# A revision of the genus Rotala (Lythraceae) 

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## A revision of the

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## Introduction

Some species of Rotala are extremely successful weeds in ricefields and irrigation ditches. In S. India it is quite common to find up to five different species in a single ricefield. The phenomenon of these closely related species growing intermingled and the difficulty of identifying the species were the stimuli for my interest in this genus. The only world-wide revision of Rotala was written by A. Koehne in a series of works (1880, 1883, 1903, 1907, 1908). By 1908 KOEHNE had recognised 41 species and since then 40 new species have been described (many of them by A. FERNANDES, 1955, 1957, 1959, 1974). Adding some nomenclatural recombinations there are today about 97 "paper" species.

Apart from accounts in Floras the following localized floristic accounts have been published: Koehne (1885), Graham (1964) - USA; Blatter \& HaLlBERG (1918) - colonial India; LOURTEIG (1954) - Argentina; RAYnAL (1967) - W. and C. Africa; Leeuwen (1971) - Malesia; Mitchell (1976) N . Australia. Very little morphological or anatomical work has been carried out, the most detailed accounts are those of VOS (1974) and Panigrahi (1975). One individual in the whole genus has been cytologically examined ( $R$. ramosior, $2 n=32$, STRIPLING \& ROSs, 1962). I have found no works on the genetics, gametogenesis, population structure, ecology, floral biology or chemistry of Rotala.

I have had the opportunity to study and make mass gatherings of 11 different species in the field and have cultivated 10 species in the botanic gardens of the University of Zürich. These studies have given me a limited insight into local population variation, ecology, breeding systems and phenotypic plasticity. On the whole, however, my work has been mostly based on herbarium and literature studies. I have attempted to produce an "alpha" revision of the genus Rotala to the level of species on a world-wide basis. I have accepted 44 of the 97 "paper" species. Many species show considerable variation but I feel it is folly to attempt any infraspecific classification on a very widespread group of aquatic and amphibious plants without an experimental approach.

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## Evolutionary considerations

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 welldefined 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 6merous 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.

## Generic description

Rotala, L., Mantissa 143, 175. Oct. $1771 \equiv$ Rotula Loureiro, Fl. Cochinch. 121: 1790 orth. mut.
= Ammannia L., Sp. Pl. 119. 1753, pro parte. Type: A. latifolia L.
$=$ Peplis L., Sp. Pl. 332. 1753, pro parte. Type: P. portula L.
$=$ Suffrenia Bellardi, Mém. Acad. Sci. Lit. Beaux-Arts Turin "pour les années 10: 1802, et 11: 1803" - Sci. Phys. Math. "an. 12: 1804" - p. 445, t. 1, f. 1, on table 1 is written: "Mém. Acad. Sci. Turin 7: 452". Type: S. filiformis Bellardi.
$=$ Sellowia Roth ex Roemer \& Schultes, Syst. Veg. 5(31): 407. 1819. Type: S. uliginosa Roth ex Roemer \& Schultes.
= Winterlia Sprengel, Syst. 1:519. 1824, non Moench 1794.
$=$ Boykiana Rafin., Neogenyton 2. 1825, nom. rej. Type: B. humilis (Michx.) Rafin. $\equiv$ Ammannia humilis Michx. $\equiv$ Boykinia Rafin., New Fl. 4: 66. 1838. orth. mut., non Boykinia Nuttall, 1834, nom. cons.
$=$ Ameletia DC., Mém. Soc. Phys. Genève 2(2): 82. 1826. Type: A. indica (Willd.) DC. ミ Peplis indica Willd.
$=$ Nimmonia (Nimmoia orth. mut.) Wight, Madras J. Lit. Sci. 5: 312. 1837. Type: N. floribunda Wight.
$=$ Nexilis Rafin., New Fl. 4: 9. 1838. Type: $N$. indica (Willd.) Rafin. इ Peplis indica Willd.
= Hypobrichia M. A. Curtis ex Torrey \& Gray, Fl. N. Amer. 1: 479. 1840. Type: H. nuttallii M. A. Curtis ex Torrey \& Gray.
$=$ Rhyacophila Hochst., Flora (Regensburg) 24: 659. 1841. Type: $R$. repens Hochst.
$=$ Quartinia Endl., Gen. Suppl. 2: 94. 1842, non A. Richard 1840. Type: Q. turfosa A. Richard.
$=$ Hydrolythrum Hooker fil. in Hooker, Ic. Pl. Ser. 2, t. 1007. 1843. Type: H. wallichii Hooker fil.
$=$ Tritheca (Wight \& Arnott) Miq., Fl. Ind. Bat. 1(1): 614. 1855. Type: T. pentandra (Roxb.) Miq. $\equiv$ Ammania pentandra Roxb.
$=$ Ditheca (Wight \& Arnott) Miq., Fl. Ind. Bat. 1(1): 615. 1855. Type: D. densiflora (Roth ex Roemer \& Schultes) Miq. $\equiv$ Ammania densiflora Roth ex Roemer \& Schultes.

Type: R. verticillaris L.

Aquatic, amphibious or terrestrial, annual or perennial, glabrous herbs. Stems creeping, ascending, erect or floating, simple or branched. Leaves decussate, whorled or rarely alternate, simple, entire, sessile or rarely shortly petiolate; stipules absent (in $R$. hexandra stipule-like outgrowths present on the nodes between the leaves). Bracts leaf-like or scale-like; bracteoles 2 or absent (additional bracteoles occasionally present in the axils of the bracteoles in $R$. hexandra). Flowers bisexual, actinomorphic, monomorphic or dimorphic (heterostylous), occasionally cleistogamous, solitary in the axils of bracts, borne along the main axis or on lateral or terminal racemes. Calyx tubular, free from but often enclosing the ovary, hypanthial; calyx lobes 3-6, valvate, persistent; tooth-like calyx appendages or small interjected folds occasionally present between the calyx lobes; nectaries often present at the base of the calyx tube. Petals $0-6$, minute or large and showy, inserted at the top of the calyx tube, usually crumpled in bud, entire, erose or pinnately divided in $R$. fimbriata. Stamens 1-6, episepalous never more in number than the calyx lobes, inserted on the inner surface of the calyx tube on the lower half or occasionally basal and appearing free, occasionally replaced by staminodes; anthers dorsifixed, introrse. Pollen tricolporate, occasionally heterocolpate, isopolar or occasionally heteropolar, often dimorphic, pseudocolpi absent or if present 3 in number, pore generally in the middle of the principle colpi, amb triangular or circular or angulo-circular, columellae present, sexine granular, reticulate or granulo-reticulate. Ovary superior, 2-4 locules; placentation axile becoming free-central at maturity; style simple; stigma capitate or 2-lobed in R. floribunda; fruit a septicidally dehiscent capsule opening by $2-4$ valves; the valves with microscopic, horizontal striations; one valve is crowned with the persistent style; seeds numerous or few, semi-ovoid to ellipsoidal, with mucilaginous hairs which invaginate before germination; germination epigeal; cotyledons simple.

Diagnostic features for Rotala with respect to the rest of the Lythraceae: capsule valves with microscopic, horizontal striations; placentation at maturity free-central; style crowning one of the valves; stamens as many or fewer than the calyx lobes; flowers solitary or in racemes (never in cymes).

## Diagnostic features of the species

The diagnostic values of morphological characters are discussed after the description of each species. The following list contains diagnostic morphological features common to less than a third of the species.

Leaves regularly whorled: $\mathbf{1 , 2 , 3}, \mathbf{4}, \mathbf{5 , 6 , 7}$.
Leaves alternate: $\mathbf{8 , 9}$.
Leaves with cartilaginous margin: 36, 37, 38.
Stipule-like outgrowths present: $\mathbf{1 0}$.
Bracts shorter than flowers: $\mathbf{8 , 9 , 3 3}$.
Bracteoles leaf-like: 7.
Bracteoles exceeding the flower in length: 7, 22, 24.
Bracteoles absent: 32, 33.
Inflorescence distinct: 8, 9, 11, 12, 13, 14, 16, 24, 28, 29, 33.
Flowers distinctly pedicellate: $\mathbf{2 , 3}, 4,8,17,18,19,23,32,33,37$.
Flowers dimorphic (heterostylous): 3, 8, 13, 14.
Calyx constricted at throat: 1, 2, 15, 16.
Calyx lobes 6: 10.
Calyx lobes 5: 6, 10, 11, 23, 24, 25.
Calyx lobes $3: \mathbf{1 , 6 , 3 0 , 3 1 .}$
Calyx appendages present: 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 30, 31, 32.
Calyx disintegrating as fruit ripens: 5, 23, 34, $\mathbf{4 0}$.
Petals pinnately divided: 23.
Stamens inserted near base of calyx tube: 10, 11, 12, 13, 14, 15, 23, 31, 33, 34, 35, 38.

Stamens 6: 10.
Stamens 5: 10, 11, 23, 24, 25.
Stigma 2-lobed: 8.
Capsule 4-valved: 1, 10, 11, 12, 13, 14, 15, 17, 18, 19, 20, 21, 22.
Capsule valves induplicate: $\mathbf{1 5}, \mathbf{1 6}, \mathbf{1 7}, \mathbf{1 8}, \mathbf{1 9}, 21$.
Capsule longer than calyx: 5, 7, 9, 17, 18, 25, 29, 31, 32, 34, 39, 40, 43, 45.

## Rotala numbered

1. R. verticillaris $L$.
2. R. gerardii Boutique
3. R. myriophylloides Welw. ex Hiern
4. R. wallichii (Hooker fil.) Koehne
5. R. hippuris Makino
6. R. mexicana Cham. \& Schlecht.
7. R. occuliflora Koehne
8. R. floribunda (Wight) Koehne
9. R. repens (Hochst.) Koehne
10. R. hexandra Wallich ex Koehne
11. R. rotundifolia (Roxb.) Koehne
12. R. macrandra Koehne
13. R. nummularia Welw. ex Hiern
14. R. thymoides Exell
15. R. elatinoides (DC.) Hiern
16. R. serpyllifolia (Roth) Bremek.
17. R. tenella (Guill. \& Perr.) Hiern
18. R. pterocalyx A. Raynal
19. R. fluitans Pohnert
20. R. ritchiei (Clarke) Koehne
21. R. illecebroides Arn. ex Koehne
22. R. ramosior (L.) Koehne
23. R. fimbriata Wight
24. R. densiflora (Roth ex Roemer Schultes) Koehne
25. R. rosea (Poiret) C. D. K. Cook
26. R. verdcourtii A. Fernandes
27. R. welwitschii Exell
28. R. cordata Koehne
29. R. rubra (Buch.-Ham. ex D. Don) Hara
30. R. juniperina A. Fernandes
31. R. malampuzhensis R. V. Nair ex C. D. K. Cook
32. R. simpliciuscula (Kurz) Koehne
33. R. serpiculoides Welw. ex Hiern
34. R. stagnina Hiern
35. R. gossweileri Koehne
36. R. indica (Willd.) Koehne
37. R. subrotunda (Wallich ex Kurz) Koehne
38. R. diandra (F. v. Müller) Koehne
39. R. filiformis (Bellardi) Hiern
40. R. capensis (Harvey) A. Fernandes \& Diniz
41. R. dinteri Koehne
42. R. fontinalis Hiern
43. R. lucalensis A. Fernandes \& Diniz
44. R. smithii A. Fernandes \& Diniz

## Key to Rotala

1 Lower leaves alternate (upper leaves occasionally arranged irregularly: alternate, whorled, opposite or in fascicles); upper bracts scale-like, resembling bracteoles

2 Stigmas distinctly 2-lobed; anthers and stigmas borne at different levels (flowers dimorphic, heterostylous); petals showy, 1-1.5 mm long; calyx tube c. 2 mm long ( W . India)
8. R. floribunda

2 Stigmas obconical; anthers and stigmas borne at the same level (flowers monomorphic); petals insignificant, c. 0.25 mm long; calyx tube c. 1 mm long (Ethiopian Highlands and Mt. Elgon) . . . . . . 9. R. repens

1 Lower and upper leaves decussate or whorled; bracts not scale-like, not resembling bracteoles or bracteoles absent
3 Leaves in whorls of 3 or more
4 Petals absent
5 Calyx disintegrating as the fruit ripens; capsule opening by 2 valves (Japan)
5. R. hippuris

5 Calyx remaining intact as the fruit ripens; capsule openny by 3 valves
6 Bracteoles leaf-like, partly or completely enclosing the flower and at least 2 times as long as the calyx; calyx tube c. 1 mm long (S. India and N. Australia)
7. R. occultiflora

6 Bracteoles scareous, linear, not enclosing the flower and rarely exceeding the calyx; calyx tube $0.5-0.7 \mathrm{~mm}$ long (Warmer regions of the World)
6. R. mexicana

4 Petals present
7 Calyx tube at anthesis cylindrical to sub-urceolate, somewhat constricted at the throat; capsules opening by 3 valves; calyx lobes 3 or 5 ; petals 3 or 5

8 Bracts cordate at base, usually in whorls of 3; calyx lobes 5; petals 5, up to 3 mm long, at least 5 times as long as calyx lobes; flower pedicellate; seeds c. 0.7 mm long (Tropical Africa) 2. R. gerardii
8 Bracts scarcely widened at base, usually in whorls of 4 or 8; calyx lobes 3 ; petals 3 , c. 0.5 mm long, scarcely exceeding the calyx lobes; flowers sessile; seeds c. 0.4 mm long (S.E. India, Sri Lanka)

## 1. R. verticillaris

7 Calyx tube at anthesis campanulate, not constricted at the throat; capsules opening by 2 or 4 valves; calyx lobes usually 4 ; petals usually 4
9 Calyx tube c. 1 mm long; style very short, not more than 0.2 mm long; bracteoles about half as long as the calyx tube; petals not exceeding 0.6 mm long (Japan)
5. R. hippuris

9 Calyx tube at least 1.5 mm long; style at least 0.5 mm long; bracteoles less than half as long as the calyx tube; petals at least 1 mm long
10 Anthers and stigmas borne at different levels (flowers dimorphic, heterostylous); petals not more than 1.5 mm long; calyx tube c. 2 mm long (Tropical Africa, Malagasy) . 3. R. myriophylloides
10 Anthers and stigmas borne at about the same level (flowers monomorphic); petals c. 2.5 mm long; calyx tube c. 1.5 mm long (Tropical S.E. Asia)
4. R. wallichii

3 Leaves decussate (or rarely in whorls of 3 at the stem apex)
11 Stipule-like outgrowths present on the nodes between leaves or bracts; calyx lobes, petals and stamens 6 -merous (S.E. Asia) 10. R. hexandra

11 Stipule-like outgrowths absent; calyx lobes, petals and stamens not
6-merous

12 Petals entire or lobed, not pinnately divided into linear segments or absent
13 Flowers in axillary clusters (bracteoles absent, leaves petiolate) (Tropical Africa)
33. R. serpiculoides

13 Flowers solitary in axils of bracts
14 Calyx appendages present between the calyx lobes
15 Calyx lobes 3
16 Flowers distinctly pedicellate; bracteoles absent; petals absent (E. India, Bangla Desh)
32. R. simpliciuscula

16 Flowers sessile or subsessile; bracteoles 2, linear, about as long as the calyx tube; petals present
17 Capsule about 2 times as long as the calyx tube; stamens inserted near the base of the calyx tube (S.W. India)
31. R. malampuzhensis

17 Capsule scarcely exceeding the calyx tube; stamens inserted slightly below the middle of the calyx tube (Tropical Africa)
30. R. juniperina

15 Calyx lobes 4 or 5
18 Calyx lobes 4
19 Capsule opening by 3 valves; stamens usually 2 or occasionally 1 or 3

20 Flowers distinctly pedicellate; bracteoles absent; capsule about 2 times as long as the calyx tube (E. India, Bangla Desh) . . . . . . . . . . . . . . . . . . . . . . . . 32. R. simpliciuscula

20 Flowers sessile or subsessile; bracteoles 2, linear, about half as long as the calyx tube; capsule scarcely exceeding the calyx tube (Tropical Africa) ....... 27. R. welwitschii
19 Capsule opening by 4 valves; stamens 4 or very rarely less
21 Stamens inserted near the base of the calyx tube; calyx tube globose to subglobose in fruit; leaves and bracts subsessile to somewhat petiolate; bracts cuneate at base (America, Philippines, N. Italy)
22. R. ramosior

21 Stamens inserted about halfway up the calyx tube; calyx tube campanulate to somewhat urceolate in fruit; leaves and bracts sessile; bracts truncate or cordate at base
22 Calyx lobes acutely triangular, apiculate at apex; bracteoles equal to or longer than the calyx tube; leaves uniform in shape, ovate-cordate with acute apex (Peninsular India)
21. R. illecebroides

22 Calyx lobes very shallowly triangular, obtuse at apex; bracteoles less than half as long as the calyx tube; leaves variable in shape (heterophyllous), with obtuse apex
23 Calyx tube not exceeding 2 mm long; capsule c. 2 mm long; capsule valves not induplicate before dehiscence; seed c. 0.3 mm long; submerged leaves linear (W. India)
20. R. ritchiei

23 Calyx tube 2.5 mm or more long; capsule c. 3.5 mm long; capsule valves induplicate before dehiscence; seed c.
0.5 mm long; submerged leaves elliptic to ovate (Southern Africa)
19. R. fluitans

18 Calyx lobes 5
24 Bracteoles longer than the total calyx (tube, lobes and appendages), with a midrib; style at least 0.5 mm long (C. and S.E. Asia, Australia, Italy) ................... 24. R. densiflora
24 Bracteoles shorter than the total calyx, without a midrib; style less than 0.5 mm long
25 Capsule exceeding the calyx; style very short less than 0.25 mm ; bracteoles equal to or slightly shorter than the calyx tube; stamens 5 (S. and E. Asia) ...... 25. R. rosea
$25 \begin{gathered}\text { Capsule not exceeding the calyx; style c. } 0.25 \mathrm{~mm} \text { long; } \\ \text { bracteoles somewhat longer than the calyx tube; stamens } 2\end{gathered}$
(Tropical Africa) ....................26. R. verdcourtii
14 Calyx appendages absent between the calyx lobes
26 Capsule opening by 4 valves
27 Floral bracts distinctly different from the foliage leaves in shape and size

28 Anthers and stigmas included within the calyx; bracts longer than wide; bracteoles about equal to the calyx tube in length; inflorescence in fruit more or less remote, lax; stigmas discoid (S. and E. Asia) . .................. 11. R. rotundifolia

28 Anthers and stigmas exerted beyond the calyx; bracts wider than long; bracteoles half or less as long as the calyx tube; inflorescence in fruit more or less sessile, dense, with imbricate bracts; stigma minutely capitate (S. India)
12. R. macrandra

27 Floral bracts like foliage leaves, at least at the base of the inflorescence
29 Anthers and stigmas borne at different levels (flowers dimorphic, heterostylous); petals showy, more than 1 mm long
30 Leaves below the inflorescence ovate to broadly ovate; inflorescence indistinct (no marked difference between sterile and fertile parts of the stem); "pin" or long style more than 5 mm long (Angola)
13. R. nummularia

30 Leaves below the inflorescence linear to lanceolate or obspathulate; inflorescence usually distinctly stalked, more or less globose; "pin" or long style less than 5 mm long (Angola)
14. R. thymoides
29 Anthers and stigmas borne at the same level (flowers monomorphic); petals absent or not showy and less than 0.5 mm long
31 Calyx tube at fruiting stage almost square in transverse section, distinctly 4 -winged (C. and W. Africa)
18. R. pterocalyx
31 Calyx tube at fruiting stage more or less terete in transverse section; not winged
32 Calyx tube at fruiting stage subcylindrical to urceolate, c. 3 mm long; stamens 2 , inserted near the base of the calyx tube (C. and W. Africa)
15. R. elatinoides
32 Calyx tube at fruiting stage semi-globose, c. 1.5 mm long; stamens 4 or rarely less, inserted about halfway up the calyx tube (Africa S. of the Sahara)
17. R. tenella

26 Capsule opening by 2 or 3 valves
33 Capsule opening by 3 valves
34 Bracteoles leaf-like, partly or completely enclosing the flower at least 2 times as long as the calyx (S. India, N. Australia)
7. R. occultiflora

34 Bracteoles scareous, linear, not enclosing the flower, not more than 2 times as long as the flower
35 Calyx lobes 5
36 Calyx tube $0.5-0.75 \mathrm{~mm}$ long; petals absent (Warmer regions of the World)
6. R. mexicana

36 Calyx tube at least 1 mm long; petals present
37 Capsule exceeding the calyx lobes; style less than 0.25 mm long; bracteoles about as long as the calyx tube (S. and E. Asia)
25. R. rosea

37 Capsule not exceeding the calyx lobes: style $0.5-1 \mathrm{~mm}$ long; bracteoles longer than the total calyx (C. and S.E. Asia, Australia, Italy)
24. R. densiflora

## 35 Calyx lobes 4 or 3

38 Calyx lobes 4
39 Calyx tube $0.5-0.75 \mathrm{~mm}$ long (Warmer Regions of the World)
6. R. mexicana

39 Calyx tube more than 0.75 mm long

40 Petals as long or longer than the calyx lobes; stamens 4, inserted about halfway up the calyx tube; bracteoles $1 / 4$ or less as long as the calyx (Asia)
41 Capsule exceeding the calyx; style very short, c. 0.1 mm long (Nepal) . . . . . . . . . . . . . . . . . . . . . . . 29. R. rubra
41 Capsule included within the calyx tube; style $1-1.5 \mathrm{~mm}$ long (S. and S.E. Asia) . .............. 28. R. cordata
40 Petals absent or rudimentary, shorter than the calyx lobes; stamens 2 , inserted near the base of the calyx tube; bracteoles about half as long as the calyx tube (Africa)
42 Calyx lobes shorter than the calyx tube, monomorphic; capsule longer than the calyx; calyx rupturing as the capsule develops (Tropical Africa) .. 34. R. stagnina
42 Calyx lobes about as long as the calyx tube, dimorphic; capsule remaining within the calyx tube; calyx not rupturing as the capsule develops (Tropical Africa)

> 35. R. gossweileri

38 Calyx lobes 3
43 Flowers distinctly pedicellate; bracteoles absent (E. India, Bangla Desh)
32. R. simpliciuscula

43 Flowers sessile or subsessile; bracteoles 2, linear
44 Capsule not exceeding the calyx lobes; petals absent (Warmer Regions of the World) ..... 6. R. mexicana
44 Capsule exceeding the calyx lobes; petals present (S.W. India)
31. R. malampuzhensis

33 Capsule opening by 2 valves
45 Leaves with a distinct cartilaginous margin
46 Flowers distinctly pedicellate; anthers borne above the petals (N.E. India and Burma)
37. R. subrotunda

46 Flowers sessile or subsessile; anthers included within the calyx
47 Style $0.5-1 \mathrm{~mm}$ long; anthers and stigmas exceeding or reaching the top of the calyx tube; stamens inserted about half way up the calyx tube, usually 4 ; bracteoles about as long or longer than the calyx tube (Warmer Regions of the World)
36. R. indica
$47 \begin{aligned} & \text { Style very short, } 0.1 \mathrm{~mm} \text { or less; anthers and stigmas scarcely } \\ & \text { reaching half the length of the calyx tube; stamens inserted }\end{aligned}$
near the base of the calyx tube, usually 2 ; bracteoles about half as long as the calyx tube (N. Australia)
38. R. diandra

45 Leaves without a cartilaginous margin
48 Calyx tube 2 mm or more long
49 Calyx tube urceolate, constricted at the throat, $2.5-3 \mathrm{~mm}$ long; anthers and stigma borne at the same level (flowers monomorphic); inflorescence compact, more or less remote (Pakistan, C. and N.W. India)
16. R. serpyllifolia

49 Calyx tube campanulate, not constricted at the throat, c. 2 mm long; anthers and stigma borne at different levels (flowers dimorphic, heterostylous); flowering and sterile parts of the stem alike (Tropical Africa, Malagasy)
3. R. myriophylloides

48 Calyx tube less than 2 mm long ( $R$. filiformis group)
50 Anthers exerted beyond the calyx lobes; style at least 1.25 mm long (E. Zaire)
44. R. smithii

50 Anthers not exerted beyond the calyx lobes; style not more than 1 mm long
51 Stamens 4 (occasionally 1 or 2 sterile and represented by naked filaments); style more than 0.5 mm long
52 Mature capsule longer than the total calyx, ellipsoidal, 2 mm or more long; seeds $0.75-1 \mathrm{~mm}$ long, ellipsoidal (C. and S. Tropical Africa) . . . . . . . . 43. R. lucalensis

52 Mature capsule shorter than the calyx tube, subglobose or obovoid, c. 1 mm long; seeds c. 0.4 mm long, semiovoid (S. Tropical Africa)
42. R. fontinalis

51 Stamens 2 or rarely 1 or 3 ; style 0.5 mm or less long
53 Calyx tube in fruit not more than 0.75 mm long (usually much less); capsule at least 2 times as long as the calyx tube; style not more than 0.2 mm long
54 Capsule subglobose; calyx tube not splitting as the fruit ripens; bracteoles linear, $0.25-0.5 \mathrm{~mm}$ long ( S . Tropical Africa)
41. R. dinteri

54 Capsule ellipsoidal; calyx tube splitting irregularly as the fruit ripens; bracteoles scale-like, minute, c. 0.1 . mm long (Tropical Africa) . . . . . . . . . . . . 40. R. capensis
53 Calyx tube in fruit at least 1 mm long; capsule less than 2 times as long as the calyx tube; style $0.25-0.5 \mathrm{~mm}$ long (Tropical Africa, N. Italy)
39. R. filiformis

1. Rotala verticillaris L., Mantissa 2: 175. 1771; non Hiern in Oliver, Fl. Trop. Africa 2: 467. 1871 三 Ammannia verticillaris (L.) Baillon, Hist. Pl. 6: 439, f. 423, 424. 1877.

- Rotala verticillata Christm., Pflanzensyst. 5: 195. 1779, orth. mut.
- Rotala petaloidea Wight ex Steudel, Nom. Bot. ed. 2, 2: 474. 1841, nom. nud.
- Ammannia rotala Clarke in Hooker fil., Fl. Brit. India 2: 567. 1879, pro syn., non F. v. Müller, Fragm. Phyt. Austral. 3: 108. 1862.

Type: India orientalis (holotype: LINN, Savage Cat. No. 52-1).
Ic.: Fig. 1A-E; Wight, Ic. Pl. Ind. Or. 1: t. 260. 1840.


Fig. 1. - R. verticillaris (Wallich 6321A); A, flowering stem; B, flower bud; C flower at anthesis; $\mathbf{D}$, flower dissection; $\mathbf{E}$, capsule.
R. gerardii (Gérard 1608); F, flower and bract at anthesis; G, flower dissection (scale: $\mathbf{A}, 5 \mathrm{~mm}$;

Amphibious perennial, or perhaps occasionally annual. Stems creeping and rooting below, floating, ascending or erect above, up to 20 cm long but usually less, simple or branched, terete below, angular above, somewhat woody at base. Leaves in whorls of $4-8$, or occasionally decussate below, 3-10 mm long; submerged leaves capillary, thin, rarely more than 1 mm wide; aerial leaves linear to oblong or oblanceolate, thick, up to 2.5 mm wide; leaf apex truncate or minutely bifid. Bracts leaf-like, usually in whorls of 4 , rarely 8 or 2; bracteoles 2, capillary, up to 0.5 mm long. Flowers monomorphic, sessile, solitary. Calyx tube membranous, sub-urceolate, constricted at mouth, up to 2 mm long; calyx lobes 3 , rarely 4 , deltate, c. 0.5 mm long; small interjected fold present between calyx lobes, persisting in fruit. Petals 3, rarely 4 , ovate to cordate, pink, usually persisting in fruit, about as long as the calyx lobes. Stamens 3, rarely 4, inserted on the upper half of the calyx tube; anthers scarcely reaching the sinuses of the calyx lobes. Ovary ellipsoidal; style very short; stigma capitate; capsule globose-ellipsoidal, opening by 3 valves; seeds semi-ovoid, $0.35-0.4 \mathrm{~mm}$ long.

## DIAGNOSTIC FEATURES

K3(-4), P3(-4), A3(-4), G3; leaves in whorls; calyx tube constricted at the throat. Like $R$. gerardii but differs in having leaves not widened at the base and small seeds, $0.35-0.4 \mathrm{~mm}$ long.

## DISTRIBUTION

Found in S.E. India and Sri Lanka (Map 1). There are many early collections and it was first reported in Rheede, Hortus Indicus Malabaricus 9: t. 81. 1678-1703. Trimen (Fl. Ceylon 2: 224. 1894) reports that Thwaites considered it common in Sri Lanka but that he himself had never found it; the most recent Sri Lanka collection I have seen is: "Thwaites 1547" collected in 1855. The most recent collection from S. India I have seen is 1915. Rotala verticillaris grows in regions that have recently been recollected, it is probable that it has become very rare or even extinct. Cooke (Fl. Bombay 1: 507. 1903) reports it from Kanara, I have not seen the cited collection but it is most likely $R$. mexicana which grows in the region; (Cooke, loc. cit., "petals fugacious or 0 " which is not normal for $R$. verticillaris). There is no ecological information available, the herbarium material suggests that it grows in temporary pools. The flowering time is form January to March. The flowers are probably autogamous.

## SELECTED SPECIMENS

India: s. loc., Bélanger 91 (LE); s. loc., Wallich $6321 B(\mathrm{~K})$; s. loc., Wight 1016 (BR, CGE, G, K, L, MEL); Andhra Pradesh: Nellore, 13 March 1901, Bourne 2144 (K); Tamil Nadu: Nagapattinam, 1830, Graham 156 (CGE);

Tranquebar, Rottler (K); Chingelput, 7 Feb. 1915, Herb. S. Ind. Fl. (K); Pondicherry, Perrotet 693 (L). Sri Lanka: s. loc., 1832, Wallich 6321A (CGE, G, K, LE); s. loc. 1855, Thwaites 1547 (G).
2. Rotala gerardii Boutique, Bull. Jard. Bot. Etat Bruxelles 34(4): 503. 1964.

Type: Zaire, Distr. de l'Ubangi-Uele, mare du Pengbele, Nov. 1957, Gérard 3354 (holotype: BR).

Ic.: Fig. 1F-G; Boutique, Bull. Jard. Bot. Etat Bruxelles 34(4): t. 9. 1964.
Amphibious herb. Stems creeping, rooting and branching below, erect and usually simple above, $10-50 \mathrm{~cm}$ long. Leaves in whorls of 3 , occasionally some decussate, ovate to ovate-lanceolate, $3-7 \mathrm{~mm}$ long, $1.5-3.5 \mathrm{~mm}$ wide, at base rotund to cordate, at apex acute, attenuate. Bracts leaf-like, at base usually somewhat cordate and shortly petiolate; bracteoles 2, capillary, 0.50.7 mm long. Flowers monomorphic, solitary, shortly pedicellate; pedicel adnate to petiole of bract, combined structure up to 0.75 mm long. Calyx tube membranous, sub-cylindrical to sub-urceolate, $2-2.5 \mathrm{~mm}$ long; calyx lobes 5, rarely 4 , deltate to triangular, $0.25-0.5 \mathrm{~mm}$ long. Petals 5, rarely 4, pink, oblong-elliptic, attenuate at base, $2.5-3 \mathrm{~mm}$ long. Stamens 5 , rarely 4 , inserted somewhat below the middle of the calyx tube; anthers scarcely reaching the sinuses of the calyx lobes. Ovary ellipsoidal; style very short, not exceeding 0.15 mm ; stigma capitate; capsule broadly ellipsoidal, opening by 3 valves; seeds semi-pyriform, up to 0.7 mm long and 0.4 mm wide.

## DIAGNOSTIC FEATURES

K5(-4), P5(-4), A5(-4), G3; like $R$. verticillaris but in all respects larger; leaves in whorls of 3 , widened at the base; petals as long or longer than the calyx tube. Like $R$. myriophylloides but perianth 5-merous; flowers monomorphic; calyx tube tubular; capsule 3-valved.

## DISTRIBUTION

Found in the northern part of the Congo basin (Map 2). It grows in temporary ponds, particularly on laterite. The flowering time is from September to December.

## SELECTED SPECIMENS

Cameroun: 60 km N.E. Tibati, 24 Sept. 1963, Letouzey 6001 (P). Central African Republic: Reg. Waka, Rewangi, 45 km E. Moroubas, March 1925, Tisserant 1690 (BR, K, P); Gomoka, 6 Oct. 1963, Audru \& Boudet 3182 bis
(P). Zaire: Distr. de l'Ubangi-Uele, Tukpwo, Dec. 1952, Gérard 497 (BR); Tukpwo, Gérard 1019 (BR); Pengbele, Nov. 1957, Gérard 3354 (BR).
3. Rotala myriophylloides Welw. ex Hiern in Oliver, Fl. Trop. Africa 2: 469. 1871.
$=$ Ammannia cryptantha Baker, J. Linn. Soc. Bot. (London) 21: 345. Dec. $1884 \equiv$ Rotala cryptantha (Baker) Koehne in Engler, Pflanzenreich 17 (IV. 216): 42. 1903. Type: Malagasy, Baron 1902 (lectotype: K).
$=$ Rotala cordifolia Baker, J. Linn. Soc. (London) 22: 478. 1887. Type: Malagasy, Baron 4313 (holo- or lectotype: K n.v.; isotype: P).
$=$ Rotala longistyla L. S. Gibbs, J. Linn. Soc. (London) 37: 445. 1906. Type: Rhodesia (Zimbabwe), Victoria Falls, Sept., L. S. Gibbs 170 (holotype: K).
$=$ Rotala longicaulis A. Fernandes \& Diniz, Bol. Soc. Brot. Sér. 2, 29: 87. 1955, op. cit. 48: 131. 1974. Type: Mozambique, Niassa, Metonia, pr. Vila Cabral, 2 May 1934, Torre 96 (holotype: COI n.v.; isotype: LISC).
$=$ Rotala pearsoniana A. Fernandes \& Diniz, Bol. Soc. Brot. Sér. 2, 31: 155. 1957. Type: Angola, Lubango (Huíla), 10 May 1909, Pearson 2657 (holotype: K).
$=$ Rotala nashii A. Fernandes, Bol. Soc. Brot. Sér. 2, 48: 129. 1974. Type: Zambia, Mbala (Abercorn) Distr., Lake Chila, April 1954, Nash 65 (holotype: BM; paratypes: ibid., Richards 4948, K; Richards 18084, K).
$=$ Rotala hutchinsoniana A. Fernandes, Bol. Soc. Brot. Sér. 2, 48: 130. 1974. Type: Zambia, Mbala (Abercorn), 19 June 1930, Hutchinson \& Gillett 3872 (holotype: BM; isotype: K).

Type: Angola, Lubango (Huíla), Lopolo, entre Nene e Ohai, 1600 m , May 1860, Welwitsch 2348 (holotype: LISU n.v.; isotypes: BM, COI n.v.; K, M).

Ic.: Fig. 2A, B; A. Fernandes, Bol. Soc. Brot. Sér. 2, t. 1. 1955; op. cit. 31: t. 5. 1957; op. cit. 48: t. 16, t. 17, t. 18. 1974.

Aquatic, amphibious or terrestrial perennial or perhaps occasionally annual. Stems creeping, rooting and branching below; often stoloniferous; floating or erect and usually simple above, up to 50 cm or more long but often much less. Leaves in whorls of 3-8 or decussate; submerged leaves in whorls of 3-8, capillary or linear, up to 20 mm long, at apex obtuse or bifid; aerial leaves rarely in whorls of more than 4 or decussate, linear to oblong or ovate, rarely exceeding 5 mm long, at base ovate or somewhat cordate, at apex obtuse. Bracts like aerial leaves, at base usually somewhat widened or cordate; bracteoles 2, membranous, linear, up to 0.5 mm long but often less. Flowers dimorphic, heterostylous, solitary, subsessile or pedicellate; pedicel adnate to petiole of bract, combined structure up to 1 mm long. Calyx tube


Fig. 2. - R. myriophylloides (de Witte 6339); A, "pin" flower and bract at anthesis; B, "thrum" flower dissection.
R. wallichii (living material, from? Johore); C, flower and bract; D, flower dissection (scale: A-D, 1 mm ).
membranous, campanulate, c. 2 mm long; calyx lobes 4 , rarely 3 or 5 , shallowly triangular, spreading, c. 0.5 mm long. Petals 4 , rarely 3 or 5 , deep rose, elliptic to obovate, up to 1.5 mm long but often less, persisting in fruit. Stamens 4, rarely 5, inserted slightly below the middle of the calyx tube; anthers borne either within the calyx tube or above the petals; filaments either c. 1.5 mm long or c .3 mm long. Ovary ovoid; style either c. 1 mm long or c. 3 mm long; stigma capitate; capsule shorter than the calyx tube, opening by 2 valves; seeds semi-ovoid, c. 1 mm long.

## DIAGNOSTIC FEATURES

$\mathrm{K}(3-) 4(-5), \mathrm{P}(3-) 4(-5), \mathrm{A}(3-) 4(-5), \mathrm{G} 2$; heterostylous, capsule shorter than calyx tube, seeds c .1 mm long. Like $R$. wallichii but calyx c .2 mm long, petals not more than 1.5 mm long, and flowers heterostylous.

## DISTRIBUTION

Southern Africa and Malagasy between latitude $8^{\circ} \mathrm{S}$. and $20^{\circ} \mathrm{S}$. (Map 2). It is found in a wide variety of aquatic and wet habitats. When the whole range is considered it flowers throughout the year.

## SELECTED SPECIMENS

Angola: Lubango (Huíla): Lopolo, entre Nene e Ohai, 1600 m , May 1860, Welwitsch 2348 (BM, COI n.v., K, M); Serra da Chela, Humpata, 2000 m, 28 Oct. 1941, Gossweiler 13246 (BM, BR); Lubango (Huíla), 1950 m, 10 May 1909, Pearson 2657 (K); Ganda: Alto Catumbela, 1450 m, Feb. 1940, Faulkner (A)320 (BM, K); Bié: Cuito-Cuanavale, Cuito, entre Cutué e Sobi, 1200 m, Baum 770 (BM, BR, G, K, M, Z). Zaire: Shaba (Katanga): Buyi-Bala, Kiluba-Mene, 1750 m, 30 March 1948, Witte 3590 (BR, K); Mitwaba, Linsinya, 11 May 1949, Van Meel, Witte 6339 (BR, G, M, Z); Mitwaba, Mukana, 2 Oct. 1948, Van Meel, Witte 6116 (BR, L); Kipopo, 20 km N.O. Lubumbashi (Elisabethville), 5 May 1958, Schmitz 6054 (BR); Lubumbashi, 1220 m, 2 Dec. 1965, Symoens 11686 (BR, K, MO); Kundelungu, 7.3 km N. Katshupa, 1690 m, 4 Aug. 1966 Malaisse 4508 (BR, K). Zambia: Mbala (Abercorn), Lake Chila, 1650 m, 24 Sept. 1949, Bullock 1071 (BR); ibid., 23 May 1952, Richards 1824 (BR, K); ibid., 15 March 1955, Richards 4948 (K); Mbala, Abercorn Lake, 19 July 1930, Hutchinson \& Gillett 3872 (K); Lake Bangweiler, 27 May 1964, Fanshaw 8694 (K); Kalabo, 17 Nov. 1959, Drummond \& Cookson 6563 (K); 5 km E. Choma, $1319 \mathrm{~m}, 28$ May 1955, Robinson 1270 (K); N. lac Shiwa Ngandu (Lake Young), 26 June 1963, Symoens 10493 (BR, K, MO); Mutuka, 1260 m, 5 Aug. 1966, Symoens 12623 (BR, K). Malawi: Nyika Plateau, Lake Kauline, 2150 m, 24 Oct. 1958, Robson \& Angus 325 (K); ibid., 12 Nov. 1967, Richards 22511 (K). Rhodesia (Zimbabwe): Victoria Falls, 960 m, May 1904, Eyles 124 (BM, K); ibid., May, Gibbs 170; ibid., May 1915, Rogers 13198 (BM, Z); ibid., Acocks \& Hafström 1024 (K); ibid., 13 July 1952, Codd 7063 (K); Salisbury, 1500 m, March 1919, Eyles 1568 (BM); ibid., June 1920, Eyles 2284 (K); ibid., 19 Feb. 1927, Eyles 4730 (K); ibid., 20 June 1931? 1937, Brain 5287 (K); Salisbury, Cleveland Dam, 21 March 1921, Godman 177 (BM); ibid., 5 May 1934, Gilliland 30 (BM, K) and 33 (BM, K); ibid., 4 May 1946, Wild 1077 (K); 37 km E. Salisbury, Goromonzi, 25 April 1967, Rushworth 662 (K); Mazoe, Henderson, Res., 7 May 1952, Wild 3832 (BR, K, MO); Marandellas, 15 April 1922, Eyles 3446 (K); ibid., 14 May 1931, Brain 4422 (MO); ibid., 9 Jan. 1942, Dehn 586 (M); Marandellas, Digglefold, 18 March 1948, Corby 20300 (BM); Gokwe, 13 Sept.

