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## 1. Introduction

*Antennaria* Gaertn. is an interesting but difficult and controversial group. About 200 taxa were described hitherto, mostly from North America. Numerous species are recorded exclusively from their type localities; however, not only endemism but also remarkably disjunctive ranges are known within the genus.

A high degree of karyological differentiation occurs in *Antennaria*. Besides the tetraploid species ( $2n=28$ ), also various higher polyploids have been found. Their chromosome numbers are:  $2n=40-42$ , c. 52, 56, 63, 70, 75-80, 84. It is interesting to note that the tetraploid species of *Antennaria* are sexual whereas higher polyploids show as a rule an apomictic mode of reproduction (JUEL 1900, STEBBINS 1932, BERGMAN 1935, NYGREN 1950, URBAŃSKA-WORYTKIEWICZ unpubl.). The only known exception is the *Antennaria carpatica* complex where not only tetraploids but also hexa- and octoploids show no tendency to a parthenogenetic seed development (URBAŃSKA-WORYTKIEWICZ 1961, 1962, 1962a, 1967, 1967a, 1967b, 1969, unpubl.).

In view of the apomixis frequently occurring within the genus *Antennaria*, its taxonomy varies greatly according to the divergent opinions concerning the taxonomical status of the apomicts. On the whole, the following sections were distinguished: *Carpaticae*, *Plantaginifoliae*, *Alpinae*, *Dioicae*, *Dimorphae* and *Racemosae* (FERNALD 1924, RYDBERG 1932, PORSILD 1950, 1965). European species of *Antennaria* were usually referred to the *Carpaticae*, *Alpinae* and *Dioicae*, respectively. Chromosome numbers and mode of reproduction occurring within these three sections are given in Table 1.

The section *Carpaticae* comprises a non-stoloniferous group of species with erect and elongate basal leaves which are oblanceolate or lanceolate. The *Antennaria carpatica* complex, which seems to be the only representative of the section, consists of the following species: *A. carpatica* (Wahlb.) Bluff et Fingerh. s.str., *A. villifera* Boriss., *A. lanata* (Hook.) Greene and *A. pulcherrima* (Hook.) Greene. This nomenclature, accepted by the present author for the species belonging to the *Antennaria carpatica* complex, is used in our whole work; the nomenclature problems are discussed in p. 152-153. *Antennaria lanata* and *A. pulcherrima* were reported exclusively from North America; *A. villifera* is an Eurasian species, whereas the range of *A. carpatica* s.str. is confined to Europe (Fig. 1).

The *Antennaria carpatica* complex represents in European flora an arctic-alpine element with a disjunctive area of distribution; its one centre is in North Fennoscandia and Russia (*A. villifera*) whereas the other corresponds to the mountains of Central and Western Europe (*A. carpatica* s.str.).



Fig. 1. Distribution of the *Antennaria carpatica* (Wahlenb.) Bluff et Fingerh. complex in Europe. Russian stations of *A. villifera* are not marked here.

A monographic investigation in *A. carpatica* has not been carried out hitherto. The data concerning its taxonomical status are rather incomplete and confused. The original concept of WAHLENBERG (1814, 1826) has been gradually extended to the whole area of distribution of the complex and subsequently decreased to some its regions. In addition, several authors have described a number of new taxa giving them various ranks. In view of this, it seemed advisable to revise the nomenclature, taxonomy as well as the geographical distribution and ecology of the complex.

*Antennaria carpatica* presents an interesting object for a biosystematic study. Karyological differentiation occurring within this group points to the fact that the polyploidization has played an important part in the evolution of the complex. The analysis of karyotype has not been performed hitherto in the genus. *A. carpatica* representatives proved to be very convenient for these studies in spite of their high chromosome numbers. Preliminary observations have already revealed differences occurring between the resp. cytotypes; therefore, it seemed interesting to carry out a more detailed investigation on material from various parts of the range.

The present work, dealing with the European representatives of the *A. carpatica* complex, is based on the studies carried out during twelve years

Table 1

The chromosome numbers and mode of reproduction within the sections Carpaticae, Alpinae and Dioicae of *Antennaria* Gaertn.

Species	2n	Ploidy	Reproduction
Carpaticae:			
<i>A. villifera</i> Boriss.	28	4x	sex
	28	4x	?
	42	6x	sex
<i>A. carpatica</i> (Wahlenb.)Bluff et Fingerh. s. str.	42	6x	?
	56	8x	sex
<i>A. pulcherrima</i> (Hook.)Greene	63	9x	?
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Alpinae:			
<i>A. alpina</i> (L.)Gaertn.	70	10x	apo
	84	12x	apo
<i>A. canescens</i> (Lge)Malte	45-56	?	apo
	56	8x	?
<i>A. Ekmaniana</i> A. E. Porsild	84	12x	?
<i>A. Porsildii</i> Ekm.	63	9x	apo
	63	9x	apo
	70	10x	apo
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Dioicae:			
<i>A. dioica</i> (L.)Gaertn.	28	4x	sex
	28	4x	sex
	28	4x	sex
	28	4x	?
	28	4x	sex
	28	4x	?
	28	4x	?
<i>A. Nordhagiana</i> Rune et Rønning	28	4x	?
<i>A. Hansii</i> Kerner( <i>A. groenlandica</i> Porsild)	56	8x	apo
<i>A. affinis</i> Fern.	56	8x	apo
<i>A. intermedia</i> ( <i>A. alpina</i> var. <i>intermedia</i> Rosenv.)	84	12x	apo

