all the three continents.

Africa and the Indian plate drifting

northward, were possibly connected for a comparatively longer time by islands in the Indian Ocean, which allowed some exchange between the populations. Also India and Malagasy probably remained joined longer than Malagasy and Africa (Raven and Axelrod, 1974). Dietz and Holden (*l.c.*) are of opinion that the rupture of South America and Africa is supposed to have taken place later than the break up of the eastern part of Gondwana, but it was more abrupt, limiting the possibilities for exchange.

According to the present estimate Connaraceae in India is represented by 4 genera, 15 species including 1 subspecies and 2 varieties (Mondal, 2000). Number of species have been reduced under a single species considering the wide range of variations. Out of the total ± 100 world species, CONNARUS L. is represented in India by 9 species including 1 subspecies. CNESTIS is represented by a single species in India out of the ± 40 species, ELLIPANTHUS Hook. f. has two species in India out of ± 10 world species, whereas ROUREA Aubl. is represented by 3 species in India out of ± 100 world species. Table II and Table III show the distribution of Connaraceae in India along with their extension in different major geographical areas of the world (World species after Leenhouts, *l.c.*).

It is important to mention here that Leenhouts (*l.c.*) reduced a number of species of ROUREA Aubl. under *R. minor* (Gaertn.) Leenh. This reduction is supported by palynological and other biosystematic data (Mondal, 1990, 2000). It is also interesting to note that phytogeographical zones affect the pollen fertility of the species (Mondal and Mitra, 1982). Leenhouts (*l.c.*) is of the opinion that the species shows a wide range of variability, which led him for a wide range of species concept. It is also observed for the Indian

specimens represented from different corners of the country. The extreme of these tendencies is characterized by a wide range of variability in the size and number of leaflets which may lead for these local populations to be distinguished as racial variants by the minor characters of the number of leaflets, their shape, size, texture and nervation etc. but detailed study on floral characters, pollen and seed morphology have little or no difference which will be published elsewhere and will be very much helpful in the identification of leaf impressions and stratigraphic correlations.

It is apparent from Table II, that *Rourea minor* (Gaertn.) Leenh. is the only species widely distributed in different phytogeographical regions like Africa, Tibet, China, India, Bangladesh, Myanmar, Thailand, Sri Lanka, Cambodia, Vietnam, etc. *R. prainiana* Talb. is distributed in different Asian countries but not in Africa. Some species of *CONNARUS* L. like *C. monocarpus* L., *C. paniculatus* Roxb. and *C. semidecandrus* Jack. are distributed widely in Asian countries. *Ellipanthus tomentosus* Kurz is distributed in India and also in surrounding Asian countries. It is important to note that *Cnestis palala* (Lour.) Merr. ssp. *palala* var. *brevistylis* Mondal, *Connarus nicobaricus* King, *Connarus andamanicus* Mondal and *Ellipanthus callophyllus* Kurz. are endemic to Andaman and Nicobar Islands only.

It is apparent from the world distribution as well as distribution of Indian species in different adjacent countries that the speciation in the members (genera) of Connaraceae has been very slow since the separation of the countries. It is clear from Table - I and Table-III that relations between the taxa of African and American tropics are less close. On the other hand, not a single genus is restricted to Asia

only. Generic endemism is restricted for two out of four genera, and these are endemic to South and Central America (*PSEUDOCONNARUS* Radlk. and *CNESTIDIUM* Planch.).

Till 1988, there was only one disputed fossil amber species assigned as a flower of Connaraceae and named *Connaracanthus roureoides* Conw. Leenhouts (*l.c.*) was struck by its clawed petals - a feature unknown in the Connaraceae, and his opinion is that the fossil flower probably belongs to Caesalpinioideae of Leguminosae. Alan (1988) when studying the geologic formations of Central Panama got a prolate, tricolporate, reticulate pollen grains of *ROUREA* Aubl. Awasthi (BSIP, Personal communication, 1994) is of opinion that Assam tertiary have many fossil pollens which resemble *CONNARACEOUS* pollen grains (cf. Mondal, 1990) particularly the pollen grains of *Rourea minor* (Gaertn.) Leenh. At present the flora of Assam and Meghalaya has a very good population of *Connarus paniculatus* Roxb. and *Rourea minor* (Gaertn.) Leenh. It may happen that the species of Connaraceae extend back to the tertiary flora of Assam.

CONCLUSION

The family Connaraceae has been designated as a megatherm pantropical family in view of the thermo - ecological concept of plant distribution by Van Steenis (1962). The distribution pattern exhibited by this family can be related to the past climatic and geological history of the continents. The extension, restriction and migration of the species into new areas followed by their establishment, naturalisation and further migration in both pre-settlement and present time illustrate the dynamic aspects of phytogeography. Phytogeographical zones affect the

Table - I : World distribution of Connaraceous species

Genus	Africa	Asia	America	Australia
AGELAEA Soland ex Planch.	4	2	0	0
BURTIA Baker. f. et Exell.	1	0	0	0
CNESTIDIUM Planch.	0	0	* 2/3	0
+ CNESTIS Juss.	12	1	0	0
+ CONNARUS L.	7	± 19	51	
+ ELLIPANTHUS Hook. f.	2	± 4	0	0
HEMANDRADENIA Stapf.	* 2/3	0	0	0
JOLLYDORA Pierre ex Gilg	* 3/6	0	0	0
MANOTES Soland ex Planch.	* 5/11	0	0	0
PSEUDOCNARUS Radlk.	0	0	* 5/6	0
+ ROUREA Aubl.	12	± 16	43	
VISMANTHUS Mildbr.	1	1	0	0

+ Indian genera.

