Pak. J. Bot., 22(1): 75-78, 1990.

PHYLOGENY AND ORIGIN OF AUSTRALIAN *CALANDRINIA* (PORTULACACEAE)

SYEDA SALEHA TAHIR[1]* AND R.C. CAROLIN[2]

[1]*The Arnold Arboretum of Harvard University, 22 Divinity Avenue, Cambridge, M.A. 02138, U.S.A.*
[2]*School of Biological Sciences, The University of Sydney, N.S.W. 2006, Australia.*

Abstract

A possible scheme of phylogeny is presented. The possible evolutionary lines in the genus *Calandrinia* are discussed. It is concluded that the species of *Calandrinia* have originated within the Australian continent.

Introduction

Genus *Calandrinia* consists of about 100 species (Syeda & Ashton, 1989). Syeda (1979) reported 34 species from Australia, and the remaining species are known to occur in South America. All the Australian species of *Calandrinia* have never been the subject of a single investigation, since Bentham (1863), most of the previous workers dealt with different *Calandrinia* species growing in various areas of Australia. The first complete monograph of the Australian species by Bentham (1863), included about 20 species. The last and most comprehensive taxonomic treatment was by Syeda (1979), in which she recognized 34 species. In the present report the possible evolutionary lines in the genus *Calandrinia* is presented.

Results and Discussions

Morphological and micromorphological studies of *Calandrinia* species, the results of cladistic analysis (Syeda & Ashton, 1988) and seed type and surface pattern (Syeda & Carolin, 1988), show two main phylogenetic groupings in the Australian native calandrinias. These groupings are based on number of carpels in the ovary, reflected in the number of stigma and capsular valves. The probable phylogenetic relationship of the major groups of *Calandrinia* species and derivation of present day sections are illustrated in phylogenetic tree diagram partially based on cladistic analysis (Fig. 1.).

The 3-carpel line contains Sect. Pseudodianthoideae and Sect. Tuberosae, whilst the 4-carpel line contains Sect. Basales. The members of Sect. Pseudodianthoideae are placed in two groups, A and B. The species of *Calandrinia* in group-A, have mostly primitive characters. *C. polyandra* and *C. eremaea* of Sect. Pseudodianthoideae which are in

*Present Address: Department of Botany, University of Sindh, Jamshoro, Sindh, Pakistan.

