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Antennaria carpatica (Wahlb.) Bl. et Fing. s.l. in North America. I. Chromosome numbers, geographical distribution and ecology

Antennaria carpatica (Wahlb.) Bl. et Fing. s.l. in Nordamerika. I. Chromosomenzahlen, geographische Verbreitung und Oekologie

by

Krystyna M. URBANSKA

Contents

1. Introduction

The present paper is the first of a series dealing with the *Antennaria carpatica* group from North America. The studies form part of a long-term research carried out by the author. Aspects of variation and evolution in the European *Carpaticae* were mostly dealt with in the author's previous publications (e.g. URBANSKA 1959, 1961, 1962 a,b, 1967a,b, 1968 a,b) and subsequently summed up in a more comprehensive paper (URBANSKA 1970). The genus *Antennaria* Gaertn. being of North American origin, it was obvious that important clues to the evolution of the whole sect. *Carpaticae* were to be looked for in the American continent; however, data from this region were very fragmentary and it was imperative to get more information. To set a basis for further discussions on evolutionary trends within the group, chromosome numbers of the *Carpaticae* from North America were examined first; to the best of the author's knowledge, they were practically unknown to date. Our results are reported in the present paper together with some data on geographical distribution and ecology of the particular taxa. We should like to emphasize that the latter evaluations are yet incomplete and have to be considered as preliminary.

The taxonomy of the sect. *Carpaticae* is rather complex. As far as North America is concerned, four taxa viz. *Antennaria pulcherrima* (Hook.) Greene, *Antennaria anaphaloides* Rydb., *Antennaria lanata* (Hook.) Greene and *Antennaria eucosma* Fern. et Wieg. were originally recognized. Before a satisfactory taxonomical treatment of the whole group is devised, we propose to retain this nomenclature; it should be kept in mind, however, that a precise rank of particular taxa as well as the validity of some names are open to verification.

Acknowledgements

The present paper, largely based on numerous field trips, was carried out at the Geobotanical Institute SFIT Zürich. The author collectively acknowledges loan of herbarium specimens from various institutions and thanks persons who helped sending live material and/or field information from

North America; they shall be separately addressed to in further publications. In the present paper, we should like to express very special thanks to Klaus and Gertrud Lackschevitz, University of Montana, Missoula, Joy D. Mastrogiuseppe, University of Washington, Pullman, as well as Lucy and Mark Uhlig, Seattle, who offered us the hospitality of their homes and helped in many other ways. Excellent field assistance of Dr. Regula Dickenmann and Dr. A. Fossati (Geobotanical Institute) was greatly appreciated. Prof. Dr. E. Landolt (Geobotanical Institute) helped with some field work in Colorado; his solitary one-day walk across the Dinosaur National Monument with the sole purpose of sampling for us a population of *Antennaria anaphaloides* shall be gratefully remembered. He also critically read our manuscript and translated the summary into German. We also thank Ms. A. Hegi who carefully prepared materials for our field trips and helped with some laboratory tests.

The study could not have been carried out without the generous travelling grant obtained in 1978 from Swiss Society of Natural Sciences as well as the financial support from Swiss Federal Institute of Technology, Zürich (in particular, grants 1973, 1980). Sincere thanks of the author are addressed to both these institutions.

2. Material and methods

Material for the present study was gathered during ten years (1973-1982). Prior to the field work, information on a general distribution and some ecological features of the *Antennaria carpatica* group in North America was compiled from various regional floras as well as herbarium specimen labels. Site conditions and population structure were studied in the wild. Materials for cytological investigations were taken in the field save for few live samples sent to the author from North America. Voucher specimens are at the time being kept in the author's personal herbarium and shall be transferred later to the Herbarium of SFIT Zürich (ZT).

On the whole, 869 individuals corresponding to 112 population samples were studied cytologically (Tables 1-5). Meristems were pretreated with 0.05% aqueous solution of colchicine for about 3 h. and subsequently fixed in acetic alcohol (1:3) with a small addition of ferric acetate and acetocarmine. For staining of preparations, lacto-propionic orcein was used with very satisfactory results.