1949, West 2999 (K). Botswana: Maun, Chobe River, 2 June 1930, van Son 28861 (BM); Maun, Thamalakane River, June 1955, Mc Connell (K); Thamalakane River, $23^{\circ} 30$ E., $19^{\circ} 55 \mathrm{~S} ., 22$ Jan. 1972, Gibbs, Russel \& Biegel 1365 (B, K, MO); ibid., $23^{\circ} 25 \mathrm{E} ., 2^{\circ} 00 \mathrm{~S}$., 28 Feb. 1972, Gibbs, Russell \& Biegel 1467 (B, K, MO); Okavango Swamp, Khwai River, $23^{\circ} 25 \mathrm{E} ., 19^{\circ} 10 \mathrm{~S}$., 1 March 1972, Gibbs, Russell \& Biegel 1478 (MO). Mozambique: N. Niassa, Metonia, pr. Vila Cabral, 2 May 1934, Torre 96 (COI n.v.) Malagasy: s. loc., Baron 4313 (P) and Baron 5248 (P); Vakinankaratra, Antsirabe, Aug. 1908, d'Alleizette 2487 (L); ibid., April 1924, Waterlot 770 (P); ibid., 1600 m, Perrier de la Bâthie 6603 (P); Vakinankaratra, d’Ambatolampy, 29 Nov. 1912, Viguier \& Humbert 1776 (G).

NOTES
I have cultivated cloned material collected in Salisbury, Rhodesia (Zimbabwe), under different conditions at Zürich. The vegetative parts of $R$. myriophylloides are phenotypically very plastic. Generally speaking, plants cultivated in water 10 cm or more deep resemble Hippuris with up to 8 linear leaves at each whorl; plants grown terrestrially in direct sunlight are creeping with small, decussate, ovate leaves. The flowers are heterostylous and effectively self-incompatible even after manual pollen transfer. From the herbarium record the "pin" or long-styled race seems to be much commoner than the "thrum" or short-styled race. This has the consequence that many plants are collected without mature capsules and seeds. Vegetative propagation must be relatively effective but no special mechanisms (bulbils, turions, etc.) have been discovered. Capsules with 3 valves have been reported in the literature but I have only seen material with 2 valves.

The spectrum of phenotypic plasticity seen in cultivation of two strains of R. myriophylloides at Zürich covers the total variation range of the numerous segregate-species listed in the synonymy.
4. Rotala wallichii (Hooker fil.) Koehne, Bot. Jahrb. 1: 154. $1880 \equiv$ Hydrolythrum wallichii Hooker fil. in Bentham \& Hooker fil., Gen. Pl. 1: 777. Sept. 1867, Hooker fil., Ic. Pl. 11 (or Ser. 3, Vol. 1): 5, t. 1007. Nov. $1867 \equiv$ Ammannia wallichii (Hooker fil.) S. Kurz, J. As. Soc. Bengal 46: 2, 84. 1877.
$=$ Ammannia myriophylloides S. T. Dunn, J. Bot. London 47: 199. 1909. Type: China, N.E. Kwantung, Hoi Fung, Kwen Ping, 29 April 1904, Dunn's collector 1838 (holotype: HK n.v.; isotype: K).

Type: Burma, Tavoy, 1827, Gomez, Wall. Cat. No. 9059 (holotype: K-W; isotypes: $\mathrm{K}, \mathrm{G}, \mathrm{LE}$ ).

Ic.: Fig. 2C, D; Hooker fil., Ic. Pl. 11 (or Ser. 3, Vol. 1): t. 1007. 1867; Fl. Taiwan 3: pl. 819. 1977 - named Elatine triandra.

Aquatic or amphibious perennial. Stems creeping, rooting and branched below, floating or erect and usually simple above, up to 30 cm or more long. Leaves in whorls of up to 20 or more; submerged leaves linear or capillary, thin, translucent, tinged with red, up to 20 mm long, at apex bifid; aerial leaves usually in whorls of 3-12 (less than submerged leaves) or rarely decussate, linear to oblong, rarely more than 5 mm long, at base scarcely narrowed, at apex obtuse or bifid. Bracts like aerial leaves, oblong to ovate, 1.5-3 mm long, at apex acute or bifid; bracteoles capillary up to 0.5 mm long. Flowers monomorphic, solitary, several at each internode, shortly pedicellate; pedicel adnate to bract, combined organ up to 1 mm long. Calyx tube campanulate, membranous, translucent, c. 1.5 mm long; calyx lobes 4 , deltate, c. 0.5 mm long. Petals 4 , obovate, showy, pink (or white?), c. 2.5 mm long. Stamens 4, inserted below the middle of the calyx tube; anthers borne level with the top of the calyx lobes; nectar scales bilobed. Ovary globose; style c. 0.5 mm long; stigma capitate; capsule globose, c. 1 mm diam., opening by 2 valves; seeds semi-ovoid, c. 0.7 mm long (size of capsule and seeds may be underestimated as I have not seen really ripe material).

## DIAGNOSTIC FEATURES

K4, P4, A4, G2; leaves never in whorls of less than 4, petals longer than calyx; capsule globose remaining within calyx tube. Like $R$. myriophylloides but not heterostylous, bracts not widened at base and petals longer than calyx. Like $R$. hippuris but flowers larger (calyx tube c. 1.5 mm long, petals c . 2.5 mm long) and not cleistogamous, capsule remaining within the calyx tube.

## DISTRIBUTION

Found in tropical S.E. Asia (Map 1), from N.E. India to Malaya and S.E. China.

## SELECTED SPECIMENS

India: Bengal, West Duars, Oct. 1895, Haines 560 (K). Burma: Moulmein, 1846, Lobb 366 (K); Tavoy 1827, Gomez, Wall. Cat. 9059 (K, K-W, G, LE). Thailand: c. 100 km N. Bangkok, 10 m, 24 Nov. 1957, van Steenis 19580 (K, L); Phatthalung (Patalung), 31 March 1899, Gwynne-Vaughan 220 (K). Malaya: Kedah, Penarak, Lankawi, 16 Nov. 1892, ? Collecter 7075 (K); Johore, Endau River, Sept. 1976, Tomey (L, Z). China: Prov. Kwangtung, Kwen Ping, Haifeng (Hoi Fung), 29 Aug. 1904, Dunn's Native Collector 1838 (K). Taiwan: Pingtung, Hsu 3278 (TAI).

## NOTES

$R$. wallichii is cultivated as a decorative aquarium plant. In culture in Zürich the submerged leaves have a reddish tinge. When grown as a
terrestrial plant the leaves are green and in whorls of at least 4. In Zürich it flowers rarely and then only on aerial stems, submerged and cleistogamous flowers have not been observed. The petals are showy but quickly fade from pink to white, which may explain reports of white-flowered plants. In culture $R$. wallichii is effectively self-incompatible even after manual pollen transfer; this may explain the scarcity of mature capsules and seeds.
5. Rotala hippuris Makino, Bot. Mag. Tokyo 12: 81. 1898.

Type: Japan, Aichi Pref., Nagoya City, Tashiro, 29 Oct. 1893, Makino herb. No. 121070 (lectotype: MAK; isotype: MAK). Paratype: Japan, Aichi Pref., Atsumi-gun, Atsumi-cho, Kameyama, 27 Oct. 1893, Makino herb. No. 121059 (MAK).

## Ic.: Fig. 3A-D.

Aquatic perennial. Stems creeping and rooting below, floating, ascending or erect above, up to 30 cm or more long. Leaves in whorls of 5-12 or perhaps more; submerged leaves, capillary $20-30 \mathrm{~mm}$ long, at apex microscopically bimucronate; aerial leaves linear, $5-10 \mathrm{~mm}$ long, $0.7-1 \mathrm{~mm}$ wide, at apex obtusely truncate to obscurely bimucronate, at base scarcely narrowed. Bracts leaf-like, either submerged or aerial; bracteoles linear, shorter than calyx tube. Flowers monomorphic, sessile, solitary, rarely more than 2 at any internode, fertile internodes somewhat erratic, borne on submerged and aerial shoots; submerged flowers cleistogamous with reduced petals and calyx lobes. Calyx tube campanulate, $0.7-1 \mathrm{~mm}$ long, splitting and disintegrating as the fruit ripens; calyx lobes 4 , deltate, $0.2-0.3 \mathrm{~mm}$ long or less in cleistogamous flowers. Petals 4, obovate $0.2-0.6 \mathrm{~mm}$ long, rudimentary in cleistogamous flowers. Stamens 4, inserted on lower half of calyx tube; anthers not exceeding the calyx. Ovary globose; style very short; stigma capitate; capsule globose, up to 1.5 mm diam, opening by 2 valves; seeds semi-ellipsoidal, c. 0.6 mm long.

## DIAGNOSTIC FEATURES

K4, C4, A4, G2; like $R$. wallichii but calyx disintegrating as the fruit ripens; fertile and sterile internodes intermixed, flowers borne on submerged stems.

## DISTRIBUTION

Endemic to Japan between latitude $32^{\circ} \mathrm{N}$. and $38^{\circ} \mathrm{N}$. (Map 1). Flowering during October.


Fig. 3. - R. hippuris (Aichi, s. coll. 1906); A, flower and bract; B, flower dissection; C, ripe capsule; $\mathbf{D}$, flowering whorl; $\mathbf{E}$, habit (scale: $\mathbf{A}-\mathbf{D}, 1 \mathrm{~mm} ; \mathbf{E}, 1 \mathrm{~cm}$ ).

Japan. Honshu: Pref. Aichi, Nagoya, Tashira, 29 Oct. 1893, Makino herb. No. 121070 (MAK) and 121068 (MAK); Pref. Aichi, Kameyama, Atsumi-cho, Atsumi-gun, 27 Oct. 1893, Makino herb. No. 121059 (MAK); Pref. Aichi, Kamashima Yatomi-cho, Amabegun, 1 Nov. 1893, Makino herb. No. 121067 (MAK); Pref. Aichi, Nagoya, Oct. 1906, s. coll. s.n. (KYO); Pref. Gunma, Tatebayashi, Tadaranuma, s.d. s. coll. herb. No. 121056 (MAK); Kyushu: Pref. Hinga, Miyazaki, Sept. 1911, Bando (KYO).
6. Rotala mexicana Cham. \& Schlecht., Linnaea 5: 567. Oct. $1830 \equiv$ Ammannia mexicana (Cham. \& Schlecht.) Baillon, Hist. Pl. Madag. Atl. t. 363. 1895.
= Rotala pusilla Tul., Ann. Sci. Nat. Sér. 4, 6: 128. 1856. Type: Malagasy, Boivin 2692 (holotype: P).
$=$ Rotala apetala F. v. Müller, Fragm. Phyt. Austral. 3: 108, 1862. Type: Australia, Western or Northern Territory, Sturt's Creek, F. v. Müller (holotype: MEL; isotypes: K, NSW).
= Hypobrichia spruceana Bentham in Bentham \& Hooker fill, Gen. Pl. 1: 777. 1867. Type: Brazil, Parà, Santarem, Aug. 1850, Spruce (holotype: K n.v.; isotypes: G, LE) [H. spruceana Bentham, var. tenuifolia Griseb., Cat. Pl. Cubens. 106. 1866 based on Wright 2543 is not validly published].
= Ammannia pygmaea S. Kurz, Seeman's J. Bot. 5: 376. $1867 \equiv$ Rotala pygmaea (S. Kurz) Rajagopal \& Ramayya, Kew Bull. 23: 465. 1969. Type: India, Hort. Bot. Calcutta, 1867? S. Kurz? (holotype: CAL?).
$=$ Rotala diglossandra Koehne, Bot. Jahrb. 23, Beibl. 57: 17. 1897. Type: Australia, North Expedition, 15 May 1869, leg. F. Schultz, comm. R. Schomburgk 318 (holotype: K).
= Rotala longibracteolata Domin, Biblioth. Bot. 89: 995 (or 441 as book). 1928. Type: Australia, Queensland, Townsville, Castle Hill, 1910, Domin 11 (holotype: PR n.v.).

- Rotala decussata DC., Prodr. 3: 76. 1828, nom. rejic. prop. $\equiv$ Ortegioides decussata Solander, nom. in sched. $\equiv$ Eutelia ammannioides R. Brown, nom. in sched. Type: Australia, Queensland, Endeavour River, R. Brown (holotype: G-DC; isotype: BM).
- Ammannia rotala F. v. Müller, Fragm. Phyt. Austral. 3: 108. 1862, nom. invalid., pro syn. Rotala apetala F. v. Müller.
- Rotala verticillaris sensu Hiern in Oliver, Fl. Trop. Africa 2: 467. 1871, non L., Mant. 2: 175. 1771.
- Rotala halophila H. Perrier, Not. Syst. (Paris) 14: 307. 1953 (dated 1952), nom. invalid. "Type": Malagasy, Maevarano, delta de la Betsiboka, Perrier 5205 (P).

Type: Mexico, prope Hacienda de la Laguna, Oct., Schiede \& Deppe 566 (holotype: HAL n.v.; isotypes: LE, MO).

## Ic.: Fig. 4A-O.

Aquatic, amphibious or terrestrial annual. Stems branched or simple, creeping, ascending, erect or floating, often tuft- or turf-forming (see notes p . 39). Leaves decussate or in whorls of $3-8$; submerged leaves linear, up to 15 mm long but usually less, rarely more than 0.5 mm wide; aerial leaves linear to lanceolate or ovate rarely more than 10 mm long but usually less. Bracts either leaf-like or ovate to obspathulate and somewhat inflated below; bracteoles linear, usually about as long as the calyx tube but sometimes longer or shorter. Flowers monomorphic, sessile, solitary, occasionally


Fig. 4. - R. mexicana (A.C, Schiede \& Deppe 566; D-F, Spruce 1850; G, H, Boivin 2692); A, flower; B, flower dissection; C, bract (A-C, "mexicana" type); D, E, flowers; F, bract ("spruceana" type); G, flower; $\mathbf{H}$, bract ("pusillus" type); I-O, see text (scale: A-H, 1 mm ).
cleistogamous. Calyx tube semi-globose, usually $0.5-0.75 \mathrm{~mm}$ long, red or pink; calyx lobes $3-5$ but usually 4 , widely deltate to triangular, $0.25-0.5 \mathrm{~mm}$ long; calyx appendages and interjected folds absent. Petals absent. Stamens $1-4$, usually included within calyx tube, but occasionally exerted. Ovary globose; style usually very short or rarely up to 0.3 mm long; stigma capitate; capsule globose, $0.5-0.75 \mathrm{~mm}$ diam. before dehiscence, red to purple occasionally with white spots, opening by 3 valves; seed semi-ovate, c. 0.3 mm long.

## DIAGNOSTIC FEATURES

$\mathrm{K}(3-) 4(-5), \mathrm{P} 0, \mathrm{~A}(1-) 2(-4), \mathrm{G} 3$; calyx (tube plus lobes) very rarely more than 1 mm long and petals absent. Like $R$. capensis but ovary and capsule globose and opening by 3 valves, not exceeding the calyx and leaves usually whorled.

## DISTRIBUTION

$R$. mexicana is found throughout the warmer parts of the world but is absent from the Congo Basin, N.E. Africa, Arabia and the Pacific Islands (Map 3).

## SELECTED SPECIMENS

Mexico: prope Hacienda de la Laguna, Oct., Schiede \& Deppe 566 (LE, MO); St. Chihuahua, Guerrero, 27 Sept. 1887, Pringle 1365 (G, MEL). Guatemala: Huehnetenango, Oct. 1876, Bernoulli \& Cario 2792 (LE). Panama: San Jose Island, c. 89 km S.S.E. Balboa, 22 Dec. 1945, I. M. Johnson 830 (MO, U); between Panama and Chepo, Nov. 1934, Hunter, Steyermark \& Allen 16721 (MO); Prov. Coclé, El Valle de Anton, 500 m, 2 Feb. 1935, Hunter \& Allen 366 (G). Cuba: s. loc. 1860-1864, Wright 2543 (G, LE, MO); Prov. Pinar del Rio, Pueblo Nuevo, 8 Oct. 1923, Ekman 17556 (G); Prov. Matanzas, Caimito de Hanabana, 8 Aug. 1923, Ekman 17015 (G). Colombia: Llanos de San Martin, Noca de Monte, Intendencia Meta, 300 m, 16 Aug. 1950, Galen Smith \& Idrobo 1396 (MO). Venezuela: Amazonas, Sanariapo, c. 100 m, 8 Sept. 1944, Steyermark 58493 (MO); Estado Bolivar, Cerro Cavilan (Cerro Carichana), $100 \mathrm{~m}, 21$ Dec. 1955, Wurdack \& Monachino 40910 (G).Surinam: Sipaliwini Savanna on Brazilian Border, 260 m, 30 Aug. 1968, Oldenburger, Norde \& Schulz 38 (U). Brazil: Roraima (Rio Branco), R. Surumu, Serra do Mel, Oct. 1909, Ule 8254 (G, L, U); Para, Santarem, Aug. 1850 Spruce 805 (G, LE, M); Para, Igarapé, Passarao, Aug. 1927, Luetzelburg 20762 (M); ibid., Apparecida, Aug. 1927, Luetzelburg 20763 (M); Mato Grosso, Nr. Santa Isabel (do Morro), Ilha de Bananal, 25 July 1968, P. W. Richards 6313 (U). Paraguay: Gran Chaco, Santa Elisa, lat. S. $23^{\circ} 10$, April 1903, Hassler 2852 (G); Concepción, Rio Apa to Aquidaban, lat. 22-230, Jan. (pre-1914), Fiebrig 5279 (G); Yague, Sept., Chodat \& Vischer (G). Argentina:

Misiones, Pesadas, Bonpland, Almacén Finlandés, 20 Jan. 1908, Ekman 1926 (ZT); Formosa, Guayculec, July 1917, Jörgensen 2348 (US), (fide Lourteig, Bol. Soc. Argent. Bot. 5(3): 145, 1954).

Senegal: Richard-Toll, Oct. 1951, Berhaut 1513 (BR, P); Niokolo-Koba, Hassirik, 21-23 Oct. 1958, Adam 15722 (P); Niokolo-Koba, Badi, 18 Nov. 1959, Adam 17067 (P). Guinea: Siguri, Sininko, Nov. 1935, Jaques Félix 521 (P). Mali: Saredina, Limons, Sept. 1962, Demange 1811 (P). Benin (Dahomy): Ouécé, Nov. 1910, Annet 41 (P). Nigeria: Nupe, 1858 Barter 898 (K); Adamawa Div., Vogel Peak, $8^{\circ} 25^{\prime}-11^{\circ} 50^{\prime}$ E., Gurum, 7 Nov. 1957, Hepper 1252 (K). Cameroun: 70 km E.N.E. Maroua, Guirvidig, 10 Oct. 1964, Letouzey 7248 bis (P); 13 km W.N.W. Yagoua, Gandjam, 1 Jan. 1965, J. \& A. Raynal 12831 (P). Chad: (fide Raynal, A., Adansonia ser. 2, 7(4): 540. 1967) Doro (?Yoro), 8 Dec. 1964 Audru 1907 (ALF). Central African Republic: Djur, 30 Aug. 1869, Schweinfurth 2432 (K, MEL, P, Z); Pangula, 26 km S.E. des Moroubas, 20 Oct. 1922, Tisserant 752 (P). Angola: Cuanza Norte, Cacuso, Pungo Adongo, lagoa de Quibinda, March 1857, Welwitsch 2337 (BM)I Uganda: ? Serere, Tozo, Dec. 1931, Chandler 319 (K). Tanzania: Kilimanjaro, 27 Aug. 1932, Geilinger 1097 (Z); Tanga Distr., 6.5 km E.N.E. Korogwe, 300 m, 27 June 1953, Drummond \& Hemsley 3044 (K); Songea Distr., Lumecha Bridge, 4 May 1956, Milne-Redhead \& P. Taylor 9387A (B, BR); 19 km E. Songea, 22 June 1956, Milne-Redhead \& P. Taylor 10866 (B, BR); 9.5 km S.W. Songea, 24 June 1956, Milne-Redhead \& P. Taylor 10890 (B, BR); Unyanyembe bei Malongwe, $1200 \mathrm{~m}, 8$ Jan. 1926, Peter 34447 (B); Useguta, Hale, 280 m, 13 Aug. 1918, Peter 24300 (B). Mozambique: (fide Fernandes in Fl. Zambes.) Mutuali, near Malema road, 29 May 1947, Pedro 3326 (LMA). Zambia: Kasama Distr., 105 km E. Kasama, 6 May 1962, Robinson 5160 (K, M); between Mazabuka and Kaleya, 15 April 1963, Van Rensburg 1914 (K); Mapanza, 14 March 1954, Robinson 621 (K); 5 km E. Mapanza, Simansunda, 28 March 1954 Robinson 651 (K); Masonna dambo, 11 April 1954, Robinson 863 (K); 9 km W. Pemba, Chepezami Dam, 21 April 1954, Robinson 706 (K). Malawi: Mangochi (Fort Johnson), Ciwalo V., 2 June 1955, Banda 105 (BM). Rhodesia (Zimbabwe): Salisbury, 2 May 1952, Wild 3812 (K); Matobo, May 1957, Miller 4355 (K). South West Africa (Namibia): Okavangobucht, Niangana, Mid. May 1934, Dinter 7625 (B). Republic of South Africa: Transvaal, Nr. Pretoria, 19 Nov. 1901, Kirk (K). Malagasy Republic: s.l. Boivin 2692 (P); delta de la Betsiboka, Maevarano, Perrier (P); Tampoketsa, 27 March 1973, Jaquemin 1300 (P); Tsaraon, Diago, Bernier (P).

India. Rajasthan: Mt. Abu, Oct. 1916, Blatter \& Hallberg 3275, 3276, 3280, 3281 (BLAT), fide Blatter \& Hallberg, J. Bombay Nat. Hist. Soc. 25: 704. 1918. Uttar Pradesh: Dehra Dun, Pholhot, c. 600 m, Nov. 1892, Gamble (K); Dehra Dun, Lachiwala, 25 Aug. 1927, Parker (MEL). Bihar: Chota Nagpur, Parasnath, 17 Nov. 1874, Clarke 24840 (K); ibid., 18 Nov. 1874, Clarke 24856A (K); ibid., 24856B (LE); ibid., 17 Oct. 1883, Clarke 33811 (B, G, K, Z); ibid., Chota Nagpur, hazaribagh, c. 700 m, 21 Nov. 1874, Clarke 24965 (K); Chota Nagpur, Jusphore, Sirgorja 800 m, 5 Nov. 1885, Clarke 34001 (K). Orissa: Keonjhar, Pipokhri, c. 100 m, 1 Oct. 1946, Mooney 2760 (K). Andhra

Pradesh: Hyderabad, Osmania University Campus, 400 m, 23 Sept. 1967, Rajagopal 352 (K). Karnataka (Mysore): N. Kanara, Kadra, 6 Oct. 1885, Talbot 1317 (K). Kerala: Badagara, Madappalli, Vasudewan H2830' 65 (K); Prov. Kottayam, between Kottayam and Vaikom, 21 Sept. 1973, Cook, Rix \& Schneller 320 (K, Z); Prov. Quilon, Quilon, ? 1975, N. Ravi (Z). Sikkim: Labhath, c. 2500 m, Ribu \& Rhomoo (fide Blatter \& Hallberg l.c.). Assam: Khasi Hills, c. 650 m, Hooker \& Thompson (K). Bangla Desh: between Titalya and Silligoree, Oct. 1868, S. Kurz (? CAL, fide Blatter \& Hallberg 1.c.); perhaps Bangla Desh, N. Bengal, S. Kurz (K). Burma: Sagaing, Mawlaik (upper Chindwin), Sittaung, Dec. 1907, Meebold 7808 (K); Irrawaddi, Pegu, Jan., S. Kurz 1967 (? CAL, fide Blatter \& Hallberg l.c. p. 703). Thailand: Nakhon Sawan, Tak (Wang Djao), $100 \mathrm{~m}, 14$ Oct. 1904, Hosseus 122A (M). China: Po Hai (Chihli Prov.), T'ien-hing (Tientsin), 1912, Clemens 1907 (BR). Taiwan-Hsinchu: 21 July 1934, Shimada (TAI); Sengari, 25 Sept. 1930, Isikawa (TAI). Korea: North; Czashigau, Vallis, 28 Aug. 1897, Komarov, ? 1128 (K); South, Seoul (Seohl), 11 Sept. 1906, Faurie 1178 (KYO); South; Cheju Do (Quelpaert), 22 Sept. 1908, Taquet 1461 (KYO). Japan. Honshu: Akita, 6 Sept. 1894, Faurie 13772 (G, K); Pref. Iwate, Mizusawa-cho, 9 Sept. 1937, Iwabuchi 5575 (KYO); Pref. Hyogo, Ichiba-mura, 27 Aug. 1935, Arakai 13636 (KYO); Pref. Hyogo, Higami-cho, 16 Aug. 1944, Hosomi 9012 (KYO); Pref. Saitama, Kobayasgi, Shobu-machi, Minamisaitama-qun, Makino 121180 (MAK); Pref. Tokyo, Omiyahachiman, Suginami-ku, Makino 121182 (MAK); Pref. Tokyo, Komaba, 12 Oct. 1911, Onuma (Z); Yokohama, 1862, Maximowicz (K); Pref. Wakầyama, Okazaki, Wakayama City, Makino 121188 (MAK); Pref. Mino, Gunjogun, 6 Sept. 1925, Shivta (KYO); Pref. Tango, Naka-gun, Ikaga-mura, 24 Sept. 1950, Nakai 4925 (KYO); Pref. Yamashiro, Kyoto, 5 Sept. 1942, Nakai 365 (KYO); Pref. Bungo, Makino 121197 (KYO); Kawahara, 6 Oct. 1940, Hara N19140 (K); M(N)idumatsuka, 23 Aug. 1890, Iwakiri \& Rikuzen (K); Chefao, 2 Sept. 1920, Cowdrey 924 (K); Suwa-no-Ike, 27 Aug. 1939, Hara N73/39 (K); Pref. Tanaba, Yagityo, Funaigun, 7 Sept. 1958, Murata 12156 (KYO); Pref. Yamaguchi, Mysonji, 30 Aug. 1939, Murata (KYO); Pref. Musachi, 3 Nov. 1893, Matsuda (KYO); Pref. Shiznoka, Morokawato, 100 m, 20 Sept. 1959, Ohmura 18442 (KYO); Pref. Settsu, Fushia-cho, 6 Aug. 1957, Tamimoto (KYO); Pref. Nagano, 17 Aug. 1913, Matsuda (KYO). Kyushu: Pref. Kumamoto, Shinkai, 28 Oct. 1951, Shimada 9864 (KYO); Pref. Kagoshima, Airagun, 4 Oct. 1964, Hatusima \& Sako 28451 (KYO). Shikoku: Pref. Kochi, Kuhokawa-oho, 4 Oct. 1967, Yamanaka 51106 (KYO); Pref. Yamato, Katagiri-tyo (Matsuo-yama), 28 Oct. 1956, Murata 10472 (KYO). Philippines-Luzon: Rizal, Oct. 1914, Merrill 9483, (K); Rizal, Montalban, Jan. 1912, Loher 12700 (M); Rizal, Caloocan (Calocan), Nov. 1903, Merrill 3659 (K); Luzon, Loher 2143 (K); Data, Benguet, 2260 m, Loher 2142 (K). Philippines-Mindanao: March 1904, Copeland 430 (K); Davao, 400 m, 26 Aug. 1949, Edano 1791 (L). New GuineaIrian (Jaya): Tjendrawasih (Vogelkopp Peninsular), Kebar Valley, 520 m , 16 Oct. 1961, Van Royen \& Sleumer 6707 (L); Kebar Valley, c. 100 km W. Manokwari, 550 m, 13 Nov. 1954, Van Royen 5045 (L). New Guinea-Papua:

Morehead River, c. 13 km inland at $141^{\circ} 30^{\prime}$ E., 12 Aug. 1967, Pullen 7040 (K, L); Daru, $9^{\circ} 05^{\prime} \mathrm{S} .-143^{\circ} 15^{\prime} \mathrm{E} .8$ June 1973, Henty NGF 49587 (L); Port Moresby, Boroko, 20 June 1970 Robbins 4286 (L); Rubulogo Creek 29 km N. Port Moresby, 11 April 1967, Pullen 6668 (L); ibid., Pullen 6669 (K, L); Mabaduan, April 1936, Brass 6536 (L); Kanosia, 1 March 1935, Carr 11557 (L). Indonesia-Java: Magelang, Madioen, 350 m, 25 Feb. 1930, Backer 36596 (L); Sukamandi, 10 m, 14 Feb. 1974, Häfliger (ZT).

Australia. Northern Territory: Port Darwin, March 1870, Schultz 318 (K, MEL); Groote Eylandt, Hemple Bay, 1 May 1948, Specht 347 (L, MEL, both mixed with $R$. occultiflora); 3 km E. Mt. Todd Battery, 27 Feb. 1965, Wilson 361 (K, NSW); Katherine, 16 Feb. 1961, McKee 8499 (K, L, NSW); Victoria River, May 1856, F. v. Müller (K, MEL); Depot Creek, F. v. Müller (K); 10 km N.N.E. Edith River Siding, 10 March 1965, Lazarides \& Adams 134 (L); Sturts Creek, F. v. Müller (K, MEL, NSW); Alice Springs, Morphelt Creek, 9 March 1959, Chippendale 5415 (K, NSW); c. 146 km N.N.E. Pine Creek Township, Baroalba Island, 24 March 1965, Lazarides \& Adams 317 (L.); Bickerton Island, $13^{\circ} 45^{\prime}$ S. $-136^{\circ} 6^{\prime}$ E., 7 June 1948, Specht 473 (K, L, MEL, NSW). Queensland: New Holland, 1770, Banks \& Solander (NSW); Cape York Pen., Portland Roads, 10 m, 1 June 1948, Brass 18982 (G, K, L, LE); Laura, 22 June 1949, Roadway 15135 (NSW); Dimbulah on Petford Road, 500 m , 30 April 1962, McKee 9412 (K, L); Atherton, Middle Claudie River, $12^{\circ}{ }^{\circ} 5^{\prime}$ S.$143^{\circ} 1^{\prime}$ E. ., 28 June 1972, Irvine 291 (L); Cairns, Davies Creek, Lamb Range, 600 m, 4 June 1967, Brass 33560 (K, L); Cook Distr., N.W. Cairns, 21 May 1962, Blake 21795 (L, NSW); Atherton, Aug. 1901, Betche (NSW); Normanton, $17^{\circ} 45^{\prime} \mathrm{S} .-140^{\circ} 57^{\prime} \mathrm{E} ., 24$ April 1974, Lodd 1225 (NSW).

## NOMENCLATURE

The type specimen of Rotala decussata in the De Candolle herbarium at Genève (G-DC) is in accordance with De Candolle's diagnosis in the Prodromus 3: 76 (1828). The specimen was collected from the Endeavour River, Queensland, Australia, it is poor but can certainly be assigned to Rotala mexicana Cham. \& Schlecht., Linnaea 5: 567 (1830). Bentham in Flora Australiensis 3: 296 (1866) reduced $R$. decussata DC. to a variety of Ammannia pentandra Roxb., Flora Indica 1: 448 (1820). From Bentham's diagnosis it is apparent that he had not consulted De Candolle's material. On botanical grounds Bentham's move cannot be supported. Hiern in Oliver, Flora of Tropical Africa 2: 467 (1871) reinstated R. decussata DC. as a species including $A$. pentandra Roxb. as a synonym. This move is, of course, against the nomenclatural rules, concerning priority. Hiern's description is not in accordance with $R$. decussata DC. nor with $A$. pentandra Roxb. but refers to a distinct African species. KOEHNE (1880 and 1903) accepted Hiern's description and cited the species as " $R$. decussata Hiern". This citation was accepted in numerous African floristic works until Exell (Bol. Soc. Brot. Sér. 2, 30: 70. 1956) pointed out this nomenclatural nonsense and correctly named

Hiern's species $R$. welwitschii. Exell, however, passed no judgement on the identity of $R$. decussata DC.

Rotala decussata DC. quoad typum is conspecific with $R$. mexicana Cham. \& Schlecht., but predates it. In terms of priority R. decussata DC. should be accepted in favour of R. mexicana Cham. \& Schlecht. In Australia since Bentham's Flora (1866) R. decussata DC. has been assigned to the $R$. pentandra group and is usually misidentified $R$. densiflora (Roemer \& Schultes) Koehne. In Africa, until 1956, the name R. decussata has been widely used for $R$. welwitschii. If one accepted $R$. decussata as the correct name for $R$. mexicana this would have the consequence that the epithet "decussata" which has been used for two different species, one in Australia and one in Africa would have to replace $R$. mexicana a well known species which, of course, occurs in both continents. Since Bentham (1866), the name R. decussata DC. has never been correctly applied. In accordance with Article 69 of the code of nomenclature (1978), the name Rotala decussata should be rejected as it has been widely and persistently used for taxa not including its type. I intend to place the name Rotala decussata on the list of nomina rejicienda. Should $R$. decussata DC. quoad typum be considered specifically distinct from $R$. mexicana then the name R. diglossandra Koehne could be accepted.

## VARIATION

R. mexicana is a widespread and very variable species. Not only does it show considerable phenotypic plasticity but there is ample evidence of genecological differentiation. I have cultivated material collected in India (Kerala, Cook, Rix \& Schneller 320) at Zürich. From experience with cultured plants, $R$. mexicana is an obligate annual and genetically selfcompatible. It is usually autogamous and the high degree of inbreeding may help in understanding the often apparently irrational distribution of minor variants. The variation is described under different headings but without more experimental evidence no attempt is made to recognise the variation in terms of taxonomic categories.

Growth form. - Plants growing in water 10 cm or more deep usually have stems branched below and simple above (Fig. 4I); the submerged leaves are linear, thin, translucent and usually in whorls of 4 but in Australia whorls of up to 8 are found. When submerged plants are stranded on land, the submerged leaves die and numerous erect shoots develop from the tips of the stems. This secondarily terrestrial state is usually turf-forming or caespitose (Fig. 4J). When seeds germinate in shallow water or on wet soil, the form of the plant is usually controlled by the density of the seedlings or competition with other plants. When many $R$. mexicana seeds germinate together without excessive interspecific competition the plants are usually erect and unbranched and are turf-forming (Fig. 4K). When the plants are less dense, the main stem is creeping; in some races it remains creeping (Fig. 4 N ) and in other
races the prostrate stem develops numerous simple erect lateral branches (Fig. 4L). Creeping stems usually develop leaves in pairs. In competition with other plants, the main stem is erect with lateral branches; when the main competitors are grass-like plants, the lateral branches are simple and erect (Fig. 4M) and in competition with low growing forbs the lateral branches are spreading and secondarily branched (Fig. 4O).

Some races of $R$. mexicana have stems which remain prostrate and creeping. I have had a creeping race collected in S. India in cultivation at Zürich; irregardless of planting density, underwater or on land it remains prostrate. However, other collections which develop erect stems underwater are indistinguishable from the creeping race when cultivated on wet mud. In S. India I have seen both races growing together. In India this race is frequently called R. pygmaea, however, indistinguishable plants have also been seen in S.E. Asia, Africa, and S. America.

Leaves. - The number of leaves at each node varies from 2 to 8 . The commonest number is 3 . In some plants the number of leaves in each whorl remains constant while in other plants it is variable, for example, plants from North-Australia have been seen (McKee 9412) with 8 leaves at the base of the stem grading to paired, decussate leaves above.

Bracts. - The bracts are usually leaf-like but somewhat shorter than normal foliage leaves. Occasionally they are ovate to obspathulate with somewhat inflated bases (Fig. 4F). This kind of bract develops late in ontogeny; the lower (older) bracts are usually leaf-like. Plants with obspathulate bracts are found in South America where they are often given the varietal name "spruceana" and Australia where they are often named " $R$. diglossandra".

Bracteoles. - The bracteoles are usually from 0.5 to 0.75 mm long and are equal to or shorter than the calyx tube. In northern Australia, plants are found with bracteoles up to 2 mm long and exceeding the calyx lobes; this race has been named $R$. longibracteolata.

Sepal lobes. - The number of sepal lobes varies from 3 to 5 . The commonest number is 4 . Some individual plants (for example, the type of Hypobrichia spruceana) has 3-, 4- and 5-lobed calyces on the same stem. Some plants from Brazil have exclusively 5 lobes but no plant with exclusively 3 lobes has been seen.

Stamens. - The commonest number of stamens is 2 but flowers with 1 or 3 stamens are often found. This variation may be inter- or intra-plant. One specimen (Ekman 17015, from Cuba) has been seen with 4 stamens, however, most of the flowers on this specimen have 3 stamens.

Capsule. - The capsule before dehiscence varies in colour from bright red to dull straw. In America and Australia the capsule often has distinct rows of regularly spaced, white spots. Normally, R. mexicana has 3 capsule valves, occasionally one valve does not split thus giving the appearance of 2 , unequal
valves. Literature reports of 2 -valved plants are probably due to missinterpretation when one valve fails to split or, more often, due to confusion with $R$. capensis which is regularly 2 -valved but superficially somewhat similar to R. mexicana.
7. Rotala occultiflora Koehne, Bot. Jahrb. 1: 152. 1880.

- Rotala braceata Blatter \& Hallberg, nom. in sched.

Type: India, Malabar, Concan, Laws, Hooker fil. \& Thomson (holotype: K ; isotype: L).

Ic.: Fig. 5A-I.


Fig. 5. $-R$. occultiflora (A-E, Sedgwick \& Bell 7433, India; F-I, Schodde AE 75, Australia); $\mathbf{A}, \mathbf{F}$, flowering whorls; B, G, flowers at anthesis; C, flower dissection; $\mathbf{D}, \mathbf{H}$, bracteoles; E, I, bracts (scale: A-I, 1 mm ).

Amphibious annual. Stems creeping and branching below, erect above, up to 10 cm long. Leaves in whorls of 3 or rarely 4 or decussate; submerged leaves linear, up 12 mm long, usually whorled; aerial leaves linear to ovate, usually less than 10 mm long. Bracts leaf-like or obspathulate and at base often boat-shaped and partly enclosing the bracteoles and flower, up to 10 mm long, at apex obtuse to bifid; braceoles 2, bract-like, ovate to obspathulate and at base often boat-shaped and partly enclosing the flower, at apex truncate to bifid. Flowers monomorphic, sessile, solitary, occasionally cleistogamous. Calyx tube membranous translucent, sub-urceolate, c. 1 mm long; calyx lobes 5 , triangular to deltate, not spreading, up to 0.4 mm long; calyx appendages and interjected folds absent. Petals absent. Stamens 3 , perhaps occasionally more or less, inserted near base of calyx tube; anthers included in calyx tube. Ovary ellipsoidal; stigma subsessile, capitate: capsule ellipsoidal, c. 1.5 mm long, somewhat longer than the calyx, opening by 3 valves; seeds semi-ellipsoidal, $0.4-0.5 \mathrm{~mm}$ long, usually black.

## DIAGNOSTIC FEATURES

K5, P0, A3, G3; bracteoles large, leaf-like, partly enclosing the flower. Like Rotala mexicana but capsule ellipsoidal and somewhat longer than the calyx, calyx tube sub-urceolate, transparent and calyx lobes consistently 5 and not spreading at anthesis.

## DISTRIBUTION

$R$. occultiflora is found in the western part of Peninsular India from about $14^{\circ} \mathrm{N}$. to $20^{\circ} \mathrm{N}$. and in western and northern Australia (Map 9).

SELECTED SPECIMENS

India: Malabar, Concan, Laws, Hooker fil. \& Thomson (K, L); Nr. Lonav(u)du, Malavli, 650 m, Sept. 1920, Sedgwick \& Bell 7433 (K); Karnataka (Mysore): N. Kanara, Shirjan, 160 m, Nov. 1929, Ambo 6877 (K); N. Kanara, Yellapur (Yellapore), 21 Oct. 1884, Talbot 273 (K); ibid., Talbot 1332 (K); Shimoga, 760 m, Oct. 1908, Meebold 10281 (fide Blatter \& Hallberg, J. Bombay Nat. Hist. Soc. 25: 705. 1918); Maharashtra (fide Blatter \& Hallberg): Bombay Island, at Sion, Blatter \& Hallberg 3277 (BLAT); Salsette, between Andheri and Marol, Blatter \& Hallberg 3303 (BLAT); Igatpuri Blatter \& Hallberg 3304, 3279 (BLAT); Khandalla, Blatter \& Hallberg 3278 (BLAT).

Australia. Western Territory: between King Island on Exmouth Gulf, 1916, Basedow (NSW). Northern Territory: Port Essington, 1840, Armstrong 522 (K); Groote Eylandt, Hemple Bay, 1 May 1948, Specht 347 (K, L, MEL, NSW - L and MEL material mixed with $R$. mexicana); Arnhemland, Adelaide River, 27 July 1971, Balgooy \& Byrnes 1410 (L); Shoalwater Bay, $R$. Brown 4471 (K); Arnhemland, Waterfall Creek, U.D.P. Falls, 150 m, 26 July

1971, Balgooy \& Byrnes 1389 (L); 30 km N. Katherine, Edith Falls, 14 April 1967, Adams 1762 (L, NSW); Herbert River to Carpenteria, Dittrich (MEL, NSW - mixed with $R$. mexicana); Nicholson River, $17^{\circ} 15^{\prime} \mathrm{S} .-137^{\circ} 29^{\prime} \mathrm{E}$., 11 June 1974, Henshall 389 (NSW); Nourlangie Billabong, 8 June 1972, Schodde AE75 (K, L).

NOTES
Variation. - Although I have seen less material of $R$. occultiflora than $R$. mexicana the variation spectrum of its vegetative parts closely parallels that of $R$. mexicana. Both species are patristically related and this variation may be considered to be homologous. In India some plants have been seen with obspathulate bracts and bracteoles (Sedgwick \& Bell 7433, Fig. 5A, D, E) which are not found in Australia. Koehne (Bot. Jahrb. 4: 387. 1883) described a variety (var. leichhardtii) for Australian material which cannot be upheld on the basis of the material I have studied.
8. Rotala floribunda (Wight) Koehne, Verh. Bot. Vereins Prov. Brandenburg 19 (Sitz. 41): 49. 1877 三 Nimmonia (Nimmoia orth. mut.) floribunda Wight, Madras J. Lit. Sci. 5: 312, t. 20. $1837 \equiv$ Ameletia floribunda (Wight) Wight in Hooker, Ic. Pl. Ser. 2, 5: t. 826. $1840 \equiv$ Ammannia floribunda (Wight) Clarke in Hooker fil., Fl. Brit. India 2: 567. 1879.

