



Distribution and origins of members of the *Family Portulacaceae* (Centrospermae)

NYANANYO, B L; *MENSAH, S I

Department of Plant Science and Biotechnology, University of Port Harcourt, Choba, P.M.B. 5323, Port Harcourt, Rivers State, Nigeria.

ABSTRACT: The present day distribution of members of the family *Portulacaceae* shows that whilst some genera such as *Portulaca* L., and to some extent *Montia* L. and *Talinum* Adanson are cosmopolitan in distribution, others such as *Ceraria* Pearson and Stephens, *Lyallia* Hooker fil., *Portulacaria* Jacquin, *Silvaea* Philippi and *Talinella* Baillon with more than six species at the most are endemic to Africa, Australia, Eurasia and South America respectively. This pattern of distribution shows that members of the family *Portulacaceae* could have originated in Gondwanaland and migrated to new niches by long range dispersal after the breakup of Gondwanaland by continental drift. @JASEM

Whilst the family *Portulacaceae* is virtually cosmopolitan in distribution (Nyananyo, 1990; Nyananyo and Olowokudejo, 1986), its component genera show interesting patterns of distribution, which may shed some light on its history and origins. The purpose of this article is two fold:-

1. To place the genera as now recognized (Nyananyo, 1990) into groups based on their geographical location together with such other systematic lines of evidence as cytology, gross morphology, physiology, palynology and phytochemistry and
2. To try to ascertain the centres of diversity and origin of the different genera and generic groups and to hypothesize about the means of which the family achieved its present day distribution.

The palynology of the family is eurypalynous varying in aperture from tricolpate (three colpi running from the north to the south pole of the pollen grain), pantocolpate, polyapantocolpate (with colpi of between eight and over thirty in number distributed all over the surface of the pollen grain) to pantoporate to polyapantoporate (with between four and over thirty pores distributed all over the surface of the pollen grain), surface ornamentation from echinate (with spines on the surface of the pollen grain) to almost glabrous (smooth) (Nowicke, 1975; Nyananyo, 1985, 1990). Cytologically, the basic chromosome numbers range from two to twelve (Nyananyo, 1986a, b, 1987). The phytochemistry of the *Portulacaceae* is interesting with the occurrence of betacyanins in their floral and vegetative parts as opposed to anthocyanins as is found in the majority of dicotyledons (Nyananyo, 1986c). Morphologically, members range from small succulent plants of a few centimeters in height to

shrubby plants of about a few meters in height occurring in a variety of habitats from deserts to waste places in urban centres.

MATERIALS AND METHODS

The following account is based on the literature, living plants and herbarium specimens. Herbarium specimens were obtained from the British Museum of Natural History (BM.), London, Royal Botanic Garden, Herbarium, Kew (K.), Forest Herbarium, Ibadan (FHI.), Nigeria.

RESULTS AND DISCUSSION

The results are presented in Tables 1 and 2. *Portulaca* occurs in all the principal regions of the world. *Montia* and *Talinum* are absent from one of the five regions recognized. *Calandrinia* H.B.K. from two and *Anacampseros* L (Rowley, 1994) from three (Table 1). The other genera show increasing levels of restricted distribution. Four genera, *Calandrinia*, *Portulaca*, *Talinum* and *Montia* occur in both the northern and Southern hemispheres, whereas the other genera, *Calyptidium* Nuttall, *Claytonia* L., *Lewisia* Pursh and *Talinopsis* Gray occur in the Northern hemisphere. The remaining twelve genera as now recognized (Nyananyo, 1990) which include the succulent tree genera, *Calyptrotheca* Gilg, *Ceraria* Pearson and Stephens and *Portulacaria* Jacquin (Applequist and Wallace, 2001; Landrum, 2002) are restricted to the Southern hemisphere particularly Africa and south America with representatives in Australasia (Table 1). The Kerguelen Islands in the Southern Ocean and New Zealand each has an endemic species of the ditypic genus, *Lyallia* (Nyananyo and Heywood, 1987) (Tables 1 and 2).