3. Results

3.1. *Chromosome numbers*

3.1.1. *Antennaria pulcherrima* 2n=28 (Figs 1-2)

A. pulcherrima studied in the course of the present investigations, originated mostly from Alaska, Yukon Territory, British Columbia and Alberta, only two populations being found much farther south i.e. in Wyoming and S Colorado, respectively (Fig. 3, Tables 1, 2). Altogether 317 individuals corresponding to 34 population samples were studied.

All the 288 plants examined from the northern part of the range of *A. pulcherrima* proved to be octoploid with the somatic chromosome number 2n=8x=56 (Figs 2, 3, 10, Table 1). On the other hand, 14 individuals from Wyoming and 5 plants from S Colorado were invariably tetraploid (2n=4x=28, Figs 1, 3, 10, Tables 1, 2).

Figs 1-2. *Antennaria pulcherrima*: somatic metaphases. Sample code is given in parentheses. 1. Wyoming (RM 13): 2n=28. 2. Alaska (AL 4): 2n=56. c. 1500x.

A. pulcherrima: Somatische Metaphasen. (In Klammern steht die Abkürzung für die Fundorte). 1. Wyoming (RM 13): 2n=28. 2. Alaska (AL 4): 2n=56. ca. 1500x.

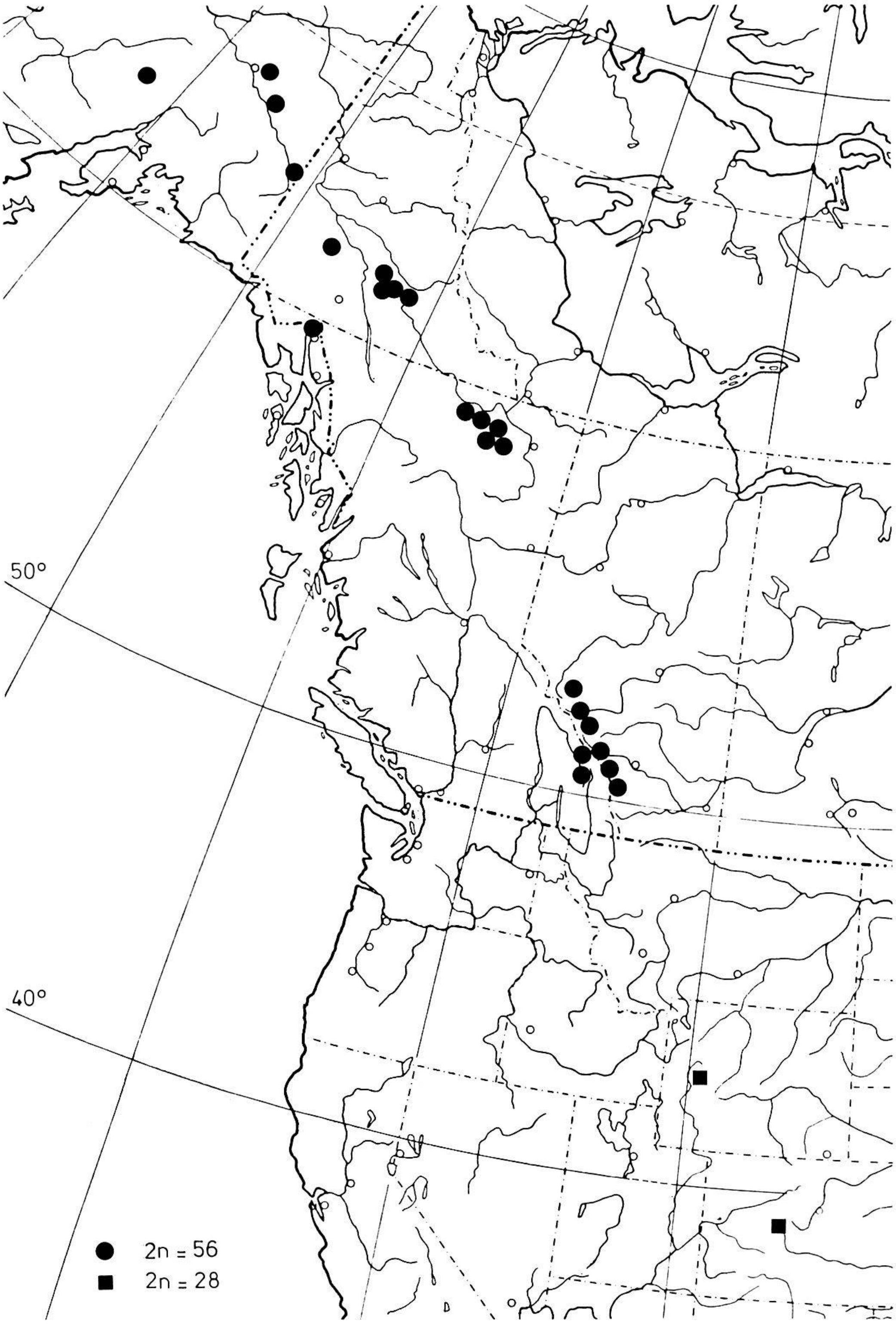


Fig. 3. *Antennaria pulcherrima*: geographical distribution of the studied material. Each dot may represent several sites.

A. pulcherrima: Herkunft des Untersuchungsmaterials (Jeder Punkt kann mehrere Fundorte umfassen).