Type: India, Maharashtra, Mahabaleshwar, Nimmon (holotype: CALMH?; Wight's illustration, loc. cit. is good and may be used as a standard pending examination of the holotype).

Ic.: Fig. 6; Wight, Madras J. Lit. Sci. 5: t. 20. 1837; Hooker, Ic. Pl. Ser. 2, t. 826. 1840.

Amphibious or terrestrial herb. Stems often shortly creeping at base, erect above, up to 40 cm tall, reddish, at base angular, terete above and very slender, branched towards apex. Leaves sessile, alternate, opposite or in fascicles (on the same plant); submerged leaves linear, up to 50 mm long, up to 2 mm wide, flaccid; aerial leaves linear to lanceolate, rarely more than 5 mm long and 0.5 mm wide, rigid, and somewhat ericoid in appearance, green or tinged, with red, at base cuneate to auriculate and clasping, at apex acute. Bracts at base of inflorescence leaf-like, about as long as the flower, at apex of inflorescence braceole-like, c. 2 mm long; bracteoles 2, linear to lanceolate, relatively thick and green or tinged with red, up to 2 mm long. Flowers dimorphic, heterostylous, subsessile or with an up to 1.5 mm long pedicel, in dense, terminal, more or less remote, globose racemes. Calyx tube elongate-campanulate, c. 2 mm long, membranous, pale green tinged with pink above, weakly 4-nerved; calyx lobes 4 , deltate, c. 0.5 mm long, pink or


Fig. 6. - R. floribunda (Stocks \& Law); A, habit; B, "thrum" flower at anthesis; C, "pin" flower dissection; $\mathbf{D}$, "thrum" flower dissection (scale: $\mathbf{A}, 1 \mathrm{~cm} ; \mathbf{B}-\mathbf{D}, 1 \mathrm{~mm}$ ).
rose; calyx appendages and interjected folds absent. Petals 4, showy, bright rose, obovate, $1-1.5 \mathrm{~mm}$ long. Stamens 4 , inserted on the lower third of the calyx tube; filaments either c. 1 mm or c .4 mm long, anthers either included in calyx tube or borne above the petals. Ovary ellipsoidal; styles either c. 0.5 mm or c .3 .5 mm long; stigmas deeply 2 -lobed, borne either above or below the anthers; capsule ovoid to ellipsoidal, opening by 2 valves; seeds semiellipsoidal, c. 0.4 mm long.

## DIAGNOSTIC FEATURES

K4, P4, A4, G2; leaves arranged irregularly; aerial leaves ericoid; stigmas deeply 2-lobed; upper bracts remembling bracteoles; distylous.

## DISTRIBUTION

India, Maharashtra, local endemic confined to Mahabalaeshwar Hills (Map 4) at an altitude of about 1500 m . It flowers in December and January. It grows in dense patches on rocks and in small rock pools.

SELECTED SPECIMENS
India: Maharashtra, Mahabaleshwar Hills, s.d., Stocks \& Law (BR, CGE, G, K, L, LE, M); ibid., Ralf 166 (CGE, K); ibid., 1848, Hooker (K); ibid., Dec. Inder (K); ibid., Dec. 1918, Sedgwick \& Bell 4600 (K); ibid., Dec. 1920, Sedgwick \& Bell 7757 (K); ibid., Jan. 1892, Cooke (K); ibid., s.d., Ritchie (K); without locality, 1902, Gibbs (K); ibid., Dalzell (K).

NOTES
An attractive plant locally called Mahableshwar heather. It is remarkable for its combination of aquatic and xerophytic characters. It shows relationships on one hand to the widespread Asian species R. rotundifolia, and on the other to the Ethiopian species $R$. repens.
9. Rotala repens (Hochst.) Koehne, Verh. Bot. Vereins Prov. Brandenburg 22 (Sitz. 73): 24. $1880 \equiv$ Rhyacophila repens Hochst., Flora (Regensburg) 24: 659. $1841 \equiv$ Quartinia repens (Hochst.) Endl. ex Walp., Rep. Bot. Syst. 5(4): 673. 1846.
$=$ Quartina turfosa A. Richard, Tent. Fl. Abyss. 1: 227. 1847. Type: Ethiopia, 1839-1843, Quartin, Dillon \& Petit (holotype: P; isotype: P).

Type: Ethiopia, distr. Sanna, Docheli, 1 Nov. 1839, W. Schimper 729 (holotype: ?; isotypes: B, BM, BR, G, L, LE, M, MEL, P, Z, ZT).

Ic.: Fig. 7A-C.
Aquatic perennial. (It grows in flowing water and looks as if it may have a rhizome resembling a podostemaceous thallus but I have not seen well collected material of the stem base). Stems floating, variously branched, flexible, terete, up to 50 cm long, often denuded of leaves below, reddish. Leaves submerged, tinged red, capillary up to 35 mm long, $0.1-0.5 \mathrm{~mm}$ wide, irregularly arranged (alternate, opposite or whorled on the same stem),


Fig. 7. $-R$. repens (A, Taylor 3412; B, C, Steudner 1165); A, habit; B, flower; C, flower dissection (scale: A, $1 \mathrm{~cm} ; \mathbf{B}, \mathbf{C}, 1 \mathrm{~mm}$ ).
numerous, covering the stem above, at apex acute. Bracts oblinear to lanceolate, up to 1.75 mm long, borne below the flower on the distal end of the pedicel: bracteoles 2, bract-like, lanceolate, up to 1.5 mm long, on any single flower slightly shorter and narrower than the bract. Flowers monomorphic, borne on simple but irregularly branched, emergent, terminal racemes, each flower borne on a c. 2 mm long pedicel. Calyx tube membranous, campanulate or cup-shaped, c. 1 mm long; calyx lobes 4 , shallowly triangular, c. 0.25 mm long; calyx appendages and interjected folds absent. Petals 4, pink or white, rhomboidal, scarcely exceeding the calyx lobes. Stamens 4, inserted near base of calyx tube; filaments c. 1.5 mm long; anthers borne above the petals. Ovary ellipsoidal to ovoid; style up to 1 mm long; stigma obconical, borne level with the anthers; capsule ovoid, c. 1.5 mm long, opening by 2 valves; seeds semi-ellipsoidal, c. 0.5 mm long.

## DIAGNOSTIC FEATURES

K4, P4, A4, G2; leaves irregularly arranged, developing only submerged in water, petals rhomboidial; bracts like bracteoles, borne on the distal end of the pedicel. Like R. floribunda but lacks ericoid, aerial leaves, flowers monomorphic with long style and stamens.

## DISTRIBUTION

$R$. repens is found in flowing water in the Ethiopian highlands and on Mount Elgon (Map 2). From the somewhat limited information it is found at an altitude of 1300 m to 2200 m .

SELECTED SPECIMENS
Ethiopia: s. loc., Schimper 33 (BR, G, LE, P, ZT); Schire (Chire), Quartin, Dillon \& Petit (P); Gondar, 23 Jan. 1862, Steudner 1165 (LE, Z); Ifag, c. 2000 m, 18 Oct. 1863, Schimper 1380 (BM, Z); Docheli, Sanna, 1 Nov. 1839, Schimper 729 (B, BM, BR, G, L, LE, M, MEL, P, Z, ZT); Lac Tana, Zeghie, 19 Feb. 1937, Pichi-Sermolli 262 (BR); Tana, Isola Dek, 22 Feb. 1937, PichiSermolli 263 (MO); Lac Tana, May 1909, Rousseau (L, MO); Abai, 17 March 1881, Stecker (L, MO); Kurudelungu, July 1939, coll. illeg. (BR). Uganda: Prov. Bugisu, Mt. Elgon, Sipi, 2160 m, Sept. 1934, Synge S1161 (BM); Mt. Elgon, Greek River, 1300 m, Jan. 1936, Eggeling 2496 (BR). Kenya: Trans Nzoia Distr., River Swan, Karamoja drift, 1660 m, 18 Feb. 1935, G. Taylor 3412 (BM, MO).
10. Rotala hexandra Wallich ex Koehne, Bot. Jahrb. 1: 167. 1880 三 Ammannia hexandra Wallich, Cat. No. 2103, nom nud.
$=$ Rotala kainantensis Masamune, Trans. Nat. Hist. Soc. Taiwan 33: 251. 1943. Type: China, Kwangtung, Hainan Tao (Kainanto), Ryosui, 1940, Masamune \& Fukuyama 503 (holotype: TAI n.v.).

- Rotala stipulata Blatter \& Hallberg, J. Bombay Nat. Hist. Soc. 25: 710. 1918, nom. invalid., based on the type of $R$. hexandra.

Type: Burma, Segaen in Ava, Wallich 2103 (holotype: K-W; isotypes G, K, LE).

Ic.: Fig. 8A-D.
Amphibious annual or perhaps perennial. Stems creeping and rooting below, erect above, up to 40 cm tall, sharply 4 -angled to 4 -winged. Leaves decussate, sessile, lanceolate to oblong, $1-3 \mathrm{~cm}$ long, at apex obtuse;


Fig. 8. - R. hexandra (Wallich 2103); A, B, flowering nodes; C, flower; D, flower dissection (scale: $\mathbf{A}, \mathbf{B}, 5 \mathrm{~mm} ; \mathbf{C}, \mathbf{D}, 1 \mathrm{~mm}$ ).
submerged or lower leaves cuneate to cordate at base; aerial or upper leaves cordate to auriculate at base; stipule-like outgrowths situated on the nodes near the leaf bases present, subulate, up to 2 mm long, caducous, not to be confused with bracteoles; similar but smaller structures occasionally found on the nodes between the leaf pairs. Bracts leaf-like, usually enclosing young flowers, at base usually auriculate, associated stipule-like outgrowths present; bracteoles scareous, linear, not more than 1 mm long; a second pair of microscopically small bracteoles often present in axils of normal bracteoles. Flowers monomorphic (?), solitary, shortly pedicellate, often cleistogamous and borne underwater. Calyx tube campanulate, c. 2 mm long, with distinct nerves between the calyx lobes; calyx lobes 6 , shallowly triangular, c. 0.5 mm long; calyx appendages absent. Petals 6, obovate to oblanceolate, c. 1 mm long, usually somewhat erose at margin. Stamens 6; filaments attached near base of calyx tube, appearing almost free; anthers exerted. Ovary globose, 4-locular; style exerted, c. 2 mm long, peristent; stigma capitate; capsule subglobose, c. 2.5 mm long, apparently breaking up at maturity (characteristic Rotala stripes present); seeds semipyriform, 0.6-1.0 mm long.

## DIAGNOSTIC FEATURES

K6，P6，A6，G4；stipule－like outgrowths；minute bracteole pairs in axils of normal bracteoles；flowers 6－merous；capsule breaks into pieces at maturity．

DISTRIBUTION
Burma，China－Hainan Tao，Philippines and Java；flowering time from July to December（Map 4）．

SELECTED SPECIMENS
Burma：Sagaing（Segaen），Ava， 4 Nov．1826，Wallich 2103 （G，K，K－W， LE）；Moulmein，1859，Parish 216 （K）．China：Kawangtung，Hainan Tao （Kainanto），Ryosui，1940，Masamune \＆Fukuyama 503 （TAI n．v．）．Philip－ pines：Luzon Centr．，San Fransisco del Monta， 8 Dec．1893，Loher 2154 （K， M）．Indonesia，Java：Bogor（Buitenzorg），Tegal Sapi， 30 July 1922，Bakhuizen van den Brink 1519 （U）；cultivated in Bogor Botanic Garden， 22 April 1927， Schröter（ZT）．

NOTES
I have not yet seen a really complete，well preserved specimen of this species．It is not certain if it is perennial or annual．The capsule has no obvious valves and appears to break up at maturity，I have sectioned a young capsule and seen 4 locules；the characteristic transverse stripes of Rotala are visible on the capsule wall．A pair of small bracteoles are present in the axils of some bracteoles which may be an indication that the solitary flower of Rotala is derived from a cymose inflorescence like that found in most other genera of the Lythraceae．The small stipule－like outgrowths around the nodes are characteristic for this species but unique in Rotala and all other Lythraceae that I have examined．

11．Rotala rotundifolia（Buch．－Ham．ex Roxb．）Koehne，Bot．Jahrb．1： 175. 1880 三 Ammannia rotundifolia Buch．－Ham．ex Roxb．，Fl．Ind．ed．1，1： 446． 1820 三 Ameletia rotundifolia（Buch．－Ham．ex Roxb．）Dalz．\＆Gib－ son，Bombay Fl．96．1861，non Wight，Ic．Pl．Ind．Or．1：t．258． 1840.
$=$ Ammannia subspicata Bentham in Hooker，London J．Bot．1：484． 1842三 Ameletia subspicata（Bentham）Bentham in Hooker，Bot．Kew Gard． Miscell．4：81．1852．Type：Hong Kong，1841，Hinds（holotype：K，iso－ type：LE）．
－Ammannia orbiculata Heyne，nom．in sched．
Type：India，＂plants sent from Lukshmeepora and Malda where they are indigenous，flowered in（Calcutta）botanic garden during the cold season

1797"; holotype: ? CAL; Roxburgh, Fl. Ind. Plate No. 1344 in K is an accurate illustration and may be used as a standard pending discovery of the holotype.

Ic.: Fig. 9A-D.
Special literature: Vos, O. C. de, The anatomy of the shoot apex of Rotala rotundifolia (Roxb.) Koehne (Lythraceae). Acta Bot. Neerl. 23(1): 7-18. 1974 - the material used in this study could be $R$. macrandra.


Fig. 9. - R. rotundifolia (Onuma 19082); A, habit; B, bract; C, flower; D, floral dissection. R. macrandra (Meebold 10284); E, habit; F, bract; G, flower; H, flower dissection (scale: A, E, $1 \mathrm{~cm} ;$ B-D, F-H, 1 mm ).

Amphibious perennial or perhaps occasionally annual. Stems branched and often somewhat woody below, creeping or floating, up to 40 cm or more long, usually simple and 4 - or occasionally 6 -angled above. Leaves decussate or occasionally in whorls of 3 , sessile or shortly petiolate, variable in form and colour; submerged leaves linear to orbicular, up to 2 cm long, green, grey or red or grey-green on adaxial surface and red or purple on abaxial surface; aerial leaves obovate to orbicular, up to 2 cm long and 2.5 cm wide, green or occasionally red on abaxial surface; leaf nerves distinct, pinnate, green, white or red. Bracts ovate, $1-4 \mathrm{~mm}$ long, usually longer than wide; bracteoles c. 1 mm long, about equal to calyx tube in length, linear to lanceolate, scarious. Flowers monomorphic, subsessile, solitary in axils of bracts; inflorescence distinct, a many-flowered, usually pedunculate raceme, dense at early anthesis, elongate, lax (stem visible between nodes) in fruit. Calyx tube campanulate c. 1 mm long, membranous, green tinged with pink, with 4 riblike nerves; calyx lobes triangular, up to 1 mm long, green or pink; calyx appendages and interjected folds absent. Petals 4, obovate, 2 to 3 times as long as calyx lobes, bright rose. Stamens 4, filaments inserted near base of calyx tube, c. 1.5 mm long; anthers level with middle of calyx lobes. Ovary globose; style up to 0.5 mm long; stigma peltate, discoid, relatively massive, about 0.3 mm diam., level with anthers; capsule globose, c. 1.5 mm diam., opening by 4 valves; seeds semi-ellipsoidal, c. 0.5 mm long.

## DIAGNOSTIC FEATURES

K4, P4, A4, G4; like $R$. macrandra but bracteoles about as long as calyx tube, filaments c. 1.5 mm long, anthers borne level with the calyx lobes, style not more than 0.5 mm long, stigma relatively massive and about 0.3 mm diam., inflorescence somewhat lax in fruit.

## DISTRIBUTION

South and Southeast Asia from India to Japan (Map 5), mostly in mountainous regions, growing up to 2650 m in China. Flowering specimens have been collected throughout the year but the majority have been collected from January to April. For further ecological information see Rotala macrandra p. 56.

## SELECTED SPECIMENS

Pakistan or India - exact locality uncertain: Punjab, Thompson (CGE, G, K, L, M); N.W. India, Royle (K); N.W. India, 1844, Edgeworth (K). India: Karnataka (Mysore): Belgaum, Ghale, Feb., Richie 1069 (K); Belgaum, Dharwar, March 1919, Sedgwick \& Bell 5512 (K); Hassan Distr., 15 Jan. 1969, Saldanha 12215 (MO); ibid., 24 March 1969, Saldanha 13112 (MO); ibid., 6 Feb. 1970, Saldanha 16271 (MO); ibid., 13 March 1970, Saldanha 16601 (MO); Hassan Distr., Habalu, 1000-1200 m, 23 Feb. 1973, Bogner 510 (M); S.

Kanara, Mercara, Feb., Hohenacker 560 (G, K, LE, M, U, Z). Kerala: Wynad, 1816, Rottler (K); S. Wynad, Naddikarna, 14 Jan. 1903, Barber 5623 (K). Tamil Nadu: Nilgiri Hills, 1837-1838, Perrottet 359 (K); ibid., Perrottet 360 (K); ibid., Perrottet (G); ibid., Wight 75 (CGE, G); ibid., Wight (M); ibid., 1851, Hohenacker 1144 (K, L, LE, M, U, ZT); ibid., Hohenacker 1145 (G, LE, M); ibid., 1823, Leschenault 52 (G); ibid., Thompson (CGE, K, M); ibid., Schmidt (K); ibid., Foulkes (K); ibid., Gardner (K); ibid., Adam (K); ibid., Preston (K); ibid., Coonoor, 1600 m , May 1883, Gamble 11640 (K); ibid., 2000 m, Oct. 1883, Gamble 13099 (K); ibid., 11 July 1896, Bourne (K); Nilgiri Hills, Arawly, 2400 m, Nov. 1884, Gamble 15697 (K); Nilgiri Hills, Pykara, 22 May 1900, Bourne (K); Nilgiri Hills, Octocamund, Rees Swamp, 11 July 1904, Bourne 4607 (K); Octocamund, The Downs, 27 July 1904, Bourne 4650 (K); ibid., 18 Sept. 1908, Bourne 5210 (K); Baudy Shola, 2200 m, 8 April 1916, Fischer (K); Moyar River, 10 Feb. 1963, Subramanian 88 (L); Madurai Distr., Kodaikanal, 2300 m, Dec., Anglade 742 (G); ibid., 26 June 1913, Sauliere 34 (K); ibid., 31 May 1926 or 5 May 1928, Bembower 159 (MO); Pulney Hills, c. 2300 m, 18 Aug. 1911, Fischer 2863 (K); Pondicherry, Perrottet (K). Andhra Pradesh: Vishakhpatnam (Vizagapatnam), Madgoe Hills, Endrika, c. 1700 m, 27 May 1914, Lushington (K). Orissa: Bonaigarh (Bonai State), Koira, 1700 m, 26 Feb. 1946, Mooney 2631 (K). Bihar: Singhbhum, Tirilpori, April 1903, Haines 669 (K); Ranchi, Ghotama Fall, 16 April 1960, Kangi, Murata \& Tuyama (KYO). Punjab: Gurdaspur, 3 March 1917, Stewart 1358 (K). Uttar Pradesh: Baijnath, Kangra, 1000 m, 19 May 1933, Koelz 4587 (MO); Kumaun, Champawat, 1650 m, 7 May 1961, Bhallacharyya 14906 (L); Kumaun, Almora, 1700 m , Strachey \& Winterbottom 1 (K); Kumaun, Bhim, 1500 m , 11 June 1885, Duthie 4021 (BR, LE); Kumaun (Kumoon), 1832, Wallich 2095/5 (G); Mussoorie, Tons, Valley, 1000 m, Duthie 5/91 (K, LE); Dehra Dun, Gamble 26513 (K); Dehra Dun, Suarua Thab, 1000 m, Schäfer (M); Tehri Garhwal, Parolha, Gamble 24402 (K); Tehri Distr., Jhadyar, 1000 m, May 1891, Gamble 23029 (K); Bahraich, 7 March 1900, Juayat 23649 (G); Bahraich (Oudh), 1825, Wallich 2095C (LE, M). Assam: s. loc., Jenkins (CGE); ibid., Masters (M, Z); ibid., Simons (L, LE, M); 1845, Griffith, Lemann (K); Khasi and Jainta Hills, Griffith (CGE); ibid., 1000 m, 1878, Gallatly 72 (M); Nongpoh, 3 April 1886, Clarke 4329B (LE); ibid., 750 m, 26 Feb. 1943, Bor 16999 (L); Umran, 1300 m, 10 April 1949, Koelz 22486 (L); Sonapahar, 1200 m, 4 March 1952, Thakur Rup Chand 5277 (L); ibid., 11 March 1952, Thakur Rup Chand 5296 (L); Mawphang, 2000 m, 18 March 1954, Thakur Rup Chand 7397 (L); Shillong, 1400 m, 21 Jan. 1943, Bor 16988 (L); Dalgaen, April 1902, Chaterjee (BR, G, L, LE, M, NSW, U); Sibsagar, Dumar Dullong, April 1895, Coll. ? 10495 (M); Assam Valley, Akha Hills, March 1890, Badul Khan 152 (Z); Lakhimpur Distr., Talap, 24 March 1894, Gammie 159 (Z); Jaboea, Nage Hill, Feb. 1899, Prain 735 (U); Shilley, 22 March 1892, Prain 70 (NSW). Sikkim: Sikkim, 1 Feb. 1867, Anderson (L). Manipur: Manipur, c. 1000 m, 4 Feb., Watt 5835 (G); Khong Valley, Noung Shong, 1300 m, 6 April 1882, Watt 6297 (Z); Ranglatongbi, $1200 \mathrm{~m}, 28$ Feb. 1946, Bullock 963 (L). India, without exact locality or locality not found:

Wight 977 (L, LE, M, sheets in L and LE mixed with R. macrandra); ? 1836, Wight 1028 (BR, CGE, G, K, LE); Stocks \& Law (G); Wallich 2095/ G (CGE); Bengal, Hooker \& Thompson (CGE, G, K, L, LE, M, U); Risekoond, 1820, Wallich 2095/L (G, LE); Devarage, 600 m, March 1919, Sedgwick \& Bell 5466 (K); Changbhakar, Bhumka, 30 March 1938, Mooney 751 (K); Kawardha, Chilpi, 800 m, 29 Feb. 1940, Mooney 1269 (K); Hawalbaugh, 11 June 1846, Fischer (LE). Bangla Desh: Sylhet (Sillet), Wallich 2095/4 or 2095/D (CGE, G, K-W, L, LE, M); ? Bangla Desh, East Bengal, Griffith 2312 (CGE, G, L, LE). Nepal: Jiri, 12 June 1963, Numata 1311 (KYO); Namudu, 18 June 1963, Numata 1623 (KYO); Katmandu, Tapley, 1400 m, April 1953, Nakao (KYO); Katmandu, Sundarijar, 1500 m, 13 Feb. 1969, Kanai 45 (KYO); SanguKoprang, 340 m, 11 Jan. 1970, Kanai 670617 (KYO); Pachkhal, 19 April ? 1963, Numata 159, 166 et 176 (KYO); Dumrie, 21 April 1963, Numata 243 (KYO); Ralmaling, Banepa, 1400 m, 19 April 1963, Yoda (KYO); S.W. Mt. Everest, 2000 m, March 1965, Noordyk (L). Burma: S. Shan State, Taungyi, 1894, Abdul Khali (G); Bhamo Distr. Kaihtaik, 1450 m, 8 Jan. 1958, McKee 6019 (NSW); Hsenwi (Hseniui), 18 April 1905, Wehrli (G, Z); Bhamo, 24 Jan. 1905, Wehrli (G, Z); Myitkyna, Indaw, 20 March 1905, Wehrli (G, Z); Kentung, Loi Mwe, 1700 m, March 1938, Dickason 9116 (L). Thailand: Chiang Mai, Doi Sutep, 750 m, 29 Dec. 1904, Hosseus 273 (G, K, L, M); ibid., 1050 m, 14 March 1905, Hosseus 491 (K, M), 491 (M), $491 B$ (M); ibid., 14 April 1958, Sørensen, Larsen \& Hansen 2726 (K, L); Bo Luang-Om Koi, 1000 m, 19 jan. 1964, Hansen, Seidenfaden \& Smitinand 10972 (L); East of Fang, 28 Feb. 1958, Sørensen, Larsen \& Hansen 1791 (K); N. Chiang Mai, Pha Maun, 1200 m, 18 April 1960, Smitinand \& Alsterlund 6713 (K); Chiang Mai, Boluang, $18^{\circ} 45^{\prime}$ N. $-98^{\circ} 25^{\prime}$ E., $1100 \mathrm{~m}, 13$ June 1973, Geesink, Phanichapol \& Santisuk 5916 (L); ibid., 1000 m, 13 June 1968, Beusekom \& Phengkhlai 1209 (L); Doi Inthanon, $19^{\circ} 30^{\prime}$ N. $-98^{\circ} 30 \mathrm{E} ., 1200 \mathrm{~m}, 20$ Jan. 1969, Nooteboom 788 (L); Doi Angka, 1260 m, 1 Jan. 1936, Garrett 1033 (K, L); Ban Kwang Hê, between Mê Rim and Sämông, 1100 m, 2 Feb. 1913, Kerr 2909 (K). Laos: Borikhane, Wiengchan, 200 m, 28 March 1932, Kerr 20775 (K, L); Sémon, Marmand 1129 (K). Vietnam: Tonkin Region: En Phap, 31 March 1887, Balansa 3121 (G, K, L, LE); Dong Dang, 27 Jan. 1886, Balansa 1401 (K); Prov. Thai-Nguyen, Don Du, Eberhardt 3943 (K); Quong Jon, Dec. 1908, Alleizette (L); Hanoi, June 1908, Alleizette (L). China: Yunnan: s. loc., Forrest 7172 (K); ibid., Delavey (K); Lang-ngu-tsin, 1904, Ducloux 2677 (G, Z); Yungbei, Dawan, 2650 m, 2 July 1914, Handel-Mazzetti 3390 (M); Houang-ts'ao-pa, 1918, Cavalerie 8069 (K); Mengbi, c. 1600 m, Henry 9355 (K); Tengyueh, 2000 m, May 1912, Forrest 7716 (K); ibid., March 1923, Rock 8046 (K). Szechuan: Pei-pah, 24 April 1946, Law 496 (K). Kweichow: Twyun, Yun-foushan, 730 m, 19 July 1930, Tsiang 5933 (G); Kweichow, Tungtzu, 400 m, 20 May 1930, Tsiang 4978 (K, M). Hunan: Yi Chang Distr., P'ing T'ou Shan, T’ang Wan, 17-30 April 1934, Tsang 23673 (G, NSW). Kwangsi: Loh Hoh Tsuen, Ling Yün Hsien, 1150 m, 12 March 1933, Steward \& Cheo 176 (G). Kwangtung: Kuang Chou (Canton), 1870, Hillebrand (G); ibid., 1 March 1884, Sampson (K); ibid., 10 Feb. 1917, Levine 385 (MO); Tsin Leong San,

850 m, June 1936, Gressitt 1254 (G, MO); ibid., 840 m, June 1936, Gressit 1245 (G, MO, Z); Naam Kwan Shah, 3 April 1932, Tsang 20074 (K, KYO); Peihai, April 1884, Playfair 47 (K); Liang-Yong, 29 Jan. 1935, Whiting \& Stewart 189 (K); Honam Island, 21 May 1917, Levine 789 (MO); Wai-yeung Distr., Pakwan Cheung, March 1932, Tsui 101 (K, KYO, MO). Kwangtung-Hainan Tao: Toam Chan-Lam Ko Distr., Lin Fa Shan, 24 April 1928, Tsang Wai-Tak 16768 (G, K, MO); Hainan, 8 Jan. 1934, Wang 36196 (G, M); T’a Hon, 21 April 1922, Mc Clure 9223 (K, MO); Ching Mai Distr., Pak Shik Ling, 18 March 1933, Lei 453 (K, KYO); Lam Ko Distr., Lin Fa Shan, July-August 1927, Tsang Wai-Tak 243 (K). Kiangsi: Lu-Ling-Hsien, 400 m , s. coll. (K); Pinghsiang, $600 \mathrm{~m}, 1920$, Wang Te Hui 175 (Z). Fukien: Baek-liang, $500 \mathrm{~m}, 26$ April 1926, Metcalf 3460 (G, M, MO, Z); Changchow, 27 March 1923, Chung 1176 (K); ibid., Faber 794 (K); Hsia-men (Amoy), 22 April 1923, Chung 1456 (K); Fu-chow, 3 May 1928, Tang Sin Ging 7625 (NSW); ibid., 1897, Charles 582 (K); Shan-t-ou (Swatow), Perry (K). Chekiang: Chekiang, Hickin (K). Shantung: Chefoo Mts., Faber 305 (K). Manchuria: Fukushu, Makino 121214 (MAK), locality not found. Hong-Kong: s. loc., Champion 99 (K); ibid., Hinds (K, LE); ibid., 1861 Urquhart 157 (K); ibid., 1853-56, Wright 164 (K, L); ibid., May 1862, Tate (K); ibid., 1845, Fortune (M); Lantao Island, Silver Mine Bay, 20 Feb. 1969, Shiu Ying Hu 6692 (K). Taiwan: s. loc., Henry 1788 (MO); ibid., 1862, Swinhoe (K); ibid., pre-1912, Price (K). Taipai Prov.: Taipai, 20 March 1968, Hsu 4330 (KYO); ibid., 23 Feb. 1929, Yamamoto \& Suzuki (TAI); ibid., 16 April 1961, Liu or Lin (MEL, MO); ibid., 2 April 1969, Hsu 5246 (KYO); Nesuangchich, 11 Feb. 1973, Kuо 2939 (TAI); Hsientien, 23 March 1974, Kио 4675 (TAI); Taikoku, 20 Jan. 1932, Kitamura (KYO); ibid., 12 April 1916, Ito (KYO); ibid., 21 March 1933, Ohmi 88 (KYO). Nantou Prov.: Sun Moon Lake, 2 Aug. 1971, Kao 5656 (TAI). Shinten Prov.: Taihoku-shu, 27 April 1932, Tanaka \& Shimada 10980 (BR, G, L, M, MEL, MO, TAI, Z). Japan. Kyushu: Higo, 10 May 1912, Tashiro (KYO); Kumamoto, June 1899, Faurie 3736 (G); ibid., Makino 121201 (MAK); ibid., Makino 121209 (MAK). Hondo City, Makino 121202 (MAK); ibid., Makino 121205 (MAK); Kiyama, 15 June 1962, Kuranari (K); Nagasaki, 1863, Maximowicz (BR, K, L). Honshu: Tokyo Pref., Yoyagi, 7 July 1908, Kohei Onuma 19082 (Z).
12. Rotala macrandra Koehne, Bot. Jahrb. 1: 176. 1880.

- Ameletia rotundifolia Wight, Ic. Pl. Ind. Or. 1: t. 258. 1840, non Buch.Ham. ex Roxb. 1820.

Type: "Mons. Ind. or., locis non indicatis (verisim. Nepal)", in 1903 Koehne (Pflanzenreich) wrote "wahrscheinlich Nepal, Wallich n. 2095H". R. macrandra does not occur in Nepal and Wallich $2095 H$ was probably collected in India, Kerala, near Ernakulam where it still grows today. It is not clear which of Wallich's numerous duplicates of 2095 H was used by Koehne, I designate the K-W specimen lectotype and the K, CGE, LE specimens isolectotypes.

## Ic.: Fig. 9E-H.

Special literature: Benl, G. Rotala macrandra Koehne (Lythraceae). Die Aquarien- und Terrarien-Zeitschrift (Stuttgart) 25(6): 198-201. 1972.

Amphibious perennial or perhaps occasionally annual. Stems branched below, creeping or floating, up to 40 cm or more long, usually simple and 4angled above. Leaves decussate or occasionally in whorls of 3, sessile or subsessile, variable in form and colour; submerged leaves linear to orbicular but usually ovate, up to 5 cm long, pink to purple with pale nerves, abaxial surface darker than adaxial; aerial leaves obovate to orbicular, up to 2 cm long, green or somewhat reddish; leaf nerves distinct, usually pale pink or whitish. Bracts broadly ovate, up to 3 mm long, as wide or wider than long; bracteoles c. 0.5 mm long, about half the calyx tube in length, linear to lanceolate, scarious. Flowers monomorphic, subsessile, solitary in axils of bracts; inflorescence distinct, a many-flowered usually sessile raceme, remaining dense in fruit (stem not visible between nodes); solitary flowers occasionally found in axils of normal foliage leaves. Calyx tube campanulate, c. 1 mm long, membranous, white or tinged with pink above, with 4 rib-like nerves; calyx lobes 4 , triangular, up to 1 mm long, pink; calyx appendages and interjected folds absent. Petals 4 , obovate, about 2 times as long as calyx lobes, bright rose. Stamens 4; filaments inserted near base of calyx tube, c. 4 mm long; anthers exceeding petals and bracts. Ovary globose; style c. 3.5 mm long; stigma minutely capitate, about level with anthers; capsule globose, c. 1.5 mm diam., 4 -valved; seeds semi-ellipsoidal, c. 0.5 mm long.

## DIAGNOSTIC FEATURES

K4, P4, A4, G4; like $R$. rotundifolia but bracteoles c. 0.5 mm long, about half as long as calyx tube; filaments c. 4 mm long; anthers exceeding petals and calyx lobes; style c. 3.5 mm long; stigma minutely capitate and scarcely wider than the style; inflorescence remaining compact in fruit.

## DISTRIBUTION

Confined to southern India in the States of Karnataka (Mysore) and Kerala (Map 5), no specimens have been seen from Tamil Nadu but it is likely to be found there. It is essentially a lowland species and flowers from about October to November.

## SELECTED SPECIMENS

India: s. loc., Bentham (M); ibid., Stocky, mixta cum R. rotundifolia (K); ibid., Wight 977, mixta cum R. rotundifolia (LE); Karnataka (Mysore): Ananthapur, Oct. 1908, Meebold 10284 (Z); Kerala: Calicut Distr., Badagara, 28 Oct. 1900, Bourne (K); Trichur Distr., Trichur, 20 Nov. 1814, Rottler (LE);

Ernakulam Distr., near Ernakulam, Wallich 2095H (CGE, K, K-W, LE); Ernakulam Distr. at edge of Muvattupuzha River, 30 Sept. 1973, Cook \& Schneller, Cult. Botanic Garden University of Zürich, pressed 28 Nov. 1974, Cook (Z).

NOTES
I have seen $R$. macrandra in the State of Kerala. It usually grows in more or less permanent water and is often found in swiftly flowing water. It is frequently found growing together with Vallisneria and Blyxa. I have cultivated both $R$. macrandra and $R$. rotundifolia and agree with BENL (1972). In general $R$. macrandra is more aquatic and develops very attractive pink to purple submerged leaves; it also requires higher temperatures and grows best with a water temperature of $25-28^{\circ} \mathrm{C}$, Rotala rotundifolia grows better at or slightly below $20^{\circ} \mathrm{C}$.
13. Rotala nummularia Welw. ex Hiern in Oliver, Fl. Trop. Africa 2: 468. 1871, pro parte, emend. Exell, J. Bot. (London) 67: Suppl. Gossweiler, Polypet. 187. 1929.

Type: Angola, Lubango (Huíla), pr. Lopollo et Catumba, 1600-1760 m, Jan. 1860. Welwitsch 2345 (holotype: LISU n.v.; isotypes: BM, M).

Ic.: Fig. 10A-C.
Amphibious perennial. Stems creeping below, floating, ascending or erect above, up to 40 cm long, often crowded, variously branched. Leaves decussate or occasionally in whorls of 3 , sessile or subsessile; submerged and juvenile leaves elliptic to ovate, up to 2 cm long; aerial leaves ovate to suborbicular, the broader ones cordate at base, up to 1 cm long; nerves pinnate not distinct. Bracts leaf-like at base of inflorescence, somewhat smaller and narrower above; bracteoles linear, membranous about as long as calyx tube. Flowers dimorphic, heterostylous, shortly pedicellate, solitary in the axils of leaf-like bracts (inflorescence not stalked). Calyx tube conical to cup-shaped, membranous, tinged with pink, c. 1.5 mm long; calyx lobes 4 , triangular, pink, c. 1 mm long; calyx appendages and interjected folds absent. Petals 4, obovate, bright pink, c. 2 mm long. Stamens 4; filaments inserted near base of calyx tube, either c. 1.5 mm or c. 6 mm long; anthers either included or excluded. Ovary broadly ellipsoidal to globose; styles either c. 1 mm or at least 5 mm long; stigma capitate, borne either above or below the anthers; capsule globose, 4-valved; seeds semi-ellipsoidal, c. 0.4 mm long.


Fig. 10. - R. nummularia (Welwitsch 2345); A, habit; B, "pin" flower; C, "thrum" flower dissection.
R. thymoides (Welwitsch 2344); D, habit; E, "pin" flower; F, flower dissection (scale: A, D, 1 cm ; $\mathbf{B}, \mathbf{C}, \mathbf{E}, \mathbf{F}, 1 \mathrm{~mm}$ ).

## DIAGNOSTIC FEATURES

K4, P4, A4, G4; like $R$. rotundifolia and $R$. macrandra but heterostylous, inflorescence not stalked and aerial leaves usually longer than wide. Like $R$. thymoides but leaves below the inflorescence not linear to lanceolate nor obspathulate and the "pin" style 5 mm or more long.

## DISTRIBUTION

Endemic to S.W. Angola in the provinces of Bié and Lubango (Huíla) (Map 6). It grows in mountainous regions at an altitude between 1400 m and 1800 m . It flowers from September to January or perhaps a little later.

## SELECTED SPECIMENS

Angola: Bié: Ganguelas, Vila Artur de Paiva (Vila da Ponte), a E. do Forte Princesa Amélia, rio Cubango, 20 Sept. 1905, Gossweiler 1997 (BM); ibid., Oct. 1905, Gossweiler 4192 (BM); Ganguelas, andados 12 km de Vila Artur de Paiva para Cassinga, 1430 m, 7 Jan. 1960, Mendes 2009 (BM, BR, P); Lubango (Huíla): Huíla, pr. fonte K'Ehombo, 1770 m , Dekindt 1150 (P); Huíla, 1770 m , Dekindt 3012 (P); Húla, pr. Missão Católica, margens do rio Mucha, 25 Jan. 1956, Santos 177 (BM); Lubango, pr. Lopollo et Catumba, 1600-1760 m, Jan. 1860, Welwitsch 2345 (BM, M).
14. Rotala thymoides Exell, J. Bot. (London) 67: Suppl. Gossweiler, Polypet. 187. 1929.
$=$ Rotala nummularia Welw. ex Hiern in Oliver, Fl. Trop. Africa 2: 468. 1871, pro parte, emend. Exell, J. Bot. (London) 67: Suppl. Gossweiler, Polypet. 187. 1929.

Type: Angola, Lubango (Huíla), entre Mumpula e Nene, rio Quipumpunhime, Oct. 1859, Welwitsch 2344 (holotype: BM; isotypes: LISU n.v., M).

Ic.: Fig. 10D-F; Fernandes \& Diniz, Bol. Soc. Brot. Sér. 2, 29: t. 5. 1955, reprinted Consp. Fl. Angolensis 4: t. 19. 1970.

Amphibious perennial. Stems creeping below, floating ascending or erect; erect stems 4 -sided, often crowded, up to 5 cm or more tall, simple or branched. Leaves decussate or in whorls of 3 or 4 , linear to oblong-elliptic, up to 8 mm long and 3 mm wide. Bracts leaf-like, obspathulate to ovate; bracteoles linear, membranous, about as long as calyx tube. Flowers dimorphic, heterostylous, subsessile, solitary in axils of leaf-like bracts; inflorescence globose, up to c .1 cm diam., sometimes stalked or continuous with foliage leaves. Calyx tube conical to cup-shaped, membranous, c. 1.5 mm long; calyx lobes 4, triangular, c. 1 mm long; calyx appendages and interjected folds absent. Petals 4, obovate, pink to violet-purple, 1-1.5 mm long. Stamens 4; filaments inserted near base of calyx tube, either c. 2 mm or c. 5 mm long; anthers either included or excluded. Ovary broadly ellipsoidal to globose; styles either c. 1 mm or c .5 mm long; stigma obconical, borne either above or below the anthers; capsule globose, 4 -valved, up to c. 1.2 mm diam.; seeds semi-ellipsoidal, c. 0.4 mm long.

## DIAGNOSTIC FEATURES

K4, P4, A4, G4; like $R$. nummularia but leaves linear to lanceolate or obspathulate, style of the "pin" flower not exceeding 5 mm and petals not exceeding 1.5 mm long.

## DISTRIBUTION

Endemic to S.W. Angola in the mountainous regions in the provinces of Bié and Lubango (Huíla) (Map 6). It is sympatric with $R$. nummularia.

SELECTED SPECIMENS
Angola: Bié: Cuito-Cuanavale, margens do ribero Chancamba, Gossweiler 2645 (BM); Cuito-Cuanavale, Cuito, margens do ribeiro Domba, Gossweiler 2823 (BM); Lubango (Huíla): entre Mumpula e Nene, margens do rio Quipumpunhime, Oct. 1859, Welwitsch 2344 (BM, M); Lubango, entre Jau e Humpata, Lagoa Nuntechite, 1840 m, 15 April 1960, Mendes 3602 (BM).

