Evolutionary considerations

Objekttyp: **Chapter**

Zeitschrift: **Boissiera : mémoires de botanique systématique**

Band (Jahr): **29 (1979)**

PDF erstellt am: **21.07.2024**

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I have had 10 species of *Rotala* in cultivation. The perennial species *(R. myriophylloides, R. wallichii, R. rotundifolia, R. macrandra)* were genetically self-incompatible, had showy flowers, showed a tendency towards having a distinct inflorescence and they flower during a distinct season; they are presumably insect pollinated. The annual species *(R. mexicana, R. ramosior, R. fimbriata, R. densiflora, R. rosea, R. indica)* were self-compatible, efficiently self-pollinated, occasionally cleistogamous, had non-showy flowers (except *R. fimbriata* and some races of *R. densiflora*), no distinct flowering season, and often showed precocious flowering.

All the heterostylous species, presumably self-incompatible, are large flowered perennials. It is likely that the large, showy-flowered, perennial species are more primitive and it is interesting to note that on the whole they have a larger number of flowering parts than the small-flowered inbreeding annuals.

Within the whole genus, three species only are really widespread, and they are all inbreeding annuals. *Rotala indica* is native in Asia and has relatively recently become established in Africa, Europe and N. America; it is a ricefield weed. *Rotala ramosior* is native in America and has spread to the Philippines and Europe, probably through rice cultivation. *Rotala mexicana* is found throughout the warmer parts of the world but it is not confined to rice growing areas. In spite of it being a small, inbreeding annual it is difficult to predict its area of origin. However, its closest relative *R. occultiflora* is sympatric with it in S. India and N. Australia.

Most species are relatively well-documented; only *R. verdcourtii* is known from a single gathering. *Rotala floribunda, R. rubra* and *R. simpliciuscula,* all Asian species, are very local endemics. All other species have relatively well-defined and "reasonable" distributions with, perhaps, the exception of *R. occultiflora* which is confined to S. India and N. Australia. Twentyone species are confined to Africa and Malagsy and twenty species are confined to S. and E. Asia and Australia but of those one species only *(R. diandra)* is confined to Australia. The region of maximum morphological diversity of *Rotala* is S. Asia; Africa has more species but many of them are closely related, inbreeding annuals.

Most annual species of *Rotala* are rather similar in habit and have a somewhat nondescript appearance; they are often confused with species in the following genera: *Ammannia, Bergia, Bythophyton, Crassula, Elatine, Gonostegia, Laurembergia, Ludwigia, Microcarpaea* and *Nesaea.* This superficial resemblance of unrelated groups indicates a relatively strong evolutionary convergence or, in other words, strong selection pressures for a particular plant form to fit a particular ecological niche. This alone is not unusual but it is unusual in one genus to find up to five related annual species, which need a hand lens for their identification, growing intermingled. The reason for this species richness without ecological differentiation is probably correlated with a high degree of inbreeding.

Species delimitation in inbreeding annuals presents some difficulties. For example, in Africa *R. filiformis* has been split into 16 species, using similar criteria one could also split the American species *R. ramosior* and the Asian species *R. densiflora, R. rosea* and *R. indica* into numerous small species. I have tried to make my treatment as even as possible which has led to considerable "lumping" of the African species.

KOEHNE (1880, 1903) based his major infrageneric categories on the arrangement of the leaves, the whorled-leaved species constituting the section *Hippuridium.* Whorled leaves are, I believe, a direct response to the aquatic environment (COOK, 1978). The species of *Rotala* with whorled leaves do not constitute a single phyletic group when their floral characteristics and distributions are considered. Also from cultivation experiments it has been seen that *R. myriophylloides* and *R. mexicana* when grown in water have whorled leaves but when terrestrially grown the same plants often have decussate leaves.

Rotala floribunda and *R. repens* have leaves arranged alternately. These two species have additional interesting common characteristics: somewhat woody at the base inspite of being submerged in water, distinct and remote inflorescences, bracts scale-like and reduced to about the size of the bracteoles, flowers 4-merous with 2-valved capsules and both are local, montaine endemics. KOEHNE (1880, 1903) placed both species together in subsections *Nimmonia.* However, each species shows remarkable unique characteristics. *Rotala floribunda* (Fig. 6) is endemic to the Mahabaleshwar Hills in the northern part of the Western Ghats in India, it has a distinctly bi-lobed style and shows an extraordinary combination of aquatic and xeromorphic features with linear, flaccid submerged leaves and ericoid aerial leaves; it is also heterostylous. *Rotala repens* (Fig. 7) is found in flowing water in the Ethiopian Highlands and on Mount Elgon, it has a podostemaceous habit with flattened, creeping rhizomes and long-stalked, almost naked inflorescences; it is homostylous but has long filaments and long styles. Taxonomically these two species take somewhat isolated places in the genus *Rotala.*

Rotala hexandra (Fig. 8) is also taxonomically somewhat isolated; it has 6-merous flowers, a capsule that probably does not open by valves but it does have the characteristic horizontal stripes, it has small, stipule-like outgrowths on the nodes between the leaves or bracts, and it occasionally has smaller bracteoles in the axils of the bracteoles which may indicate that the solitary flower of *Rotala* is reduced from a cymose inflorescence.

Except for *R. floribunda, R. repens* and *R. hexandra* the genus *Rotala* is very uniform. There are many smaller phenetic groups within the genus which I have done my best to combine in the indented key. I have, however, found no satisfactory subgeneric classification that neatly divides the genus into a few, large, more or less natural groups. An arbitrary division based on characters such as number of capsule valves or stamens serves, as far as I can see, no useful purpose. I have, therefore, not proposed any subgeneric classifications.