Chromosome numbers in *Antennaria pulcherrima* from Central and Northwest Pacific Range have not been studied hitherto. A previous report by LÖVE and LÖVE (in LÖVE and SOLBRIG 1964) presenting a hexaploid chromosome number 2n=63 in *A. pulcherrima* from Yoho Valley, British Columbia, was based on an erroneous determination of the material (Dr. A. LÖVE, personal communication). Another report by LÖVE and LÖVE (in LÖVE 1982) dealing with a single dodecaploid (2n=84) individual of *A. pulcherrima* from Manitoba remains to be verified.

3.1.2. *Antennaria anaphaloides* 2n=28 (Fig. 4)

Chromosome number of *A. anaphaloides* was studied in 19 samples from British Columbia, Idaho, Montana (the type locality), Wyoming and Colorado (Fig. 5, Tables 1, 3). The 126 examined plants were invariably tetraploid (2n=4x=28, Fig. 4). The present results confirm a previous report by the author based on materials from three sites in Colorado (URBANSKA 1974). No other data on chromosome number in *A. anaphaloides* were published to date.

Fig. 4. *Antennaria anaphaloides*: somatic metaphase. Sample code is given in parentheses. Wyoming (RM 29): 2n=28. c. 1500x.

A. anaphaloides: somatische Metaphase. (In Klammern steht die Abkürzung für den Fundort). Wyoming (RM 29): 2n=28. ca. 1500x.