NOTES

Fernandes and Diniz (Bol. Soc. Brot. Sér. 2, 29: 90, t. 5. 1955) described a variety angustifolia based on details of leaf shape and the size of calyx and petals. I can find no clear cut distinction between this variety and the type.
$R$. thymoides superficially looks unlike $R$. nummularia but florally they are very similar and no doubt patristically related. I suspect when some more plants have been collected or cultivation experiments are undertaken that $R$. thymoides will not deserve specific status.
15. Rotala elatinoides (DC.) Hiern in Oliver, Fl. Trop. Africa 2: 466. 1871三 Ammannia elatinoides DC., Mém. Soc. Phys. Hist. Nat. Genève 3(2): 92, tab. 3, fig. B. 1826, non A. Rich. 1847 = Ameletia elatinoides (DC.) Blume, Mus. Bot. Lugd. Bat. 2: 136. 1856.

Type: Senegal, s. loc., 25 Jan. 1825, "Lythrum uniflorum" Perrottet 92 (holotype: P; probable isotypes: BR, G, G-DEL K, LE).

Ic.: Fig. 11A-E; De Candolle, Mém. Soc. Phys. Hist. Nat. Genève 3(2): tab. 3, fig. B. 1826.

Terrestrial or amphibious annual or perennial. Stems simple or creeping and branched below, erect above; erect stems usually simple or occasionally irregularly branched, $5-15 \mathrm{~cm}$ long, often denuded of leaves below. Leaves decussate, sessile or subsessile; lower or submerged leaves linear to oblong,


Fig. 11. - R. elatinoides (Richard 1407); A, flower; B, bract; C, flower dissection; D, capsule; $\mathbf{E}$, transverse section of capsule (scale: A-E, 1 mm ).
R. serpyllifolia (Cook \& Gut 63); F, habit; G, flower; H, flower dissection (scale: F, $1 \mathrm{~cm} ; \mathbf{G}, \mathbf{H}$, 1 mm ).
up to 20 mm long, thin and flaccid; upper or aerial leaves oblong to ovate, rarely more than 8 mm long, subcordate to cordate at base, obtuse at apex. Bracts leaf-like, ovate, up to c. 6 mm long, subcordate to cordate at base, obtuse at apex; bracteoles capillary, c. 1.5 mm long, about half as long as calyx tube. Flowers monomorphic, subsessile, solitary in axils of leaf-like bracts. Calyx tube subcylindrical to somewhat urceolate, not accrescent, c. 3 mm long, 8 -nerved ( 4 distinct, 4 less so); calyx lobes 4 , widely deltate, c. 0.5 mm long, somewhat mucronate at apex; calyx appendages absent; small interjected folds present. Petals 4, obovate, not exceeding the calyx lobes. Stamens 2, opposite; filaments c. 3 mm long, inserted at base of calyx
tube but slightly adnate to it for about half their length, at base running into 2 of 4 triangular, glandular regions; anthers level with top of calyx tube. Ovary ellipsoidal, 4-locular with each loculus induplicate; style very short; stigma capitate, subsessile; capsule ellipsoidal, 4 -valved, c. 3 mm long; seeds semiellipsoidal, c. 0.6 mm long.

## DIAGNOSTIC FEATURES

K4, P4, A2, G4; calyx tube cylindrical to urceolate, stamens 2 and inserted at base of calyx tube, ovary loculae induplicate and seeds c. 0.6 mm long.

## DISTRIBUTION

In the dryer regions of West and Central Africa from Mauritania and Senegal to Chad and Central African Republic (Map 6). It is usually collected from the banks of relatively large rivers. It flowers from December to June.

## SELECTED SPECIMENS

Mauritania: Kaedi, 3 Dec. 1898, Chevalier 2823bis (P). Senegal: s. loc., 26 Jan. 1825, Perrottet 92 (P); ibid., s. dat., Perrottet (BR, G, G-DEL, K, LE, Z); ibid., Perrottet 332 (BM, LE, M); ibid., 1831, Perrottet (L); Walo, 1827, Perrottet (K); Walo, 1834, Perrottet (P); Dagana, 1825, Leprieur (G, K, LE, P); Matam, 6 April 1965, Adam 28021 (MO); Richard-Toll, Feb. 1951, Berhaut 1407 (BR, P, Z); Tiguet, 27 Jan. 1966, Audru 3146 (P). Mali: Gao, Bagoundie, 20 Feb. 1936, De Wailly 4966 (P); Gao, Goura, R. Niger, 16 April 1937, De Wailly 4692 (P); Gao, R. Niger, 3 March 1936, De Wailly 4983 (P); ibid., 17 Nov. 1935 - Sterile, De Wailly 4891 (P). Cameroun: Makari, Serbewel, 26 Dec. 1964, J. \& A. Raynal 1281 (P). Chad: Bahr el Azreg, près Ft. Archambault, 10 June 1903, Chevalier 8683 (K, P). Central African Republic: Dar Goulla, entre Ndellé et le Mamoun, March 1903, Chevalier 7870 ( P - fide Raynal, Adansonia 7: 542. 1967).
16. Rotala serpyllifolia (Roth) Brem., Acta Bot. Neerl. 3(1): 149. 1954 三 Micranthus serpyllifolius Roth, Nov. Pl. Sp. Halberstadt: 282. 1821.
$=$ Ameletia tenuis Wight, Ic. Pl. Ind. Or. 1: n. 13, tab. 257B. $1840 \equiv$ Ammannia tenuis (Wight) Clarke in Hooker fil., Fl. Brit. India 2: 567. 1879 ㅋ Rotala tenuis (Wight) Koehne, Bot. Jahrb. 1: 177. 1880. Type: it is not certain which of Wight's plants was used as the basis of his illustration, Wight's plate loc. cit. can be accepted as standard.

Type: Herb. Ind. Or., Heyne (isotype: L).
Ic.: Fig. 11F-H; Wight, Ic. Pl. Ind. Or. 1: tab. 257B. 1840.

Terrestrial or amphibious, often cushion-forming, annual or perhaps occasionally perennial. Stems creeping and rooting below, ascending above or with erect axillary branches; erect flowering stems up to 25 cm long, slender, terete, red and shining. Leaves decussate, sessile or subsessile, linear to broadly ovate (lower ones sometimes orbicular), 2-15 mm long, cuneate at base, acute or obtuse at apex. Bracts green or tinged with red, lanceolate to oblong, at base occasionally subcordate, smaller than foliage leaves, rarely exceeding 4 mm long; bracteoles caducous, linear-lanceolate, c. 1.5 mm long. Flowers monomorphic, sessile or subsessile, solitary in the axils of bracts, in dense, terminal, pedunculate, spike-like racemes; racemes up to 35 mm long. Calyx tube urceolate, constricted at the top, $2.5-3 \mathrm{~mm}$ long, often exceeding the bract, white with red nerves; calyx lobes 4 , widely deltate, $c .0 .5 \mathrm{~mm}$ long; appendages and interjected folds absent. Petals 4 , obovate, somewhat longer than the calyx lobes, pink. Stamens 4 ; filaments inserted about halfway up the calyx tube; anthers included within the calyx. Ovary ellipsoidal; style c. 1 mm long; stigma capitate, level with the anthers; capsule ellipsoidal, somewhat shorter than the calyx, 2-valved; seeds semi-ellipsoidal, c. 0.7 mm long.

## DIAGNOSTIC FEATURES

K4, P4, A4, G2; inflorescences spike-like, pedunculate; calyx tube constricted below the calyx lobes; capsule ellipsoidal but shorter than calyx.

## DISTRIBUTION

Widespread in C. and N.W. India and Pakistan (Map 4). It grows in seasonally inundated areas and flowers as the water recedes. Flowering may take place throughout the year, but the main flowering time is from October to February. The erect stems are often densely packed and cushion-forming. I have seen it in India at the Abheba Tank, Kota, Rajasthan. The commonest associated species were: Eriocaulon cinereum R. Br., Scirpus maritimus L., Rotala indica (Willd.) Koehne, R. rosea (Poiret) Cook, Ammannia baccifera L., Glossostigma diandra (L.) O. Kuntze, Bacopa floribunda (R. Br.) Wettst., Microcarpaea minima (Koenig) Merr., Dopatrium junceum (Roxb.) Buch.Ham.

## SELECTED SPECIMENS

Pakistan: Dera Ismael Khan, 15-22 Feb. 1857, Schlaginweit (G, L, LE, M, Z). India: s. loc., Heyne (L); Stocks \& Law (BR, CGE, G, K, L, M, U); s. loc., Stocky (K); s. loc., Jaquemont (G, K); "Behar", Hooker (CGE, G, K, L, M); "Behar", S. Kurz (K); Deccan, Ralf (G); Bengal, Griffith (CGE, K, LE); Concan, Law (K, LE); Maharashtra: Bombay, Law (K); Bombay, Dalzell (K); Bombay, 3 July 1901, Woodrow 19 (K); Bombay, Oct. 1934, Lester-Garland (K); Rewa, S. Kurz (K); Sendwal, 17 Dec. 1888, Duthie 8295 (K, LE); Bundelkhand, Edgeworth (K); Bundelkhand, 9 Dec. 1886, Duthie 6382 (K);

Nala, 8 Nov. 1910, Haines 3282 (K); Nagpur, Nov. 1912, Haines 3283 (K); Rajasthan, Kota, 29 Oct. 1970, Cook \& Gut 63 and 75B (K, Z); Sambalpur, 31 Dec. 1942, Mooney 2142 (K); Satpuras, Dec. 1918, Bell \& Sedgwick 4996 (K); Jabalpur, Jan. 1874, Kurz (K); Jabalpur, 4-19 Jan. 1856, Schlaginweit (LE); Kolapur, Jan. 1853, Richie (K); Karnataka (Mysore), Belgaum, Jan.? 1853, Richie (K); Banda, 1852, Edgeworth 3005 (K); Lalitpur, 7 Jan. 1888, Duthie 6954 (LE); Singharh Fort, 19 Nov. 1950, Santapau 12012 (MO); Unai, 2 Nov. 1953, Santapau 17191 and 17192 (MO); Khandala, 26 Oct. 1950, Santapau 11724 (MO); Saurashtra, 5 Oct. 1953, Raizada 21384 (L); Mirzapur, 9 Feb. 1961, Bhattacharyya 13607 (L). Bangla Desh: ?E. Bengal, Griffith 2310 (K).
17. Rotala tenella (Guill. \& Perr.) Hiern in Oliver, Fl. Trop. Africa 2: 467. 1871 三 Ammannia tenella Guill. \& Perr. in Guillemin, Perrottet \& Richard, Fl. Senegambiae: 297. 1833 (or? 1832) $\equiv$ Ameletia tenella (Guill. \& Perr.) Blume, Mus. Bot. Lugd. Bat. 2: 136. 1852.
$=$ Rotala brevistyla Baker fil., J. Linn. Soc. Bot. (London) 37: 153, 154, 30 Sept. 1905. Type: Uganda, Mulema, 29 May 1903-1904. Bagshaw 316 (holotype: BM).
$=$ Rotala oblonga Peter, Abh. Ges. Wiss. Göttingen N.F., 13: 22, in obs., 87, fig. 18. 1928. Type: Tanzania, Uyansi, Tschaya-See, 1240 m, Jan., Peter 34143 A (holotype: B; isotype: B).
$=$ Rotala submersa Dinter ex Pohnert, Mitt. Bot. Staatssammlung München 1(9-10): 449. 1954 三 Ammannia submersa nom. in sched. 1934, Dinter 7351. Type: South-West Africa (Namibia), Amboland, Kanovley, Dinter 7281 (holotype: M; isotype: B); paratype: Pad Tsumeb-Grootfontein, 22 April 1934, Dinter 7351 (B, M n.v., Z).
$=$ Rotala pedicellata A. Fernandes \& Diniz, Bol. Soc. Brot. Sér. 2, 31: 152. 1957, op. cit. 48: 128. 1974. Type: Zambia, Mapanza, 14 March 1954, Robinson 622 (holotype: SRGH n.v.; isotype: K).

- Rotala peregrina Perrier, Not. Syst. (Paris) 14: 308. 1953 (dated 1952), nom. invalid., no type indicated, among the material cited are two species of Ammannia as well as Rotala tenella - the description is "stretched" to incorporate all the material.

Type: Senegal, s. loc., Perrottet 333 (holotype: P; isotypes: BM, G, LE).
Ic.: Fig. 12A-K; Fernandes \& Diniz, Bol. Soc. Brot. Sér. 2, 31: t. 2. 1957.
Aquatic or amphibious annual or perhaps perennial. Stems inflated when submerged, floating or creeping and branching below, usually erect and scarcely branching above, up to 40 cm long but usually less. Leaves decussate, sessile; submerged leaves membranous, elliptic to oblong or obovate, up to 20 mm long but usually less, cordate at base, obtuse at apex;



E


F


Fig. 12. - R. tenella (A-D, Schlieben 9413; E, F, Perrottet 333, "tenella"type; G-K, Dinter 7351, "brevistyla" type); $\mathbf{A}$, bract; $\mathbf{B}$, flower; $\mathbf{C}$, flower dissection; $\mathbf{D}$, ripe capsule; $\mathbf{E}$, flower bud; $\mathbf{F}$, ripe capsule; $\mathbf{G}$, bract; $\mathbf{H}$, flower bud; $\mathbf{I}$, flower dissection; $\mathbf{J}$, ripe capsule surrounded by calyx; $\mathbf{K}$, dehiscing capsule (scale: A-K, 1 mm ).
aerial leaves oblong to obovate, rarely exceeding 12 mm in length, cordate at base, obtuse at apex. Bracts like foliage leaves; bracteoles 2, capillary to linear-lanceolate, membranous, $0.25-1.0 \mathrm{~mm}$ long. Flowers monomorphic, solitary in axils of leaf-like bracts, distinctly pedicellate; pedicel in fruit up to 2 mm long. Calyx tube at anthesis subcylindrical to urceolate, accrescent, at fruiting stage semi-globose, often splitting as the capsule dehisces; calyx lobes 4, at anthesis widely deltate, c. 0.5 mm long, often mucronate, in fruit becoming shallowly triangular; interjected folds distinct at anthesis but stretched in fruit. Petals very variable, caducous, absent or. up to 4, rudimentary, linear to obovate, at anthesis not exceeding the calyx lobes, pink. Stamens 4 or occasionally less, inserted about halfway up the calyx tube or somewhat lower; anthers level with the top of the calyx tube. Ovary at anthesis ellipsoidal, 4-locular with each loculus induplicate; style very short; stigma capitate, subsessile; capsule ellipsoidal to globose, 2-3 mm long, equal to or exceeding the calyx, 4 -valved; valves induplicate before dehiscence, usually rupturing the calyx tube as they open; seeds semi-ovoid, $0.35-0.6 \mathrm{~mm}$ long.

## DIAGNOSTIC FEATURES

K4, P0-4, A4, G4; calyx distinctly accrescent after anthesis. Like $R$. pterocalyx but calyx tube without wings; like $R$. fluitans but without calyx appendages.

## DISTRIBUTION

Widespread in the dryer regions of Tropical Africa, south of the Sahara and in southern Africa (Map 7).

## SELECTED SPECIMENS

Senegal: s. loc., Perrottet 333 (BM, G, P); s. loc., 1833, Perrottet (G, LE); s. loc., Heudelot 632 (P); Niokolo-Koba, April 1951, Berhaut 1512 (P). GuineaBissau: Dandun, Boé, 27 Jan. 1947, Santo 2370A (P); ibid., Santo 2379 (K); Madina, Boé, 10 Jan. 1951, Santo 2869 (BR, M). Guinea: Toumanéa, Oct. 1907, Pobéguin 1897 (K, P). Sierra Leone: N. Province, Kambia, Magbema, 24 Nov. 1949, Jordan 377 (K); ibid., 14 July 1951, Jordan 472 (K sterile material); ibid., 20 Dec. 1954, Jordan 970 (K); ibid., Jordan 971 (K); Kambia, 3 Nov. 1963, Morton \& Gledhill SL 570 (K); Kasewe Hills, 15 Nov. 1964, Morton SL 1548 (K); Talla Hills, Mt. Gonkwi, 16 Feb. 1892, Scott Elliot 4852 (BM, K); Toma, Bonthe Island, 11 Nov. 1931, Deighton 2285 (K). Mali: Bura, 24 Sept. 1927, Hagerup 406 (K); Bura, Ansongo, Vand, 24 Aug. 1927, Hutchinson 406 (BR). Ivory Coast: Ferkassidongou, 13 Oct. 1967, Ouliop (P). Ghana: Lawra, Burufo, 4 Sept. 1965, Hall 752 (K). Togo: s. loc., Sept. 1931, Mahoux 96 (P). Nigeria: Ado Rock, $7^{\circ} 49^{\prime}$ N., $3^{\circ} 26^{\prime}$ E., July 1960, cult., Ibadan, 21 Nov. 1960, Hambler 1028 (BM). Central African Republic: Yaoyam, 20 km
W. Bozoum, 11 Nov. 1937, Tisserant 3582 (P); 6 km S.W. Ippy, Reg. Bambari, Oubangui, 4 Dec. 1928, Tisserant 2734 (K); Ylinga, 21 July 1921, Le Testu 2993 (P); Bongo, Gir, 27 July 1869, Schweinfurth 2146 (K - mixta cum R. stagnina); ibid., 12 Oct. 1869, Schweinfurth 2489 (K, MEL); Djur, 2 Oct. 1870, Schweinfurth 4265 (K). Sudan Republic: Jebel Marra, Mortagello, 6 May, Wickens 1590 (K). Cameroun: s. loc., 1938-39, Jaques-Félix (K); Dega près Guirvidig, 70 km E.N.E. of Maroua, 10 Oct. 1964, Letouzey 7262 (K, MO, P); Maltam, 28 Dec. 1964, J. \& A. Raynal 12733 (P). Gabon: Tchibanga (Mokoualou), 1908, Le Testu 1355 (BM, BR, P). Republic of Congo: Loango, Joffre-Madingou, May 1959, Koechlin 5855 (P); Madimba, Kimayala, 27 April 1960, Compère 2040 (BR). Zaire: Kinshasa (Leopoldville), 1915, Achten $54 A$ and 54B (BR); Bokala, March? 1909, Laurent 604 (BR); Garamba, 8 June 1950, Noirfalise 446 (BR); Garamba, 7 Dec. 1951, De Saeger 1559 (BR); Garamba, 17 July 1952, Troupin 1560 (BR); Garamba, 19 July 1952, Troupin 1587 (BR); Tupkwo, 7 July 1955, Boutique 113 (BR); entre Amadi et Poko, June 1931, Lebrun 3112 (BR). Rwanda: Kigali, Nyamata, 1450 m, 13 April 1959, Deuse 1377 (BR); ibid., 1530 m, 2 May, Troupin 15051 (BR); ibid., 4 May, Troupin 15092 (BR); Kibungu, Matinza, 1500 m, 31 March 1973, Troupin 14906 (BR). Uganda: E. Mengo Distr., Bulemezi, Co. Kakinzi, $0^{\circ} 57^{\prime} \mathrm{N} ., 32^{\circ} 28^{\prime} \mathrm{E} ., 1100 \mathrm{~m}, 4$ Oct. 1969, Lye 4390 (K); Karamoja Distr., Dodoth Co., Karenga, Hapore Hills, Nov. 1972, Wilson 2168 (K); Kampala, June 1917, Dümmer 3204 (BM, K, MO); Kampala, Ngulu Hill, Aug. 1937, Hancock \& Chandler 1843 (B, BM, BR, K); Serere Teso, Dec. 1931, Chandler 320 (K); Kalula, May 1919, Dümmer 4109 (BM, P, Z); Mulema, May 1903-04, Bagshaw 316 (BM); Bunyoro, Sonso Riv., Nov. 1935, Eggeling E2312 (BM, MO). Kenya: Thika Plateau, c. 1700 m, 25 June 1947, Bogdan 793, comm. Bally 5197 (K); Thika, 16 Sept. 1967, Faden 67632 (K); Nairobi, Royal National Park, Nr. Impala Point, 21 Jan. 1962, Verdcourt 3237 (BR, K); Mwea-Tebere Scheme, Nguka Village, c. 1300 m, 14 Nov. 1966, Wood 751 (K). Tanzania: Iringa Distr., Tanganyika River, $900 \mathrm{~m}, 6$ May 1970, Greenway \& Kanuri 14466 (M); Iringa Distr., Makindi, $7^{\circ} 43^{\prime}$ S., $34^{\circ} 55^{\prime}$ E., 850 m, 10 Aug. 1970, Thulin \& Mhoro 677 (K); Lake Prov., Mwanza-Burru, 1250 m, 30 March 1952, Tanner 619 (B, BR, K); Mbeya Distr., Kazikazi, 1300 m, 10 June 1932, Burtt 3705 (K); Moshi Distr., Mpolo, 1150 m, Aug. 1928, Haarer 1528 and 1529 (K); Ujansi, Tschaia See, 1240 m, 4 Jan.1926, Peter 34143A (B). Zambia: Mbala (Abercorn), Michelmore 434A (K); Mazabuka, Mapanza, Choma, c. 1155 m, 13 April 1958, Robinson 2837 (K, M); Mapanza, 14 March 1954, Robinson 622 (K). Rhodesia (Zimbabwe): Kariba, Sengwa, 18 Nov. 1964, Jarman 80 (K); Wankie, April 1932, Levy 24 (K); Gatooma, Salope Farm, 12 April 1971, Conway 34/71 (K). Botswana: 196.5 km N. of Maun, 19.5 km N. of Jovenega Pan, 7 Aug. 1937, Erens 345 (PRE, fide Fernandes, Fl. Zamb.). South West Africa (Namibia): Ovamboland (Amboland) Kanovley, Dinter 7281 (B, M); Grootfontein, Tsumeb, 22 April 1934, Dinter 7351 (B, Z); Waterberg, 28 April 1963, Giess, Volk \& Bleissner 6619 (M). Republic of South Africa (Transvaal): Kruger Nat. Park, Nelspruit, Skukuza Koppies, 6 Feb. 1962, Schlieben 9413 (B, BR, M, Z);

Ramakapa, 1330 m, 16 Feb. or Nov. 1894, Schlechter 4506 (BM, G, LE, MEL, NSW, Z); Trigardsfontein, Hogge Veld, 1875-80, Rehmann 6703 (BM); Kwenene, c. 650 m, 2 Feb. 1953, Schyff 2101 (K). Malagasy Republic: Andramasina, 7 June 1972, Jacquemin HJ1051 (P); Autsirabe, Perrier 6596 (P); Autsirabe (Centr.), 1500 m, Perrier 18476 (P); Autringiha, 1600 m, Perrier 13647 (P); Tampoketsa, 24 March 1973, Jacquemin 963 (P); Tampoketsa, 27 March 1973, Jacquemin 1299 (P); Andramasina, 7 June 1972, Jacquemin HJ1051 (P).

NOTES
$R$. tenella is a very variable species. The type specimen, collected in West Africa, represents a more or less intermediate state: capsule equal to or slightly exceeding the calyx, bracteole c. 0.5 mm long (Fig. 12F). In western and southern Africa there is a tendency for the capsule to exceed the calyx and the bracteole is up to 1 mm long (Fig. 12D illustrates an extreme state); this state has never been taxonomically recognised. In eastern and southern Africa there is a tendency for the calyx to be highly accrescent and longer than the ripe capsule, the bracteole is also smaller and may be no more than 0.25 mm long (Fig. 12J); this state has been recognised as a distinct species. The earliest name is $R$. brevistyla, later names are: $R$. oblonga, $R$. submersa and $R$. pedicellata. From herbarium studies all degrees of intermediacy between the extremes are found throughout the range of the species. However, R. brevistyla plants are commoner in East Africa. Morphologically certain correlations can be seen, generally speaking the longer the mature calyx the shorter the bracteole. Without firsthand field experience or cultivation experiments, I feel it is safer to follow a "lumping" policy.
18. Rotala pterocalyx A. Raynal, Adansonia N.S. 7: 337. 1967.

- Rotala rotunda A. Chevalier, Etudes Fl. Afr. Centr. Franç. 1: 130. 1913, nom. nud. "Type": Central African Republic, Dar Banda, 4 Dec. 1902, A. Chevalier 6651 (BR, P).

Type: Senegal, Tiél, 106 km N.E. of Kaffrine, 12 Oct. 1961, J. Raynal 7704 (holotype: P).

Ic.: Fig. 13A-E; Raynal, A., Adansonia N.S. 7: 338, fig. 8. 1967.
Amphibious annual. Stems ascending or erect, rarely branched, when submerged somewhat inflated. Leaves decussate, obovate up to 7 mm long but usually less, cuneate at base, obtuse at apex. Bracts leaf-like; bracteoles 2, subulate, not exceeding 0.5 mm long. Flowers monomorphic, probably cleistogamous, solitary in the axils of leaf-like bracts, distinctly pedicellate; pedicel in fruit up to 2 mm long. Calyx tube at anthesis 4 -sided and 4 -angled


Fig. 13. - R. pterocalyx (J. Raynal 7704); A, bract; B, flower bud; C, flower dissection; D, dehiscing capsule; $\mathbf{E}$, mature calyx.
R. fluitans (Exell \& Mendonça 2834); F, bract and flower bud; G, flower dissection; H, mature calyx (scale: A-H, 1 mm ).
(almost square in transverse section) with distinct wings on the angles, accrescent, up to 2.5 mm long in fruit; calyx lobes 4 , broadly triangular, c. 0.5 mm long, remaining more or less closed; interjected folds distinct, persisting in fruit but obviously folds and not calyx appendages. Petals absent or up to 4 , smaller than calyx lobes or rudimentary. Stamens 4 , inserted about halfway up the calyx tube or somewhat lower; anthers below the top of the
calyx tube. Ovary ellipsoidal, 4 -valved, with each valve induplicate; style very short; stigma capitate, subsessile; capsule ellipsoidal, not exceeding the calyx tube, opening by 4 valves; seeds semi-ovoid, c. 0.6 mm long.

## DIAGNOSTIC FEATURES

K4, P0-4, A4, G4; calyx almost square in transverse section with distinct wings on the angles; capsule valves distinctly induplicate before dehiscence; stigma subsessile; flowers pedicellate. R. pterocalyx is somewhat similar to the "brevistyla" state of $R$. tenella (p. 67) but can be distinguished by the 4sided and 4 -winged calyx; it is also like $R$. fluitans but can be distinguished by the presence of broadly triangular calyx lobes (even in fruit) and the lack of calyx appendages.

## DISTRIBUTION

Northern Senegal, Niger and Central African Republic (Map 7). Flowering time is from October to December.

SELECTED SPECIMENS
Senegal: Tiél, 106 km N.E. Kaffrine, 12 Oct. 1961, J. Raynal 7704 (P); Matam, 22 Oct. 1969, Fotius 1801 (G). Niger: Takiéta, 15 Oct. 1966, Peyre de Fabrègues 2234 (P). Central African Republic: Dar Banda, Fluv. Kourouron an Kaga Mbrarupes, 4 Dec. 1902, A. Chevalier 6651 (BR, G, L).

NOTES
R. pterocalyx is known from only four collections all of which show a very similar habit (small, erect, annual plants with obovate leaves). It is, however, likely that this species is capable of developing longer, branched stems and specialized submerged leaves.
19. Rotala fluitans Pohnert, Mitt. Bot. Staatssamml. München 1(9-10): 448. 1954.
$=$ Rotala tetragonocalyx A. Fernandes \& Diniz, Bol. Soc. Brot. Sér. 2, 29: 88. 1955. Type: Angola, Lubango (Huíla), Humbe, rio Cunene, 11 April 1937, Exell \& Mendonça 2834 (holotype: COI n.v.; isotypes: BM, EA n.v., LISC n.v., LISJC n.v., M, SRGH n.v.).

Type: South West Africa (Namibia), Ovamboland (Okavangobucht), Niangana, Mitte April? 1934, Dinter 7621 (holotype: M. There are two collections with the number Dinter 7621, one collected in April, the other in May; the following herbaria probably have isotypes: $\mathrm{B}, \mathrm{BM}, \mathrm{G}, \mathrm{K}, \mathrm{M}, \mathrm{Z}$ ).

Ic.: Fig. 13F-H; A. Fernandes \& Diniz, Bol. Soc. Brot. Sér. 2, 29: tab. 2. 1955; named $R$. tetragonocalyx.

Aquatic or amphibious annual or perennial. Stems creeping and rooting below, floating or erect above, up to 40 cm or more long. Leaves decussate, sessile; submerged leaves membranaceous, often tinged red, widely elliptic to ovate, often cordate at base, up to 2 cm long and 1 cm wide; terrestrial leaves herbaceous to cartilaginous, elliptic to ovate, usually cordate at base, usually less than 1 cm long. Bracts leaf-like; bracteoles subulate, c. 1 mm long. Flowers monomorphic, sessile or very shortly pedicellate, solitary in the axils of bracts. Calyx tube distinctly 4 -angled, at anthesis tubular-campanulate and c. 2.5 mm long, accrescent, in fruit somewhat urceolate and c. 3.5 mm long; calyx lobes 4 , very shallowly triangular to almost flat; calyx appendages 4 , erect, subulate, up to 1 mm long. Petals 4 , suborbiculate, $0.25-1.0 \mathrm{~mm}$ long. Stamens 4, inserted slightly below the middle of the calyx tube; anthers included within the calyx tube. Ovary ellipsoidal; style very short; stigma capitulate; capsule ellipsoidal, c. 3.5 mm long, opening by 4 somewhat induplicate valves; seeds semi-ellipsoidal, c. 0.5 mm long.

## DIAGNOSTIC FEATURES

$\mathrm{K} 4+4, \mathrm{P} 4, \mathrm{~A} 4, \mathrm{G} 4 ; R$. fluitans is phenetically similar to the Asian species $R$. ritchiei but it develops no linear submerged leaves; flowers sessile or subsessile; calyx 4 -angled, becoming urceolate in fruit and reaching 3.5 mm long; petals distinct; seeds up to 0.5 mm long. Like R. pterocalyx but calyx appendages present; calyx tube not winged; flowers sessile or subsessile.

## DISTRIBUTION

Central and western Africa between $10^{\circ} \mathrm{S}$. and $23^{\circ} \mathrm{S}$. (Map. 7).

## SELECTED SPECIMENS

Zaire. Shaba (Katanga): Dilolo, River Mangoa, 23 July 1932, Young 243 (BM). Angola. Lubango (Huíla): Cuamato, Humbe, rio Cunene, 11 April 1937, Exell \& Mendonça 2834 (BM, M); Curoca, rio Cunene, 29 Aug. 1954, Pritchard 388a (BM). South West Africa (Namibia): Ovamboland, Niangana, April or May 1934, Dinter 7621 (B, BM, G, K, M, Z); Grootfontein N., Runtu, 8 May 1939, Volk 1910 (M). Zambia: Senanga, $16^{\circ}$ S. $-23^{\circ} 3^{\prime}$ E., 2 Sept. 1952, Codd 7345 (BM, K); Chroma, Mapanza, 13 April 1958, Robinson 2837 (M); Kalabo, 2 Aug. 1962, Robinson 5443 (B). Rhodesia (Zimbabwe): Victoria Falls, Südseite Insel, Nov. 1933, Meebold 11768 (M). Botswana: Chobe River, Kazane, 13 July 1937, Erens 416 (K).
20. Rotala ritchiei (Clarke) Koehne, Bot. Jahrb. 4: 386. 1883 三 Ammannia ritchiei Clarke in Hooker fil., Fl. Brit. India 2: 566. 1879.

Type: India, Maharashtra, Belgaum, Oct., Ritchie 1184 (holotype: K).
Ic.: Fig. 14A-E.

B



F


Fig. 14. - R. ritchiei (Ritchie 1184); A, submerged leaf; B, bract and flower; C, flower dissection; $\mathbf{D}$, flower bud; $\mathbf{E}$, mature calyx (scale: $\mathbf{A}, \mathbf{B}, 5 \mathrm{~mm} ; \mathbf{C}-\mathbf{E}, 1 \mathrm{~mm}$ ).
R. illecebroides (Rangachari 13962); F, bract; G, flower; H, flower dissection; I, dehiscing capsule (scale: F-I, 1 mm ).

Aquatic or amphibious perennial or annual. Stems branched below, creeping or floating and usually simple above, up to 40 cm or more long. Leaves decussate, sessile, very variable in form; submerged leaves linear to orbicular, up to 3 cm long, almost translucent, green to red; terrestrial leaves obovate to orbicular, up to 1 cm long, with indistinct nerves. Bracts leaf-like; bracteoles subulate, $0.2-0.4 \mathrm{~mm}$ long. Flowers monomorphic, solitary in the axils of bracts, distinctly pedicellate; pedicels in fruit 1.0-1.5 mm long. Calyx tube sub-cylindrical, c. 2 mm long, pink when young; calyx lobes 4 , very shallowly triangular, almost flat in fruit; calyx appendages or interjected folds 4 , acute, somewhat exceeding the calyx teeth. Petals 4 , minute and caducous or absent. Stamens 4, inserted below the middle of the calyx tube; anthers included within the calyx tube. Ovary ellipsoidal; style very short; stigma capitate; capsule ellipsoidal, up to 2 mm long, opening by 4 valves; seeds semi-ellipsoidal, c. 0.3 mm long, straw-coloured.

## DIAGNOSTIC FEATURES

K4 + 4, P0-4, A4, G4; like the African species $R$. fluitans but submerged leaves often linear; flowers distinctly pedicellate; petals minute or absent; somewhat smaller in the dimensions of floral parts.

## DISTRIBUTION

India, northern part of the western Ghats (Map 8). Flowering starts in August.

## SELECTED SPECIMENS

India: Maharastra, Poona Distr., Kochala cha talao, on Chakam-Alandi road, 16 Aug. 1966, Janardhanan 68579 (K, L); ibid., 8 Oct. 1966, Janardhanan 92784 (K, L); Karnataka (Mysore), Belgaum, Oct., Ritchie 1184 (K).
21. Rotala illecebroides (Arn. ex Clarke) Koehne, Bot. Jahrb. 1: 161. 1880三 Ammannia pentandra Roxb. var. illecebroides (Arn. ex) Clarke in Hooker fil., Fl. Brit. Ind. 2: 569. 1879.
$=$ Rotala fysonii Blatter \& Hallberg, J. Bombay Nat. Hist. Soc. 25: 709. 1918. Type: India, Tamil Nadu, Anaimalai (Anamally), Dec. 1916, P. F. Fyson 3292 (holotype: MH n.v.).

- Rotala fischeri Gamble, nom. in sched., India, Tamil Nadu, Anaimalai Hills (Anaimallais), Attakatti, 1200 m, 27 Dec. 1911, C. E. C. Fischer 3218 (K) nom. invalid.

Type: India "Peninsula Ind. Orientalis", Herb. Wight propr. No. 2317 (holotype: K ; isotypes: $\mathrm{K}, \mathrm{G}$ ).

Ic.: Fig. 14F-I; Fyson, Fl. S. Ind. Hill Stat. 2: 611. 1932; Rajagopal, T. \& Ramayya, N., Curr. Sci. 37: 387. 1968.

Special literature: Rajagopal, T. \& Ramayya, N., Rotala illecebroides (Lythraceae) - a little known flowering plant from India. Curr. Sci. 37: 386-388. 1968.

Terrestrial or amphibious annual. Stems erect or creeping and rooting below, simple or branched above; erect flowering stems up to 10 cm long, slender, 4-angled to 4 -winged. Leaves decussate, sessile, regularly spaced along the stem, often red above, broadly ovate-cordate, c. 4 mm long, c. 3 mm wide, semi-amplexicaul at base, acute at apex. Bracts leaf-like; bracteoles 2, persistent, whitish, linear, equal to or somewhat exceeding the calyx tube in length. Flowers monomorphic, sessile, solitary in axils of leaflike bracts. Calyx tube in fruit, scarious, whitish, campanulate, c. 1 mm long; calyx lobes 4 , acutely triangular, c. 1 mm long, apiculate at apex; calyx appendages 4 , linear, about as long as calyx lobes, spreading in bud. Petals minute or absent. Stamens 4, or occasionally less; filaments inserted on upper half of calyx tube; anthers level with top of calyx tube. Ovary globose; style very short; stigma capitate; capsule globose, red, c. 1 mm long, opening by 4 (or rarely 3 ) valves, seeds semi-ellipsoidal, c. 0.3 mm long.

## DIAGNOSTIC FEATURES

$\mathrm{K} 4+4, \mathrm{P} 0-4, \mathrm{~A} 4, \mathrm{G} 4 ; R$. illecebroides is a very distinct species with regularly spaced ovate-cordate leaves which remain very constant in shape and size, and the calyx tube is equal in length to the calyx lobes and the calyx appendages.

## DISTRIBUTION

Central Peninsula India between $18^{\circ} \mathrm{N}$. and $12^{\circ} \mathrm{N}$. (Map 8).
SELECTED SPECIMENS
India: s. loc., Wight 2317 (G, K); ibid., Heyne (LE). Andhra Pradesh: Hyderabad, Campbell (G); Hyderabad, Thummla Kunta, 400 m, Rajagopal 578 (HY n.v.). Karnataka (Mysore): Anekal, 38 km S. of Bangalore, 11 Nov. 1970, Cook \& Gut 169 (K, Z); Salem Distr., Hosur, 29 Dec. 1916, Rangachari 13962 (K). Tamil Nadu: Anaimalais, Attakatti, 1200 m, 27 Dec. 1911, Fischer 3218 (K).

NOTES
I have seen $R$. illecebroides at Anekal about 38 km South of Bangalore. It was growing on a wet flush on a granite hill, the associated species were:

Drosera burmannii Vahl．，Striga euphrasioides（Vahl．）Bentham，Eriocaulon quinquangulare L．，Panicum myosuroides R．Br．，Fimbristylis dichotoma Vahl．，F．monostachya Hassk．，F．woodrowii Clarke and Cyperus hyalinus Vahl．Rajagopal \＆Ramayya（l．c．，1968）reported it to be growing on sandy soil on dripping rocks with Drosera burmannii，$D$ ．indica and various grasses and sedges．It flowers from November to January．

22．Rotala ramosior（L．）Koehne in Martius，Fl．Brasiliensis 13（2）：194． 1877三 Ammannia ramosior L．，Sp．Pl．：120． 1763.
＝Ammannia humilis Micheaux，Fl．Bor．－Amer．1：99． 1803 三 Boykiana humilis（Micheaux）Rafin．，Neogenyton：2． 1825 －Boykinia humilis （Micheaux）Rafin．，New Fl．4：66．1838，orth．mut．（Boykiana Rafin．and Boykinia Rafin．have been rejected in favour of Boykinia Nutt．－Saxifra－ gaceae）．Type：North America，Micheaux（holotype：P n．v．）．
$=$ Ammannia catholica Cham．\＆Schlecht．，Linnaea 2：378．1827，pro var． philippinensis，excl．var．brasiliensis $\equiv$ Rotala catholica（Cham．\＆ Schlecht．）B．van Leeuwen，Blumea 19（1）：54．1871．Type：Philippines， Luzon，Chamisso（lectotype：LE，see B．van Leeuwen，op．cit．；isolecto－ type：G）．
＝Ammannia monoflora Blanco，Fl．Filip．（ed．1）：64．1837．Type：Philip－ pines（topotype：Luzon，Manila，Oct．－Nov．，Merrill 426 and 752：K，L， MO）．
$=$ Ammannia dentifera A．Gray，Smithsonian Contrib．Knowl．（Washington） 5：55． 1853 三 Rotala dentifera（A．Gray）Koehne，Bot．Jahrb．1： 161. $1880 \equiv$ Rotala ramosior（L．）Koehne var．dentifera（A．Gray）Lundell， Bull．Torrey Bot．Club 69：395．1942．Type：Mexico，Sonora，Santa Cruz， Wright 1063 （holotype：？US n．v．，；isotype：G）．
－Ammannia ramosa Hill．，Veg．Syst．11：14．1767，nom．illeg．
－Peplis occidentalis Sprengel，Syst．2：135．1825，nom．nud．$\equiv$ Ammannia occidentalis（Sprengel）DC．，Prodr．3：78． 1828.

Type：North America，Virginia，Clayton（Gronovius）No． 774 （holotype： BM，see Fernald \＆Griscom，Rhodora 37：169．1935）．

Ic．：Fig．15A－G；Martius，Fl．Brasiliensis 13（2）：pl．39，fig．1．1877；Mason， Fl．Marshes California，fig． 275 and 276 a－g． 1957.

Chromosome number： $2 n=32$ ，USA，Texas，Angelina Co．，voucher： Lewis \＆Oliver 5273 （SMU）－Lewis，W．H．，Stripling，H．L．\＆Ross，R． G．，Rhodora 64：152，fig．27． 1962.

Vernacular name in the USA：Toothcap．
Terrestrial or amphibious annual，low and sprawling to erect and spreading．Stems creeping and rooting below，ascending above or erect，


Fig. 15. - R. ramosior (A-D, Cook \& Rix 103; E, Pringle 4337; F, Curtiss 5901; G, Kiener 17130; $\mathbf{H}$, Langlois 1885); A, bracts and flowers; B, flower dissection; C, flower bud; D-H, mature flowers (scale: A, $1 \mathrm{~cm} ; \mathbf{B}-\mathbf{H}, 1 \mathrm{~mm}$ ).
simple or branched; erect flowering stems $1.5-55 \mathrm{~cm}$ long (usually $10-25 \mathrm{~cm}$ long), weakly 4 -angled. Leaves decussate, subsessile to somewhat petiolate, linear-oblong to elliptic or oblanceolate, up to 45 mm long, 3-7 mm wide, obtuse at apex. Bracts leaf-like, cuneate at base; bracteoles persistent, 16 mm long, $0.25-1 \mathrm{~mm}$ wide, the larger bracteoles somewhat leaf-like. Flowers monomorphic, sessile, solitary in axils of bracts. Calyx tube in fruit globose, 2-4.5 mm long, greenish-white or tinged with red; calyx lobes 4, shallowly triangular, c. 0.5 mm long, acute or apiculate; calyx appendages 4 , triangular or apiculate, spreading in bud, $0.5-2 \mathrm{~mm}$ long (usually $0.5-1 \mathrm{~mm}$ long). Petals 4 , minute or up to 0.5 mm long, white or pink, or usually absent. Stamens 4 ; filaments inserted near base of calyx tube; anthers white, included within calyx. Ovary globose; style less than 0.5 mm long; stigma capitate; capsule globose, $2-4.5 \mathrm{~mm}$ long, enclosed within the calyx, opening by 4 or rarely 3 valves; seeds numerous, semi-pyriform, c. 5 mm long, dark red to brown.

