

BIOTAXONOMIC NOTES ON THE RUMEX ACETOSELLA COMPLEX IN THE NETHERLANDS

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SUMMARY

Cytological studies of the *Rumex acetosella* complex in the Netherlands have shown that in this country tetraploids and hexaploids occur. Such plants are referred by Löve to *R. tenuifolius* and *R. acetosella*, respectively. Diploid angiocarpous specimens belonging to *R. angiocarpus* have not been encountered, in contradistinction to a report by Löve. However, apart from gymnocarpous hexaploids, also angiocarpous hexaploids have been found to occur in the Netherlands. The range of distribution of these angiocarpous hexaploids corresponds with the distribution indicated by Löve for angiocarpous diploids. The results of our studies render the occurrence of the diploid *R. angiocarpus* in the Netherlands most unlikely. Angiocarpy can not be considered a good diagnostic character to distinguish *R. angiocarpus* and, accordingly, the keys to the species of *Rumex* belonging to the complex and the circumscription of these species by Löve and in several recent floral works are in need of revision.

1. INTRODUCTION

Rumex acetosella L., in the classical sense, is a strongly variable entity in which a great number of infraspecific taxa have been recognised (see, e.g., ASCHERSON & GRAEBNER 1908–1913). LÖVE (1940, 1941a, 1941b, 1944, 1960) has studied this complex taxon cytologically in Europe, and on the basis of his findings he distinguished within the complex the following four species:

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|---|----------------|
| (1) <i>Rumex angiocarpus</i> Murb. | (2n = 14), |
| (2) <i>R. tenuifolius</i> (Wallr.) Löve | (2n = 28), |
| (3) <i>R. acetosella</i> L. s.s. | (2n = 42), and |
| (4) <i>R. graminifolius</i> Lamb. | (2n = 56). |

According to this author these species constitute a polyploid series with the basic number $n = 7$. LÖVE (1941b, 1944) also studied the range of distribution of these four species of *Rumex*. According to the maps of their distributional areas published by Löve, all species, *R. graminifolius* excepted, occur in the Netherlands, with the restriction that the specimens Löve referred to *R. angiocarpus* are, upon the whole, only found south of the line Nijmegen-Dordrecht below the Great Rivers (see map 1). Earlier, JANSEN and WACHTER (1913) and DANSER (1920, 1923) had already made extensive taxonomic studies of *R. acetosella*

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(*s.l.*) in the Netherlands. Danser recognised, within this taxon, a number of varieties on the basis of the width of the leaf blade, the number of lobes of the leaf blade, the sex distribution, fruit characters (*i.e.*, whether the persistent perianth lobes are fused with the pericarp or appear as free "valves"), and the colour of the inflorescence. Taxonomic studies were also carried out by ZWART-RINSEMA (1962) and by VAN DER LEEUW (1969); cytological studies in the Netherlands were carried out by NIENHUIS (1964) and by SIMONS (1964).¹

In the most recent Dutch floras (HEIMANS, HEINSIUS & THYSSE 1965 and HEUKELS-VAN OOSTSTROOM 1962, 1968), Löve's classification is not taken into account, only "*Rumex acetosella* L." (which obviously means the *R. acetosella*-complex) being mentioned. The reason why Löve's proposals were not accepted is presumably that, in the Netherlands, a thorough cytotaxonomic study of that complex had not been made, and this is also the reason why the first of the present authors started such a biotaxonomic investigation in 1962. In many recent European floras Löve's above-mentioned subdivision of the complex is adopted: CLAPHAM *c.s.* (1962); HEGI (1957); LAWALRÉE (1952); LID (1952); ROTHMALER (1963); and TUTIN *c.s.* (1964).