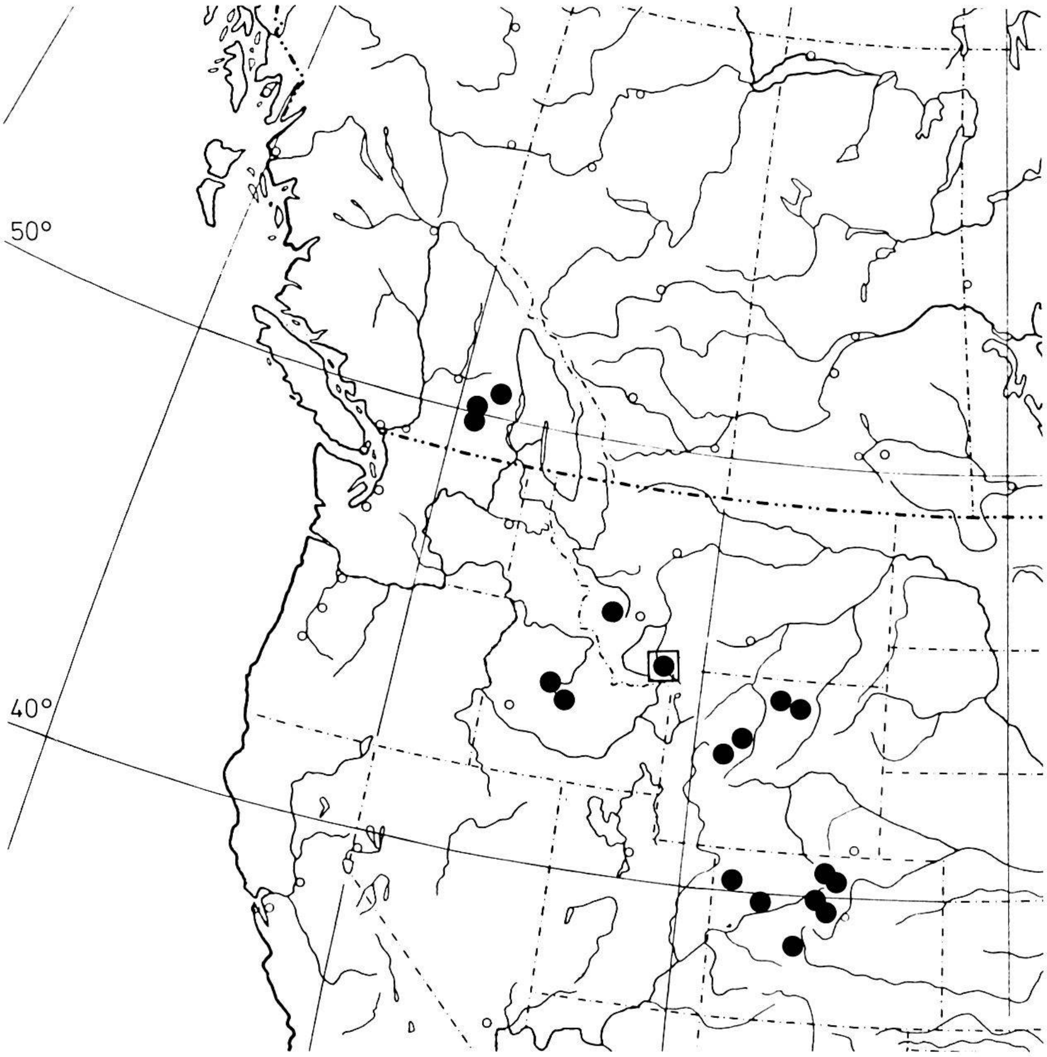


Fig. 5. *A. anaphaloides*: distribution of the studied material. Framed dot refers to the type locality. Each dot may represent several sites.

A. anaphaloides: Herkunft des Untersuchungsmaterials. Der eingerahmte Punkt bezeichnet den Typus-Ort. (Jeder Punkt kann mehrere Fundorte umfassen).

3.1.3. *Antennaria lanata* 2n=28 (Fig. 6)

A. lanata was studied from 54 sites distributed in various parts of the total range of the taxon (Fig. 6, Tables 1, 4). The ample material examined consisted of 385 individuals that were uniformly tetraploid (2n=4x=28, Fig. 7, Table 1).

The chromosome number of *A. lanata* is given here for the first time.

Fig. 6. *Antennaria lanata*: somatic metaphase. Sample code is given in parentheses. Wyoming (RM 19): 2n=28. c. 1500x.