## DIAGNOSTIC FEATURES

$\mathrm{K} 4+4, \mathrm{P} 0-4, \mathrm{~A} 4, \mathrm{G} 4 ; R$. ramosior is distinct and not readily confused with other Rotala species: characteristic are the relatively long bracts with cuneate bases; calyx appendages spreading in bud; fruits relatively large (up to 4.5 mm diam.), globose and enclosed within the calyx tube. Superficially $R$. ramosior resembles several species of Ammannia but on floral characteristics it clearly belongs to the genus Rotala.

## DISTRIBUTION

$R$. ramosior is widespread in America between about $50^{\circ} \mathrm{N}$. and $30^{\circ} \mathrm{S}$., and in the Caribbean Islands (Map 9). It is not known if the absence of $R$. ramosior from most of the Amazon Basin and the Guianas is real or due to insufficient collecting. $R$. ramosior is naturalized in the Philippines on the island of Luzon. It was first collected in the 1820's and probably got there from Mexico through the Spanish Acapulco-Manila galleon route between 1570 and 1812. This is supported by Merrill, E. D., 1954 (The Botany of Cook's Voyages, Chronica Botanica, Waltam, Mass. 14(5-6): 193, 273) and by morphological evidence. This Mexican race of $R$. ramosior has also become naturalized in the ricefields of the USA and northern Italy around Vercelli, Cook, C. D. K., 1973 (New and noteworthy plants from the northern Italian ricefields, Ber. Schweiz. Bot. Ges. 83(1): 61). It is not certain whether the Italian plants came directly from the Philippines or indirectly from the USA. In the Italian ricefields it grows with weeds from Asia and America. The flowering time is somewhat variable; in the USA and Italy it flowers from June to September, in Central America and the Carribbean from February to December, in South America from March to August and in the Philippines from October to March.

SELECTED SPECIMENS (the distribution in America is far from complete)
United States of America. Washington: Spokane Co., 28 June 1884, Suksdorf (M, LE, Z); Falcon Valley, 17 July 1886, Suksdorf (G); ibid., 7 Aug. 1909, Suksdorf (G, L). Oregon: Dalles City, 18 July 1909, Suksdorf (Z). Idaho: Canyon Co., Falk's Store, c. 700 m, 7 June 1910, Mac Bride 199 (G). California: Plumas Co., Lake Almanor, 18 Aug. 1949, Nobs \& Galen Smith 1355 (UC); Butte Co., Butte Sink, 15 Aug. 1946, Mason \& Grant 13048 (UC); Butte Co., 833 Canal, 4 Sept. 1946, Mason \& Grant 13110 (UC); Butte Co., 4.5 km W. of Biggs, 27 Sept. 1946, Mason \& Grant 13134 (UC); Sierra Nevada, Sierra Co., Calpine, c. 1600 m, 19 July 1952, Mason 14454 (UC); Lake Co., Thurston Lake, 8 Sept. 1949, Nobs \& Galen Smith 1853 (UC); Colusa Co., 4 km W. of Williams, 18 July 1949, Nobs \& Galen Smith 1008 (UC); Sutter Co. Sutter bypass S. of Marysville, ricefield, 29 July 1949, Nobs \& Galen Smith 1094 (UC); San Joaquin Co., Stockton, 1890-91, Stanford (JEPS); Tuolumne Co., Malther, c. 1400 m, 15 July 1936, Mason 11256 (G,

LE, UC); Merced Co., Los Banos, Aug. 1921, Jussel (JEPS); ibid., 22 July 1948, Nobs \& Galen Smith 204 (UC); Merced Co., 24 km E. of Gustine, 24 Aug. 1948, Nobs \& Galen Smith 425 (UC); Fresno Co., 3.5 km W. of Tranquility Junction, Highway 180, 29 July 1941, Bacigalupi, Wiggins \& Ferris 2683 (UC); Fresno Co., Sandbar, Mendota Pool, 24 Aug. 1948, Nobs \& Galen Smith 445 (UC); Fresno Co., 8 km S. of White's Bridge, Highway 180, 15 July 1949, Nobs \& Galen Smith 998 (UC); Fresno Co., 8 km S. of White's Bridge, Highway 180, 15 July 1949, Nobs \& Galen Smith 998 (UC); Fresno Co., 5 km W. of Orange Core, 4 June 1936, Hoover 1270 (UC). Arizona: Apache Pass, 1881, Lemmon \& Wife 493 (UC). Nebraska: York, c. 600 m, 15 Aug. 1944, Kiener 17130 (G). Kansas: Neodesha, 11 July 1937, Horr E157 (L). Texas: s. loc., 1848-49, Wright (G); Wood Co., Hawkins, Shinners 24272 (U); Dallas, July 1879, Reverchon (LE); Dallas Co., Bachman's Dam, 24 Aug. 1942, Lundell 11630 (UC); Austin, 28 June 1911, Fischer (G); Austin, Colorado River, 2 Nov. 1938, Tharp (UC); Bastrop, 14 Aug. 1936, Tharp 43432 (UC); Madison Co., Normangee, 11 Sept. 1968, Correll 36414 (UC); Hempstead, 1872, Hall (LE). Missouri: St. Louis, Engelmann (K, L, LE, M, ZT); St. Louis, Mississippi Fl., 22 Aug. 1875, Eggert (Z); Columbia, 23 Aug. 1933, Drouet 1004 (Z); Centerville, July 1938, Meebold 25384 (M); Greer, July 1938, Meebold 25266 (M); Butler Co., Bluespring, 19 Aug. 1892, Eggert (U); Mc Donald Co., Noel, Butler Creek, 1 Sept. 1913, Palmer 4046 (LE). Arkansas: s. loc., Rafinesque (G). Louisiana: Maguernine, 12 Aug. 1885, Langlois (M); Alexandria, Carey (K); De Soto Parish, Logansport, 12 July 1955, Shinners 20501 (U). Michigan: s. loc., Carey (K); Illinois: Peroia, Sept. 1858, Mendel (Z); St. Clair Co., E. St. Louis, 4 Aug. 1892, Eggert (U). Mississippi: Lowndes Co., Columbus, 9 Aug. 1964, Demaree 51271 (G). Massachusetts: Sharon, Massapoag Lake, 7 Sept. 1901, Williams \& Fernald 25 (G, L, LE, Z); Boston, Hooker (LE). There are literature records for Rhode Island and Connecticut. New York: Wading River, 16 Aug. 1872, Miller (LE). Pennsylvannia: Bucks Co., Morrisville, 13 Sept. 1925, Diersbach 4127 (LE). Ohio: s. loc., 1837, Frank (G, L, LE); Columbus, Sullivant (K); Fernbank, Steetz (M); Fernbank, North Bend, Short (K); Loveland, 9 Sept. 1877, James 947 (K). Indiana: Goldie, Fischer (LE); Alleghany Mt., Gray \& Sullivant (LE). New Jersey: Sussex Co., Panther Pond, 18 Sept. 1904, Mc Kenzie 1070 (CGE); Camden, Martindale (L). Washington D.C.: Washington, Aug. 1877, Holm (G); Washington, 1 Aug. 4 Sept. 1899, Steele (G). Virginia: Bedford Co., Sept., Curtiss (LE, Z, ZT); Sussex Co., Stony Creek, 24 Aug. 1938, Fernald \& Long 853 (G, L, LE, U); Stafford C., Falmouth, 12 Sept. 1943, Illtis 2299 (LE). Kentucky \& Tennessee: s. loc., Rafinesque 149 (G); Kentucky: Harlan Co., Harlan Court, Aug. 1893, Kearney (G); Bullitt Co., Lake Nevin, 22 Aug. 1954, Gunn 1222 (U). North Carolina: Rutherfordton, Sept. 1841, Rugel (G, LE); N. Carolina: Tyrrell Co., Columbia, 6 Aug. 1958, Radford 39179 (U). Tennesse: Olympia Springs, Aug. 1835, Peter (L). Georgia: Chattooga Co., E. of Menlo, 19 Aug. 1951, Venard \& Duncan 13093 (LE). Florida: Collier Co., 16 km W. of Monroe, 18 Oct. 1936, Fennell \& Jones 868 (LE); Collier Co., 5 Oct. 1965, Lakela 29192 (U); ibid., 14 Sept.

1966, Lakela 30232 (U); Key West, Chapman (K); ibid., Blogett \& Gray (K); Jamony, June 1843, Rugel (G); De Funiak Springs, 22 June 1897, Curtiss 5901 (CGE, G, LE, Z); Apalachicola, Aug. 1897, Chapman 2015 (Z); Indian River, July, Curtiss 947 (LE, M); Dade Co., Everglades, Perrine, 18 Nov. 1916, Small 7879 (G). Mexico: Sinaloa, Culiacan, 23 Nov. 1939, Gentry 5011 (MO); Sina loa, N.E. Imala, 450 m, 22 Oct. 1973, Breedlove 35591 (MO); Chihuahua, Rio Mayo, Guasaremos, 27 Sept. 1935, Gentry 1876 (MO); St. Jalisco, Guadalajara, Nov. 1892, Pringle 4337 (G, LE, M, MO, Z); ibid., Pringle 4337A (G, M); ibid., 14 Oct. 1895, Pringle 7365 (G); ibid., 5 Aug.-5 Dec. 1902, Pringle 11279 (L, MO, NSW, Z); Morelia, Aug. 1909, Arsène (G); Tampico, Tamaulipas, sea level, Feb. 1910, Palmer 299 (MO); Guerrero, 28 km W. of Chilpancingo, 2000 m, 24 Oct. 1944, Sharp 441489 (MO); Vera Cruz, Corral de Piedras, Oct. 1918, Purpus 8242 (MO); Chiapas, Tonalá, Puerto Arista, 3 m, 18 Oct. 1971, Breedlove \& Thorne 20888 (MO); Temascaltepec, Tenayac, 18 Aug. 1933, Hinton 4444 (G). Guatemala: s. loc., 1841, Friedrichsthal (LE); Izabal, Quiriguá, May 1922, Standley 24172 (MO); Retalhuleu, Nov. 1875, Bernoulli \& Cario 2780 (LE). Belize: Toledo Distr., Forest Home, 50 m, 18 Dec. 1933, Schipp 5492 (MO). El Salvador: Dept. Morazán, Divisadero, ( $13^{\circ} 36^{\prime} \mathrm{N}$., $88^{\circ} 02^{\prime} \mathrm{W}$.), $210 \mathrm{~m}, 14 \mathrm{Dec} .1941$, Tucker 543 (G, MO). Costa Rica: Guanacaste, Comeko, 5 km N.W. Bagaces, 26 Nov. 1973, Opler 1921 (MO); Guanacaste, 10 km S. Las Canas, 10 March 1965, Godfrey 66970 (MO). Cuba: Santa Clara, Mordazo, 9 Aug. 1923, Ekman 17040 (G), Dominican Republic: Santa Domingo, Bertero comm. Balbio (M); ibid., Dec. 1930, Ekman 16532 (G). Puerto Rico: Coamo, 16 Dec. 1885, Sintenis 3099 (LE, M); Bayamon, Oct. 1886, Stahl 588 (L, Z); Fajardo to Ceiba, March 1913, Britton \& Shafer 1513 (MO). Guadeloupe, Martinique, Barbados, Trinidad - literature records. Colombia: Santa Marta, 30 m, March 1898-1901, H. H. Smith 1966 (LE, MO, U); Cundinamarca, c. 150 m, 5 Dec. 1917, Pennell 2933 (MO); Huíla, Villaviaja, 450 m, in ricefields, 13 July 1950, Galen Smith 1212 (MO). Venezuela: Cabo Blanco, 20 Feb. 1922, Pittier 10202 (G). Brazil: s. loc., 1837, Sellow (L, E); Salvador (Bahia), 1838 or earlier, Salzmann 243 (G, LE, M). Ecuador: Prov. Manabi, Manta, 6 April 1955, Asplund 15979 (G, Z); Guayaquil, 1845, Jameson 382 (G); Chanduy, "litore Maris Pacifici", 1865, Spruce 6385 (G, LE). Peru: Dept. Loreto, Caballo Cocha, on Amazon River, Aug. 1929, Llewelyn Williams 2299 (MO). Bolivia: Dept. Santa Cruz, Sara, 400 m, July 1924, Steinbach 6086 (G). Paraguay: Gran Chaco, 10 June 1903, Pride (K); Cordillera de Altos, May 1913, Hassler 12615 (K). Argentina: Prov. Formosa, Laishi, March 1924, Herb. Mis. Furanciscanas (BAF); Prov. Corrientes, Riochuelo, ricefield, 1973, Cristobal \& Schiekini (?Schinini) 1011 (MO, ZT). Philippines. Luzon: s. loc., Chamisso (G, LE); Ilocos, Bangui, Mar. 1909, Ramos 7688 (NSW); ibid., Feb.-Mar. 1917, Ramos 27639 (MO); Manila, Eschscholtz (LE); ibid., Nov. 1903, Merrill 3667 (K); ibid., Nov. 1909, Merrill 17 (G, M, Z); ibid., 21 Nov. 1910, Merrill 8015 (G, MO); ibid., Oct.Nov. 1914, Merrill 426 (K); ibid., Merrill 752 (K, L); ibid., Oct. 1914, Merrill 9782 (K, mixed with R. rosea); ibid., 27 Dec. 1903, Hallier 4214 a (L); ibid., Loher 2153 (K); ibid., Nov. 1905, Loher 6104 (K). Italy: Prov. Vercelli,

Prarolo, 23 Aug. 1972, Cook \& Rix 102 and 103 (Z); ibid., 2 km N. Prarolo, 20 Aug. 1974, Krattinger \& Schneller (Z); ibid., 1 km N. Prarolo, 21 Aug. 1974, Krattinger \& Schneller (Z).

## NOTES

Ecology. - R. ramosior is usually found in annually inundated areas. The seeds germinate when submerged; flowering and fruiting takes place as the habitat dries out. It is also a relatively widespread weed in ricefields. Sometimes it is found in shallow permanent water in ponds and streams and occasionally on wet grounds in marshes. It is frequently associated with various species in the following genera: Cyperus, Eleocharis, Bergia, Elatine, Lindernia and Bacopa.

Variation. - I have cultivated $R$. ramosior collected from North Italy under various conditions in the University of Zürich botanic gardens. Rotala ramosior is an obligate annual. It is self-compatible and is normally selfpollinated; the flowers frequently never open but set copious seed.

The degree of branching, length and number of internodes and length and width of the leaves are readily modified by environmental factors. Solitary plants in a wet, rich potting mixture have large leaves with branched stems up to 50 cm tall. Solitary plants in moist sand or crowded plants in rich soil have simple, short stems and small leaves. Plants grown in poor conditions flower very early, occasionally the first foliage leaves bear flowers.

The length of the calyx tube and the size of the fruit can be modified by environmental factors; on well grown plants the first flowers and fruits are smaller than the later ones and on poorly grown plants the flowers and fruits remain small. The bracteoles are more complicated in their variation. Some races have small bracteoles (c. 1 mm long) that are non-accrescent and remain small as the fruit develops (Fig. 15F, G); other races have longer bracteoles that are sometimes accrescent and either continue growth as the fruit matures (Fig. 15E, H) or they are non-accrescent (Fig. 15D). Occasionally, accrescent and non-accrescent bracteoles are found on the same plant (Fig. 15C, D).

The calyx lobes are shallowly triangular and about 0.5 mm long; within and between plants they remain more or less constant in shape and size. The calyx appendages are more or less constant in size on any particular plant but very variable between plants (the minimum length is 0.5 mm , the maximum is 2.0 mm ). Accrescent bracteoles are usually but not invariably associated with long calyx appendages; the two extreme states are rather unalike (compare Fig. 15E and Fig. 15G). However, all degrees of intermediacy between these extreme states are found (Fig. 15F, H). The type of $R$. ramosior has short bracteoles and short calyx appendages. The type of $R$. catholica $(=R$. dentifera) has long but not extremely long bracteoles and long but not extremely long calyx appendages. Because there is continuous variation in these characters I am not willing to recognise two species. However, the
morphological variability is correlated with geographical distribution. It is hoped to publish a detailed description of the geographical variation of $R$. ramosior elsewhere but, generally speaking, the plants with extremely long bracteoles and calyx appendages are found in Central Mexico and there are clines of decreasing length going South and North. The race that became established in the ricefields of the Philipinnes (variable bracteoles and middle-long calyx appendages) has also become established in ricefields in Italy and America. This has the consequence that the cline becomes interrupted in rice growing areas. This is particularly well marked in the USA in Central California where very different looking plants may be found growing relatively close together. The very high degree of inbreeding may prevent hybridization.
23. Rotala fimbriata Wight, Ic. Pl. Ind. Or. 1: t. 217. $1840 \equiv$ Ammannia pentandra Roxb. var. fimbriata (Wight) Clarke in Hooker fil., Fl. Brit. India 2: 569. 1879 (excl. syn. Ammannia hexandra Wallich).

- Ammannia heyneana Wallich, Cat. No. 2104. 1828, nom. nud.

Type: it is not certain which of Wight's collections was used as the basis of his illustration, Wight's plate (t. 217) loc. cit. can be accepted as lectotype.

Ic.: Fig. 16A-D; Wight, Ic. Pl. Ind. Or. 1: t. 217. 1840.
Amphibious annual. Stems creeping and rooting below, erect above, up to c. 50 cm tall, simple or branched, weakly 4 -angled. Leaves decussate, sessile, lanceolate to oblong, $1-3 \mathrm{~cm}$ long, obtuse at apex; lower leaves cuneate to cordate at base; upper leaves cordate or auriculate at base. Bracts like upper leaves, usually somewhat auriculate at base; bracteoles acute-triangular to subulate, usually somewhat less than 1 mm long. Flowers monomorphic, sessile, solitary in axils of leaf-like bracts. Calyx tube campanulate, $2-2.5 \mathrm{~mm}$ long, disintegrating in fruit; calyx lobes 5 or rarely 6 , deltate, c. 0.5 mm long; calyx appendages absent; interjected folds rudimentary. Petals 5 or rarely 6 , pinnately divided into linear segments, $2-3 \mathrm{~mm}$ long, bright pink, showy. Stamens 5 or rarely 6; filaments $3-3.5 \mathrm{~mm}$ long, attached to base of calyx tube thus appearing free; anthers exerted, borne level with the stigma, deep brown before dehiscence. Ovary ellipsoidal; style c. 2 mm long, exserted; stigma capitate; capsule elongate-ellipsoid, c. 3 mm long, opening by 3 valves; seeds semi-ellipsoidal, c. 1.5 mm long.

## DIAGNOSTIC FEATURES

K5(-6), P5(-6), A5(-6), G3; petals fimbriate, pinnately divided into linear segments; seeds exceptionally large, c. 1.5 mm long.


Fig. 16. - R. fimbriata (Cook \& Gut 107); A, bract and flower; B, flower; C, flower dissection; D, mature capsule (scale: A, $5 \mathrm{~mm} ; \mathbf{B}-\mathbf{D}, 1 \mathrm{~mm}$ ).

## DISTRIBUTION

Endemic in peninsular India between latitude $12^{\circ} \mathrm{N}$. and $16^{\circ} \mathrm{N}$., up to an altitude of about 1300 m (Map 8). The flowering time is from August to December, seeds germinate at the beginning of the Monsoon.

## SELECTED SPECIMENS

India: s. loc., ex Herb. Heyne, 1832, Wallich 2104 (CGE, G - one sheet mixed with $R$. rosea, K-W, LE); s. loc., probably Karnataka (Mysore), Wight 975 (K, L, LE, M, MEL). Goa, Daman et Din: Sanvardem, Oct. 1908, Meebold 10282 (fide Blatter \& Hallberg). Karnataka (Mysore): Badami, Sept. 1911, Bhide (fide Blatter \& Hallberg); Bangalore, Campus of the Agricultural University, 4 Nov. 1970, Cook \& Gut 107 (K, Z); ibid., Paddy testing fields,

5 Nov. 1970, Cook \& Gut 113 (K, Z). Tamil Nadu: Horsley Konda, Aug. 1889, Gamble 21171 (K); ibid., 3 Sept. 1918, Fischer (K).

NOTES
I have studied this species around Bangalore. It grew in ricefields, the commonest associated species were: Rotala densiflora (Roth ex Roemer \& Schultes) Koehne, Dopatrium junceum (Roxb.) Buch.-Ham., Lindernia hyssopioides (L.) Haines, Lindernia antipoda (L.) Alston, Myriophyllum oliganthum (Wight \& Arn.) F. v. Müller, Leptochloa chinensis (L.) Nees, Cyperus difformis L. and Fimbristylis littoralis Gaudich. It was also found in small rock pools that dry out after the Monsoon; it usually grew in dense, single species stands or occasionally mixed with Rotala densiflora. When growing in dense stands the flowers are conspicuous and attractively scented.

I have cultivated $R$. fimbriata at Zürich from seeds collected at Bangalore. The seeds germinate submerged in water or in wet soil. Flowering is precocious; the first flowers develop in the axils of the 3rd or 4th leaf pairs. The cultivated plants were self-compatible and efficiently self-pollinated. Except for occasional 6-merous flowers, the form and size of the flowers remains very constant; 4-merous flowers have been reported but I have not seen any in the examined material.
24. Rotala densiflora (Roth ex Roemer \& Schultes) Koehne, Bot. Jahrb. 1: 164. 1880 ́ Ammannia densiflora Roth ex Roemer \& Schultes, Syst. Veg. 3: 304. 1818 三 Ditheca densiflora (Roth ex Roemer \& Schultes) Miq., Fl. Ind. Bat. 1(1): 1855.
$=$ Sellowia uliginosa Roth ex Roemer \& Schultes, Syst. Veg. 5: 407. 1819 $\equiv$ Winterlia uliginosa (Roth ex Roemer \& Schultes) Sprengel, Syst. 1: 788. 1824. Type: India orientali, B. Heyne (isotype: L - not the same specimen as the type of $R$. densiflora).

- Rotala roxburghiana Wight, Ic. Pl. Ind. Or. 1: t. 260B, 1840, nom. illeg. based on Ammannia pentandra Roxb.
- Ammannia pterocaulon Edgeworth 3029, nom. in sched. (K).

Type: India orientali, B. Heyne (isotype: L).
Ic.: Fig. 17A-H.
Amphibious or terrestrial annual. Stems erect, rooting at base, tetragonous and usually winged but wings not running directly into the leaves or bracts, up to 40 cm or more tall, simple or branched; lower branches erect like the primary stem; upper branches slender, usually opposite and spreading, usually fertile with leaf-like bracts considerably shorter than foliage leaves. Leaves decussate (on upper portion of the stem alternate


Fig. 17. $-R$. densiflora (A-D, Cook \& Rix 101; E, Sedgwick \& Bell 7563; F, Gamble 8765; G, Sedgwick \& Bell 4874; H, Cook \& Gut 114); A, habit; B, flower bud; C, flower; D, flower dissection; E-H, flowers (scale: A, $1 \mathrm{~cm} ; \mathbf{B}-\mathbf{H}, 1 \mathrm{~mm}$ ).
internodes are often shortened thus leaves may appear to be in whorls of 4), very variable in shape and size (even on a single plant), linear-lanceolate to ovate or oblong, 2-35 mm long, at base cordate to obtuse, at apex obtuse to acute or acuminate. Bracts almost dimorphic; on the main stem or on lower branches bracts like foliage leaves; on the upper lateral branches bracts usually ovate to broadly ovate, much shorter than foliage leaves and sometimes scarcely exceeding the flowers; bracteoles pinkish, lanceolate to oblong-ovate, usually with a distinct midrib, attenuate at apex, at maturity as long as or exceeding the calyx. Flowers monomorphic, solitary and sessile or subsessile in the axils of bracts. Calyx tube campanulate at anthesis becoming subglobose in fruit, $1-1.5 \mathrm{~mm}$ long; calyx lobes 5 or rarely 4 , triangular to shallowly triangular, acute to acuminate, c. 0.5 mm long; calyx appendages alternating with calyx lobes, usually linear or capillary, as long as or up to 2 times as long as calyx lobes or rarely rudimentary or absent, usually erect in bud, becoming brittle in fruit and often breaking off. Petals 5 or rarely 4, obovate, obtuse, occasionally erose or 2-lobed at apex, bright pink or rarely white, persistent but loosing colour in fruit, $0.5-1 \mathrm{~mm}$ long, at least as long as the calyx lobes. Stamens 5 or rarely 3 or 4 ; filaments inserted just below the middle of the calyx tube; anthers borne about level with the calyx lobes. Ovary globose; style $0.5-1 \mathrm{~mm}$ long; stigma capitate, exerted; capsule globose, occasionally flattened above, about as long as calyx tube, opening by 3 valves; seeds semi-ovoid, c. 0.5 mm long.

## DIAGNOSTIC FEATURES

$\mathrm{K}(4-) 5+(4-) 5$ (or calyx appendages rarely rudimentary or absent), $\mathrm{P}(4-) 5$, A(3, 4-)5, G3; capsule not exceeding the calyx; style exerted, $0.5-1 \mathrm{~mm}$ long; bracteoles as long as or exceeding the calyx; bracts almost dimorphic, long on main axis or lower branches, short on upper lateral branches; petals longer than calyx lobes.

## DISTRIBUTION

Western Himalaya (Tadzhik, Pamir, N. Pakistan and N. India), absent from the N. Indian Plain, reappearing in the hills of N.E. India (Assam and Manipur), widespread in peninsular India, Sri Lanka, Australia (E. Queensland) and isolated collections in Sabah (N. Borneo) and N. Italy (Prov. Vercelli) (Map 10). Rotala densiflora is certainly a relatively recent introduction to N. Italy (COOK, 1973). In Australia it is almost certainly native as it was collected by Banks \& Solander in 1770 on Cook's first voyage.

## SELECTED SPECIMENS

USSR. Central Asia: Sry Darya, Mzlikstan, 27 Sept. 1932, Variter \& Alektorolea (LE); Pamir-Alai, W. part of Pamir-Alai, Kasha Darya Valley, 1938, Goucarov (LE). Pakistan: Kurram, Shálizán, 10 Aug. 1880, Aitchison 417 (K,

LE). Pakistan or India (exact location not found): Kashmir, Pir Pãtšáski or Kishtár Pass to Islamabad, 5-10 Aug. 1856, Schlaginweit (G); W. Himalaya, Griffith (CGE, G, L, M, Z); N.W. Frontier, Ba(o)tel, Hazaru(n), Sept. 1907, Deane (K); N.W. Himalaya, between Dharmasala and Dadh, 1350 m, 22 Aug. or Sept. 1896, Gammie 18678 (K); ibid., 22 Aug. 1896, Duthie 18678 (LE); N.W. India, Royle (LE). India. Kashmir: Sringagar, 10 Aug.-30 Sept. 1856, Schlaginweit 4273 (L, LE); Dal Lake, Shalimar, 1850 m, 4 Aug. 1917, Stewart 3226 (K); ibid., Stewart 23062 (K); ibid., ricefields, 17 Aug. 1917, Stewart 3319 (K); Nowb?g, 13 Sept. 1876, Clarke 31239 (K); Erin Nallah, 3 Aug. 1960, Malhotra 12222 (L). Himachal Pradesh: Manali, Kuln Valley, 1850 m, 2 Aug. 1964, Maas 14088 (L); Simla, Aug., Edgeworth 3029 (K); Chanda Distr., 18 Dec. 1889, Duthie 9479 (K). Maharashtra: Bombay, Dalzell (K); Lonavala, Malavi, c. 700 m, Sept. 1920; Sedgwick \& Bell 7435 (K); ibid., 7437 (K); ibid., 7440 (K); Mahabaleshwar, 1500 m, Oct. 1920, Sedgwick \& Bell 7443 (K); ibid., Nov. 1918, Sedgwick \& Bell 579 (K); Pauchgani, 135 m, Oct. 1920, Sedgwick \& Bell 7563 (K); Kahandala, Meebold 8909 (Z). Karnataka (Mysore): N. Kanara, Karwar, Dec. 1918, Sedgwick \& Bell 5035 (K); N. Kanara, Kumat (Coompta), 17 Dec. 1884, Talbot 271 (K); N. Kanara, Honavar (Honore), sea coast, 19 Nov. 1884, Talbot 46 (K); Kalinadi, 600 m, Nov. 1918, Sedgwick \& Bell 4874 (K); S. Kanara, Mangalore, Hohenacker 1611 (G, K, L, LE, M, Z); Belgaum, Belgaum, Sept., Ritchie 1749 (K); ibid., Oct. 1852, Ritchie 1185 (K); Hassan Distr., 10 km before Arsikere, 25 Jan. 1971, Ramamoorthy HFP1258 (MO); Hassan Distr., Magadi, 15 Jan. 1969, Saldanke 12262 (MO); Bangalore, University of Agriculture Campus, 5 Nov. 1970, Cook \& Gut 114 (K, Z); probably Karnataka (Mysore), Wight 974 (M, MEL); ibid., Wight 1026 (G); ibid., Wight 1027 (G, K, L, LE, NSW - this number represents several different collections). Kerala: Wynad, Beddome 3113 (Z); Ernakulam, nr. Piravam, c. 50 m, 18 Sept. 1973, Cook, Rix \& Schneller 289 (Z); 12 km E. of Ernakulam, sea level, 18 Sept. 1973, Cook, Rix \& Schneller 295 (Z); half way between Trivandrum and Quilon, 27 Sept. 1973, Cook, Rix \& Schneller 353 (Z). Tamil Nadu: Distr. Salem, Hofanakkal, 260 m, 10 Feb., or 2 Oct. 1927, Jacob 17984 (K). Andhra Pradesh: Hyderabad, Campbell (G). Madhya Pradesh: Chota Nagpur, Jashpurnagar, c. 800 m , 25 Nov. 1890, Wood 126 (K). Bihar: Chota Nagpur, Hazaribagh, Mandu, 25 Nov. 1874, Clarke 25034C (LE); Singhbhum, 7 Dec. 1903, Haines 713 A (K); W. Ranchie, Lahardaga, 650 m, Nov. 1880, Gamble 8765 (K). Orissa: Kalahandi, Jamchua, 650 m, 22 Jan. 1943, Mooney 2179 (K); Gangpur, Dalakudar, 23 Feb. 1946, Mooney 2617 (K mixed with Ammannia). Assam: Khasi Hills, Jumbulpore, Griffith (L, M); Jaintia Hills, River Mungut, 1000 m, 21 Oct. 1867, Clarke 5920 (LE). Manipur: Imphal, c. 800 m, 12 Dec. 1954, Bullock 859 (K, L). India or Bangladesh. Bengal, s. loc., S. Kurz (M). Sri Lanka: s. loc., Thwaites 1548 (BR, G, LE); s. loc., 1829, McRue-Lindley (K). Australia: s. loc., "New Holland", 1770, Banks \& Solander (NSW). Queensland: Brisbane River, Aug. 1855, F. v. Müller (K); Brisbane Rifle Range, March 1917, Langman (K); Brisbane, Geebung, 2 April 1934, Blake 5305 (K); Atherton, May 1910, Betche 81901 (MEL, NSW); Moreton Bay, F. v. Müller
(MEL); Port Mackay, Dietrich 2544 (MEL). Sabah (N. Borneo): Usukan to Khota Balud, Kinabalu trip, 27 Oct. 1915, Clemens 9766 (K). Italy: Prov. Vercelli, Prarolo, c. 6 km S.E. Vercelli, 24 Aug. 1972, Cook \& Rix 101 (K, Z).

## NOTES

I have seen Rotala densiflora in N. Italy and in India at Bangalore and three localities in Kerala. Except for some rockpools near Bangalore where it was growing with $R$. fimbriata, it was always in ricefields with other ubiquitous ricefield weeds and almost invariably growing together with $R$. indica. In Kerala, in addition to $R$. indica it was usually growing intermingled with $R$. malampuzhensis and $R$. rosea.

I have cultivated material at Zürich collected from Italy (Cook \& Rix 101) and India, Bangalore (Cook \& Gut 114) and Ernakulam (Cook, Rix \& Schneller 289). In cultivation all three populations were alike. The cultivated plants were annual and self-compatible with efficient self-pollination. The first flowers develop on the main axis in the axils of leaf-like bracts; these flowers usually have much shorter calyx appendages and in some cases the appendages are rudimentary or absent (Fig. 17G, H); these early flowers are occasionally 4 -merous. On poorly grown or crowded plants, side branches rarely develop and all flowers may have reduced calyx appendages. On wellgrown plants the majority of flowers are borne on lateral branches with small bracts; these flowers usually have long calyx appendages and 5 -merous flowers. The length of the style and the bracteoles remains under all conditions relatively constant. The length and shape of the petals is variable but does not appear or follow any discernable pattern.

From the rather limited amount of Australian material examined, the plants appear to have 3 stamens. There is no doubt that $R$. densiflora is native in Australia as it was first collected by Banks \& Solander in 1770. These plants may be worthy of taxonomic recognition below the rank of species.

On mature stems alternate internodes are often shortened and thus the leaves appear in whorls of 4 . It is possible that other species have evolved to the whorled leaved state by irregular growth of internodes. This phenomenon is described by Соок (1978).
25. Rotala rosea (Poiret) C. D. K. Cook, comb. nova $\equiv$ Ammannia rosea Poiret in Lamarck, Encycl. Méth. Bot. Suppl. 1: 329. 1810.
$=$ Ammannia pentandra Roxb., Fl. Ind. (ed. 1) 1:448. $1820 \equiv$ Tritheca pentandra (Roxb.) Miq., Fl. Ind. Bat. 1(1): 614. $1855 \equiv$ Rotala pentandra (Roxb.) Blatter \& Hallberg, J. Bombay Nat. Hist. Soc. 25: 707. 1918, pro parte, pro basionym et syn. R. leptopetala. Type: Roxburgh, Flora Indica, unpublished plate No. 548 (holotype: K).
$=$ Ammannia littorea Miq., Prol. Fl. Jap.: 149. $1866 \equiv$ Rotala littorea (Miq.) Nakai, Chôsen-Shokubatsu: 359. 1914. Type: Japan, pr. Simonose Ky, Miquel (holotype: L).
$=$ Rotala densiflora (Roth ex Roemer \& Schultes) Koehne var. formosana Hayata in Matsumumura \& Hayata, Enum. Pl. Formos.: 149. 1905. Type: not located.

- Ammannia leptopetala Blume, Mus. Bot. Lugd. Bat. 2: 134. $1856 \equiv$ Rotala leptopetala (Blume) Koehne, Bot. Jahrb. 1: 162. 1880, pro parte, emend. Koehne, Bot. Jahrb. 3: 388. 1883; nom. illeg. based on Ammannia pentandra Roxb.
- Ammannia repens Heyne, nom. in sched.

Type: Indes orientales, herb. Desfontaines (holotype: FT).
Ic.: Fig. 18A-H.


B


D
F






J

E



C





K



L

Fig. 18. - R. rosea (A-E, Merrill 9432; F, Cook \& Gut 32; G, Taquet 1462 ; H, Sedgwick \& Bell 4330); A, bract; B, flower bud; C, flower; D, flower dissection; $\mathbf{E}-\mathbf{H}$, mature capsules.
R. verdcourtii (Verdcourt 2854); I, bract; J, flower at anthesis; K, flower with dehiscing capsule; $\mathbf{L}$, flower dissection (scale: 1 mm ).

Amphibious or terrestrial annual. Stems erect, rooting at base, simple or branched from below, rarely branched above, rarely more than 30 cm tall. Leaves decussate, linear-lanceolate to ovate, at base obtuse or cuneate, at apex obtuse or acute. Bracts like foliage leaves, usually obtuse at base; on the rarely developed upper lateral branches bracts smaller than foliage leaves but always longer than the flowers; bracteoles linear or capillary, $0.5-1 \mathrm{~mm}$ long, not exceeding the calyx tube. Flowers monomorphic, solitary and sessile in the axils of bracts. Calyx tube campanulate at anthesis becoming semiglobose as the fruit ripens; calyx lobes 5 or rarely 4 , shallowly triangular, c. 0.25 mm long; calyx appendages alternating with calyx lobes, subulate, spreading in bud, usually about as long as the calyx lobes, c. 0.25 mm , rarely longer or rarely rudimentary or absent. Petals 5 or rarely 4 or rarely rudimentary, not persisting in fruit, up to 0.25 mm long. Stamens 5 or rarely less; filaments inserted just below the middle of the calyx tube; anthers included, borne level with the top of the calyx tube. Ovary globose; style very short, absent to 0.25 mm long; stigma capitate; capsule globose, about 2 times as long as calyx tube, up to 2 mm diam., usually red above, opening by 3 valves; seeds semi-ovoid, c. 0.3 mm long, straw coloured.

## DIAGNOSTIC FEATURES

$\mathrm{K}(4-) 5+(-4) 5$ (or calyx appendages rarely absent or rudimentary), $\mathrm{P}(4-) 5$, $\mathrm{A}(3,4-) 5, \mathrm{G} 3$; capsule about 2 times as long as calyx tube, bright red above; style very short, less than 0.25 mm long; petals c. 0.25 mm long, not persisting in fruit.

## DISTRIBUTION

India, S.E. Asia to New Guinea, Philippines, S. China, Korea and Japan up to latitude $40^{\circ} \mathrm{N}$. (Map 11). In tropical regions it may be found flowering at any time of the year but in temperate regions it flowers from August to October.