* Distribution of species after Leenhouts (1958).

morphological variation and pollen fertility of the species also.

The current climatic condition, dispersal of seeds and the geological history have been taken into account while analysing the distribution pattern. From the above discussion it is quite apparent that the members mostly dominate in the Old World. The centre of origin and distribution being in Africa, more precisely Central Africa percentage relationship from different continents also support the view (Map-1).

The affinity between the African and Asian taxa is more in comparison to the American taxa. Perhaps the Gondwanaland separated by continental drifting showed similar floristic elements in the past and present.

Most of the generic variation is found in Africa, followed by Asia and America.

The evolution in the members of Connaraceae has been very slow after the separation of the continents which may be

because of their large seeds.

Fossil reports from India reveal that the Assam tertiary is rich in Connaraceous fossil pollen.

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Table - II : Distribution of Connaraceous species in India along with their extension into outer World.

S. No. Name of the Taxa with important synonyms	Africa	INDIA										Tibet, China	Bangladesh	Myanmar	S. E. Asia, Malaysia, Cambodia, Thailand, Vietnam	Sri Lanka
		Meghalaya	Assam	Nagaland	Manipur	Mizoram	Tripura	Tamil Nadu	Kerala	Karnataka	Maharashtra (W. Ghats)					
	1	2	3	4	5		6	7	8	9	10	11	12	13	14	15
1. <i>Cnestis palala</i> (Lour.) Merr. ssp. <i>palala</i> var. <i>palala</i> (= <i>Thynus palala</i> Lour., <i>Cnestis ramiflora</i> Griff., <i>C. diffusa</i> Blanco)	+										+			+	+	
2. <i>C. palala</i> (Lour.) Merr. ssp. <i>palala</i> var. <i>brevistylis</i> Mondal											+					
3. <i>Connarus andamanicus</i> Mondal											+					
4. <i>C. kingii</i> Schellenb. (= <i>C. gibbosus</i> Wall. ex King, <i>C. gibbous</i> Wall.)				+							+					
5. <i>C. monocarpus</i> L. ssp. <i>monocarpus</i> = <i>Rhus zeylanicus</i> Burm. f <i>C. pinnatus</i> Lam., <i>Canarium zeylanicum</i> (Burm. f) Blj.							+	+	+							+
6. <i>C. monocarpus</i> L. ssp. <i>malayensis</i> Leenh. (= <i>C. falcatus</i> Bl., <i>C. oligophyllus</i> Wall. ex Planch., <i>C. maingayii</i> Hook. f.).											+				+	
7. <i>C. nicobaricus</i> King											+					

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
8. <i>Connarus paniculatus</i> Roxb. (= <i>C. nitidus</i> Roxb., <i>C. pentandrus</i> Roxb. <i>C. bariensis</i> Pierre, <i>C. harmandianus</i> Pierre, <i>C. yunanensis</i> Schellenb.)		+	+	+	+	+	+			+	+	+		+	
9. <i>C. parameswaranii</i> Ramamurthy et Rajan							+								
10. <i>C. sclerocarpus</i> (Wt. et Arn.) Schellenb. (= <i>Rourea sclerocarpa</i> Wt. et Arn. <i>C. wightii</i> Hook. f., pro parte)						+	+	+							
11. <i>C. semidecandrus</i> Jack. (= <i>C. gibbosus</i> Wall. ex Hook. f. <i>C. griffithii</i> Hook. f. <i>C. ellipticus</i> King)										+			+	+	
12. <i>C. wightii</i> Hook. f. (= <i>C. ritchiei</i> Hook.f.)						+	+	+	+	+					
13. <i>Ellipanthus callophyllus</i> Kurz															
14. <i>E. tomentosus</i> Kurz ssp. <i>tomentosus</i> var. <i>gibbosus</i> (King) Leenh. (= <i>E. helferi</i> Hook. f. <i>E. gibbosus</i> King)										+			+	+	
15. <i>Rourea mimosoides</i> (Vahl) Planch. (= <i>Connarus mimosoides</i> Vahl, <i>R. villosa</i> Planch., <i>R. parallela</i> Planch., <i>R. concolor</i> Bl., <i>R. similis</i> Bl.)										+			+	+	
16. <i>R. minor</i> (Gaertn.) Leenh. (<i>Aegiceras minus</i> Gaertn., <i>R. caudata</i> Planch., <i>R. commutata</i> Planch. <i>R. acuminata</i> Hook. f.)	+	+	+			+	+	+		+	+	+	+	+	+
17. <i>R. prainiana</i> Talb. (= <i>Roureopsis scortechinii</i> King. <i>Santaloides prainianum</i> Schellenb.)						+	+	+					+	+	+

Table - III : Indian genera and their extension with species ratio

Genus	Distribution	Total ssp./Indian spp.
CNESTIS Juss.	Tropical Africa, Malagasy, South east Asia, West Malaysia.	40/1
CONNARUS L.	Africa, South east Asia, Malaysia, Australia, South America.	100/9
ELLIPANTHUS Hook. f.	Tropical Africa, Malagasy, Sri Lanka, South east Asia, Continental Malaysia.	10/2
ROUREA Aubl.	Africa, South east Asia, Malaysia, North east Australia, Melanesia, Central and South America.	100/3

Prof. Christian Smith in the vicinity of the Congo, during the expedition to explore that river under the Command of Captain Tuckey in the year 1816, originally issued 1818, but reprinted in the Miscellaneous Botanical Works of Robert Brown, Vol. I, Ray Society, London. 1818.

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