A. lanata: somatische Metaphase. (In Klammern steht die Abkürzung für den Fundort). Wyoming (RM 19): 2n=28. ca. 1500x.

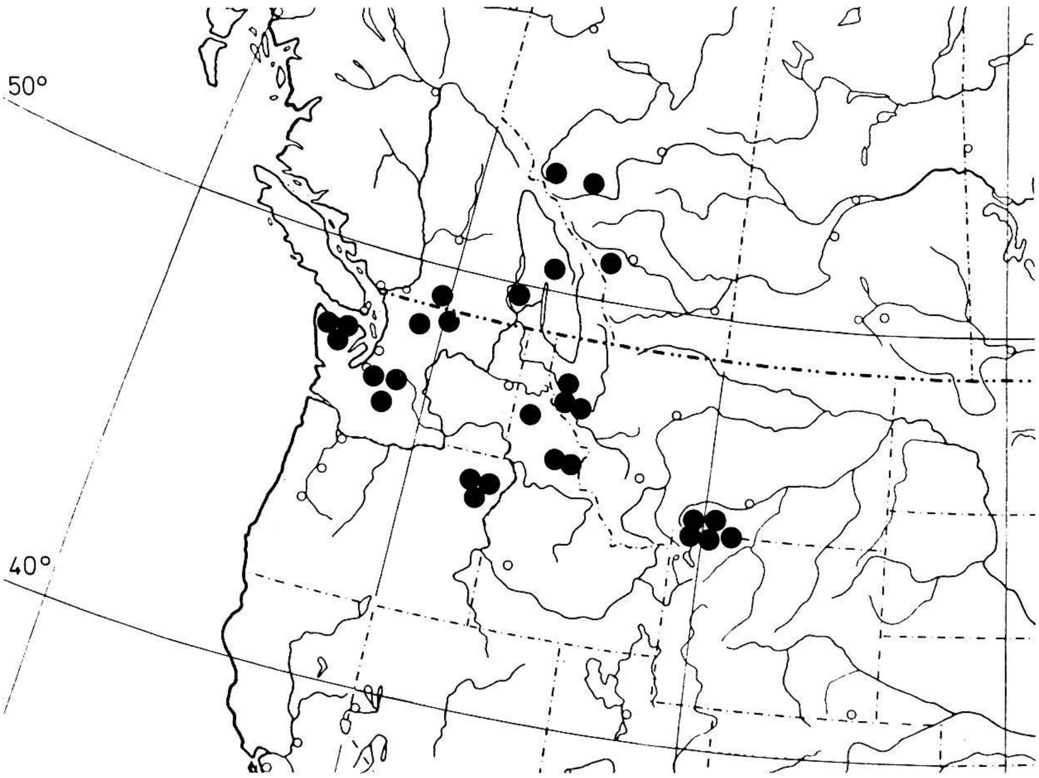


Fig. 7. *A. lanata*: geographical distribution of the studied material. Each dot may represent several sites.

A. lanata: Herkunft des Untersuchungsmaterials (Jeder Punkt kann mehrere Fundorte umfassen).

3.1.4. *Antennaria eucosma* 2n=56 (Fig. 8)

A. eucosma was studied from five localities in Newfoundland, including the type locality at Table Mtn. (Fig. 9). The material examined comprised 41 individuals; all of them were octoploid (2n=8x=56, Fig. 8, Table 1).

A. eucosma has not been cytologically studied hitherto.

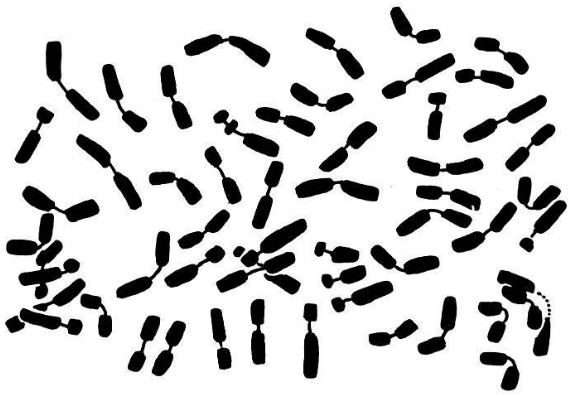


Fig. 8. *Antennaria eucosma*: somatic metaphase. Sample code is given in parentheses. Newfoundland (NF 5, the type locality): 2n=56. c. 1500x.