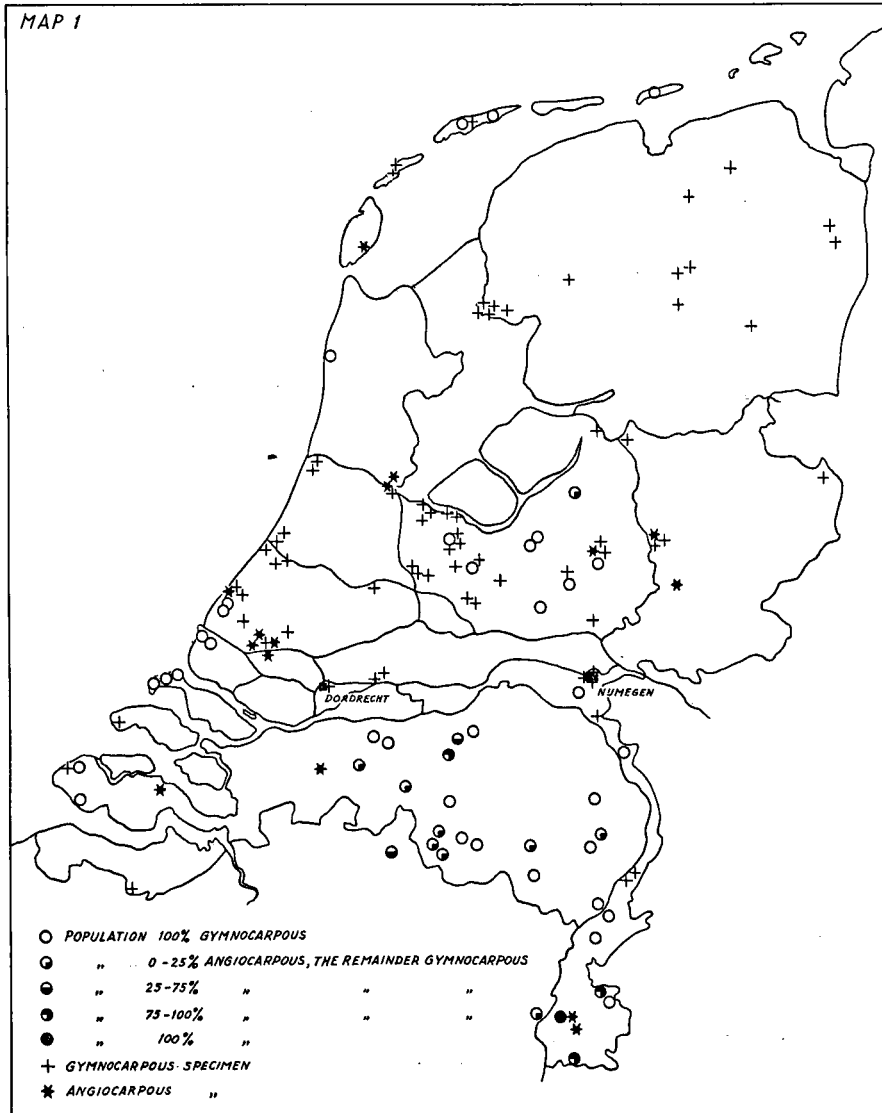
In the present report, two important biotaxonomic aspects of the *R. acetosella* problem will be discussed, *viz.*, the character of angiocarpy *versus* gymnocarpy, and the number of chromosomes.

2. THE CHARACTER OF ANGIOCARPY VERSUS GYMNOCARPY

Angiocarpy in *Rumex* is the conrescence of the three inner perigone lobes and the pericarp; gymnocarpy means that this is not the case. The incidence of angiocarpy can be ascertained by rubbing mature fruits firmly in the palm of one's hand with ones fingers: the perigone lobes stick to the fruit wall, whereas the perigone lobes of gymnocarpous plants easily rub off. When a large number of plant specimens are examined for angio- or gymnocarpy, it appears that certain individual plants can produce both angiocarpous and gymnocarpous fruits, so that the distinction between "angiocarpous plants" and "gymnocarpous plants" is not a very sharp one. This phenomenon was noted as early as 1892 by ČELAKÓVSKY. In the present report all plants producing both angiocarpous and gymnocarpous fruits are referred to the angiocarpous group. Such plants are encountered in several populations, but always occur in low frequencies.