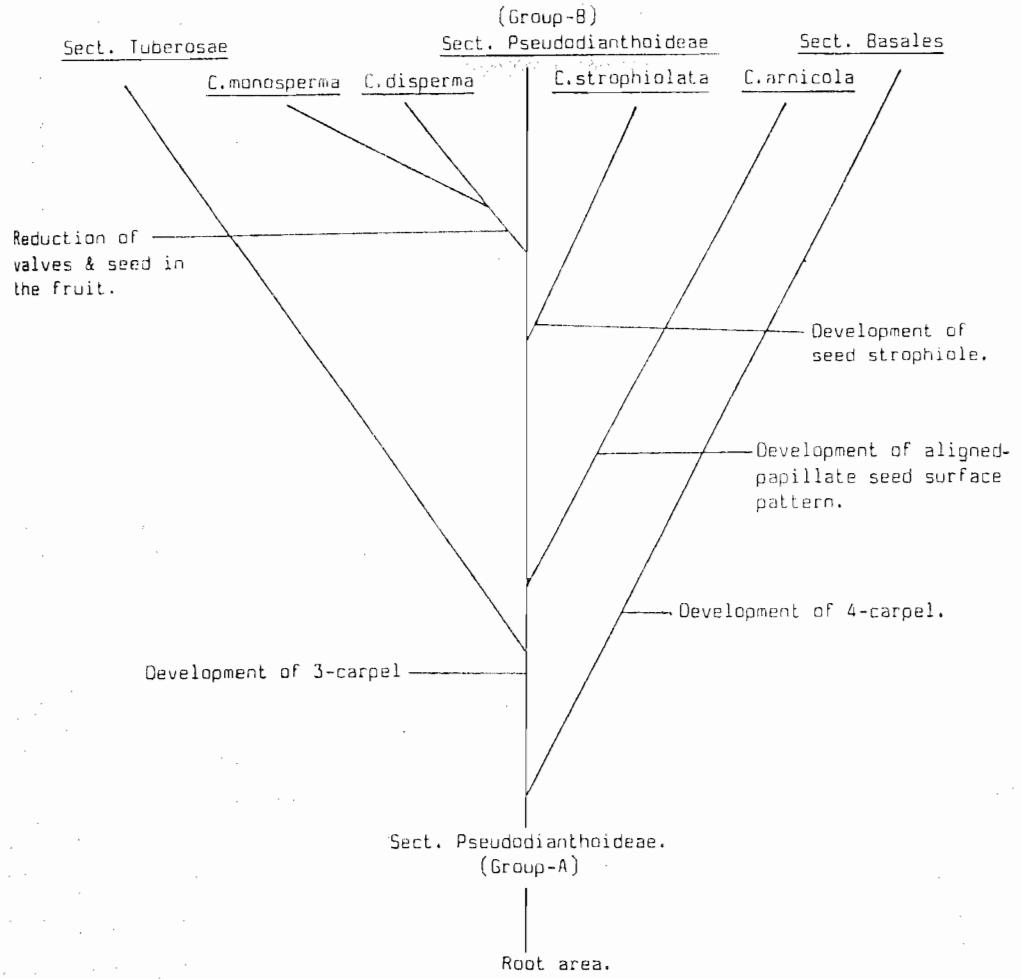

Fig. 1. Probable phylogenetic relationship of the *Calandrinia* species and derivation of present day sections. This diagram is partially based on the computer analysis.

group-A, have inaperturate pollen grains, which are mostly found in lower plants and in Pteridophytes. It is suggested that the root of the tree lies somewhere in group-A, which contains the species of Sect. Pseudodianthoideae. The main reason for suggesting the root area in group-A, of Sect. Pseudodianthoideae, is the presence of inaperturate pollen in two members of Sect. Pseudodianthoideae, thus, inaperturate pollen is generally considered as a primitive feature.

From group-A, of Sect. Pseudodianthoideae a line of evolution can be seen, which has developed and evolved 4-stigma free to the base, and 4-valved capsule which mostly have smooth to colliculate seed surface pattern. The groups of species evolved on this line of evolution are the members of Sect. Basales.

From the line giving rise to Sect. Pseudodianthoideae (group-B), another fairly clear line can be seen, which has developed and evolved tuberous roots, rugose to verrucate seed surface pattern, and pantocolpate grains. The group of species evolved on this line of evolution are the members of Sect. Tuberosae. Tuberosae is the only natural group of species, which are held together by tuberous roots, 3-stigma, usually connate at the base into a short style, capsule 3-valved, seeds trigonous with a common seed surface pattern, and pantocolpate operculate pollen grains.

Group-B, which contains the members of Sect. Pseudodianthoideae is evolved from group-A, which also contains the members of Sect. Pseudodianthoideae. It appears that, the species evolved on this line of evolution, have evolved from some primitive members of Sect. Pseudodianthoideae, e.g. *C. polyandra* and *C. eremaea*, *C. monosperma*, *C. disperma*, *C. strophiolata* and *C. arenicola* have some unique characters, and it appears that these species evolved independently along the line giving rise to group-B. It is possible that *C. monosperma* evolved through *C. disperma*, by the reduction of seeds and valves in the fruit. *C. monosperma* has only a single seed in the fruit, which is indehiscent and the fruit wall surface has a prominent colliculate-verrucate pattern. *C. disperma* always has two seeds in the capsule, one is broad ca. sub-rhomboid in shape retained in the lower and swollen portion of the capsule, and the other narrower, but larger seed contained in the attennuate narrow part of the capsule, the seeds are superposed, and capsule dehisces by a terminal pore.

On the other hand a line showing the development of seed strophiole and increase in the number of carpels and capsule valves has evolved *C. strophiolata*, which have a well developed strophiole, 6-stigmas, and 6-valved capsule.

