CHROMOSOME STUDIES ON EUROPEAN SPECIES OF THE GENERA ANEURA AND RICCARDIA (HEPATICAE)

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1. INTRODUCTION

Until recently relatively little attention has been paid to the study of chromosomes in liverworts. The first substantial contributions were made by HEITZ (1927, 1928) and LORBEER (1934). In the second half of this century chromosome studies on liverworts were mainly carried out in Europe (e.g. FRITSCH 1972; NEWTON 1977, 1979) and Japan (e.g. TATUNO 1959; SEGAWA 1965a, b, c; INOUE 1968). Inoue (in KOPONEN 1979) reports that until now 28% of all bryophyte species in Japan have been investigated as to their chromosome complement. A comprehensive, but rather outdated, survey of chromosome numbers in Hepaticae and Anthocerotae was given by BERRIE (1960). Work on a new, updated survey is now underway (FRITSCH, in prep.).

In the present article results are presented of a cytotaxonomic investigation of European species of the genera *Aneura* and *Riccardia* (Aneuraceae). Most specimens were gathered in the Netherlands, but some chromosome counts based on French and German plants are also included.

2. MATERIALS AND METHODS

The liverworts were collected in the field in the period of march-august 1980, and subsequently cultivated during several months in growth chambers at 14 °C and illuminated 12 hours a day. Specimens were grown in transparent, closed plastic boxes on a substrate consisting of garden mould and sand (1:1), and were watered every two days.

Plant material was gathered in the following localities:

The Netherlands

1. Staverden (Prov. of Gelderland)
2. Utrecht (Prov. of Utrecht)
3. Wassenaar (Prov. of Zuid-Holland)
4. Kortenhoef (Prov. of Utrecht)
5. Dronten (Oostelijk Flevoland)

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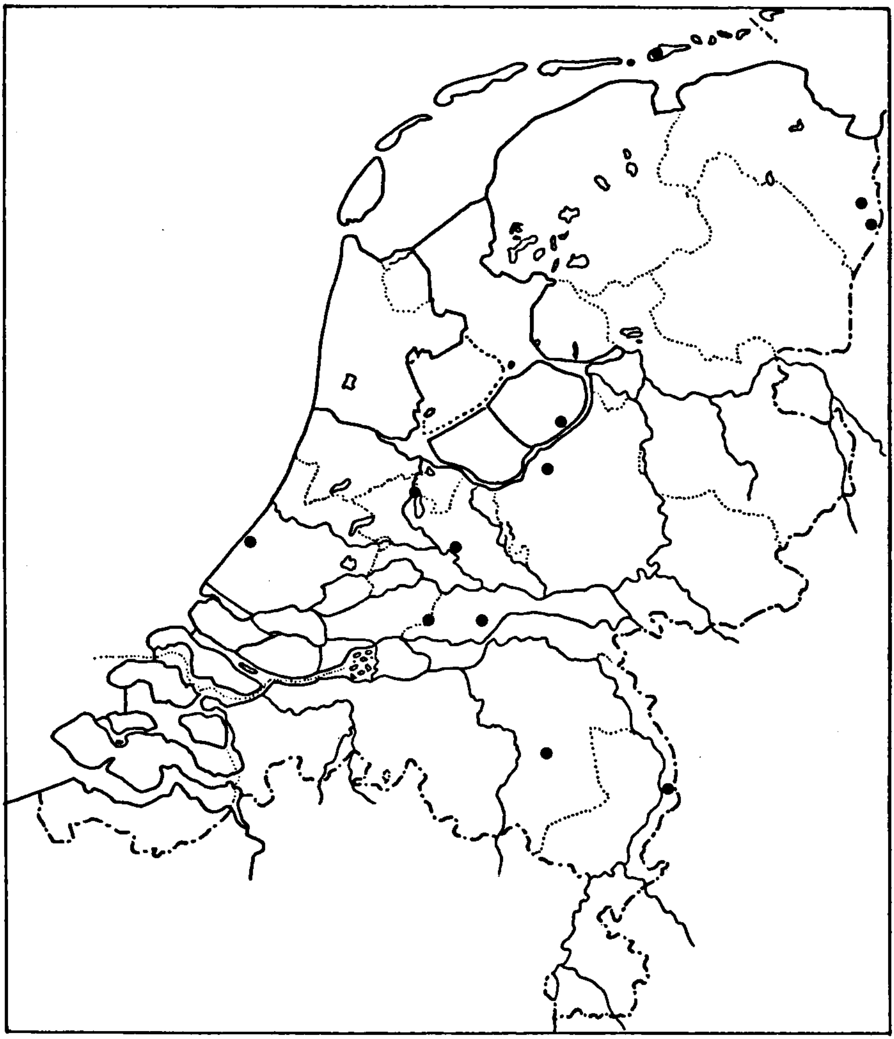