The investigation into the character of angiocarpy versus gymnocarpy was carried out in 50 populations. *R. angiocarpus* being restricted in its occurrence to the area south of the line Nijmegen-Dordrecht according to Löve, the population samples were mainly taken from the regions lying north and south of the border line of the range of *Rumex angiocarpus*. Per population, in most cases, from 30 to 50 fruit-bearing plants were examined. The data relating to populations from the coastal areas of the south-western part of the Netherlands are borrowed from ZWART-RINSEMA (1962). Owing to the lack of adequate popula-

¹ The results of these studies were partly used for the preparation of the present paper.



Map 1. Map of the Netherlands showing the localities of the various populations and herbarium specimens of the *Rumex acetosella* complex studied.

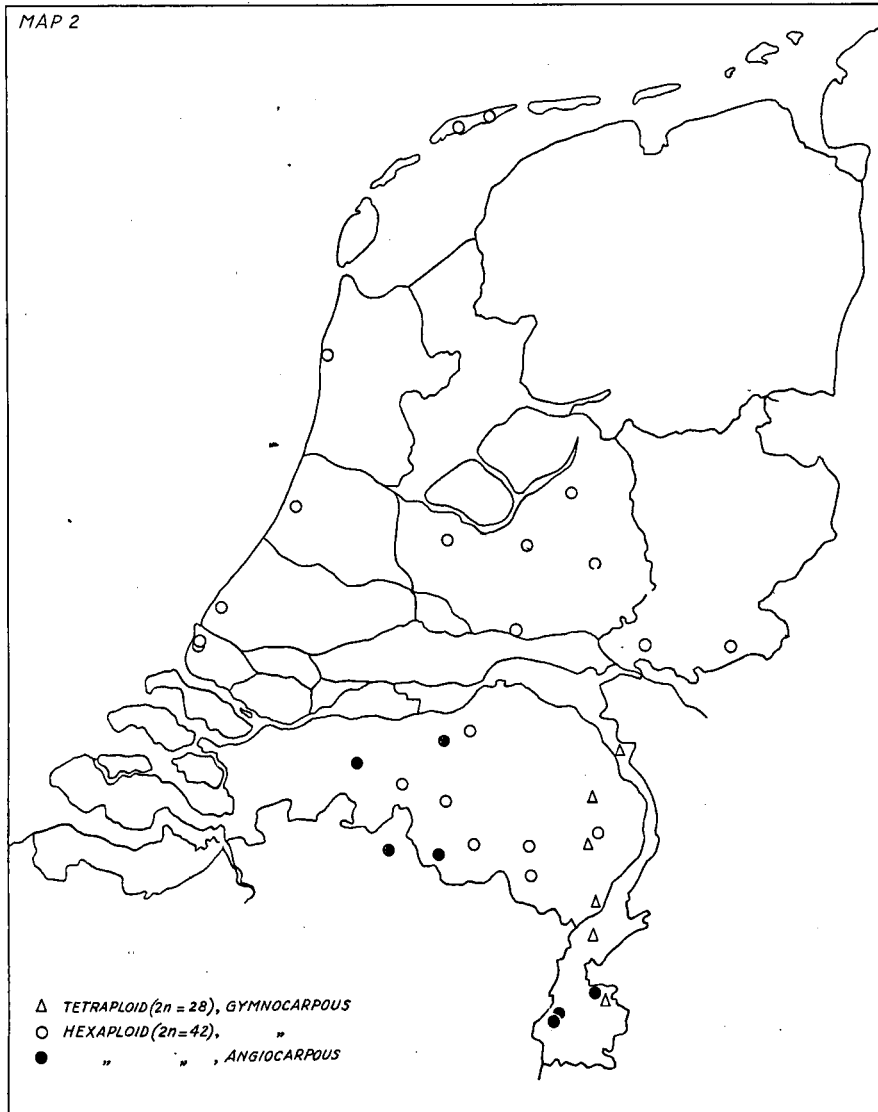
tion samples from the eastern and north-eastern parts of this country, individual specimens from these areas were studied in the herbaria of Groningen and Utrecht and in several herbaria preserved in the Rijksherbarium, Leiden,¹ in addition to the material in the herbarium of the University of Amsterdam. The herbarium specimens studied were mostly collected before 1940. The results of