A. eucosma: somatische Metaphase. (In Klammern steht die Abkürzung für den Fundort). Neufundland (NF 5, Typus-Ort): 2n=56. ca. 1500x.

The present study reveals an interesting pattern of karyological differentiation within the *Antennaria carpatica* group in North America (Table 1, Fig. 10). The two levels of polyploidy recognized within the group correspond, on the one hand, to an interspecific differentiation; on the other hand, intraspecific differentiation in *A. pulcherrima* seems to stay in some relation to the geographical distribution of the taxon, the South-North gradient being rather distinct (Table 1, Figs 2, 10).

Table 1. Chromosome numbers observed within *Antennaria carpatica* s.l. in North America

Chromosomenzahlen von A. carpatica s.l., die in Nordamerika beobachtet wurden

Taxon	2n	Polyploidy level	Origin of the studied material
A. pulcherrima	56	8x	Alaska, Yukon Territory, British Columbia, Alberta
	28	4x	Wyoming, Colorado
A. anaphaloides	28	4x	British Columbia, Washington, Idaho, Montana, Colorado
A. lanata	28	4x	Olympic Mts, N Cascades, Blue Mts, Rocky Mts (British Columbia, Alberta, Idaho, Montana/Wyoming)
A. eucosma	56	8x	Newfoundland

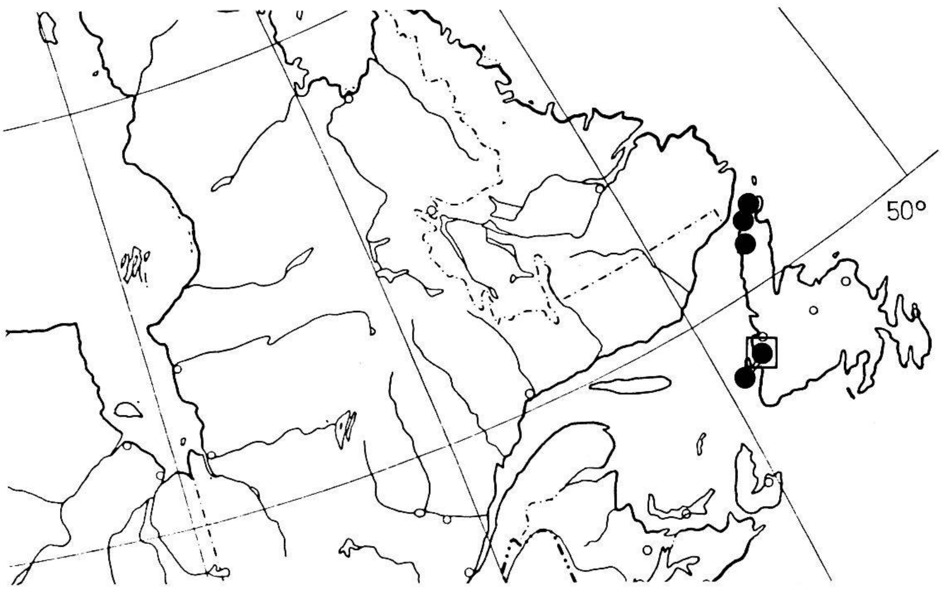


Fig. 9. *A. eucosma*: distribution of the studied material in Newfoundland. Framed dot refers to the type locality.

A. eucosma: Herkunft des Untersuchungsmaterials in Neufundland. Der eingerahmte Punkt bezeichnet den Typus-Ort.

3.2. Geographical distribution

A global distribution area of the *Antennaria carpatica* group in North America is very large and comprises a considerable part of Canada as well as some parts of the United States in Central and Pacific Northwest Range (Fig. 10). It should be noted, however, that particular taxa of the group greatly differ from one another both as to the actual area size as well as patterns of occurrence within a given area.