Origin of material	Authors
Scandinavia	Urbańska-Worytkiewicz 1967, 1967a,b
Tschukotchka Peninsula	Zhukova 1968
Scandinavia	Bergman 1935, 1951, Urbańska-Worytkiewicz 1967, 1967a, b
Tschukotchka Peninsula	Zhukova 1968
Tatra Mts, Alps, Pyrenees	Urbańska 1959, Urbańska-Worytkiewicz 1961, 1962, 1962a, 1965, 1967, 1968, 1968a
Canada	Löve and Solbrig 1964
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Scandinavia	Urbańska-Worytkiewicz 1967, Urbańska-Worytkiewicz unpubl.
Scandinavia	Bergman 1935, Nygren 1950, Löve a. Löve 1956, Urbańska-Worytkiewicz 1967, Urbańska-Worytkiewicz unpubl.
Scandinavia	Juel 1900
Greenland	Jørgensen, Sørensen and Westergaard 1958
Greenland	Jørgensen, Sørensen and Westergaard 1958
Greenland	Bøcher and Larsen 1950
Scandinavia	Nygren 1950
Scandinavia	Urbańska-Worytkiewicz 1967, Urbańska-Worytkiewicz unpubl.
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Scandinavia	Juel 1900, Bergman 1935, Urbańska-Worytkiewicz 1967, Urbańska-Worytkiewicz unpubl.
?	Sokolovskaja and Strelkova 1948
S. Poland incl. Tatra Mts	Urbańska 1959, Urbańska-Worytkiewicz unpubl.
Bulgaria: Rila Mt.	Kozuharov a. Kuzmonov 1970
Alps	Urbańska-Worytkiewicz 1968, Urbańska-Worytkiewicz unpubl.
Sierra Nevada	Küpfer 1968
Scandinavia	Nygren (from Rune and Rønning 1956)
Greenland	Jørgensen, Sørensen and Westergaard 1958
Greenland	Jørgensen, Sørensen and Westergaard 1958
Greenland	Bergman 1935

(1958–1970). It comprises investigations on the karyology, morphology, geographical distribution and ecology of *Antennaria carpatica* s.str., *A. villifera* and, partially, *A. lanata*. The results of our cyto-embryological studies were previously published (URBAŃSKA 1959, URBAŃSKA-WORYTKIEWICZ 1961, 1962, 1962a, 1965, 1967, 1967a, 1967b, 1968, 1969); observations on the embryology of *Antennaria carpatica* s.str. from the Alps and the Pyrenees remained unpublished.

## 2. Cytology

### 2.1 Material and methods

Material for the present study consisted of plants collected in North Scandinavia, the Tatra Mountains, the Alps and the Pyrenees. The voucher specimens were deposited at the Institute of Special Botany, Swiss Federal Institute of Technology, Zurich; some of them were also forwarded to the Botanical Department of the Tromsø Museum, Tromsø, Norway.

Scandinavian plants and the material from the Tatra Mountains were fixed in their natural habitats. Fixation of the material from the Alps and the Pyrenees was mostly performed in the experimental garden of the Botanical Institute, University of Neuchâtel, where the plants were transferred from their alpine localities. The root tips were left for 3–4 hours in a 0.05% aqueous solution of colchicine. Subsequently, they were fixed in acetic alcohol (1 : 3) with a small addition of ferric acetate and acetocarmine. The squashes were stained with lacto-propionic orcein.

For the analysis of karyotype, *Antennaria carpatica* s.str. from 6 localities in the Tatra Mountains, 10 localities in the Alps and a single locality in the Pyrenees was selected (Table 3). It should be noted that plants with tomentose and non-tomentose upper surface of the rosette leaves were studied separately; however, no evident differences in the chromosome morphology were found. Likewise no differences of karyotype occurred between staminate and pistillate plants.

As far as *Antennaria villifera* is concerned, 15 clones were studied; 6 of them represented the tetraploid cytotype whereas 9 were hexaploid (Table 2).

For the studies on the chromosome morphology, 8–12 well-spaced metaphase plates of each plant were observed. In addition, we have measured chromosomes in incomplete plates; however, the results are not included into the material presented in the resp. tables. As a criterion for the same degree of contraction of the chromosomes the length of the SAT-chromosomes