¹ The authors are much indebted to the curators of these herbaria, especially to Dr. S. J. van Ooststroom (Leiden).

the investigation are shown in *map 1*. It appears that angiocarpous plants are of common occurrence in the S.- and S.E. Netherlands: in 14 of the 28 populations sampled angiocarpous individuals were recorded. Angiocarpy was not found in the populations in the south-western coastal areas. In the remaining part of the country angiocarpy is of rare occurrence: only in one out of 22 populations sampled a single angiocarpous plant was recorded. It is noteworthy that the relatively highest number of populations containing angiocarpous specimens is found in the most southernly part of the country (Zuid-Limburg), where the percentage of angiocarpous plants is also the highest. In a northward direction the percentage of angiocarpous plants, a few cases excepted, rapidly decreases to become almost non-existent to the north of the Great Rivers. The examination of the herbarium sheets has, likewise, shown that to the north of the Great Rivers angiocarpous specimens are relatively rare: only 12 out of 87 specimens were found to be angiocarpous. According to DANSER (1923), the angiocarpous plants from this area which were recorded from Rotterdam, Vlaardingén, Apeldoorn, Deventer, Amsterdam and The Hague (accounting for 9 of the 12 angiocarpous plants) are adventitious and introduced from elsewhere; he drew this conclusion because the plants in question were collected near sea ports, in marshalling yards, etc. According to Danser, angiocarpous plants are only indigenous in the southernmost part of the Netherlands (Zuid-Limburg), but the present investigation has proved this conclusion to be partly incorrect. Both the samples of populations and the herbarium studies, barring a few incidental occurrences to the north of the line Dordrecht-Nijmegen, confirm Löve's conclusion concerning the distribution of angiocarpous specimens in this country.

3. THE NUMBER OF CHROMOSOMES

The number of chromosomes was counted in a single specimen or in a few plants of 34 cultivated population samples. To this end, root tips were fixed in Navashin's fluid, bulk-stained with Gention Violet and microtome-sectioned (the sections made were 10 μ thick), or the root tips of germinated seeds, pre-treated with para-dichlorobenzene and fixed in Carnoy's mixture, were squashed and stained with orcein. The results of these determinations of chromosome numbers and the range of distribution of the numbers are shown in *map 2*. It appears that in the Netherlands tetraploid and hexaploid plants of the *R. acetosella* complex occur. From the fact that tetraploids were recorded in only 6 out of 34 populations it may be inferred that tetraploids are of less common occurrence than the hexaploids. It is striking that in the populations of the coastal dunes, the specimens of which possess the habit and the leaf-shape of the tetraploid *R. tenuifolius* (*sensu* Löve), hexaploid individuals were found. This is a direct indication of a phenotypical convergence of habit form and leaf shape of hexaploids towards those of the tetraploid plants in certain environments. It is also worthy of note that tetraploids are exclusively found in the south-east of the Netherlands, but the relatively few number of records do not warrant the drawing of more than preliminary conclusions. Near Someren (Noord-Brabant)



Map 2. Localities of the tetraploid gymnocarpous, the hexaploid gymnocarpous and the hexaploid angiocarpous plants.

both hexaploid gymnocarpous and tetraploid gymnocarpous individuals were encountered in a single population. Both chromosomal races may apparently occur synoecially.

According to LÖVE (1944), tetraploids and hexaploids may hybridise and yield a sterile pentaploid progeny. Additional relevant investigations will be carried out.