Fig. 1. Map, showing the distribution of the Netherlands populations investigated.

6. Venlo (Prov. of Limburg)
7. Buren (Prov. of Gelderland)
8. Asperen (Prov. of Zuid-Holland)
9. Oosterburen (Isle of Schiermonnikoog)
10. Bourtange (Prov. of Groningen)
11. Onstwedde (Prov. of Groningen)
12. Eindhoven (Prov. of Noord-Brabant)

France

13a, b, c. Nant (Dept. Aveyron), 3 different populations

West Germany
14. Herrenstrunden (Nordrhein-Westfalen)

Voucher specimens have been deposited in the herbarium of the State University of Utrecht (U) in the Netherlands. Thallus apices of growing gametophytes were fixed in Karpechenko's fixative, embedded in paraffin-wax and sectioned at 12 μm on a microtome. The chromosomes were stained according to Heidenhain's haematoxylin method.

3. RESULTS

Four species of the Aneuraceae were investigated:
Riccardia chamedrifolia, *R. multifida*, *R. incurvata* and *Aneura pinguis*. The results are given below, including the localities of the specimens concerned. Examples of karyograms determined are given in *fig. 2*.

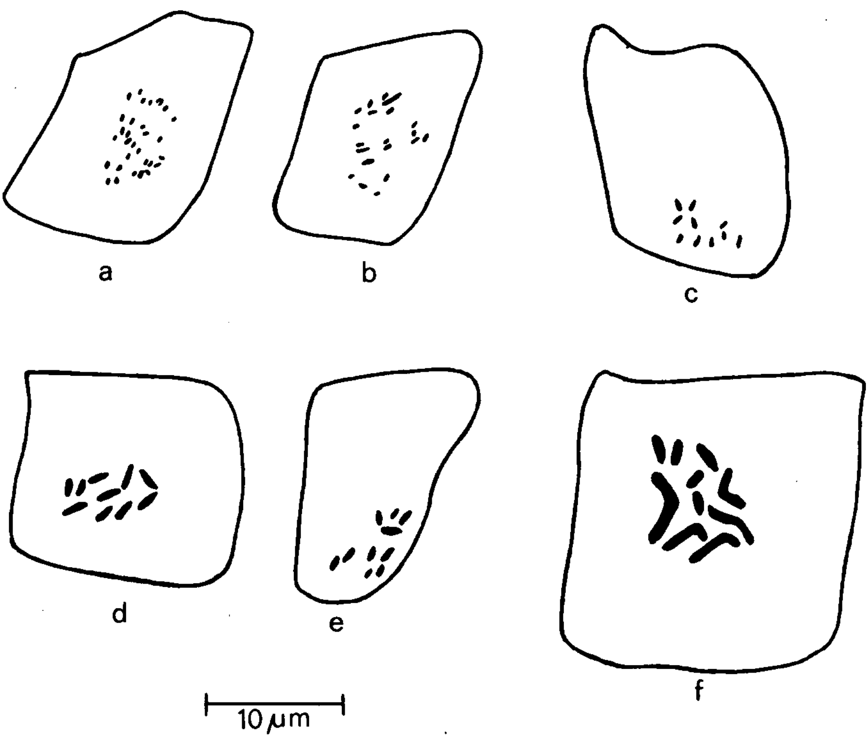

Fig. 2. Karyograms of the investigated species (schematic). a. *Riccardia chamedrifolia* (Kortenhoef); b. *R. multifida* (Kortenhoef); c. *R. incurvata* (Staverden); d. *R. incurvata* (Venlo); e. *R. incurvata* (Schiermonnikoog); f. *Aneura pinguis* (Wassenaar).