## SELECTED SPECIMENS

India: s. loc., Wallich 2105 (CGE, G, LE); ibid., Ritchie (K); N.W. India, s. loc., Royle (LE); Concan, s. loc., Law (K). Punjab: nr., Indri, 1888-1889, Drummond (K). Rajasthan: Kota, 28 Oct. 1970, Cook \& Gut 32 (K, Z). Karnataka (Mysore): N. Kanara, Sidashyagud, 2 Aug. 1883, Talbot 586 (K); N. Kanara, Castle Rock, 600 m, Sept. 1918, Sedgwick \& Bell 4330 (K); N. Kanara, Karwar, by sea, Oct. 191?, Sedgwick \& Bell 6680 (K); s. loc., probably Mysore, Wight 1026 (G, K); ibid., Thomson (G, L). Kerala: Prov. Ernakulam, 6 km N. Alwaye, sea level, 17 Sept. 1973, Cook, Rix \& Schneller 269 (K, Z); ibid., outskirts of Alwaye, sea level, 17 Sept. 1973, Cook, Rix \& Schneller 265 (Z); ibid., S. Perumpavur, 17 Sept. 1973, Cook, Rix \& Schneller 276 (Z); ibid., between Ernakulam and Vaikom, sea level, 19 Sept. 1973,

Cook, Rix \& Schneller 307 (K, Z); ibid., c. 10 km N.W. Moolamattom, c. $600 \mathrm{~m}, 19$ Nov. 1970, Cook \& Gut 2.22 (K, Z); ibid., Vaikom (Vaikam), 30 Nov. 1970, Cook \& Gut 286 (K, Z); Prov. Kottayam, between Kottayam and Vaikom, sea level, 21 Sept. 1973, Cook, Rix \& Schneller 318 (Z); Prov. Quilon, 20 km E. Quilon, c. 50 m, 26 Sept. 1973, Cook, Rix \& Schneller 345A (Z); Prov. Trivandrum, between Trivandrum and Quilon, sea level, 27 Sept. 1973, Cook, Rix \& Schneller 351 (K, Z); ibid., Cook, Rix \& Schneller 352 (Z); ibid., Kovalum, sea level, 28 Sept. 1973, Cook, Rix \& Schneller 358 (K, Z); Adur (Adyar), 22 Jan. 1899, Barber 99 (K). Tamil Nadu: Salem Distr., Hosur, 29 Dec. 1916, Madras Herb. No. 13960 (K); Madura Distr., Pulney Hills, Tamdikuoli, 100 m, Jan. 1925, Anglade 743 (G); ibid., 28 May 1899, Bourne 2624 (K); ibid., Poombarai Valley, 1899, Bourne 933 (K); Madras, Spur Tank, 19 Sept. 1899, Bourne (K). Pondicherry, 1835, Perrottet (BR, K, M, L, LE); ibid., s.d., Perrottet 247 (L). Orissa: Ganjam Distr., Naupada, Jan. 1890, Gamble 21603 (K). Bihar: Singbhum, 18 Aug. 1903, Haines 5191 (K); Chota Nagpur, Ranchi, 650 m, 25 Oct. 1873, Clarke 20608 (LE). Bengal: S. Calcutta, Komurah Kali, 27 March 1960, Hara, Kanai \& Tuyama 2903 (KYO). Assam: Upper Assam, Jenkins (K); ? Cachar, 1 Dec. 1872, Clarke 18553C (LE). Bangla Desh: Sylhet (Sillet), ?1832, Wallich 2101B or $/ 2$ (BR, CGE, G, K, LE); Nasirabad (Mymensingh), 4 Nov. 1868, Clarke 7975 (K); Chittagong, 3 Jan. 1851, Hooker \& Thomson (K); ?E. Bengal, Griffith 2311 (LE). Burma: Ava, ?1826, Wallich 2102 A or /1 (G, K, LE); Ramree Island, Kyaukpyu, Aug. 1945, Wallace 9143 (K). Sri Lanka: Kalutara (Caltura), Macrae 172 (CGE, BR); s. loc., Macrae (BR). Malaysia: Malacca, Alor Gajah Distr., Kampong Gadek, 20 April 1957, Sinclair 8928 (L). Thailand: Chiang Mai, 300 m, 18 Jan. 1911, Kerr 1648 (K, L). Vietnam: Tongking, Sha Nam, Yen The, 13 Dec. 1902, Bois 222 (K); South Vietnam, Nha Trang, Annam, March 1911, Robinson 1205 (L). Indonesia: Java, s. loc., Horsfield (CGE, K); ibid., van Hall 127 (L); ibid., Zollinger 714 (L, LE); ibid., 1880, Zollinger (G, LE, ZT); ibid., Hostm. (U); Java, Bogor (Buitenzorg), 240 m, 1 Feb. 1950, van Ooststrom 21654 (L); Dramaga, 30 Jan. 1921, Bakhuisen van den Brink 741 (U). W. Sumatra, Mt. Sago, nr. Pajakumbuh, 800-900 m, 4 May or 5 April 1957, Meijer 5760 (L). Irian Barat (New Guinea, Jaya), Maranke, between Mopa and Taram, 5 m, 4 Aug. 1954, van Royen 4579 (K, L). Philippines: s. loc., Cuming 735 (CGE); ibid., 1841, Cumming (LE); Luzon, Manila, Sept. 1892, Loher 2160 (M); Luzon, Rizal, Oct. 1914, Merrill 9782 (K mixed with $R$. ramosior, L); Mindanao, Surigao, Hinatun, 16 May 1911, Piper 508 (K); Mindanao, Davoe Prov., 425 m , Aug. 1949, Edaño 11302 (L). China. Yunnan: s. loc., Ducloux 263 (K). Kwangtung, Hainan Tao: Ting Ch’ang (Zaom-chau), Chi To Shan, 16 Sept. 1927, Tsang Wai-Tak 882 (L, U); ibid., Tsang Wai-Tak 16381 (G, K). Kiangsi: Lungnan, Lam Uk, 1-15 Oct. 1934, Lan 4806 (G). ?Lungchow, Morse 251 (K). Taiwan: Lake Suisya, 12 Sept. 1929, Sasaki 79644 (TAI); probably Taiwan, locality not found, Pachuna, 29 Nov. 1896, Makino (KYO). Korea: Cheju Do (Quelpaert), Honguo, Sept. 1908, Taquet 1462 (G, K, KYO); Pusan, 30 Oct. 1901, Faurie 472 (G); not found, Mantoku-zan, Zenrahokudo, 15 Sept. 1940, Cho 1226 (KYO). Japan:

Okinawa. Kunigami: Kunigami, 7 Aug. 1951, Walker, Tawanda \& Amano 6463 (K, L); Nagocho, 1 Sept. 1938, Kaneshira 903 (KYO); Higashi-mur(s)a, 18 Sept. 1938, Kaneshira 1416 (KYO); Beemata, 30 Sept. 1934, Kaneshira 1815 (KYO). Kyushu: Hizen Pref., Noma, 15 Sept. 1934, Nakazima 471 (KYO); Kagoshima Pref., Tarumi, Makino 121170 (MAK); Naga-saki, 1863, Maximovicz (K). Shikoku: Kochi Pref., Mihara-mura, Hatagun, 28 Sept. 1967, Yamanaka 51002 (KYO); Kochi Pref., Kochi, Misato, Makino 121164 (MAK). Honshu: Kii Pref., Owase-tyo, 31 Oct. 1954, Higuchi (KYO); Tomida Pref., Ise, Sept. 1905, Makino 121154 (MAK); Mie Pref., Yokkaichi, Makino 121154 (MAK) a duplicated herbarium number; Gifu Pref., Nakatsugawa, Makino 121149 (MAK); Tango Pref., Naka-gun, 24 Sept. 1950, Nakai 4933 (KYO); Hanto Pref., Takatamatsuhara, 10 Aug. 1932, Toba 223 (KYO); Yokohama, 1862, Maximovicz (BR, K, M); Yama-gata Pref., Murayama, Makino 121142 (MAK); Aichi Pref., Hoi-gun, Ichinomiyamachi, Makino 121152 (MAK); Akita, 6-7 Sept. 1894, Faurie 13762 (G, K). The following localities have not been found: Loochoo, 1923, Koidzumi (KYO); Utchina, Nagagami, 27-31 May 1923, Koidzumi (KYO); Hata, Tosa, 12 Oct. 1891, s. coll. (K); Japan, s. loc., Bürger (M); ibid., 1880, Makino (ZT).

NOTES
I have seen Rotala rosea in India, Rajasthan, near Kota where it was growing in shallow water and on land at the edge of a water reservoir; the associated species were: Ceratopteris thalictroides (L.) Brongn., Limnophila aquatica (Roxb.) Alston and Rotala indica (L.) Willd. In India, Kerala it is very common in seasonally inundated places and ricefields and frequently grows with other species of Rotala: R. densiflora, R. indica, R. malampuzhensis and R. mexicana.

I have cultivated material collected in Kerala. The cultivated plants were obligately annual, self-incompatible and efficiently self-pollinated. The calyx appendages are small or rudimentary on poorly grown or crowded plants. The relative proportions of the bracteoles, calyx and capsule remain more or less constant. The petals are very variable in size and shape and are occasionally absent; there does not appear to be any discernable pattern in the variation.
26. Rotala verdcourtii A. Fernandes, Bol. Soc. Brot. Sér. 2, 49: 10. 1975.

Type: Tanzania, Buha Distr., 115 km from Kibondo on Kasulu Road, 1340 m, 15 July 1960, Verdcourt 2854 (holotype: COI n.v.; isotype: K).

Ic.: Fig. 18I-L; Fernandes, Bol. Soc. Brot. Sér. 2, 49: t. 3. 1975.
Amphibious annual or perhaps perennial. Stems erect, rooted and denuded of leaves below, irregularly branched above, up to c .30 cm long.

Leaves decussate, sessile; submerged leaves linear but gradually tapering towards the apex, up to c. 15 mm long; aerial leaves linear-lanceolate to lanceolate, rarely exceeding 6 mm long, truncate or bifurcate at apex, cuneate at base. Bracts leaf-like, lanceolate, up to c. 6 mm long; bracteoles 2, linear, c. 1.25 mm long. Flowers monomorphic, sessile, solitary in the axils of leaf-like bracts. Calyx tube cup-shaped at anthesis becoming hemispherical in fruit, c. 1 mm long, whitish below, pinkish above; calyx lobes 5 , triangular at anthesis becoming shallowly triangular in fruit, up to 0.5 mm long, pink; calyx appendages 5 , capillary to subulate, c. 0.5 mm long. Petals absent. Stamens 2 , inserted on the lower half of the calyx tube; anthers borne at top of calyx tube. Ovary ovoid to globose; style c. 0.25 mm long; stigma capitate; capsule globose c .1 mm diam., opening by 3 valves; seeds hemispherical, c. 0.3 mm diam.

## DIAGNOSTIC FEATURES

$\mathrm{K} 5+5, \mathrm{P} 0, \mathrm{~A} 2$, G3; it is like $R$. welwitschii but differs in having 5 calyx lobes, bracteoles c. 1.25 mm long and style c. 0.25 mm long.

DISTRIBUTION
Tanzania (Map 10), known only from the type gathering.

## SELECTED SPECIMENS

Tanzania: Buha Distr., 115 km from Kibondo on Kasulu Road, 1340 m, 15 July 1960, Verdcourt 2854 (COI n.v., K).
27. Rotala welwitschii Exell, Bol. Soc. Brot. Sér. 2, 30: 69. 1956.

- Rotala decussata auct., sensu Hiern in Oliver, Fl. Trop. Afr. 2: 467. 1871, excl. syn., et distrib. austral. et asiat., non Rotala decussata DC.

Type: Angola, Cuanza Norte, Pungo Andongo, Lagoa de Quibinda, Mar. 1857, Welwitsch 2340 (holotype: BM; isotype: LISU n.v.)

Ic.: Fig. 19A-D.
Amphibious or terrestrial annual or perennial. Stems branching and rooting below, erect above; erect stems 10 cm or more long, 4 -angled to 4 winged. Leaves decussate, sessile; submerged leaves linear but gradually tapering towards the apex, up to 40 mm long, red to pink, sometimes almost translucent; aerial leaves elliptic to oblong or obovate, up to c. 6 mm long and c .4 mm wide, at base cuneate on lower part of stem becoming cordate on upper part of stem, at apex obtuse. Bracts leaf-like, linear to oblong or




Fig. 19. - R. welwitschii (Warnecke 229); A, bract; B, flower at anthesis; C, flower with mature capsule; $\mathbf{D}$, flower dissection.
R. juniperina (Robinson 5353); E, bract; $\mathbf{F}$, flower at anthesis; $\mathbf{G}$, flower with mature capsule; $\mathbf{H}$, flower dissection (scale: A-H, 1 mm ).
obovate, usually cordate at base; bracteoles 2 , linear, c. 0.5 mm long. Flowers monomorphic, sessile, solitary in axils of leaf-like bracts. Calyx tube cupshaped at anthesis becoming hemispherical in fruit, c. 1 mm long; calyx lobes 4, deltate, up to 0.5 mm long; calyx appendages 4 , linear or capillary, c. 0.5 mm long. Petals absent or up to 4, microscopically small. Stamens 2 or occasionally 3 or 1 , inserted about halfway up the calyx tube; anthers visible between the calyx lobes. Ovary ovoid to globose; style very short, less than 0.2 mm long; stigma capitate; capsule globose, $1-1.25 \mathrm{~mm}$ diam., opening by 3 valves; seeds numerous, hemispherical to rounded-deltoid, c. 0.25 mm diam.

## DIAGNOSTIC FEATURES

$\mathrm{K} 4+4, \mathrm{P} 0-4, \mathrm{~A} 2, \mathrm{G} 3$; it is like $R$. verdcourtii but differs in having 4 calyx lobes, bracteoles c. 0.5 mm long and a very short style (less than 0.2 mm long).

## DISTRIBUTION

Tropical West Africa from Sierra Leone (Senegal) to northern Angola, and Tropical Central Africa to Sudan (Map 10). Flowering time from October to March.

## SELECTED SPECIMENS

Sierra Leone: northern Prov., Kambia, 2 Nov. 1963, Morton \& Gledhill SL25 (MO). Upper Volta: Broussèra, 30 Dec. 1964, Aké Assi 7549 (BR). Ghana: Tamale to Bolga, mile 48, 27 Aug. 1965, Hall 430 (K); Busunu, Damongo to Yapei, 10 Sept. 1965, Hall 889 (K). Togo: Lome, Warnecke 229 (BM, BR, G, K, L, P, Z). Nigeria: 3 km S.W. Iseyin, $7^{\circ} 58^{\prime} \mathrm{N} .3^{\circ} 34^{\prime} \mathrm{E} ., 350 \mathrm{~m}$, 1962, Gillett 15397 (K); Lokoja, 7 Nov. 1909, Dalziel 210 (K). Cameroun: 80 km N.E. Mora, Ndiguina, 5 Oct. 1964, Letouzey 7354 (K, P); 70 km N.E.E. Maroua, Guirvidig, Dega, 10 Oct. 1964, Letouzey 7270 (P). Gabon: Ogooué, plaine de Sopi, Feb. 1887, Thollon 772 (K, P). Angola: Cuanza Norte, Pungo Adongo, Lagoa de Quibinda, March 1957, Welwitsch 2340 (BM); ibid., Pungo Adongo, pr. Motola, March 1857, Welwitsch 2343 (BM). Sudan: Bahr el Ghazal, Ghabbt el Arab, 29 March 1930, Simpson 7699 (K). Raynal, Adansonia 7: 544. 1967, cites specimens from: Senegal, Mali, Ivory Coast and the Republic of Central Africa.
28. Rotala cordata Koehne, Bot. Jahrb. 1: 172. 1880.
$=$ Rotala diversifolia Koehne, Bot. Jahrb. 41: 77. 1907. Type: Thailand, Chiang-Mai (Chieng-mai), E. Dai Sutep, c. 750 m, 29 Dec. 1904, Hosseus 275 (holotype: G; isotypes: K, L, M).

Type: Koehne op. cit. wrote "Bengal, Herb. Ind. Or., Hook. fil. \& Thomson, als $R$. roxburghiana ausgegeben, mixta cum $R$. pentandra." One sheet at G (De Candolle legat, presented 1921) bears two species, one is $R$. densiflora $(=R$. pentandra sensu Koehne), the other is $R$. cordata. The plant of $R$. cordata has four labels in Koehne's handwriting, including a provisional description and the intention to name it $R$. cordata. This specimen can be accepted as the holotype (holotype: G).

Ic.: Fig. 20A-E.
Amphibious or terrestrial annual or perhaps perennial. Stems erect, rooting at base, usually branched but occasionally simple, up to 50 cm or

C




G

F



Fig. 20. - R. cordata (Hooker fil. \& Thomson); A, bract and flower from main stem; B, bract and flower from lateral branch; C, flower at anthesis; $\mathbf{D}$, flower with mature capsule; $\mathbf{E}$, flower dissection.
R. rubra (Wallich 2107A); F, flower bud; G, flower at anthesis; $\mathbf{H}$, flower with mature capsule; $\mathbf{I}$, flowering node; $\mathbf{J}$, flower dissection (scale: A-J, 1 mm ).
more long, brown or yellow below, usually red above with 4, distinct, white wings which run into the leaf or bract margins at each internode. Leaves decussate, sessile, lanceolate to ovate or oblong, up to 25 mm long, cordate at base, obtuse at apex. Bracts on main stem like foliage leaves; bracts on lateral inflorescence branches lanceolate to oblong, usually tinged with red, spreading or recurved, cordate at base, 2-3 times as long as subtended flower;
bracteoles 2, minute, c. 0.2 mm long. Flowers monomorphic, subsessile or shortly pedicellate, solitary in axils of bracts, usually borne on contracted lateral branches or occasionally on the main stem. Calyx tube campanulate at anthesis becoming subglobose in fruit, $1-1.5 \mathrm{~mm}$ long; calyx lobes 4 , triangular, acuminate, usually microscopically toothed at margin, 0.5 mm long, usually pinkish; calyx appendages absent. Petals 4, obovate, equalling or up to 2 times as long as calyx lobes, pink to purple, persistent in fruit. Stamens 4 or rarely less, inserted about halfway up the calyx tube; anthers level or slightly exceeding the tips of the calyx teeth. Ovary globose; style elongate, $1-1.5 \mathrm{~mm}$ long, persistent; stigma capitate, exerted; capsule globose, usually somewhat flattened above, $1-1.5 \mathrm{~mm}$ diam., included within the calyx tube, opening by 3 valves; seeds semi-ovoid, c. 0.5 mm long.

## DIAGNOSTIC FEATURES

$\mathrm{K} 4, \mathrm{P} 4, \mathrm{~A}(2-) 4, \mathrm{G} 3 ; R$. cordata has white wings on the stem which run directly into the margins of the leaves or bracts at each internode, the calyx has 4 lobes without calyx appendages, the style is $1-1.5 \mathrm{~mm}$ long and the stigma is exerted. It bears a superficial resemblance to $R$. densiflora but is easily distinguished by the characters mentioned above and by the very short bracteoles.

## DISTRIBUTION

From N.E. India (Orissa and Bihar) and E. Nepal through Tropical S.E. Asia to Irian Barat (W. New Guinea) (Map 12). R. cordata is mostly found in mountainous regions where it grows in bogs and besides streams and waterfalls. It appears to be one of the few Rotala species not recorded from ricefields. The flowering time is from August to March.

## SELECTED SPECIMENS

India. Orissa: Keonjhar, Garjantoli, 1000 m, 3 Oct. 1946, Mooney 2812 (K); Ganjam Distr., Bondogorha, 500 m , March 1884, Gamble 14071 (K). Bihar?: Purnea Distr. (Purnesh), Adikari, Dec. 1918, Haines 5164 (K). Bengal: Siliguri (Silliguri), Dec. 1874, Gamble 527 (K). India or Bangla Desh: Bengal, Hooker fil. \& Thomson (G). Nepal: eastern Nepal, Khebang-Bharomdin, 24 Nov. 1963, Hara, Kanai \& al. 6306503 (K - mixed with $R$. indica, KYO). Burma: Pegu, 1854, McLelland (K). Thailand. Chiang Mai: Dai Sutep, 750 m , 29 Dec. 1904, Hosseus 275 (G, K, L, M); ibid., c. 600 m, 3 Dec. 1911, Kerr 2260 (K, L); 5 km W. Bo Luang, 1100, 29 Jan. 1964, Hansen, Sidenfaden \& Smitihand 10983 (L). Kanchanaburi Distr., Huay Bankau, $14^{\circ} 55^{\prime}$ N.- $98^{\circ} 45^{\prime}$ E., 750 m, 10 Nov. 1971, van Beusekom, Phegkhlai, Geesink \& Wongwan 3629 (KYO, L). Vietnam: South, Bien Hoa, Jan. 1873, Pierre (K - mixed with R. indica); ibid., March 1873, Pierre (K). Indonesia. Sulawesi (Celebes): Masamba, between Wono and Lodang, 1100 m, 24 July 1937, Eyma 1253 (K,
U); Poso, swamps nr. Malino, 20-21 Aug. 1938, Eyma 3458 (K, L, U). Irian Barat (W. New Guinea): Tjendrawasih (Vogelkop Peninsular), Kebar Valley, 520 m, 16 Aug. 1961, van Royen \& Sleumer 6704 (L). Djawa (Java), Djawa Barat, Sukamani, 10 m, 14 Feb. 1974, Häfliger (ZT).
29. Rotala rubra (Buch.-Ham. ex D. Don) Hara, J. Jap. Bot. 52(7): 197. 1977 三 Ammannia rubra Buch.-Ham. ex D. Don, Prodr. Fl. Nepal.: 220. 1825.
$=$ Rotala alata Koehne, Bot. Jahrb. 1: 171. 1880. Type: Koehne, op. cit. wrote "Nepal, Wallich 2107A, intermixt. cum R. indica". None of the Wallich $2107 A$ specimens that I have seen has $R$. alata and $R$. indica mixed. One specimen in G ( De Candolle legat, presented in 1921) bears two labels in Koehne's handwriting mentioning his intention to name the plant R. alata. I select this specimen as lectotype (lectotype: G; isolectotypes: BR, CGE, G, K, K-W, LE).

- Ammannia pentandra Roxb. var. "alpha" Wight \& Arn., Prodr. Fl. Pen. Ind. Or. 1: 305. 1834, pro parte, quoad specim. Wallich 2107.

Type: Nepaliâ (Nepal), Hamilton (holotype: BM).
Ic.: Fig. 20F-J.
Amphibious or terrestrial annual or perhaps perennial. Stems erect rooting at base, simple or branched, up to 20 cm or perhaps more long, brown or red above with 4 , distinct, white wings which run into the leaf or bract margins at each internode. Leaves decussate, linear-lanceolate to ovate, up to 20 mm long, usually cuneate or occasionally obtuse at base, obtuse to acute at apex. Bracts on main stem like foliage leaves; bracts on lateral inflorescence branches lanceolate to broadly ovate, about 2 times as long as subtended flower; bracteoles 2, minute, c. 0.2 mm long. Flowers monomorphic, sessile or subsessile, solitary in axils of bracts, usually borne on contracted lateral branches or occasionally on the main stem. Calyx tube campanulate at anthesis becoming hemispherical in fruit, c. 1 mm long; calyx lobes 4 or rarely 3 , triangular, c. 0.5 mm long, margin occasionally microscopically toothed, acuminate at apex; calyx appendages absent. Petals 4 or rarely 3, obovate, equalling or somewhat exceeding the calyx lobes, up to c. 1 mm long, often with erose margin, persistent, pink but loosing colour in fruit. Stamens 4 or rarely 3 , inserted half-way up the calyx tube; anthers borne below the tips of the calyx lobes. Ovary globose; style very short, c. 0.1 mm long; stigma capitate; capsule globose, c. 1.5 mm diam., exceeding the calyx, opening by 3 valves; seeds semi-ovoid, up to 0.4 mm long.

## DIAGNOSTIC FEATURES

$\mathrm{K}(3-) 4, \mathrm{P}(3-) 4$, A4, G3; $R$. rubra is like $R$. cordata but has a very short style (c. 0.1 mm long) and a capsule that exceeds the calyx tube, the leaves are
cuneate to obtuse at the base, the petals are smaller (not exceeding 1 mm long) and the flowers are usually sessile.

## DISTRIBUTION

Known only from Nepal (Map. 11).

## SELECTED SPECIMENS

Nepal: s. loc., Wallich 2107A (BR, CGE, G, K, K-W, LE); the following specimen is cited by Hara, J. Jap. Bot. 52(7): 197. 1977: E. Nepal, Tumingtar, Arun R., c. $600 \mathrm{~m}, 25$ Dec. 1961, Norkett 8120 (no herbarium cited).
30. Rotala juniperina A. Fernandes, Bol. Soc. Brot. Sér. 2, 48: 126. 1974.
$=$ Rotala decumbens A. Fernandes, Bol. Soc. Brot. Sér. 2, 48: 127. 1974. Type: Zambia, Kabulamwanda Dam, 108 km N. of Choma, c. 1150 m, 24 April 1954, Robinson 723 (holotype: K).

Type: Malawi, Mlanje Distr., 16 km N.W. of Likabula Forest Depot, 700 m , 15 June 1962, Robinson 5353 (holotype: SRGH n.v.; isotypes: BR, $\mathrm{K}, \mathrm{M})$.

Ic.: Fig. 19E-H; Fernandes, Bol. Soc. Brot. Sér. 2, 48: t. 12 and t. 13. 1974.
Amphibious annual or perhaps perennial. Stems creeping, ascending or erect, branched, up to 30 cm or more long, when submerged somewhat inflated, when aerial 4 -angled occasionally with wings on the angles. Leaves decussate or occasionally in whorls of 3 , lanceolate to ovate, up to 20 mm long on main axis but less on lateral branches, cuneate to cordate at base, acute at apex. Bracts like foliage leaves on main axis, smaller on lateral inflorescence branches; bracteoles 2, linear, 1-1.5 mm long. Flowers monomorphic, solitary in axils of bracts, borne mostly on lateral branches. Calyx tube campanulate, c. 1 mm long at anthesis, c. 1.5 mm long in fruit; calyx 3, very shallowly triangular, c. 1 mm wide at base; calyx appendages 3 , spreading at anthesis, subulate in fruit, up to 0.5 mm long, exceeding the calyx lobes. Petals 3 , elliptic, up to 0.5 mm long, more or less persistent. Stamens 3 , inserted slightly below the middle of the calyx tube; anthers borne at the top of the calyx tube. Ovary subglobose; style c. 0.25 mm long; stigma capitate; capsule subglobose, $1.5-2 \mathrm{~mm}$ long, equal to or scarcely exceeding the calyx, opening by 3 valves; seeds semi-ovoid, c. 0.4 mm long.

## DIAGNOSTIC FEATURES

$\mathrm{K} 3+3, \mathrm{P} 3, \mathrm{~A} 3, \mathrm{G} 3$; in habit $R$. juniperina resembles the Asian species $R$. densiflora, $R$. cordata and $R$. rubra but is easily distinguished on the basis of
the 3-merous flowers. Florally it is like $R$. malampuzhensis but the calyx appendages are subulate in fruit, the capsule scarcely exceeds the calyx and the stamens are inserted about half-way up the calyx tube.

## DISTRIBUTION

Known from three gatherings from E. Zaire, S. Zambia and S. Malawi (Map 9). Flowering time from April to July.

SELECTED SPECIMENS
Zaire: Shaba (Katanga), Mitwaba Terr., Simama, riv. Dikuluwe, 12 July 1956, Bryneart 505 (BR). Zambia: Kabulamwanda Dam, 108 km N. of Choma, 1150 m, 24 April 1954, Robinson 723 (K). Malawi: S. Malanje Distr., 16 km N.W. of Likabula Forest Depot, 15 June 1962, Robinson 5353 (BR, K, M).
31. Rotala malampuzhensis R. V. Nair ex C. D. K. Cook $\equiv$ Rotala malampuzhensis R. V. Nair, J. Bombay Nat. Hist. Soc. 72(1): 57. 1975, nom. inval. published without nomenclatural type.

Type: I choose the following specimen: India, Kerala, Palghat Distr., Malampuzha River, July 1971, R. Vasudevan Nair, herb. No. 89602 (holotype: MH).

Ic.: Fig. 21A-E; Nair, J. Bombay Nat. Hist. Soc. 72(1): 58-59, fig. 1-18. 1975.
Amphibious or terrestrial, usually tuft-forming annual. Stems creeping, much branched, often denuded of leaves and rooting below with numerous, erect branches or stems; erect branches and stems simple or scarcely branched, up to 30 cm tall but usually less. Leaves decussate, sessile; submerged or lower leaves scale-like to orbicular, c. 2 mm long becoming lanceolate to linear further up the stem; aerial or upper leaves linear to narrowly oblong or lanceolate, up to 15 mm long and 4 mm wide but usually less. Bracts like upper leaves, linear to lanceolate; bracteoles capillary, c. 1 mm long, about as long as the calyx tube. Flowers monomorphic, sessile, solitary. Calyx tube campanulate, up to 1 mm long, bright red; calyx lobes 3 , shallowly triangular at anthesis, becoming laterally stretched as the fruit matures, up to 0.5 mm long but usually less, bright red; calyx appendages 3 , shorter than the calyx lobes at anthesis sometimes rudimentary or absent. Stamens 3, inserted near the base of the calyx tube; anthers included. Ovary globose; style very short or absent; stigma capitate, sessile or subsessile; capsule globose, exceeding the calyx, up to 1.5 mm diam., opening by 3 valves, bright red; seeds semi-ovoid, c. 0.6 mm long, bright red or yellow.


G



Fig. 21. - R. malampuzhensis (Cook, Rix \& Schneller 276B); A, bract; B, C, flower buds; D, flower with mature capsule; $\mathbf{E}$, flower dissection.
R. simpliciuscula (Hooker fil. \& Thomson); F, habit; G, flower with mature capsule; H, flower at anthesis; I, flower dissection (scale: A-I, 1 mm ).

## DIAGNOSTIC FEATURES

K3 +3 (appendages sometimes rudimentary or absent), P3, A3, G3; like $R$. rosea but flowers 3 -merous, seeds c. 0.6 mm long. It often grows intermingled with $R$. rosea but in the field is simply identified by its tufted habit, smaller and narrower leaves and the intense red of the calyx and fruit.

## DISTRIBUTION

The coastal plain of Kerala, S. India, between the latitudes $9^{\circ} \mathrm{N}$. and $12^{\circ} \mathrm{N}$. (Map 12). It flowers and fruits from about July to September.

## SELECTED SPECIMENS

India. Kerala State: Calicut Distr., Badagara, Sept. 1967, R. V. Nair (MH); Palghat Distr., Malampuzha River, July 1971, R. V. Nair (MH); Ernakulam Distr., Perumpavur, sea level, 17 Sept. 1973, Cook, Rix \& Schneller 276B (Z); Ernakulam Distr., Piravam (Privam), c. $50 \mathrm{~m}, 18$ Sept. 1973, Cook, Rix \& Schneller 290 (K, Z); Distr. Kottayam, between Kottayam and Vaikom, sea level, 21 Sept. 1973, Cook, Rix \& Schneller 319 (Z); Quilon Distr., Kottarakara, 26 km E. Quilon, c. 50 m, 26 Sept. 1953, Cook, Rix \& Schneller 343 (Z); Quilon Distr., 20 km E. Quilon, c. 50 m, 26 Sept. 1973, Cook, Rix \& Schneller 345B (Z).

NOTES
Rotala malampuzhensis is a small, inbreeding, shortlived annual common in ricefields and other inundated places along the coastal plain of S. Kerala. It flowers and fruits during the western Monsoon season. I found it in great quantities in September usually with other Rotala species ( $R$. densiflora, $R$. indica, $R$. mexicana and $R$. rosea). On a second visit in December I failed to find it. Other annuals in Kerala seem to have a similar rhythm, i.e. Nymphoides macrospermum Vasudevan, N. parvifolium (Griseb.) Knuth, Microcarpaea minima (Koehne) Merr., Mitrasacme polymorpha R. Br., and several species of Lindernia.
32. Rotala simpliciuscula (S. Kurz) Koehne, Bot. Jahrb. 1: 159. 1880 三 Ammannia simpliciuscula S. Kurz, J. Asiatic Soc. Bengal 40(2): 54. 1871 - reprinted with comments by C. Hasskarl, Flora (Regensb.) 54(19): 291. 1871.

Type: Bangla Desh, Chittagong, S. Kurz (holotype?: CAL n.v.).
Ic.: Fig. 21F-I.
Dwarf, mat-forming, amphibious annual. Stems creeping and branching below, ascending and usually simple above, 1-4 cm long, 4 -angled. Leaves decussate, somewhat petiolate; lower leaves narrowly oblong to oblong, 2.55 mm long, $0.5-2 \mathrm{~mm}$ wide; upper leaves somewhat smaller, oblong to obovate oblong, obtuse or retuse at apex. Bracts leaf-like, oblong to oblanceolate, usually shortly petiolate; bracteoles absent. Flowers monomorphic, solitary in axils of bracts, distinctly pedicellate; pedicel $0.5-1 \mathrm{~mm}$ long. Calyx tube campanulate at anthesis becoming hemispherical in fruit, $0.25-0.35 \mathrm{~mm}$ long, red; calyx lobes 3 or rarely 4 , deltate at anthesis becoming shallowly triangular in fruit, $0.25-0.35 \mathrm{~mm}$ long; calyx appendages 3 or rarely 4, minute, erect in bud. Petals absent. Stamens 1 or occasionally 2, inserted
on the lower half of the calyx tube. Ovary globose; style very short; stigma subsessile, capitate; capsule globose, up to 1.4 mm diam., about 2 times as long as the calyx, opening by 3 valves; seeds semipyriform to hemispherical, c. 0.5 mm long.

## DIAGNOSTIC FEATURES

K3(-4) $+3(-4)$, P0, A1-2, G3; R. simpliciuscula is a distinct species with the habit of Elatine (dwarf, mat-forming plants with creeping stems and opposite leaves). The calyx is 3 -merous with small calyx appendages and the flowers are distinctly pedicellate and lacking bracteoles

## DISTRIBUTION

Known only from Chittagong, Bangla Desh (Map 11).
SELECTED SPECIMEN
Bangla Desh: Chittagong, Hooker fil. \& Thomson (G, K, L, M).
NOTES
S. Kurz in his original description said that it grows on muddy ground around ponds and in inundated ricefields at Chittagong. He also mentioned that it was rare and flowers in October. In the key he wrote that the calyx is 4toothed; from my experience this is rarely the case, most flowers have 3 calyx lobes. In the description he wrote "stamina 4 ", this must be a mistake as I have examined many flowers and found 1 or occasionally 2 stamens. However, I have not examined the holotype.
33. Rotala serpiculoides Welw. ex Hiern in Oliver, Fl. Trop. Africa 2: 469. 1871.

Type: Angola; Lubango (Huíla), pr. Monhino, c. 1850 m, April 1860, Welwitsch 2355 (holotype: LISU n.v.; isotype: BM).

## Ic.: Fig. 22A-E.

Terrestrial or amphibious annual. Stems erect, simple or sparsely branched, up to 25 cm or more tall, green or tinged with red. Leaves decussate, elliptic, attenuate at base into a short petiole, erecto-patent, up to c. 25 mm long, with a prominent midrib (the leaves are very constant in shape). Bracts of two kinds; bracts subtending axillary racemes like normal foliage leaves; bracts subtending individual flowers on lateral inflorescences


Fig. 22. - R. serpiculoides (Milne-Redhead \& Taylor 9860); A, inflorescence; B, flower and flower bud; $\mathbf{C}$, diagramme of inflorescence; $\mathbf{D}$, flower dissection; $\mathbf{E}$, vegetative growth beyond the flowers (scale: 1 mm ).
linear, membranous, c. 1 mm long, about as long as the pedicel, borne at base of pedicel; bracteoles absent. Flowers monomorphic, (1-)3-12 in contracted axillary racemes, pedicellate; pedicel up to 2 mm long. Calyx tube cupshaped, membranous, often tinged with red, c. 0.6 mm long; calyx lobes 4 , triangular, tinged with red or pink, c. 0.4 mm long, scarcely spreading. Petals absent. Stamens 1 (?2 or 3), inserted at base of calyx tube; anther borne level with calyx lobes. Ovary subglobose; style very short; stigma capitate, subsessile; capsule globose, up to 1 mm diam., opening by 3 valves; seeds semi-ellipsoidal, c. 0.5 mm long.

## DIAGNOSTIC FEATURES

K4, P0, A1, G3; the flowers are pedicellate, lack bracteoles and are borne in contracted, lateral racemes.

## DISTRIBUTION

Central Tropical Africa from Sudan to S. Zambia and S. Angola (Map 13).

## SELECTED SPECIMENS

Sudan: Kartoum, 30 Jan. 1963, Pettet 111 (K). Central African Republic: 50 km N. of Bambari, Gerelenji, 26 Nov. 1928, Tisserant 2736 (P); Djur, Ghattus, 30 Oct. 1869, Schweinfurth 2575 (K, MEL); Djur, Molmul, Oct. 1870, Schweinfurth 4270 (K). Uganda: Masaka Distr., Lake Nabugabo, c. 1260 m, Aug. 1935, Chandler 1366 (K). Kenya: Thika, 16 Aug. 1967, Faden 67629 (K); Nairobi, c. 1500 m, 22 Sept. 1916, Dowson 409 (K); ibid., July 1951, Verdcourt 536 (K); ibid., 21 Jan. 1962, Verdcourt \& Brown 3249 (K). Tanzania: Tanga Prov., Pangani, Serawani, 18 Sept. 1955, Tanner 2047 (K); Manyoni Distr., Itigi Station, $1350 \mathrm{~m}, 11$ April 1964, Greenway \& Polhill 11514 (BR, K); Ruaha Riv., 2 km S. of junction with Yovi Riv., 450 m , 15 July 1970, Thulin \& Mhoro 418 (K); Iringa Distr., Ruaha Nat. Park, Magangwe, 1330 m, 9 May 1972, Bjørnstad AB1654 (K); Songea Distr., Songea, 990 m, 30 April 1956, Milne-Redhead \& Taylor 9860 (B, BR, G, P); 19 km E. of Songea, $1050 \mathrm{~m}, 22$ June 1956, Milne-Redhead \& Taylor 10873 (B, BR). Rwanda: Kigali, 26 Oct. 1953, Liben 842 (BR); Terr. Kigali, Uruanda, Bugesera, 3 March 1954, Liben 1398 (BR). Burundi: Terr. Bujumbura, Ruzizi, 800 m, 19 March 1973, Reekmans 2532 (BR). Zaire: S. of Lake Edward (lac Edouard), 1100 m, April-May 1929, Humbert 8708 (BR, P); locality not found: Zambi, bank of Congo River, 23 June 1915, Bequaert 7872 (BR). Malawi: Zomba Distr., W. of Lake Chilwa, 21 June 1962, Robinson 5398 (K); not located: Ciwalo, Kalembo Jackson 1671 (BR). Zambia: Mkushi Distr., Fiwila, c. 1300 m, 1932, Hewitt 6 (BM); Choma Distr., Mapanza, 24 March 1957, Robinson 2185 (BR); ibid., 20 March 1958, Robinson 2871 (K, M); Choma (Tchoma), July 1939, Bredo 3184 (BR); Kafue Basin, Namvala, 18 April 1963, van Rensburg (K). Rhodesia (Zimbabwe): Salisbury, Gatooma road, 12 Jan. 1946, Wild 1062 (SRGH n.v.). Angola: Lubango (Huíla), pr. Monhino, c. 1850 m, April 1860, Welwitsch 2355 (BM).

## NOTES

Superficially $R$. serpiculoides differs from other species of Rotala by having several flowers in the leaf axils. These partial inflorescences are usually described in the literature as being cymose (scorpiod, dichasial, trichasial or pleiochasial) and thus similar to the lateral inflorescences of other related genera of the Lythraceae (Ammannia, Hionanthera and Nesaea). However, closer examination reveals that they are no more than contracted simple racemes (Fig. 22C) and thus not comparable with the other genera. Occasionally vegetative growth continues after flowering (Fig. 22E). Similar but less contracted lateral inflorescences are seen in: $R$. floribunda, $R$. repens, $R$. densiflora, $R$. cordata, $R$. rubra, $R$. rotundifolia and $R$. indica.

The bracts subtending the racemes are leaf-like but the bracts subtending the individual flowers are small, membranous and bracteole-like. In contradiction to literature accounts the bracteoles in $R$. serpiculoides are lacking. This missinterpretation in the literature is probably because the floral bracts have about the same dimensions as bracteoles in most other species. Small bracts resembling bracteoles are found in: R. floribunda and R. repens. In floral characteristics $R$. serpiculoides is very like $R$. simpliciuscula, a species which also lacks bracteoles. In the literature R. serpiculoides is reported to have $1-3$ stamens, I have examined many flowers and found only solitary stamens.
34. Rotala stagnina Hiern in Oliver, Fl. Trop. Africa 2: 467. 1871.

Type: Ethiopia, Gafta, 14 Sept. 1838, Schimper 1187 (holotype: BM; isotypes: B, CGE, G, K, L, LE, M, Z, ZT).

Ic.: Fig. 23A-E.


Fig. 23. $-R$. stagnina (Schimper 1187); A, bract; B, flower dissection; C, flower with mature capsule; $\mathbf{D}$, flower at anthesis; $\mathbf{E}$, dehiscing capsule.
R. gossweileri (Gossweiler 1145); F, bract; G, flower at anthesis; H, flower dissection; I, flower with mature capsule (scale: A-I, 1 mm ).

Amphibious or terrestrial annual. Stems erect, simple or irregularly branched, up to c. 20 cm long. Leaves decussate, sessile or subsessile, lanceolate to ovate or oblong, up to 9 mm long, truncate to cordate at base, obtuse at apex. Bracts leaf-like but somewhat smaller, rarely more than 6 mm long, usually somewhat cordate at base; bracteoles capillary, c. 0.5 mm long. Flowers monomorphic, sessile or subsessile, solitary in the axils of leaf-like bracts. Calyx tube scareous, cup-shaped at anthesis, not accrescent, splitting irregularly as the fruit ripens, c. 1 mm long; calyx lobes 4 , triangular to widely deltate, c. 0.5 mm long, pink, not spreading; calyx appendages absent; small interjected folds visible in bud but becoming stretched and not visible at anthesis. Petals usually absent but occasionally 1 or 2 linear, caducous petals present at anthesis. Stamens 2, opposite, inserted at base of calyx tube; filaments 2 , c. 1 mm long, somewhat thickened below; anthers included in calyx tube. Ovary subglobose; style c. 0.25 mm long; stigma capitate; capsule globose, exceeding the calyx lobes, c. 2 mm diam., opening by 3 valves; capsule valves spreading and rupturing the calyx; seeds semi-globose, c. 0.4 mm long.

## DIAGNOSTIC FEATURES

K4, P0(-2), A2, G3; like R. gossweileri but the developing fruit ruptures the calyx, the calyx lobes are equal in shape and shorter than the calyx tube and the capsule is up to 2 mm diam.

## DISTRIBUTION

West and Central Africa from Senegal to Ethiopia more or less in a band between $5^{\circ} \mathrm{N}$. and $15^{\circ} \mathrm{N}$. (Map 13).

## SELECTED SPECIMENS

Senegal: s. loc., Perrottet 332 or 333 (P); Niokolo-koba, April 1951, Berhaut 1513 (P). Guinea: Mali, Aug.-Sept. 1937, Scaetta 3383 (P); de Sombalato à Boulivel, 28-29 Aug. 1907, Chevalier 18657bis (P). Sierra Leone: Kurubonla, 15 Nov. 1965, Morton SL2524 (K); Kambia, 22 Nov. 1963, Morton \& Gledhill SL25 (K); Wonkifu (Tonko-Limba), 2 Oct. 1953, Jordan 933 (K). Ivory Coast: entre Ségiuéla et Bonabé, 6 Nov. 1965, Bonardi (P). Ghana: Lawra, Burufo, 4 Sept. 1965, Hall 747 (K); ibid., Oct. 1947, Hinds 5013 (K). Nigeria: Zaria, 30 Sept. 1948, Olorunfemi 24400 (BR, K); Zaria, Anara, Kan Gimi, 20 Oct. 1947, Keay 20130A (K); Fuka, c. 56 km E. of Minna, 9 Oct. 1957, Hepper 968 (K); Guduma, c. 60 km E. of Minna, 9 Oct. 1957, Hepper 973 (K); Adamawa Prov., S. Muri Distr., Gidan-Anju, Kurmi Nya, 22 Nov. 1954, Latilo \& Daramola 28727 (K, MO). Cameroun: Ouda Ngaoui, 70 km E.N.E. of Meiganga, 17 Oct. 1963, Letouzey 6209 (P). Central African Republic: Yalinga, 9 Oct. 1921, Le Testu 3336 (BR, P); Yakélé, pr. Ft. Crampel, Sept. 1957, Trochain 10460 (P); Sanba, 21 Sept. 1963, Audru \&

Boudet 1976 (P); Djur, Seriba Ghattas, 1869, Schweinfurth 2442 (MEL). Zaire: Sources de la Bili, Ango, 700 m, Dec. 1945, Germain 4396 (BR, M); Distr. de l'Ubangi-Uele, Tukpwo, 22 Oct. 1959, Gérard 4259 (BR); Mont. Genze, 30 Sept. 1953, Gérard 839 (BR). Ethiopia: Gafta (?Gamo Gofa), 14 Sept. 1838, Schimper 1187 (B, BM, CGE, G, K, L, LE, M, Z, ZT); Chire (?Sire), ?1844, Quartin, Dillon \& Petit 169 (P). Raynal, Adansonia 7: 542. 1967, cites specimens from: Mali and Upper Volta.