A very important conclusion to be drawn from the present studies, hitherto not mentioned in the literature pertaining to the subject, is that apart from hexaploid gymnocarpous specimens previously reported by Löve, hexaploid angiocarpous plants occur. According to LÖVE (1941b, 1944), angiocarpy occurs exclusively in the diploid segregate taxon *R. angiocarpus*. By means of this character of angiocarpy, erroneously supposed to be linked with diploidy, LÖVE (1941b) attempted to establish the range of distribution from herbarium specimens and from literature studies and thus arrived at the conclusion that the diploid *R. angiocarpus* is also found in the Netherlands. Angiocarpy manifestly not being restricted to diploids but also occurring in hexaploids, Löve's maps of the ranges of distribution of the diploid *R. angiocarpus* and the hexaploid *R. acetosella* s.s. are not correct. That Dutch angiocarpous plants not cytologically examined are not diploids either is rendered highly probable by the study of the range of variation of the fruit size: the angiocarpous fruits are not smaller than the gymnocarpous ones, which would have been the case if the angiocarpous plants were all diploids and the gymnocarpous plants all hexaploids (LÖVE 1944).

If one relates these data with the population studies shown in *map 1*, it can be concluded that of the hexaploid race in the Netherlands both angiocarpous and gymnocarpous populations occur, in addition to the populations containing angiocarpous as well as gymnocarpous individuals. An investigation carried out in the experimental garden indicates that the character of angiocarpy or gymnocarpy is genetically determined in the *R. acetosella* complex. From the distributional records and from ecological studies (not to be discussed in the present paper) it is quite obvious that the ecological tolerance and *milieu* preferences of the angiocarpous and the gymnocarpous hexaploid forms, although overlapping to a large extent, do not coincide altogether.

4. DISCUSSION

The present study clearly shows that angiocarpy is not an exclusive character of the diploid *R. angiocarpus*. A combination of cytological and morphological characters renders it highly probable that the true (diploid) *R. angiocarpus* does not occur in the Netherlands, but more extensive studies are intended by the first of the present authors. The situation within the *R. acetosella* complex turns out to be even more complicated by the fact that, apart from tetraploid gymnocarpous plants, also tetraploid angiocarpous ones are found. Hylander was the first to point this out (LÖVE 1960). Tetraploid angiocarpous plants have not (yet?) been recorded from the Netherlands, but they have been encountered among plants reared in our experimental garden in Amsterdam from seeds received from other countries. A relevant publication is in course of preparation.

The question arises whether *R. angiocarpus* ($2n = 14$), *R. tenuifolius* ($2n = 28$), and *R. acetosella* s.s. ($2n = 42$) can be regarded as "good" taxonomic species. Taking the results of studies made by LÖVE (1944) into consideration,

we must assume that the diploid, tetraploid, and hexaploid population complexes are separated by reproductive barriers, but the question remains whether there are indeed reliable morphological "markers" for such population complexes, which enable an unequivocal distinction of taxonomic species within the *R. acetosella* complex. These morphological diagnostic characters must be reliable in the sense that all individuals of all three taxa must be absolutely identifiable by means of these markers. The morphological differences to segregate the three taxa mentioned by LÖVE (1944) include the absence or the presence of angiocarpy, the relative size of cell nuclei, of the cells, and of the stomata, and also the diameter of the pollen grains and the relative sizes of flowers and fruits. The ranges of variation indicated by him show an appreciable overlap, which means that the differences are quantitative and can only be demonstrated statistically. They may serve to characterise populations, but are not adequate to characterise every individual specimen.

Investigations into the possible morphological discontinuity of the three euploid population complexes is one of the aspects of biotaxonomic studies that are, among other things, of great practical significance in ecological studies. Our results make it quite clear that the incidence of angiocarpy is not a satisfactory diagnostic feature of *R. angiocarpus*. This means that in the publications of Löve and in a number of recently published regional floras (CLAPHAM *c.s.* 1962, HEGI 1957; LAWALRÉE 1952; ROTHMALER 1963; TUTIN *c.s.* 1964) the keys to identify the species of *Rumex* and the circumscriptions of the species have to be revised at least as far as this point is concerned. Lawalrée states that *R. angiocarpus* is of quite common occurrence in Belgium. We suspect that this remark actually relates to the angiocarpous *hexaploid* form, for which we have a direct indication in the form of a record of this hexaploid type from a locality near Turnhout in Belgium (see *map 1*). From 1968 onward, the *R. acetosella* complex in Belgium and Luxemburg has been included in our studies.

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