*Corresponding author

Table 1. Distribution of members of the Portulacaceae

Taxa	Continents				
	Africa	Australia	Euro- asia	South America	North America
Anacampseros L.	+	-	-	+	-
Calandrinia H.B.K	-	+	-	+	+
Calyptridium NUTTALL	-	-	-	-	+
Calyptrotheca GILG	+	-	-	-	-
Ceraria PEARSON et STEPHENS	+	-	-	-	-
Claytonia L.	-	-	+	-	+
Grahamia GILLIES	-	-	-	+	+
Lenzia PHILIPPI	-	-	-	+	-
Lewisia PURSH	-	-	-	-	+
Lyallia HOOKER FIL.	-	-	+	-	-
Monocosmia FENZL	-	-	-	+	-
Montia L.	+	-	+	+	+
Montiopsis O. KUNTZE	-	-	-	+	-
Portulaca L.	+	+	+	+	+
Portulacaria JACQUIN	+	-	-	-	-
Silvaea PHILIPPI	-	-	-	+	-
Talinella BAILLON	+	-	-	-	-
Talinopsis GRAY	-	-	-	-	+
Talinum ADANSON	+	+	-	+	+
Wangerinia FRANZ	-	-	-	+	-

Table 2. Endemism in the Portulacaceae

Continent	Endemic genera	Habit	Pollen type
Africa (including Madagascar)	Calyptrotheca	Woody	Pantoporate
	Ceraria	„	Tricolpate
	Portulacaria	„	„
	Talinella	„	Pantoporate and pantocolpate
New Zealand and Kerguellan Islands	Lyallia	Herbaceous	Tricolpate
North America	Calyptridium	Herbaceous	Tricolpate
	Lewisia	„	„
	Talinopsis	Woody	Pantoporate

Distribution and origins of ...

South America	Lenzia	Herbaceous	Tricolpate
	Monocosmia	„	„
	Montiopsis	„	„
	Silvaea	„	„
	Wangerinia	„	„

There is an overlap of biogeography and traits, especially in the arid regions of southern Africa, with more succulent genera of *Aizoaceae* (genera within subfamilies *Mesembryanthemoideae* and *Ruschioideae*) and *Portulacaceae* (*Anacampseros*, *Calypotrothea*, *Ceraria* and *Portulacaria*) being found as mostly endemics (Landrum, 2002). By the Miocene, there were definite signs of increasing aridification of southern Africa and the isolation of *Aizoaceae* and *Portulacaceae* ancestral elements. Of the four families of *Portulacaceae*, *Cactaceae*, *Aizoaceae* and *Didieraceae* the portulac-cactus alliance is less segregated than members of the *Aizoaceae* and *Didieraceae*. Some 85% of *Aizoaceae* are endemic to southern Africa (Goldblatt, 1978), and all *Didieraceae* (Rowley, 1992) are endemic to Madagascar whereas the arguably paraphyletic portulacs are much more geographically widespread (Hershkovitz, 1993; Applequist and Wallace, 2001). Their sister taxa are, however, notably western Hemisphere in distribution (Landrum, 2002).

The family *Portulacaceae* could probably have originated in Gondwanaland and attained its present day distribution with taxa occurring in all the continents of the world (Table 1), as a result of continental drift and long distance dispersal. The apparent ability of numerical and structural chromosome changes to increase the capacity of plants to expand into new areas (Stebbins, 1971; Moore, 1972; Nyananyo and Okoli, 1987; Stern, 1997) is of value in some members of the family *Portulacaceae* supporting the distribution data in for example *Portulaca* and *Talinum*. These genera have their centres of diversity in the northern hemisphere where polyploids occur, but diploids alone are found in the Southern hemisphere which is probably their centre of origin.

Also, the successiform theory in pollen evolution (Van Campo, 1976), which basically says that the ancestral angiosperm pollen was tricolpate and that this evolved sequentially into pantocolpate, pantoporate, polyantocolpate and polyantoporate types. The considerable variation in aperture type and number seen in the family *Portulacaceae* (Nilsson, 1967; Nowicke, 1975; Nyananyo, 1985, 1989, 1992)

suggests that the successiform series in pollen evolution has occurred many times in different lineages. Hence, by implication, the change from tricolpate to other forms is developmentally straight forward, and supports the possible origin of the *Portulacaceae* in Gondwanaland.