NOTES
In the original description Hiern wrote "leaves 1 in . long" this is a missprint and should be " $1 / 2$ in.".
35. Rotala gossweileri Koehne, Bot. Jahrb. 42: Beibl. 97: 48. 1908.
$=$ Rotala urundiensis A. Fernandes \& Diniz, Bol. Soc. Brot. Sér. 2, 29: 89. 1955. Type: Burundi, Ruyigi, Sept. 1951, Michel \& Reed 228 (holotype: COI n.v.; isotypes: BR, MO, YANG n.v.).
$=$ Rotala minuta A. Fernandes \& Diniz, Bol. Soc. Brot. Sér. 2, 31: 151. 1957, quoad typum. Type: Zambia, Mufulira, 11 May 1934, Eyles 8343 (holotype: SRGH n.v.; isotype: K).

Type: Angola, Malange, Quizanga, 1903, Gossweiler 1145 (it is not certain which specimen is the holotype, perhaps it was destroyed in B ; isotypes: BM, K, P).

Ic.: Fig. 23F-I; Fernandes \& Diniz, Bol. Soc. Brot. Sér. 2, 29: t. 4. 1955 as $R$. urundiensis; op. cit., 31: t. 1957 - as $R$. minuta.

Amphibious or terrestrial perennial or annual. Stems erect or creeping below, simple or irregularly branched, up to c .15 cm long often much less. Leaves decussate, sessile or subsessile, narrowly elliptic to ovate-orbicular, up to c .6 mm long, attenuate to cordate at base, obtuse at apex. Bracts leaflike, up to c. 6 mm long, usually obtuse or cordate at base; bracteoles capillary, c. 0.5 mm long. Flowers monomorphic, sessile or subsessile, solitary in the axils of bracts. Calyx tube scareous, cup-shaped, not markedly accrescent but not splitting as the fruit ripens, c. 1 mm long; calyx lobes 4 or rarely 5 , triangular, c. 1 mm long, red, dimorphic, 2 opposite lobes somewhat wider at base than the other pair; calyx appendages absent; interjected folds distinct at anthesis, sometimes persisting in fruit. Petals absent. Stamens 2, opposite, inserted at base of calyx tube; filaments 2 , c. 1 mm long, not thickened at base; anthers included in calyx tube. Ovary subglobose; style c. 0.25 mm long; stigma capitate; capsule globose, remaining within the calyx tube, c. 1 mm diam., opening by 3 valves; capsule valves not widely spreading and not rupturing the calyx tube; seeds semi-globose, c. 0.3 mm long.

## DIAGNOSTIC FEATURES

K4(-5), P0, A2, G3; like R. stagnina but the calyx lobes are dimorphic (1 opposite pair wider at base than the other opposite pair) and the lobes are at least as long as the calyx tube, the capsule remains within the calyx tube and does not rupture it as the capsule matures.

## DISTRIBUTION

Tropical Africa from Senegal to Ethiopia between $20^{\circ} \mathrm{N}$. and $20^{\circ} \mathrm{S}$. but absent from the southern part of West Africa and most of the Congo Basin (Map 15).

## SELECTED SPECIMENS

Guinea Bissau: Bafata, Bricama, 28 Dec. 1961, Alves Pereira 2486 (K). Senegal: Niokolo-Koba, Badi, Dec. 1951, Berhaut 113 (P). Mali: Bamako, 16 Dec. 1955, Adam 11359 (P). Nigeria: between Kontagora and Auna, 17 Jan. 1950, Meikle 1040 (BR, K). Cameroun: 25 km N.E. of Bafia, Niasskounou, 26 Nov. 1969, Letouzey 9632 (K); Bamenda, Wum, April 1931, Maitland 1594 (K); Iri, $5^{\circ}$ N. $-12^{\circ}$ E., 20 Dec. 1969, Letouzey 9738 (P); 17 km S.S.W. Koso, 60 km S.S.W. Batouri, 28 July 1963, Letouzey 5525 (BR, K, P); 47 km E. Nagaoundere, Tello Riv., $1200 \mathrm{~m}, 27$ Nov. 1964, de Wilde 4272 (BR); Roumsiki, 35 km S.W. Mokolo, 10 Jan. 1965, J. \& A. Raynal 12928 (P); Ngoro, 30 March 1963, J. \& A. Raynal 10603 (P). Chad: Reg. Moundo, Logone, 25 March 1963, Descoings 10560 (P). Central African Republic: 20 km N. Bambari, Kogo, Ndokpwa, 1925, Tisserant 2818 (P); 40 km N. Bambari, Balimbwa, 13 Oct. 1925, Tisserant 2044 (P); next two localities not found but the place names occur in Zaire: Télé, 2-12 May 1903, Chevalier 8255bis (P); Dinga, 24 Nov. 1921, Le Testu 3478 (P). Zaire: Garamba, Nawozoko, 26 Feb. 1952, Troupin 211 (BR); Garamba, Mabanga, 7 March 1952 Troupin 359 (BR); Garamba, Bagbele, Mogbwamu, 7 March 1950, Noirfalise 2 (BR). Angola: Malange, Quizanga, 1903, Gossweiler 1145 (BM, K, P); Malange, 22 Sept. 1932, Young 856 (BM); Lunda, Dala, Biúla, rio Cassai, c. 1190 m, 28 April 1937, Exell \& Mendonça 1346 (BM, M); Benguela, Caconda, rio Polente, 22 May 1937, Carrisso \& Sousa 163 (BM). Ethiopia: Kefa Prov., Kochi, $7^{\circ} 38^{\prime}$ N., $36^{\circ} 50^{\prime}$ E., $1690 \mathrm{~m}, 1$ Jan. 1973, Friis, Getachew, Aweke, Rasmussen \& Voliesen 2066 (BR, K). Kenya: Kitale, 18 Sept. 1956, Bogdan 4296 (K); ibid., 15 May 1961, Bogdan (BM); ibid., 200 m, March 1967, Tweedie 3426 (K). Uganda: Koboko, Eggeling 1854 (K); Maracha, April 1940, Eggeling 3880 (K); Bukasa, Kigezi, 1952, Norman 150 (K); Entebbe, Victoria Nyanza, 17 Sept. 1905, Bagshaw 769 (BM); Bukoto Co., Masaka Distr., E. Side Lake Kayanja, 1150 m, 14 March 1971, Lye 5917 (K); Masaka Distr., Lake Nabugabo, 1140 m, 6 Oct. 1953, Drummond \& Hemsley 4639 (BR, K); Kampala, King's Lake, 1300 m, Sept. 1935, Chandler \& Handcock 30 (BR, K). Rwanda: Kibungu, lac Ihema, 27 Oct. 1969, Bouxin \& Michel 527
(BR - sterile). Burundi: Ruyigi, Sept. 1951, Michel \& Reed 228 (BR, MO); Kiharo, $3^{\circ} 6^{\prime}$ S., $30^{\circ} 6^{\prime}$ E., 8 april 1952, Michel \& Reed 1663 (BR - sterile). Tanzania: Songea Distr., Chipoli, $890 \mathrm{~m}, 2$ June 1956, Milne-Redhead \& Taylor 10537 (B, BR, K); Songea Distr., Luhira, ricefield, 1050 m, 23 June 1956, Milne-Redhead \& Taylor 10889 (B, BR, G). Malawi: N. Prov., Mzimba Distr., c. 4.8 km W. of Mzuzu, Katoto, $11^{\circ} 30^{\prime}$ S., $34^{\circ} 00^{\prime} \mathrm{E} ., 1500 \mathrm{~m}, 3$ Aug. 1973, Pawek 7284 (MO); Nyassa Highlands, Kyimbila, c. 1000 m, 10 June 1912, Stolz 1347 (B, BM, G, L, MO, U, Z). Zambia: Mbala (Abercorn), May 1943, Bre-?on 5389 (BR); Mbala (Abercorn), Mwambe R., Chitembwa, nr. Kambole, 1500 m, 14 June 1961, Richards 15268 (K); Mbala, Mbulu, 18 May 1968, Sanane 132 (K); Serenje, Bolelo R., 1370 m, 24 June 1963, Symoens 10429 (K); Mufulira, $1350 \mathrm{~m}, 11$ May 1934, Eyles 8343 (K); Mwinilunga, Kalenda Plain, Matonchi, 16 April 1960, Robinson 3578 (K, M). Rhodesia (Zimbabwe): Sebungwe, Chicomba Vlei, 12 Aug. or Sept. 1951, Whellan 525 (BM); ibid., Whellan 526 (BM).

NOTES
$R$. urundiensis was separated from $R$. gossweileri because it was larger, more robust, more branched and had rounder leaves. In the material I have examined I have found all degrees of intermediacy between $R$. urundiensis and $R$. gossweileri. Also R. urundiensis-like plants are widespread and not limited to a particular area. I have no doubts that the two species should be united. The type of $R$. minuta has been dried without being pressed; on some flowers, the interjected folds look a little like calyx appendages. This led Fernandes to separate $R$. minuta from $R$. welwitschii. Some specimens determined $R$. minuta by Fernandes are $R$. welwitschii but the type specimen is $R$. gossweileri.
36. Rotala indica (Willd.) Koehne, Bot. Jahrb. 1: $172.1880 \equiv$ Peplis indica Willd., Sp. Pl. 2(1): 244. $1799 \equiv$ Ameletia indica (Willd.) DC., Mém. Soc. Phys. Nat. Hist. Genève 3(2): 82, t. 3, f. A. $1826 \equiv$ Nexilis indica (Willd.) Rafin., New Fl. 4: 9. 1838.
$=$ Ammannia nana Roxb., Fl. Ind. (ed. 1) 1: 448. 1820, non Wallich. Type: Roxburgh plate No. 549 - kept at K.
= Ammannia repens Rottler ex Martius, Acad. Münch. Philos. 6: 190. 1820. Type: India, Bengala, Rottler 789 (holotype: M).
= Ameletia polystachya Wallich ex Wight \& Arnott, Prodr. Fl. Ind. Or. 1: 304. 1834 三 Ammannia polystachya Wallich, Cat. No. 2094, nom. nud. $\equiv$ Rotala subrotunda (Wallich ex S. Kurz) Koehne var. polystachya (Wallich ex Wight \& Arnott) Koehne, Bot. Jahrb. 1: 174. 1880. Type: Wight \& Arnott cited two Wallich collections ( 2904 A and 2904B). I choose to select the "A" collection as lectotype. Bangla Desh, Sylhet (Silhit, Sillet), Wallich 2094A (lectotype: K-W; isolectotypes: CGE, K, G, LE, M).

Syntypes: Nepal, s. loc., Hamilton?, Wallich 2094B (K, K-W, G, LE, M, U). (The Wallich collection from "Prome" is incorrectly numbered 2094 in G and LE, it should be 2093).
$=$ Ameletia elongata Blume, Mus. Bot. Lugd.-Bat. 2: 135. 1852, fide Koehne.
$=$ Ameletia acutidens Miq., Fl. Ind. Bat. 1: 617. 1855, fide Koehne.
= Ameletia uliginosa Miq., Ann. Mus. Lugd.-Bat. 2: 261. 1865-1866, fide Koehne $\equiv$ Rotala indica (Willd.) Koehne var. uliginosa (Miq.) Koehne, Bot. Jahrb. 1: 173. $1880 \equiv$ Rotala uliginosa (Miq.) Nakai, Bull. Sci. Mus. Tokyo 31: 80. 1952.
$=$ Rotala elatinomorpha Makino, Bot. Mag. Tokyo 24: 100. 1910. Type: Japan, Tosa Pref., Iwamedzi, 22 Oct. 1892, Makino, or Japan, Shimoosa Pref., Usui, 10 Sept. 1895, Makino (no type material in MAK, perhaps in TI) - material determined by Makino seen in MAK.
$=$ Rotala koreana (Nakai) Mori, Enum. Pl. Cor. 261. 1922, n.v. $\equiv$ Rotala indica (Willd.) Koehne var. koreana Nakai, Fl. Korea 1: 236, t. 12, f. 3. 1909.

- Ammannia peploides Sprengel, Syst. Veg. (L., Syst. Nat., ed. 16) 1: 444. 1824; nom. illeg.
- Ammannia obovata Buch.-Ham. nom. in sched.

Type: India, 1795, Klein 546 (holotype: B-Herb. Willdenow 814/7001).
Ic.: Fig. 24A-F.


Fig. 24. $-R$. indica ( $\mathbf{A}, \mathbf{C}, \mathbf{D}$, living material from Cook \& Rix 32; B, living material from Cook, Rix \& Schneller 268; E, Hosseus 135; F, Gamohama 1930); $\mathbf{A}$, habit "uliginosa"; $\mathbf{B}$, habit "indica"; $\mathbf{C}$, flower; $\mathbf{D}$, flower dissection; $\mathbf{E}, \mathbf{F}$, flower (scale: A, B, $1 \mathrm{~cm} ; \mathbf{C}-\mathbf{F}, 1 \mathrm{~mm}$ ).

Amphibious or terrestrial annual. Stems erect or decumbent and rooting at the nodes, usually 1,2 or more times branched, occasionally simple; erect flowering stems usually $4-40 \mathrm{~cm}$ long (exceptionally up to 86 cm long), weakly 4 -angled or terete, when old somewhat woody. Leaves decussate, sessile or subsessile, obovate to subspathulate-oblong or suborbicular or narrowly oblong, $4-20 \mathrm{~mm}$ long, cuneate to obtuse or somewhat cordate at base, acute or obtuse with or without mucro or emarginate at apex; leaf margin cartilaginous (distinct on dried leaves). Bracts polymorphic, leaf-like or on short spike-like, lateral inflorescence branches smaller than foliage leaves, occasionally hardly exceeding the flowers, when very small usually lanceolate; bracteoles 2, linear to lanceolate, $1.25-2.25 \mathrm{~mm}$ long, usually about as long as the calyx tube. Flowers monomorphic, sessile or subsessile, solitary in axils of bracts, borne either on main axis or on short, spike-like, lateral inflorescences. Calyx tube narrowly to broadly campanulate, angled on the nerves, pink or red at anthesis, light brown and scareous in fruit, 1.52.25 mm long; calyx lobes 4 , deltate to acutely triangular, $0.5-1.5 \mathrm{~mm}$ long, with cartiginous margin, often mucronate at apex; calyx appendages absent. Petals 4, persistent, pinkish, linear to narrowly ovate, less than half as long as the calyx lobes or occasionally minute. Stamens 4 or occasionally less; filaments inserted about half-way up the calyx tube; anthers appearing just above the calyx lobe sinuses. Ovary ellipsoidal; style $0.5-1 \mathrm{~mm}$ long, persistent in fruit; stigma capitate, borne level with or above the calyx lobes; capsule ellipsoidal, c. 2 mm long, opening by 2 valves; seeds almost hemispherical, 0.3-0.4 mm long.

## DIAGNOSTIC FEATURES

$\mathrm{K} 4, \mathrm{P} 4, \mathrm{~A} 4, \mathrm{G} 2$; the leaves have a distinct cartilaginous margin which is clearly visible on dried material. Like $R$. subrotunda but flowers are not pedicellate, petals are shorter than the calyx lobes, the stamens are not longer than the calyx and the style is not more than 1 mm long. Like $R$. diandra but petals present, stamens 4, filaments inserted about half-way up the calyx tube and the calyx tube not more than 2.25 mm long.

## DISTRIBUTION

S.E. Asia from Tadzhik to N. Korea and N. Honshu southwards to Java and Sri Lanka. Perhaps also native in a small area on the W. side of the Caspian Sea from E. Azerbaydzhan to N. Iran. Introduced and more or less naturalized in N. Italy, C. Portugal, Congo near Brazzaville and the USA in California and Louisiana (Map 14). It is a very successful weed in ricefields.

## SELECTED SPECIMENS

Iran: Lahijan, Guilan, 1937, Lindsay 980 (K). U.S.S.R. Azerbaydzhan: Prov. Talysch, pr. Astara, Oct. 1821-41, Hohenacher (K, M); ibid., Hohen-
acher (LE); Prov. Baku, Lenkoran, 6 Sept. 1914, Pastuchow (LE); ibid., 30 July 1930, Bobrov \& Cvelev́ 1090 (LE); Bakinskaya, Gerherniga, Lenkasran, 15 Sept. 1914, Pastuchow (LE). Tadzhikistan: 12 km from Dushaube (Stalinbad), 13 Sept. 1932, coll. illeg. (LE). Afghanistan: Kabul, Griffith 2313 (K). Pakistan: no specimens seen but likely to be present. India. Kashmir: Srinagar, 10-30 Sept. 1856, Schlagintweit 4273 (LE); Lower Scinde Valley, 2000 m, 8 Sept. 1922, Stewart (K). Haryana: Karnal, 1886, Drummond 24401 (G, K); Sadhaura, 1844, Edgeworth 36 (K). Uttar Pradesh: Moradabad, Sept. 1844, Thomson 810 (K); Mirzapur, Sirsi, 9 Dec. 1961, Bhattacharyya 18313 (L). Rajasthan: Kota, 29 Oct. 1970, Cook \& Gut 62 (K, Z); ibid., 28 Oct. 1970, Cook \& Gut 33 (Z). Maharashtra: Uran, 27 Dec. 1961, Divakar 5310 (MO); ibid., 18 Feb. 1962, Divakar 3829 (MO); ?Bhandup, Dec. 1919, Sedgwick \& Bell 7314 (K). Karnataka (Mysore): Karwar, Dec. 1918, Sedgwick \& Bell 5118 (K). Kerala: Nilambur, Jan. 1881, Beddome 3116 (Z); ibid., s.d., Beddome 7181 (K); Badagara, 27 Oct. 1900, Bourne (K); 6 km N. of Alwaye, 17 Sept. 1973, Cook, Rix \& Schneller 268 (Z); between Kottayam and Vaikom, 21 Sept. 1973, Cook, Rix \& Schneller 317 (Z); Thekkadi (Tekkadi), Anaipadi, 600 m, 3 Dec. 1912, Fischer 3520 (K). Tamil Nadu: Nilgiris, Thomson (CGE, G, K, L, M, U); Tranquebar (Trankenbar), Schwaegrichen dedit. Hiendlmayr (M - very old specimen). Orissa: Ganjam Distr., Bondogorka, 500 m, March 1884, Gamble 14072 (K); ibid., Chatrapur, Dec. 1887, Gamble 21547 (K). Bihar or Orissa: Chota (Chutia) Nagpur, Sirguja, 500-600 m, 21 Dec. 1890, Wood (K). Bihar: Singbhum, Dec. 1903, Haines 714 (K); Ranchi, 500-600 m, 30 Sept. 1871, Wood (K); Hazaribagh, Manda, 26 Dec. 1874, Clarke 25128 (LE). Bengal: Calcutta, 1836-38, Helfer 169 (G, L); Serampore, 1845, Griffith(CGE, K). Assam: Cachar, Keenan (K); Assam, 1865, Masters (G, L, M); Assam, Jenkins (CGE); Assam, Simons (K); Khasi Hills, Jumbhelpore, Griffith (CGE). Nagaland: Naga Hills, Sibong, 1000 m, Dec. 1907, Meebold 7475 (K). Andaman Islands: South Andaman, Port Mouat, 18 March 1893, King's collector (CGE, L, LE); Car Nicobar, Johnson's Village, 20 June 1895, King's collector (G). Sri Lanka: Kalutara (Caltara), Macrae 208 (BR, K); s. loc., Thwaites 1546 (BR, CGE, G, LE different collections); s. loc., Walker (G); s. loc., 1839, Mackenzie (K). Nepal: between Khebang and Bharomdin, 24 Nov. 1963, Hara, Kanai \& al. 6306593 (K); Mahara, Bahara-Gauriganja, 13 Dec. 1963, Kanai, Murata \& Togashi 6306590 (K, KYO); Illam-Jog, Mai-Ranga Pan, 8 Dec. 1963, Hara, Kani \& al. 6306578 (KYO); Ghorwa-Sanichare, 10 Dec. 1963, Hara, Kanai \& al. 6306588 (KYO); Tapeljung Distr., Dumhan, $700 \mathrm{~m}, 31$ Oct. 1963, Murata, Togashi \& Tuyama 6306585 (KYO); ibid., 1 Nov. 1963, Murata, Togashi \& Tuyama 6306586 (KYO); Biratnagar, 14 Oct. 1963, Hara, Kanai \& al. 6306584 (KYO); Katmandu Airport, 13 Oct. 1963, Hara, Kanai \& al. 630692 (KYO); s. loc., 1821, Wallich 2094A (G, LE, M, U, additional specimens in G and LE from Prome, 1826 are incorrectly numbered 2094). Bhutan: (Bhotan), s. loc., 1863, Griffith (G, K, LE). Bangla Desh: Nasirbad (Mymensingh), Dewanganj, 14 Nov. 1868, Clarke 8036 (LE); Sylhet (Silhit), 1832, Wallich 2094B or 2094/2 (B, CGE, G, K, K-W, LE, M); E. Bengal, Noogury, Griffith (CGE, K, M, L);
perhaps Bangla Desh: Bengal, Kurz (M, Z); Bengala, Rottler 798 (M). Burma: Meiktila, Dec. 1887, Collett 37 (K); Prome, 1826, Wallich 2093 (CGE, K, LE, additional sheets in G and LE incorrectly numbered 2094); Pegu, 20 m , 15 Dec. 1957, Mc Kee 5834 (K, NSW); Mergiu, Griffith (K). Thailand: Fang, 21 Feb. 1958, Sørensen, Larsen \& Hansen 1444 (K); Chiang Mai, 300 m, 18 Jan. 1911, Kerr 1647 (K, L); ibid., 27 Dec. 1912, Kerr 2816 (K); Bau Mae Kon, N. of Chiang Mai, 5 Jan. 1962, Matsuoka 105 (KYO); Nakawn Sawan, Wang Chao (Wang Djar), 100 m, 31 Oct. 1904, Hosseus 135 (M); Distr. Kanchanaburi, $14^{\circ} 55^{\prime}$ S., $98^{\circ} 45^{\prime}$ E., $750 \mathrm{~m}, 7$ Nov. 1971, Bensekom, Phengkhlai, Geesink \& Wongwan 3489 (L); Ayuthia, Sara Buri, $50 \mathrm{~m}, 8$ Dec. 1923, Kerr 7953 (K); Nakawn Sritamarat, Padang Besar, 50 m, 25 Dec. 1927, Kerr 13633 (K); Phuket, Ranawng, Lam Lieng, c. 10 m, 18 Dec. 1918, Kerr 16406 (K, L); Krabi, Ban Heng, c. 25 m, 10 Nov. 1930, Marcan 2591 (K); Hugop, 14 Dec. 1918, Haniff \& Nur SFN4033 (K); nr. Sriracha, c. 10 m, 30 Nov. 1927, Collins 2008 (K). West Malaysia: Kedah, Langkawi, Jan. 1897, Ridley 8293 (K); Perak, Perlis, ?Gwlney Kalok, March 1910, Ridley 15034 (K); Malacca, Alor Gajah, Kampong Gadek, 20 April 1957, Sinclair 8927 (L). Laos: N. of Ban Hang (?Ban Hai), 2 Jan. 1958, Toyama L57449 (KYO); Ban Kinsing (?Khing), Feb. 1914, Faurie 738 (KYO). Cambodia: no specimens seen but recorded in Fl. Indochine. Vietnam: Tonkin Prov., Ninh-Binh, Bon 99 (BR); ibid., Bon 117 (Z); Tonkin, Khang Khuong, 22 Dec. 1881, Bon 1175 (K); Qung Yen, E. Hanoi, 26 Dec. 1885, Balansa 1403 (G, K); Ouanlei, Nov. 1885, Balansa 1402 (G, K); En Phap, Jan. 1880, Balansa 3124 (G, K); Puc Yen Prov., Phu Lo, Jan. 1936, Pételot 5550 (MO); Quang Lon, Dec. 1908, Alleizette (L); Bien Hoa, Jan. 1873, Pierre 1272 (K); ibid., April 1873, Pierre 1272 (G, K mixed with R. cordata); ibid., 1862-66, Thorel (G, Z); ibid., Thorel 193 (BR); Nha Trang, Annan, March 1911, Robinson 1530 (K). Indonesia. Sumatra: Medan, 15-20 m, 20 March 1928, Lörzing 13013 (L, Z); N. of Pajakumbuh, Suliki, 500 m, 8 May 1957, Meijer 5778 (L); nr. Pajakumbuh, Sikabu-Kabu, 700 m, 27 July 1957, Meijer 7139 (L). Djawa (Java): Bogor (Buitenzorg), 29 Dec. 1888, Borlage (L); Tjibodas, Tjisaraea, 20 July 1896, Raap 885 (L); Bantardjati, 29 July 1896, Raap 513 (L); Tjiamis, Kamp Gawa, 10 Oct. 1888, Boerlage (L); Tegal, Sapi, 26 June 1922, Bakhuizen van den Brink Jr. 1510 (U); Solo, 18 Aug. 1932, Kooper 1907 (U); Preanger, Malang-Tjadas, 20 July 1917, Bakhuizen van den Brink Jr. 2547 (L, U); Tengger, Bodo Gendro, 1000 m, Aug. 1911, Moussefs (G); s. loc., 1845, Zollinger 540 (G); ibid., Zollinger 714 (G - sterile); ibid., 4 Sept., Horsfield (CGE, K). Sumbawa, Lombok: Pangantaps, sea level, 2 July 1909, Elbert 2366 (L). Sulawest (Celebes): Palopo, 22 July 1929, Kyellberg 1952 (L); Makasar, July 1913, Robinson 2456 (K, L); Lombasang, c. 950 m, 4 May 1921, Bünnenmeyer 11347 (K, L). Philippines. Luzon: Rizal, San Pedro Macati, Dec. 1909, Merrill 62 (G, M, U, Z); Rizal, May 1907, Ramos 2692 (BR, L, LE); ibid., Dec. 1912, Reillo 19157 (MO); Iba, Zambales, 27 Dec. 1954, Santos (L); Cavite, 9 Feb. 1913, Robinson 18268 (MO, NSW); Manila, Santa Rosa, 8 Dec. 1892, Loher 2158 (K, M); Manila, San Francisco del Monte, 8 Dec. 1892, Loher 2157 (K, M); Nueva Vizcaya, Dupax, March-April 1912, McGregor 11454 (K). Panay,
?1841, Cumming 1655 (CGE, G, K, L, LE). China. Yunnan: Bhamo, 23 Jan. 1868, Anderson (K); Pin-fa, 24 Feb. 1902, Cavalerie 4279 (K); Gan-chouen, 1914, Cavalerie 4279 (K); Tao-wang, 2400 m, 2 July 1914, Schneider 1707 (K). Szechuan: Hui-li Chuo, 24 March 1914, Schneider 562 (K); O-mei Shan (Mt. Omi), June 1904, Wilson 3653 (K). Kweichow: Fan Ching Shan, Ta Ho Yen, 19 Aug. 1931, Steward, Chiao \& Cheo 631 (K, L). Kwangtung: Canton (Kuang Chou), Nov. 1869, Hillebrand 1889 (G); ibid., 9 Oct. 1884, Sampson (K); ibid., Oct. 1866-Nov. 1869, Hance 10322 (K). Kwangtung-Hainan Tao: Pao-t'ing (Po-ting), c. 360 m, Aug. 1935, How 73473 (G - mixed label "Tree by stream, flowers white"); T'un-ch'ang, Chi-to Shan, 16 Sept. 1927, Tsang \& Qai Tak 882 (K); Hai-k’ou (Jaichow), Jan. 1933, How \& Chun 70012 (K). Kiangsi: Lungnan Distr., Oo Chi Shan, Lam Uk Village, Oct. 1934, Lau 4805 (G). Chekiang: Hang Chow, 11 Oct. 1928, Chiao 18680 (G); Chekiang, Hickin (K). Hupeh: I-ch-ang, Feb. 1887, Henry 2369 (K); Hupeh, Cheo 18453 (Z). Taiwan: Teipeh, 1896, Makino (KYO); ibid., 12 Oct. 1960, Chou, Li, Lin, T'sai \& Wang 7422 (TAI); Kao-hsiung (?Boakinsing), Henry 814 (K); Skniten, Nov. 1914, Faurie 1255 (KYO); Taoyuan, Chungli, 24 Oct. 1975, Kuo 6381 (TAI); Nantou, Ta-kan-hu, 5 Aug. 1971, Huang 5670 (TAI); Nantou, Lake Shuishe (Suisya), 12 Sept. 1929, Sasaki (TAI); Jaihoku, 3 Nov. 1932, SuzukiTokio 7776 (TAI); Insl. Yonaguni, Liukiu, 11-13 Aug. 1923, Koidzumi (K). Japan. Okinawa: Nago-cho, 27 Oct. 1938, Kanashiro 1198 (KYO); Okinawa, 23 Sept. 1937, Nakanone (KYO). Kyushu: Kagoshima Pref., Kagoshima, Makino 121133 (MAK); Kumamoto Pref., Shinkai, 28 Oct. 1951, Shimada 12672B (KYO); Kumamoto, 16 Oct. 1954, Shimada 9859 (KYO); Satsuma Pref., Koshikijima, Mt. Otake, 20 Oct. 1928, Ohyi 8928 (KYO); Unzen, Fotlara 104/37 (K); Nagasaki, Simabara, 1863, Maximowicz (K, ZT); Nagasaki, 7 Sept. 1935, Fo Hara 126/35 (K). Shikoku: Awa Pref., Shishikui, Kaihu-gun, 1 Nov. 1951, Kitamura \& Nakai 139 (KYO); Ehime Pref., Kitayoshii, Shigenobu-cho, Onsen-gun, Makino 121123 (MAK). Honshu: Kii Pref., between Koguchi and Zizochaya, Higashimuro-gun, Makino 13102 (MAK); ibid., Okumotori-yama, 16 Oct. 1960, Murata 13719 (MAK, U); ibid., Koguchi, 16 Oct. 1960, Murata 13719 (KYO); ibid., 16 Oct. 1960, Kitamura (KYO - last 3 one gathering?). Kyoto Pref., Uji River, Oct. 1920, Fushimi (KYO); ibid., Funai-gun, Sonobe-cha, Rurikei, 29 Sept. 1963, Aya Nitta 11799 (KYO); ibid., Iwakura, 1 Nov. 1938, Okamoto (KYO); ibid., Sugo, 10 Sept. 1936, Okamoto (KYO); ibid., Kamigamo, 16 Oct. 1920, Kinashi (KYO). Hyogo Pref., Shizimi-cho, Miki-schi, 22 Sept. 1968, Murata \& Nishimura (KYO). Hiroshima Pref., Onomichi, 10-11 Nov. 1893, Faurie (G, K). Settsu Pref., Toyonaka, 5 Oct. 1958, Murata 12263 (KYO), U). Yamato Pref., Katagiri-tyo, 28 Oct. 1956, Murata 10473 (KYO). Yokohama, 1862, Maximowicz (BR, G, K, L, M). Koshigaya in Musashi, Sept. 1885, s. coll. (G). Komba nr. Tokyo, 20 Sept. 1911, Onuma (Z). Mikawa, Mima-mura, 21 Sept. 1953, Murata 6677 (KYO). Tanaba Pref., Yagi-tyô, Hunai-gun, 28 Sept. 1954, Murata 8344 (KYO). Nagano Pref., Suwa, 27 Aug. 1939, Fo Hara (K). Kawachi Pref., Shinodamura, Izukita-gun, 23 Sept. 1956, Murata 10221 (KYO). Shiga Pref., Bomura, Shiga-gun, 10 Oct. 1966, Nagai (KYO). Mikawa

Pref., Kamogaya, Thukude-mura, 55 m, 24 Sept. 1959, Murata 13180 (KYO). Yamashiro Pref., Tanbetyo, 22 Sept. 1950, Nakai 4980 (KYO). Tobori Pref., Yoshinaro, 10 Oct. 1971, Tanaka 14170 (KYO). Gunma (Gumma) Pref., Numata City, Yakatahara, Makino 121092 (MAK). Kumamoto Pref., Tômonji, Kawachiyoshinomura, Houtaku-gun, Makino 121128 (MAK). Miyagi Pref., Kateyama, 30 Oct. 1931, s. coll. (Z); ?ibid., Sendai, 20 Oct. 1918, Isiba (G); ibid., Nagamati, 17 Oct. 1927, Iisiba (G). Akita Pref., Akita, 67 Sept. 1894, Faurie 13763 (G, K). Aomori Pref., Hirosaki, Nov. 1888, Faurie 3389 (K). Korea: Cheju do (Quelpaert, Hongno), Oct. 1907, Taquet 281 (KYO); ibid., 28 Sept. 1908, Taquet 1463 (G, K, KYO); ibid., Oct. 1906, Faurie 925 (KYO). Pusan, 4 Oct. 1901, Faurie 473 (KYO). Chinese-Korean boarder: Ya-lü Chiang (Amnok-Gan River), Pen-nian Prov., 31 Aug. 1897, Komaròv 1124 (K). Korea localities not found: Mt. Tii, 27 Sept. 1934, Okamoto 17916 (KYO); Zenrahokudo, Tokutsu, 13 Sept. 1940, Cho 1263 (KYO).

Italy. Piemonte: Vercelli, 16 Sept. 1909, Ferrari \& Gola (L, NSW); ibid., 17 Sept. 1909, Mattirolo 1517 (LE, Z); ibid., 7 Sept. 1951, Koch \& Hess 680A, 685 A and 687 (ZT); ibid., 8 Aug. 1951, Koch \& Hess 577 (ZT); ibid., 29 Aug. 1955, Landolt 120 (ZT); ibid., 1 Aug. 1957, Merxmüller \& Wiedmann 15/57 (M); ibid., 23 Aug. 1972, Cook \& Rix 32, 33, 57 and 95 (Z); Novara, 31 Aug. 1950, Berger (ZT); ibid., 7 Aug. 1951, Koch \& Hess 555 (ZT); ibid., 6 Sept. 1951, Koch \& Hess 639, 641 A and 653 A (ZT); 22 Aug. 1972, Cook \& Rix 1, 6 and $25(\mathrm{Z})$. Portugal: no specimens seen, reliable records from C. Portugal.

Congo: Brazzaville, Pongo, Sept. 1900, Coomans (BR).
USA: no specimens seen, reliable records from: California, Butte Co. (Mason) and Louisiana, Rice Experiment Station, 4 km N.E. of Crowley, Acadia Parish, 16 Sept. 1971, Thieret 36102 (LAF).

## NOTES

Variation. - I have cultivated material of R. indica collected in Kerala, India (Cook, Rix \& Schneller 268) and N. Italy (Cook \& Rix 6) through two generations. The plants in cultivation were obligate annuals, self-compatible and effectively self-pollinated. When grown singly in pots without competition, the Indian material developed branched stems with lateral, contracted, spike-like inflorescences (Fig. 24B). The Italian plants remained virtually unbranched and developed flowers on the main stem in the axils of leaf-like bracts (Fig. 24A). These unbranched plants have been recognised as taxonomically distinct and given the rank of variety or species with "uliginosa" as the epithet.

The "uliginosa" race certainly has a genecotypic basis but it is often morphologically masked by the plasticity of "normal" $R$. indica. When "normal", $R$. indica is cultivated under unsuitable conditions or at high density it remains unbranched and develops flowers on the main stem; it is not distinguishable from the genetically fixed uliginosa genecotype. This has the consequence that uliginosa-like plants are found throughout the geo-
graphical range but the branched state is more or less confined to the tropical zone. This is a fine example of phenotypic plasticity masking genecological differentiation and thus hindering taxonomic recognition based on morphological characteristics.

The flower of $R$. indica is variable in shape, two extremes are shown on Fig. 24 E and 24 F . However, there are all degrees of intermediacy between these extremes.

Ecology. $-R$. indica is a very successful weed in ricefields. In Italy and India I have hardly found a ricefield without $R$. indica but in both countries I have never found $R$. indica not associated with rice cultivation.
37. Rotala subrotunda (Wallich ex S. Kurz) Koehne, Bot. Jahrb. 1: 174. 1880, excl. var. polystachya (Wallich ex Wight \& Arnott) Koehne $\equiv$ Ammannia subrotunda Wallich ex S. Kurz, J. Asiatic Soc. Bengal 40(1): 55. 1871, reprinted in Flora (Regensb.) 54(19): 191. 1871, typified in J. Asiatic Soc. Bengal 46(2): 85. $1877 \equiv$ Rotala indica (Willd.) Koehne forma subrotunda (Wallich ex S. Kurz) Blatter \& Hallberg, J. Bombay Nat. Hist. Soc. 25: 713. 1918.

- Ammannia latifolia Wallich in Wallich Cat. No. 2096, nom. nud., non L., nec Walp.

Type: Burma, Sagaing (Segain, Segaen) 1826, Wallich 2096 (holotype: ?CAL n.v.; isotypes: G, K-W, LE).

## Ic.: Fig. $25 \mathrm{~A}-\mathrm{C}$.

Terrestrial or amphibious annual or perhaps perennial. Stems erect or decumbent and rooting at the base, usually branched with numerous, upright, distinctly 4 -angled shoots, $8-40 \mathrm{~cm}$ long. Leaves decussate, sessile, broadly ovate to suborbicular, rarely more than 10 mm long, obtuse to cordate at base, obtuse at apex; leaf margin distinctly cartilaginous (visible on dried leaves). Bracts lanceolate to oblanceolate, scarcely exceeding the flowers, obtuse or acute at apex; bracteoles 2, capillary, rarely exceeding 1 mm long. Flowers monomorphic, distinctly pedicellate, solitary in the axils of bracts, borne on contracted, spike-like lateral branches; pedicels $0.5-2 \mathrm{~mm}$ long. Calyx tube campanulate, membranous, pink, c. 1.5 mm long; calyx lobes 4 , deltate, c. 0.5 mm long, with cartilaginous margins, occasionally mucronate at apex; calyx appendages absent. Petals 4 , narrowly obovate to suborbicular, c. 1 mm long, up to 2 times as long as calyx lobes, deep pink to purple. Stamens 4; filaments inserted about half-way up the calyx tube, c. 2.5 mm long; anthers exerted, borne above the petals. Ovary ellipsoidal; style 2 mm or more long; stigma capitate, exerted, borne level with the anthers; capsule ellipsoidal, c. 1.5 mm long, opening by 2 valves; seeds elongate-ellipsoidal, c. 0.4 mm long.


Fig. 25. - R. subrotunda (Lace 4490); A, inflorescence; B, flower; C, flower dissection. R. diandra (Victoria R., Müller); D, inflorescence; E, flower; F, bract; G, flower dissection (scale: A, D, $1 \mathrm{~cm} ; \mathbf{B}, \mathbf{C}, \mathbf{E}-\mathbf{G}, 1 \mathrm{~mm}$ ).

## DIAGNOSTIC FEATURES

K4, P4, A4, G2; like $R$. indica but plants usually taller and more branched; flowers distinctly pedicellate, not borne on main axis; petals relatively large and showy, up to 1 mm long; anthers and stigmas exerted and borne above the petals.

## DISTRIBUTION

N.E. India and Upper Burma (Map 12). Flowering time December to April.

## SELECTED SPECIMENS

India. Manipur: Laireen, c. 1000 m, April 1882, Watt 7312 (K). Burma: Sagaing (Segain, Segaen), 1826, Wallich 2096 (G, K-W, LE); Mandalay, 11 Jan. 1868, Anderson (LE); ibid., 14 Jan. 1964, Kanai 2542 (KYO); Myinmoo (Minjoo), 10 March 1893, King's Coll. 304 (Z); Monywa, Dec. 1907, Meebold 7928 (K); Chindwin, Tawnob, Dec. 1907, Meebold 7602 (K); Bhamo Distr., Palin, c. 160 m, 14 Dec. 1908, Lace 4490 (K); Katha Distr., 19 Jan. 1868, Anderson (L); Zhemun, Muilen, Jan. 1903, Shalk Mokin 1123 (G, NSW); Yun Tee, c. 100 m, 10 Jan. 1970, s. coll. (K); ibid., 20 Jan. 1970, s. coll. (K).
38. Rotala diandra (F. v. Müller) Koehne, Bot. Jahrb. 1: 169. $1880 \equiv$ Ameletia diandra F. v. Müller, Fragm. Phyt. Austral. 3: 108. 1862 三 Ammannia diandra (F. v. Müller) Bentham, Fl. Austral. 3: 296. 1866.

Type: Australia, Northern Territory, Victoria River, F. v. Müller (holotype: MEL; isotypes: $\mathrm{K}, \mathrm{MEL}$ ).

Ic.: Fig. 25D-G.
Amphibious annual. Stems erect or creeping and rooting below, variously branched, erect above, up to c. 20 cm tall. Leaves decussate, sessile, broadly ovate to suborbicular, usually less than 10 mm long, obtuse to cordate at base, obtuse at apex; leaf-margin cartilaginous (distinct on dried leaves). Bracts leaf-like, broadly ovate to suborbicular, somewhat imbricate and covering the flowers; bracteoles 2, capillary, membranous, up to 1.5 mm long. Flowers monomorphic, sessile, solitary in the axils of leaf-like bracts. Calyx tube campanulate, membranous, ?straw-coloured, up to 2.5 mm long; calyx lobes 4 , triangular, up to 1.5 mm long, without a cartilaginous margin; calyx appendages absent; interjected folds rudimentary. Petals absent. Stamens 2; filaments inserted near base of calyx tube, c. 1.5 mm long; anthers included, reaching about half-way up the calyx tube. Ovary ellipsoidal; style very short, almost absent; stigma capitate, borne about level with the anthers; capsule ellipsoidal, c. 1.5 mm long, scarcely exceeding half the length of the calyx tube, opening by 2 valves; seeds narrowly ellipsoidal, c. 0.4 mm long.