C. arnicola has the characteristic stigma and capsule valve number of Sect. Pseudodianthoideae, but is unique in its seed surface pattern, and in inaperturate pollen. It appears that this is the connecting species between the two groups of Sect. Pseudodianthoideae and Sect. Basales. The reason for suggesting *C. arnicola*, as a connecting species between the two above cited sections, is based on cladistic study, which reveals that *C. arnicola*, in spite of its striking 3-carpelled ovary is phyletically very close to the members of Sect. Basales, and more importantly as it shares equally the primitive and advance characters.

The presence of *Calandrinia* species in two different continents i.e., in Australia and America clearly postulates a case of disgust distribution. Thorne (1973) classifies the type distribution as a South America, Australia disgust type along with several genera like *Uncina*, *Azorella*, *Nothofagus*, *Discaria* etc. Probably *Calindrinia* has a bitopic origin with one centre in South America and the other in Australia.

Calandrinia species seems to have originated within Australia and are not migrated from South America, at least in the recent times, to any great extent. Long distance dispersal may have not occurred through the action of birds, winds or ocean currents. If action of the birds, winds or ocean currents, had played a role in the *Calandrinia* species distribution, then some of its species should have been found in the Islands between South America and Australia, for example, in New Zealand where suitable habitats are available, it does not occur. Thus it appears that the dispersal by the birds wind, ocean current does not explain *Calandrinia* migration from South America to Australia.

The distribution of species in the suggested root area of the phylogenetic tree diagram (Fig. 1) are mostly temperate. Therefore it is possible that the genus arose in the temperate climates, in inland Australia, sometimes after the separation of New Zealand, since *Calandrinia* is not found in New Zealand, where suitable habitats are available.

The continued northward movement caused a tremendous change in the humidity of the inland area of Australia, therefore temperate *Calandrinia* species have been pushed south, and as the southern isthmus connecting east and west Australia move into the climatic zone of *Calandrinia* tolerance, some species of *Calandrinia* have migrated eastwards. *C. stagensis* an eastrn species, shows close resemblance with *C. creethae*, a western species, it is likely that *C. stagensis* evolved from *C. creethae* by migration from west to east during the course of evolution.

The members of Sect. Tuberosae, probably were developed as a direct response to the tropical dry conditions in the north Australia. As *Calandrinia* moved onto the sandy country of south-west, members of Sect. Tuberosae would have evolved. The only species *C. calyptrata* with its distribution in other states of Australia, is also found in Tasmania. It is possible that long distance dispersal may have occured in recent times or it may have migrated by land, when Tasmania was connected to the mainland during the glacial period. No other species of *Calandrinia* are found in Tasmania, presumably because it is situated further south of Australia, and due to climatic conditions.

Acknowledgements

Senior author is thankful to Dr. Peter Ashton, Director and the Arnold Professor of Botany, Harvard University, for providing all the necessary facilities to examine the American collection during her stay at the Harvard University. She is also grateful to Mr. Michael Conoso, Manager of the Systematic collections, the staff of the Arnold Arboretum herbaria for the administration of herbarium loan. Travel grants to the senior author from the University Grants Commission Islamabad, and the Council for International exchange of Scholars Washington D.C., for travelling to Sydney and Boston, is thankfully acknowledged. We are indebted to Mr. Walter Kelley, for allowing us to use some of his unpublished work.

References

Bentham, G. 1863. *Flora Australiansis* Vol. I, Lovell Reeve & Co., London.

Carolin, R.C. 1987. A review of the family Portulacaceae. *Aust. J. Bot.*, 35: 383-412.

Syeda, S.H. 1979. *Calandrinia in Australia.* University of Sydney, M.S. Thesis.

Syeda, S.T. and R.C. Carolin. 1988. Seed type and seed surface pattern in the *Calandrinia* Sens. Lat. (Portulacaceae). *Pro. Linn. Soc. N.W.S.W. Australia,* 110: 307-316.

Syeda, S.T. and P.S. Ashton. 1989. A cladistic analysis of *Calandrinia* (Portulacaceae). *Pak. J. Bot.*, 21: 158-169.

Thorne, R.F. 1973. Major disjunctions in the geographic ranges of seed plants. *Quarterly Review of Biology,* 47: 365-411.

(Received for publication 23 December 1989)