After the breakup of Gondwanaland due to continental drift, members of the *Portulacaceae* in the component parts, Africa, including Madagascar, Australia, Eurasia, Islands in the Southern Ocean, New Zealand and South America could have evolved independently of each other and migrated to new niches in Laurasia by long distance dispersal leading to the present day distribution of the family (Table 1).

REFERENCES.

- Applequist, WL and Wallace, RS (2001), Phylogeny of the portulacaceous cohort based on *ndhF* sequence data. *Syst. Bot.* 26, 406-419.
- Goldblatt, P (1978), An analysis of the flora of southern Africa: its characteristics, relationships, and origins. *Ann. Missouri Bot. Gard.*, 65, 369-436.
- Hershkovitz, M (1993), Revised circumscription and subgeneric taxonomies of *Calandrinia* and *Montiopsis* (*Portulacaceae*) with notes on phylogeny of the portulacaceous alliance. *Ann. Missouri Bot. Gard.*, 80, 333-365.
- Landrum, JV (2002), Four succulent families and 40 million years of evolution and adaptation to xeric environments: What can stem and leaf anatomical characters tell us about their phylogeny? *Taxon*, 51(3), 463-473.
- Moore, DM (1972), Connections between cool temperate floras, with particular reference to southern South America. In: Valentine, DH (ed.) *Taxonomy, phytogeography and evolution*. Academic Press, London. p120.

- Nilsson, O (1967), Studies in *Montia* L and *Claytonia* L. and Allied genera 3, Pollen morphology. Grana, 15, 51-77.
- Nowicke, J (1975), Pollen morphology in the Order Centrospermae. Grana, 15, 51-77.
- Nyananyo, BL (1985), Pollen morphology in *Talineae* (*Portulacaceae*) sensu McNeill, 1974. Biol. Africana, 2, 41-47.
- Nyananyo, BL (1986a), Chromosome number reports. *Taxon*, 35(4), 902-903.
- Nyananyo, BL (1986b), Chromosome number reports of members of the *Portulacaceae* from Africa. Biol. Africana, 3(1&2), 1-8.
- Nyananyo, BL (1986c), A survey of leaf flavonoids in the *Portulacaceae*. Biochem. Syst. Ecol., 14(b), 633-635
- Nyananyo, BL (1989), Taxonomy of the endemic African genera of the *Portulacaceae*. Feddes Repert., 100(5-6), 235-239.
- Nyananyo, BL (1990), Tribal and generic relationships in the *Portulacaceae* (Centrospermae). Feddes Repert. 101(5-6), 29-33.
- Nyananyo, BL (1992), Pollen morphology in the *Portulacaceae* (Centrospermae). Folio Geobot. Phytotaxa., 27, 387-400.
- Nyananyo, BL and Heywood, VH (1987), A new combination in *Lyallia* (*Portulacaceae*). *Taxon* 36(3), 640-641.
- Nyananyo, BL and Okoli, BE (1987), Cytological and morphological studies on Nigerian species of *Portulaca* (*Portulacaceae*) in relation to their taxonomy. Feddes Repert., 98(11-12), 583-587.
- Nyananyo, BL and Olowokudejo, JD (1986), Taxonomic studies in the genus *Talinum* (*Portulacaceae*) in Nigeria. Willdenowia, 15, 455-463.
- Stebbins, GL (1971), Chromosomal evolution in higher plants. Edward Arnold Publishers, London. p60.
- Rowley, GD (1992), Didieraceae; Cacti of the Old World. British Cactus and Succulent Society, Edward Arnold Publishers, London. p70.
- Rowley, GD (1994), Anacampseros and allied genera – a reassessment. Bradleya, 12, 105-112.
- Stearn, KR (1997), Introductory plant biology. Brown Publishers, Chicago. p150.
- Van Campo, M (1976), Patterns of pollen morphological variation within taxa. In: Ferguson, IK; Mueller, J (eds.) The evolutionary significance of the exine. Academic Press, London. p72.