## DIAGNOSTIC FEATURES

$\mathrm{K} 4, \mathrm{P} 0, \mathrm{~A} 2$, G2; like $R$. indica but bracts imbricate more or less covering the flowers; calyx large up to 4 mm long (tube and lobes); anthers and stigmas about half-way up the calyx tube - no sexual parts visible from outside; petals absent; stigma sessile to subsessile.

DISTRIBUTION
Northern Australia from W. Queensland to King's Sound (Map 14). Flowering time from April to August?

SELECTED SPECIMENS
Australia. Queensland: Nicholson River, $17^{\circ} 56^{\prime}, 138^{\circ} 43^{\prime}, 5$ May 1974, Jacobs 1459 (NSW). Northern Territory: Victoria River, F. v. Müller (K, MEL); Upper Victoria River, F. v. Müller (K); Herbert River to Carpentaria, 1886, Dittrich (MEL); Lake Nash, Milne River, 1886, Dittrich (MEL); Newcastle Waters, 1887, Giles (MEL); $51 \mathrm{~km} \mathrm{S.W} .\mathrm{of} \mathrm{Hooker's} \mathrm{Creek}$, 12 Aug. 1956, Chippendale 2251 (MEL); Ampax Camp, 2 June 1971, Taylor 63 (MEL); Katherine, $14^{\circ} 20^{\prime}, 132^{\circ}$, $107 \mathrm{~m}, 24$ April 1947, Blake 17438 (L, MEL). Western Australia: King's Sound, 1888, Froggat (NSW); Kimberly Distr., 1887, Nyulasy (MEL, NSW); Kunumurra, Sept. 1967, Johnson NSW137475 (NSW); Fitzroy River, 1883, Forrest (MEL); W. of Cambridge Gulf, 1887, Keiller (MEL); between Norman and Gilbert Rivers, 1874, Gulliver 89 (MEL).

## The Rotala filiformis group

The Rotala filiformis group can be characterized by the following diagnostic features: annual or perhaps occasionally perennial; leaves decussate; calyx 4 -lobed; petals small, rudimentary or absent; stamens 4 or less, inserted about half-way up the calyx tube; capsule opening by 2 valves.

The $R$. filiformis group is widely distributed in Africa. From the floral structure the plants are highly inbreeding. As it is frequently the case in inbreeding annuals, numerous races with more or less distinct morphological, geographical and ecological characteristics have evolved. Some of the races have been given formal taxonomic recognition, others not. The following species in this group have been described: $R$. capensis, perhaps $R$. cataractae, R. congolensis, R. cordipetala, R. debilissima, R. dinteri, R. filiformis, $R$. fontinalis, $R$. heteropetala, $R$. heterophylla, R. lucalensis, $R$. milne-redheadii, $R$. robynsiana, R. smithii, R. sphagnoides, $R$. stuhlmannii and $R$. wildii. Authentic herbarium material of $R$. cataractae and R. stuhlmannii, both described by Koehne, has not been found (probably destroyed in Berlin) so their exact identity is not known, $R$. cataractae is probably synonymous with R. myriophylloides.

Morphological distinctions between species are sometimes obscured by phenotypic variability. Unfortunately, I have not had the opportunity to cultivate plants from this group, but when an analysis is made of repeated gatherings from one locality (i.e. the spray zone below the Victoria Falls) or comparisons made between individual plants from large gatherings (i.e. collections of: Milne-Redhead \& Taylor, Richards, Robinson, Schlieben or Verboom) it is possible to predict which morphological features are unreliable as diagnostic characters.

With some reservations, the following previously accepted morphological characters are unreliable and can hardly be used as diagnostic features:

1. The length and degree of branching of the stem, although $R$. capensis and $R$. dinteri are usually much smaller than the other species.
2. The dimensions and shapes of the foliage leaves; the bracts, on the other hand, are relatively constant.
3. The relative proportions of the bracteoles, calyx tube and calyx lobes, although absolute measurements are often of use.
4. The number, size and shape of the petals is very variable between individuals and often between flowers on a single stem. $R$. capensis appears to be the only species in this group that is consistently without petals, although some races of the other species may be apetalous.
5. The number of stamens varies from 1 to 4 . Some races have consistently 2 stamens and no staminodes while other races have consistently 4 stamens but occasionally 1 or 2 are sterile. Other races have from 1 to 3 fertile stamens. Stamen number is a useful character when used in conjunction with other characters.
6. The shape of the ovary at anthesis is globose in all species, in some it remains globose, in others it becomes ellipsoidal.

The following characters have been found to be of diagnostic value in the $R$. filiformis group: bract shape and length, bracteole length, calyx tube length, calyx lobe length, stamen number, filament length, style length, capsule shape and length, seed shape and length. The distribution of these diagnostic features are summarized on Table 1.
Table 1. - Diagnostic features in the Rotala filiformis group (all length measurements in mm )

|  | R. filiformis | R. capensis | R. dinteri | R. fontinalis | R. Iucalensis | R. smithii |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Bract shape . . . . . . . . . . . . . . . . . . . . | lanceolate to ovate | linear to lanceolateovate | linear to ovate | lanceolate to widely ovate | lanceolate | ovate to widely ovate |
| Bract length.. | -8 | -5 | -8 | -8 | -8 | C. 4 |
| Bracteole length | 0.5-1 | 0.1-0.25 | 0.25-0.5 | -1 | -1 | c. 0.5 |
| Calyx tube length | 1-1.5 | 0.3-0.5 | 0.4-0.5 | 1-1.5 | C. 1 | C. 1.25 |
| Calyx lobe length . . . | c. 0.5 | 0.2-0.4 | 0.3-0.45 | 0.5 | 0.5 | 0.5-0.75 |
| Stamen number | $(1-) 2(-3)$ | 2 | $(1-) 2(-3)$ | 4 | 4 | 4 |
| Filament length | 0.5 | 0.1 | 0.4 | 0.5 | 0.5 | 1.0-2.5 |
| Style length . | 0.25-0.5 | 0.1-0.2 | 0.2 | 1 | 0.75-1 | 1.25-2.5 |
| Capsule shape | ellipsoid to obovoid | ellipsoid | subglobose | subglobose | ellipsoid | ellipsoid |
| Capsule length . . . . . . . . . . . . . . | -2 | 1-1.25 | 1-1.25 | 1 | 2 | 1.5 |
| Seed length . . . . . . . . . . . . . . . . . . . | 0.4 | 0.4 | 0.4 | 0.4 | 0.75-1 | 0.4 |

39. Rotala filiformis (Bellardi) Hiern in Oliver, Fl. Trop. Africa 2: 468. 1871, excl. syn. $\equiv$ Suffrenia filiformis Bellardi, Mém. Acad. Sci. Lit. Beaux-Arts Turin - Sci. Phys. Math. pt. 1, "pour les années X (1802) et XI (1803)": 445, t. 1, f. $1 . ? 1804$. (The publication date is uncertain, Koehne cites "1794" which is incorrect, the work was perhaps published in 1803 but had certainly appeared by 1804).
$=$ Rotala heteropetala Koehne, Bot. Jahrb. 22: 149. 1895. Type: Ethiopia, Sire (Schire), ?1840, Dillon \& Petit 761 (holotype: ?destroyed in B; isotype: P).
$=$ Rotala debilissima Chiov., Ann. Bot. (Roma) 9: 61. 1911. Type: Ethiopia, Erithrea, Scimezana Guna Guna, 2000 m, 21 Aug. 1902, Pappi 769 (holotype: ?FI).
$=$ Rotala congolensis A. Fernandes \& Diniz, Bol. Soc. Brot. Sér. 2, 29: 89. 1955. Type: Zaire, Shaba (Katanga), Lubumbashi (Elisabethville), May 1948, Schmitz 1684 (holotype: COI n.v.; isotype: BR).
$=$ Rotala heterophylla Welw. ex A. Fernandes \& Diniz, Bull. Jard. Bot. Etat. Bruxelles 27: 106. 1957. Type: Angola, Cuanza Norte, Pungo Andongo, Lagoa de Quibinda, March 1857, Welwitsch 2342 (holotype: LISU n.v.; isotypes: BM, M).

Type: Italy, Piemonte, Vercelli, Suffrens (holotype: TO n.v.; probable isotypes: G, K, LE, M).

Ic.: Fig. 26A-E; Fernandes \& Diniz, Bol. Soc. Brot. Sér. 2, 29: t. 3. 1955 (R. congolensis); Fernandes \& Diniz, Bull Jard. Bot. Etat. Bruxelles 27: pl. 3. 1957 ( $R$. heterophylla).

Amphibious or aquatic annual or perhaps occasionally perennial. Stems erect, occasionally creeping below, simple or irregularly branched, often packed together and denuded of leaves below, $5-40 \mathrm{~cm}$ long. Leaves decussate, sessile or subsessile; submerged leaves usually linear to lanceolate, up to 10 mm long; aerial leaves lanceolate to ovate, rarely more than 8 mm long, truncate to cordate at base, obtuse at apex. Bracts sessile or subsessile, lanceolate to ovate, rarely more than 8 mm long; subcordate to cordate at base, obtuse at apex, imbricate at anthesis, spreading in fruit; bracteoles 2, capillary, c. $0.5-1 \mathrm{~mm}$ long. Flowers monomorphic, sessile or subsessile, solitary in axils of leaf-like bracts. Calyx tube cup-shaped, membranous, somewhat accrescent, $1-1.5 \mathrm{~mm}$ long; calyx lobes 4 , deltate, c. 0.5 mm long; calyx appendages absent, small interjected folds present at anthesis. Petals absent or up to 4 , not exceeding the calyx lobes, linear to obovate or orbicular (often variable in shape within one flower, petalous and apetalous flowers often found on the same plant). Stamens 2 and opposite or occasionally 3 or 1 , inserted about half-way up the calyx tube; filaments c. 0.5 mm long; anthers included, borne below the stigma. Ovary at anthesis subglobose; style $0.25-0.5 \mathrm{~mm}$ long; stigma capitate; capsule ellipsoid or obovoid, up to c. 2 mm long, as long as or somewhat exceeding the calyx lobes, opening by 2 valves; seeds semi-ellipsoidal, c. 0.4 mm long.


Fig. 26. - R. filiformis (Malinverni Sept. 1875); A, habit; B, bract; C, flower at anthesis; D, flower with mature capsule; $\mathbf{E}$, flower dissection (scale: $\mathbf{A}, 2 \mathrm{~cm} ; \mathbf{B}-\mathbf{E}, 1 \mathrm{~mm}$ ).

## DIAGNOSTIC FEATURES

$\mathrm{K} 4, \mathrm{P} 0-4, \mathrm{~A}(1-) 2(-3)$, G2; capsule before dehiscence ellipsoid or obovoid, as long as or somewhat exceeding the calyx; style $0.25-0.5 \mathrm{~mm}$ long; calyx tube at least 1 mm long.

## DISTRIBUTION

Widespread in Africa from Mali to Ethiopia southwards to the northern part of South West Africa and the Transvaal, it is also in Malagasy. It was found in Piemonte, North Italy from the 18th century until about 1912; repeated searches in the last few years have failed to find it. Its relatively short time in Italy and the fact that it was known only from ricefields support the argument that it was never truly native in Italy (Map 16).

## SELECTED SPECIMENS

Italy: in $\mathrm{BR}, \mathrm{G}, \mathrm{K}, \mathrm{LE}, \mathrm{M}$ and MO are some very old specimens without locality, date and collector. Piemonte: s. loc., Balbis (G, LE); ibid., 1807, Bellardi (LE); ibid., 1868, van Herch (BR); ibid., Müller-Arg. (ZT); ibid., 22 Sept. 1827, Welden (M); Vercelli, Suffrens (G, K, LE, M); ibid., Caesati (LE, ZT); ibid., 1876, Gibelli (G, LE, Z, ZT); ibid., 1864, Rostan (G); ibid., 1887, Rostan (G); Prov. di Vercelli, Quinto, Sept. 1871, Gibelli (BR, K, Z, ZT); ibid., 30 Sept. 1875, Malinverni (K, M, Z, ZT); ibid., 1878, Gibelli 252B (Z); ibid., Sept. 1880, Mori (M); Oldenico, Caesati (BR, LE, MO, U, Z, ZT); ibid., 8 Aug. 1879, Malinverni (LE, Z); Novara, 1809, De Candolle (Z); ibid., 10 Aug. 1875, s. col. (Z); Pavia, s.d. Franzoni (M); ibid., Oct. 1823, Franzoni (ZT); ibid., Sept. 1840, Franzoni (ZT); ibid., 1823, Mayer (M); Legnano, Bubani (LE); Villerboit, Aug. 1812, Perret (LE).

Mali: Gao, vers la Dune Rose, 5 April 1936, De Wailly 5016 (P). Nigeria: Zaria Prov., Anara, Kan Gimi, 20 Oct. 1947, Keay 20130 (K). Cameroun: 13 km W.N.W. of Yagoua, Gandjam, 1 Jan. 1965, J. \& A. Raynal 12832 (P). Central African Republic: Gungere, pr. Ippy, 4 Nov. 1928, Tisserant 2735 (P). Ethiopia: Sire (Schire), ?1840, Dillon \& Petit 761 (P); Kaffa Prov., Kochi, c. 5 km E. of Jimma, $1740 \mathrm{~m}, 2$ Nov. 1970, Friis 55 (BR, K). Zaire: Terr. Kasangulu, Zongo, 2 July 1971, Hallé 1927 (BR); L’Upemba, Ngose, $27^{\circ} 15^{\prime}$ E., $8^{\circ} 50^{\prime}$ S., 11 May 1942, de Witte 6329 (BR); 80 km N.E. of Lubumbashi (Elisabethville), 3 March 1961, Schmitz 7195 (BR); Keyberg, pr. Lubumbashi, Sept. 1945, Quarré 6936 (BR); ibid., May 1948, Schmitz 1684 (BR); Lubumbashi, 25 June 1928, Quarré 1240 (BR, G, K); Katentania, $26^{\circ} 02^{\prime} 5$, 1700 m, 26 May 1952, Schmitz 3993 (BR). Angola. Cuanza Norte: Pungo Andongo, Lagoa de Quibinda, March 1857, Welwitsch 2342 (BM, M); Lubango (Huíla): Alto Cunene, Mulondo, 23 Sept. 1963, Menezes 803 (K); Calueca, Donguena, Rio Runene, 1000 m, 10 May 1937, Gossweiler 10892 (K); between Ruancana and Humbe, 1000-1150 m, 10 June 1937, Exell \& Mendonça 2904 (BM, M); Kamba sur le Cunene, 6 July 1933, Thiébaud (ZT). Tanzania: Iramba Distr., Kiomboi, 1800 m, 30 April 1962, Polhill \& Paulo 2262 (B, BR, K); Lupembe, Ruhudje Riv., March 1931, Schlieben 450 (B, BM, BR, G, K, M, P, Z); Songea Distr., Kwamponjore Valley, 19 June 1956, Milne-Redhead \& Taylor 10835 (B, BR); ibid., 20 June 1956, Milne-Redhead \& Taylor 10848 (BR); Songea Distr., Riv. Luhira, nr. Mshangano, N. of Songea, 1030 m, 15 June 1956, Milne-Redhead \& Taylor 10815 (B, BR).

Malawi: Central Prov., Kasungu Distr., Kasungu National Park, 1000 m, 7 Sept. 1972, Pawek 5699 (MO). Zambia: Mbala (Abercorn); Ningi Pans, 1500 m, 1 June 1961, Richards 15193 (K); Mbala (Abercorn), Michelmore 433 (K); ibid., Lake Lyapa, 7 Sept. 1966, Richards 31415 (K, numbered 21415 in MO); Kasama Distr., Chiskimba Falls, 20 May 1962, Robinson 5202 (B, BR, K); 25 km W. of Kasama, 7 May 1961, Robinson 4637 (K, M); Bangweulu, Ncheta Island, 3 Sept. 1969, Verboom 2638 (B, BR, K); Chilongowelo, Plain of Death, 1600 m, 5 May 1955, Richards 5536 (BR, K); Mwinilunga Distr., 7 km N. of Kalene Hill, 15 April 1965, Robinson 6565 (B, K); Barotse, Masese, 16 June 1960, Fanshaw 5740 (BR, K); Barotse, Mongu, Nov. 1959, Drummond \& Cookson 6349 (K); c. $20 \mathrm{~km} \mathrm{S} .\mathrm{of} \mathrm{Mongu}, \mathrm{Namushakende} 1150 \mathrm{~m},$,25 June 1955, King Aie 33 (K); Mazabuka, 19 March 1958, Robinson 2798 (K, M); Namwala, Mulela Flood Plain, 19 April 1963, van Rensburg 2065 (K); ibid., 17 April, van Rensburg 2031 (K). Rhodesia (Zimbabwe): Victoria Falls, 1860, Kirk (K); ibid., Keilhack (B); ibid., May 1915, Rogers 5986 (BM); ibid., 6 Aug. 1929, Rendle 418 (BM); ibid., 18 July 1930, Young-Moss 18542 (BM); ibid., 30 Aug. 1947, Greenway \& Brenan 8031 (K); Salisbury, Parktown, 11 April 1944, Greatrex 18410 (BM); ibid., Greatrex 18412 (BM); Arcturus, 18 April 1944, Greatrex 18411 (BM). South West Africa (Namibia): Okavango, Niangana, May 1934, Dinter 7261 (B, BM, K, M); ibid., Dinter 7622 (K, M, Z); Grootfontein N. Runtu, 8 May 1939, Volk 1934 (M); Ovamboland, Eunda, 15 June 1963, Giess \& Leippert 7609 (M). Republic of South Africa: Transvaal, Ermelo Distr., Chrissiesmeer (Lake Chrissie), 27 Feb. 1928, Weintroub \& Blenkinson 16291 (BM). Malagasy Republic: Tananarive, May 1962, Bosser 15587 (P); ibid., Nanilana, Feb. 1906, D'Alleizette 2487 (L); ibid., entre Tanjobato et Ankadievo, Ambohimanatrika, 7 Sept. 1972, Jacquemin 1103 (P); Andramasina, 7 June 1972, Jacquemin 1052 (P); ibid., 1053 (P); ibid., 1054 (P).

## NOTES

The form of the vegetative part of this species is very variable; at one extreme is $R$. filiformis quoad typum ( $=R$. heterophylla) a slender, heterophyllous plant and the other extreme is $R$. congolensis a robust, homophyllous plant with large ovate leaves. R. filiformis from N. Italy is heterophyllous but most sheets bear only apical portions of mature stems. I cannot agree with A. Fernandes \& M. A. Diniz, Bull. Jard. Bot. Etat Bruxelles 27: 104-111. 1957 and A. Raynal, Adansonia 7: 544-545. 1967 that the European and African material belong to different species. I am not suggesting that the variation spectrum is no more than phenotypic plasticity. It is an autogamous species and almost certainly has numerous genecotypically distinct races but the morphological variation presented on herbarium specimens covers a whole range of intermediates. This has forced me to lump some widely recognised species together. Two collections are particularly interesting. The mass gathering by Milne-Redhead \& Taylor 10815 from Tanzania shows almost the whole range of variation in one
collection and the collection J. Pawek 5699 from Malawi shows a "congolensis" plant at the stem apex with linear submerged leaves below.
40. Rotala capensis (Harvey) A. Fernandes \& Diniz, Bull. Jard. Bot. Etat. Bruxelles 27: 105. 1957 三 Suffrenia capensis Harvey, Thes. Cap. 2: 56, t. 189. 1863.
$=$ Rotala robynsiana A. Fernandes \& Diniz, Bull. Jard. Bot. Etat. Bruxelles 27: 110. 1957. Type: Zaire, Shaba (Katanga), Dilolo, 1940, F. Freyne 48 (holotype: COI n.v.; isotypes: BR, YANG n.v.).

- Rotala sphagnoides Perrier, Not. Syst. (Paris) 14: 308. 1953 (dated Dec. 1952), nom. invalid., no type designated, material cited: Malagasy, Antsirabe, Perrier 6598 (n.v.); ibid., 6620 (P); ibid., 6621 (n.v.); Andringitra, Perrier 13592 (P); ibid., 13592 (P); ibid., 13651 (P); Firingalava, Perrier 752 (P).

Type: Republic of South Africa, Draakensberg, 1862, T. Cooper 1044 (holotype: TCD n.v.; isotypes: K, MEL, Z).

Ic.: Fig. 27A-D; Harvey, Thes. Cap. 2: t. 189. 1863; Fernandes \& Diniz, Bull. Jard. Bot. Etat. Bruxelles 27: t. 3. 1957.

Amphibious, tufted or turf-forming annual. Stems branched and creeping below, erect and mostly simple above, often packed together and denuded of leaves below, up to 10 cm long but usually less. Leaves decussate or rarely in whorls of 3 ; submerged leaves linear, tapering to a slender, emarginate apex, up to 8 mm long; aerial leaves linear to lanceolate or ovate, obtuse or emarginate at apex, rarely exceeding 5 mm long. Bracts leaf-like, linear to lanceolate or lanceolate-ovate, rarely exceeding 5 mm long; bracteoles 2 , scarious, minute, $0.1-0.25 \mathrm{~mm}$ long. Flowers monomorphic, subsessile, minute, solitary in axils of bracts. Calyx tube cupshaped, membranous, 0.30.5 mm long, not accrescent, splitting irregularly as the fruit ripens; calyx lobes 4 , deltate, $0.2-0.4 \mathrm{~mm}$ long; calyx appendages and interjected folds absent. Petals absent. Stamens 2, inserted about half-way up the calyx tube; filaments very short, c. 0.1 mm long; anthers included within the calyx tube. Ovary at anthesis globose becoming ellipsoidal later; style $0.1-0.2 \mathrm{~mm}$ long; stigma subcapitate; capsule ellipsoidal, $1.0-1.25 \mathrm{~mm}$ long, about twice as long as the calyx, bright red, opening by 2 valves; seeds semi-ellipsoidal, c. 0.4 mm long.

## DIAGNOSTIC FEATURES

K4, P0, A2, G2; calyx (tube plus lobes) less than 1 mm long; capsule twice as long as the calyx; calyx tube splitting irregularly as the capsule develops. Like $R$. mexicana in habit but it has a 2 -valved capsule that exceeds the calyx. See notes following $R$. dinteri p. 128.




Fig. 27. - R. capensis (Cooper 1044); A, bract with flower; B, flower at anthesis; C, flower dissection; $\mathbf{D}$, flower with dehiscing capsule.
R. dinteri (Dinter 7262); E, F, bracts with flowers; $\mathbf{G}$, flower at anthesis; H, flower dissection; $\mathbf{I}$, flower with mature capsule (scale: A, E, F, $1 \mathrm{~mm} ; \mathbf{B}-\mathbf{D}, \mathbf{G}, \mathbf{I}, 0.5 \mathrm{~mm}$ ).

## DISTRIBUTION

Widely scattered from northern Cameroun and Tanzania southwards to the eastern part of South Africa and Malagasy (Map 15).

## SELECTED SPECIMENS

Cameroun: 70 km E.N.E. of Maroua, Guirvidig, Oct. 1963, Letouzey 7248 bis (BR); 60 km N.E. of Tibati, Sabal Haléo, 26 Sept. 1963, Letouzey 6021 (P). Zaire: Shaba (Katanga), 15 km E. of Lubumbashi (Elisabethville), 23 March 1955, Schmitz 4814 (BR); ibid., 25 km N.E.E. of Lubumbashi, 23 March 1955, Schmitz 6446 (BR); ibid., 26 km N.E. of Lubumbashi, 12 Feb. 1961, Schmitz 7119 (BR); ibid., 25 km N.E. of Lubumbashi, 10 April 1963, Schmitz 8296 (BR); ibid., Namopala, 1300 m, 12 April 1962, Symoens 9376 (BR, K); Dilolo, 1940, F. Freyne 48 (BR). Angola: Lubango (Huíla), Humpata, rio Maombo, $2020 \mathrm{~m}, 18$ April 1960, Mendes 3654 (BR). Tanzania: Itigi, E. of Bangayega, 1300, 30 Dec. 1925, Peter 33758 (B); Ujansi, Schaya Lake, Pori, 1250 m, 3 Jan. 1926, Peter 34009B (B); ibid., 34012 (B); ibid., 1240 m, 4 Jan. 1926, Peter 34143B (B). Rhodesia (Zimbabwe): Salisbury, 19 May 1953, Wild 4114 (K, MO); Hartley, 7 April 1954, Wild 4553 (K, MO); Bikita, Turgwe-

Dafana confluence, 1050 m, 5 May 1969, Biegel 3029 (K); Matobo, 1500 m, April 1958, Miller 5890 (M). Republic of South Africa: Transvaal, Benoni, 19 April 1925, Moss 11006 (BM); Orange Free State, Harrismith, Laskop, 2100 m, 13 March 1970, Stam 411 (L); Swinburne, 23 March 1970, Stam 426 (L); Natal, Naanwhoek, 2250 m, 28 Feb. 1963, Devenish 1604 (K). RSA, or perhaps Lesotho: Drakensberg, 1862, T. Cooper 1044 (K, MEL, Z). Malagasy Republic: Antsirabe, Perrier 6620 (P); Massif d’Andringitra, Perrier 13592 (P); ibid., 13651 (P); Firingalava, Perrier 752 (P).
41. Rotala dinteri Koehne in Schinz, Mém. Herb. Boissier 20: 24. 1900.
$=$ Rotala milne-redheadii A. Fernandes \& Diniz, Bol. Soc. Brot. Sér. 2, 33: 21. 1959. Type: Zambia, Mwinilunga Distr., Kalenda Plain, 30 Jan. 1938, Milne-Redhead 4414 (holotype: K; isotype: COI, the type material is immature and may be referrable to $R$. filiformis).

Type: South West Africa (Namibia), Hereroland, Waterberg, 9 April 1899, Dinter 564 (Z).

Ic.: Fig. 27E-I; Fernandes \& Diniz, Bol. Soc. Brot. Sér. 2, 33: 5, 2. 1959.
Amphibious, tuft-forming annual. Stems simple or branched below and usually simple above, up to 12 cm long but usually less. Leaves decussate, sessile; submerged leaves lanceolate to linear tapering to a slender and emarginate apex, c. 8 mm or perhaps more long; aerial leaves linear to lanceolate or lanceolate-ovate, up to c. 8 mm long. Bracts leaf-like, linear to lanceolate or ovate, when ovate then imbricate, up to 8 mm long; bracteoles 2, linear, $0.25-0.5 \mathrm{~mm}$ long. Flowers monomorphic, sessile, solitary in axils of bracts. Calyx tube cup-shaped, membranous, $0.4-0.5 \mathrm{~mm}$ long; calyx lobes 4, deltate, $0.3-0.45 \mathrm{~mm}$ long, usually not splitting as the fruit ripens; calyx appendages and interjected folds absent. Petals absent or 1-2 rudimentary. Stamens 2 or rarely 1 or 3 , inserted about half-way up the calyx tube; filaments c. 0.4 mm long; anthers included in the calyx. Ovary at anthesis and when ripe subglobose; style c. 0.2 mm long; stigma capitate; capsule subglobose, bright red, exceeding the calyx, $1.0-1.25 \mathrm{~mm}$ diam., opening by 2 valves; seeds semi-ellipsoidal, c. 0.4 mm long.

## DIAGNOSTIC FEATURES

$\mathrm{K} 4, \mathrm{P} 0-2, \mathrm{~A}(1-) 2(-3), \mathrm{G} 2$; capsule subglobose and exceeding the calyx lobes; calyx (tube plus lobes) not more than 1 mm long.

## DISTRIBUTION

Northwestern Zambia, Northeastern Namibia (South West Africa) and Northeastern South Africa (Map 15).

## SELECTED SPECIMENS

Zambia: Mwinilunga Distr., Kalenda Plain, 30 Jan. 1938, Milne-Redhead 4414 (K); Mbala (Abercorn) Distr., Chilongolwelo, 1440 m, 9 May 1957, Richards 9620 (K). South West Africa (Namibia): s. loc., Volk (M); Hereroland, Waterberg, March 1898, Bernsmann (Z); loc. cit., 9 April 1899, Dinter 564 (Z); Flugplatzufer am Okavango in Niangana, Mid-May 1934, Dinter 7262 (B, M, Z); Grosshuis, Early May 1934, Dinter 7292 (B, BM, K, M, Z); Tsumeb, Nosibpad, km 11, Mid-April 1934, Dinter 7445 (BM, M, Z). Republic of South Africa. Transvaal: pr. Mororiol-Drift, $1400 \mathrm{~m}, 14$ April 1894, Schlechter 4774 (Z). Natal: Estcourt, Griffinshill, 1875-1800, Rehmann 7298 (K, Z).

NOTES
Rotala dinteri is not a very satisfactory species because it grades into $R$. filiformis at one end of its variation spectrum and into $R$. capensis at the other. Some collections, particularly from Zambia (Robinson 5202, 6565 and Richards 5536, 31415) are intermediate between $R$. dinteri and R. filiformis but as they are relatively large plants with calyces exceeding 1 mm long and a fruit scarcely exceeding the calyx, I have assigned them to $R$. filiformis. The type specimen of $R$. robynsiana (Freyne 48) and the collection of Symoens 9376A from Zaire are intermediate between $R$. dinteri and $R$. capensis but as they have ellipsoidal capsules, no petals and consistently 2 stamens I have assigned them to $R$. capensis.
42. Rotala fontinalis Hiern in Oliver, Fl. Trop. Africa 2: 468. 1871; excl. specim. Christen Smith 13, 14, and 16.
$=$ Rotala cordipetala R. E. Fries, Feddes Repert. 12: 541. 1913. Type: Zambia, Lake Bangweulu, 19 Sept. 1911, R. E. Fries 656 (holotype: UPS n.v.; isotype: Z - calyx and petal length shorter on the isotype Z than reported in the type description).

Type: Angola, Pungo Andongo, pr. Lombe et Quisonde, March 1857, Welwitsch 2346 (holotype: BM; isotype: LISU n.v.).

Ic.: Fig. 28A-D.
Amphibious or terrestrial annual or perhaps perennial. Stems simple or branched, creeping and often denuded of leaves below, erect above, up to 20 cm or more long. Leaves decussate, sessile, lanceolate to widely ovate, up to 8 mm or perhaps more long, cuneate to cordate at base, rounded at apex. Bracts leaf-like, lanceolate to widely ovate, usually cordate at base, imbricate at anthesis, spreading in fruit, up to 8 mm long; bracteoles linear, up to 1 mm



H


Fig. 28. - R. fontinalis (Welwitsch 2347); A, bract; B, flower; C, flower dissection; D, capsule. R. lucalensis (Bamps \& Martins 4296); E, flower dissection; F, flower with mature capsule; $\mathbf{G}$, flower at anthesis; $\mathbf{H}$, bract.
R. smithii (Bequaert 7897); I, bract; J, flower at anthesis; K, flower dissection; L, flower with mature capsule (scale: A-L, 1 mm ).
long, usually about half as long as the calyx tube. Flowers monomorphic, sessile solitary. Calyx tube cup-shaped, membranous, not accrescent, 11.5 mm long; calyx lobes 4 , deltate, c. 0.5 mm long; calyx appendages and interjected folds absent. Petals usually 4, ovate, about as long as the calyx lobes, or 1 or more reduced and rudimentary. Stamens 4 , occasionally 1 or 2 sterile and represented by naked filaments, inserted somewhat below the middle of the calyx tube; filaments c. 0.5 mm long, somewhat glandular at base; anthers borne at top of calyx tube or slightly exerted. Ovary
subglobose; style up to c. 1 mm long, persisting in fruit; stigma capitate borne above the calyx lobes; capsule obovoid to subglobose, usually somewhat flattened above, c. 1 mm long, opening by 2 valves, remaining within the calyx tube; seeds semi-ovoid, c. 0.4 mm long.

## DIAGNOSTIC FEATURES

K4, P4, A4, G2; stamens 4, occasionally 1 or 2 sterile and represented by naked filaments; mature capsule subglobose, remaining within the calyx tube.

## DISTRIBUTION

Northern Angola, Eastern Zaire and Northern Zambia (Map 13).

## SELECTED SPECIMENS

Angola: Cuanza Norte, Pungo Andongo: pr. Lombe e Quisonde, March 1857, Welwitsch 2346 (BM); ibid., pr. Candumba e Mutollo, March 1857, Welwitsch 2347 (M). Zaire: Shaba (Katanga), Kaniama, Haut Lomami, 900 m, 20 April 1947, Mullenders 266 (BR). Zambia: Lake Bangweulu, 19 Sept. 1911, R. E. Fries 656 (Z).
43. Rotala lucalensis A. Fernandes \& Diniz, Bol. Soc. Brot. Sér. 2, 31: 154. 1967.
$=$ Rotala wildii A. Fernandes, Bol. Soc. Brot. Sér. 2, 40: 128. 1974. Type: Rhodesia (Zimbabwe), Mtoko, Makate Ruins, 15 Feb. 1962, H. Wild 5662 (holotype: SRGH n.v.; isotypes: COI n.v., K, MO).

Type: Angola, Malange, Rianzondo, Duque de Bragança, ad margines fluminis Lucala, 1000 m , March 1937, Gossweiler 11818 (holotype: COI n.v.).

Ic.: Fig. 28E-H; Fernandes \& Diniz, Bol. Soc. Brot. Sér. 2, 31: t. 3. 1957, reprinted in: Consp. Fl. Angolensis 4: t. 17. 1970; Fernandes, Bol. Soc. Brot. Sér. 2, 40: t. 15. 1974, reprinted in Fl. Zambes. Lythraceae, t. 79. 1978 - the scale of Fig. 9 and 10 is not in accordance with the type description and specimen.

Amphibious annual or perennial. Stems creeping and irregularly branched below, usually erect above, up to c. 25 cm long. Leaves decussate, sessile; submerged leaves linear to lanceolate; aerial leaves narrowly lanceolate to lanceolate, up to 8 mm long. Bracts leaf-like, lanceolate, up to 8 mm long; bracteoles 2, capillary, up to 1 mm long. Flowers monomorphic,
sessile, solitary. Calyx tube cup-shaped, membranous, not accrescent but remaining intact in fruit, whitish or pink, c. 1 mm long; calyx lobes 4 , deltate, pink, c. 0.5 mm long; calyx appendages and interjected folds absent. Petals 4 or occasionally less, lanceolate to ovate, from rudimentary to c. 0.25 mm long. Stamens 4 or occasionally less, inserted about half-way up the calyx tube; filaments c. 0.5 mm long; anthers included within the calyx. Ovary ellipsoidal; style $0.75-1.0 \mathrm{~mm}$ long, folded in bud and at early anthesis becoming erect later; stigma capitate, borne level with the stamens at anthesis becoming erect later; capsule ellipsoidal to obovoid, at least 2 mm long about twice as long as the calyx tube, opening by 2 valves; seeds ellipsoidal, black or dark brown, $0.75-1.0 \mathrm{~mm}$ long.

## DIAGNOSTIC FEATURES

K4, P4-0, A4(or less?), G2; seeds $0.75-1.0 \mathrm{~mm}$ long and ellipsoidal; mature capsule at least 2 mm long; style $0.75-1.0 \mathrm{~mm}$ long, folded in bud and at early anthesis becoming erect later; anthers included within the calyx.

## DISTRIBUTION

Angola, Western Kenya, Northern Uganda and Rhodesia (Zimbabwe) (Map 16).

## SELECTED SPECIMENS

Angola: Malange, Duque de Bragança, Rianzondo, pr. catarates do rio Lucala, 1000 m, March 1937, Gossweiler 11818 (COI); Cuanza Sul, Santa Comba-Amboiva, bac du Queve, 1300 m, March 1973, Bamps \& Martins 4296 (BR, MO); Bié, Cuando-Cabango, Menongue, c. 10 km de Cuchi para a Missao, 1430 m, 30 March 1960, Mendes 3357 (BM, BR, P). Kenya: Western Prov., Kipkarren, Brodhurst Hill 565 (K). Rhodesia (Zimbabwe): Mtoko, Makate Ruins, 15 Feb. 1962, Wild 5662 (K, M, MO). Uganda: Maracha, Dec. 1937, Hazel 397 (K).
44. Rotala smithii A. Fernandes \& Diniz, Bol. Soc. Brot. Sér. 2, 31: 154. 1958. - Rotala fontinalis Hiern in Oliver, Fl. Trop. Africa 2: 468. 1871; pro parte, quoad specim. Christen Smith 13, 14 and 16.

Type: Zaire, s. loc., Christen Smith 16 (holotype: BM; paratypes: Christen Smith 13 BM; ibid., 14 BM).

Ic.: Fig. 28I-L; Fernandes \& Diniz, Bol. Soc. Brot. Sér. 2, 31: t. 4. 1959; reprinted in Consp. Fl. Angol. 4: 6. 17. 1970; Boutique, Fl. Cong. Rwand. Bur., Lythraceae: t. 16. 1967.

Amphibious annual or perhaps perennial. Stems erect, occasionally creeping below, simple or irregularly branched, often packed together and denuded of leaves below, up to c. 25 cm long. Leaves decussate, sessile, elliptic to widely ovate, up to 4 mm long but usually less. Bracts leaf-like, ovate to widely ovate, c. 4 mm long; bracteoles 2 , capillary, c. 0.5 mm long, shorter than the calyx tube. Flowers monomorphic, sessile, solitary. Calyx tube cup-shaped, membranous, not accrescent and remaining intact in fruit, c. 1.25 mm long; calyx lobes 4 , deltate, $0.5-0.75 \mathrm{~mm}$ long; calyx appendages and interjected folds absent. Petals $4-0$, variable in size and number between and within individuals, ovate to subulate or rudimentary, up to 0.5 . mm long but usually less. Stamens 4 , inserted half-way up the calyx tube; filaments 1.0 2.5 mm long; anthers exerted beyond the calyx lobes, borne just below or around the stigma. Ovary ellipsoidal; style $1.25-1.5 \mathrm{~mm}$ long, erect at anthesis; stigma capitate borne above or level with the anthers; capsule ellipsoidal, c. 1.5 mm long, when ripe exceeding the calyx, opening by 2 valves; seeds semi-ovoid, c. 0.4 mm long.

## DIAGNOSTIC FEATURES

K4, P4-0, A4, G2; anthers exerted beyond the calyx lobes. Like $R$. lucalensis but anthers exerted; bracts ovate to widely ovate; seeds c. 0.4 mm long, semi-ovoid.

DISTRIBUTION
Eastern Zaire (Map 16).

## SELECTED SPECIMENS

Zaire: s. loc., Chr. Smith 13 (BM); ibid., 14 (BM); ibid., 16 (BM); Malela (Nualela), 31 Dec. 1918, Vermoesen 1246 (BR - I am not sure that the dot on the distribution map is correctly located, there are several Malelas); Katale (Zambi), 28 June 1915, Bequaert 7897 (BR).

## Uncertain species

Rotala cataractae Koehne, Bot. Jahrb. 39: 663 (1907). Type: Rhodesia (Zimbabwe), Victoria Falls, "grasiger Rand des Regenwaldes, bespritzte Felsen", 930 m, 12 and 13 Sept. 1905, Engler 2990 (type material destroyed in B). It is most likely a "pin" race of $R$. myriophylloides and not a near relative of $R$. fontinalis as Koehne suggests.

Rotala stuhlmannii Koehne ex Gilg in Engler, Pflanzenwelt Ost Afrikas, Teil C: 285. 1985. Type: "Pori, Ost-Usindscha, Stuhlmann 3551" (type material destroyed in B ). It is most likely in the $R$. filiformis group and not near $R$. tenella and $R$. rubra ( $R$. alata) as suggested by Gilg.


Map 1. $\quad$. verticillaris.

- $R$. wallichii.
- R. hippuris.


Map 2. - R. myriophylloides.
© R. gerardii.

- R. repens.

Map 3. $\quad$. mexicana.

Map 4. - R. serpyllifolia.





Map 9. - R. ramosior.
R. occultiflora.
R. juniperina.

Map 10. $\quad$. densiflora.


Map 12. - R. cordata.


Map 14. $\quad$ R. india.




## Abstract / Résumé

A formal taxonomic revision of the genus Rotala (Lythraceae) to the level of species with, key, synonymies, descriptions, distributions, notes, illustrations and maps. A total of 44 species are accepted. Two new names are used: Rotala rosea (Poiret) C. D. K. Cook, comb. nova for the species variously known as $R$. pentandra, $R$. leptopetala, $R$. littorea or $R$. densiflora var. formosana. R. malampuzhensis R. V. Nair ex C. D. K. Cook, is validated and typified. The name Rotala decussata DC. is proposed as a nomen rejiciendum.

Révision taxonomique complète du genre Rotala (Lythraceae) au niveau des espèces avec clé, synonymies, descriptions, répartitions, notes critiques, illustrations et cartes. Au total 44 espèces ont été retenues. Une combinaison nouvelle est effectuée: Rotala rosea (Poiret) C. D. K. Cook, comb. nova pour une espèce connue sous des noms divers comme: R. pentandra, R. leptopetala, R. littorea ou $R$. densiflora var. formosana. R. malampuzhensis R. V. Nair ex C. D. K. Cook est validé par la désignation d'un type. Le nom Rotala decussata DC. est proposé comme nomen rejiciendum.

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