Riccardia chamedrifolia (With.) Grolle
Localities: 1, 4, 5, 6, 7, 8, 10, 11, 12, 13a, 13b, and 13c.
In the 12 populations investigated the chromosome number n = 30 was found. This is in agreement with an earlier count by LORBEER (1934). NEWTON (1971) reports n = 20 for British material, a number also indicated by the results of HEITZ (1928).

Riccardia multifida (L.) Gray
Locality: 4.
The chromosome number observed in the single population investigated was n = 20. The same number was found in plants of Central Europe by HEITZ (1928) and LORBEER (1934), while NEWTON (1971) refers a number of n = c. 19 for an Irish specimen.

Riccardia incurvata Lindb.
Localities: 1, 6 and 9.
In this species a chromosome number of n = 10 was observed. The difference in size between the chromosomes of the populations investigated is striking (cf. *fig. 2c, 2d* and *2e*). This chromosomal difference could, however, not be correlated with morphological features. Chromosome counts of n = 10 for *R. incurvata* are also reported for Central Europe (LORBEER 1934) and Great-Britain (NEWTON 1975).

Aneura pinguis (L.) Dum.
Localities: 1, 2, 3, 4, 5, 6, 7, 8, 9, 13a, 13b, 13c and 14.
The haploid complement consists of 5 V- and 5 J-shaped chromosomes (*fig. 2f*), which are nearly always larger (3–8 μm) than the chromosomes of the investigated *Riccardia* species (1–3 μm). The chromosome number n = 10 in *A. pinguis* is known from North-America (SHOWALTER 1923), Central Europa (HEITZ 1927; LORBEER 1934), Japan (TATUNO 1941; INOUE 1977), Great-Britain (NEWTON 1971) and Colombia (Meenks, unpubl.). In a chromosome study on arctic liverworts INOUE (1976) reports for *A. pinguis* n = 10 and also a polyploid race of n = 20.

4. DISCUSSION

While the chromosome numbers in Hepaticae in general seem to be very constant, nevertheless many polyploids are known in the *Aneuraceae* (BERRIE 1966). In the genus *Aneura* the chromosome numbers n = 10 and n = 20 are known, as well as n = 8 in the Australian *A. alterniloba* (BERRIE 1962; HEWSON 1970a). The latter number might either be a dysploid of n = 10 or the result of doubling a complement of 4 chromosomes. In the latter case n = 10 could be the polyploid of n = 4 + 1. Among the European species of the genus *Riccardia* the chromosome numbers n = 10, n = 20 and n = 30 are found. Furthermore BERRIE (1966) indicates n = 40 for West African specimens of *R. stephanii*. In her study on

Australian *Riccardia*'s HEWSON (1970b) reports for both *R. babindae* and *R. cochleata* n = 10 and n = 20.

Polyploidy often results from the fact that a gametophyte contains a separate male and female genome (LEWIS 1961). Possibly this might refer to the monoecious species *Riccardia chamedrifolia* (n = 30) and *R. multifida* (n = 20), the dioecious species *R. incurvata* and *Aneura pinguis* having n = 10. Polyploidy might, however, also result from speciation in response to environmental extremes (LEWIS 1966). This could be an explanation for the origin of the polyploid arctic *Aneura pinguis* discovered by INOUE (1976). It is also important to note that many Aneuraceae species are growing in pioneer vegetations, where speciation coupled with polyploidy is relatively common (STEBBINS 1966). The rather common occurrence of polyploids in Aneuraceae may thus be explained.

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