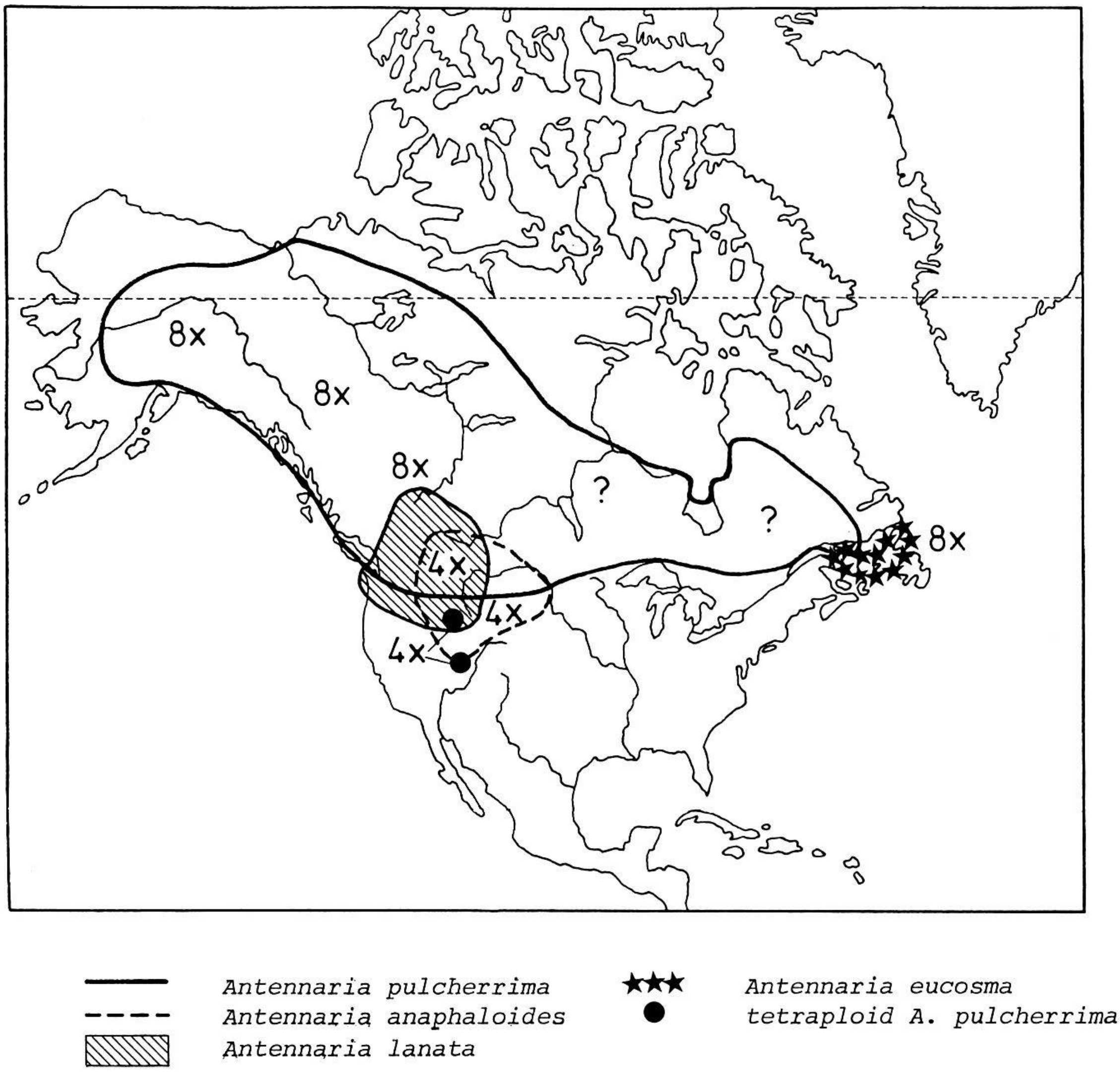


Fig. 10. General patterns of geographical distribution of *A. carpatica* group in North America.

Allgemeines Verbreitungsmuster der A. carpatica-Gruppe in Nordamerika.

Antennaria pulcherrima. - Of all the North American *Carpaticae*, *A. pulcherrima* has by far the largest total area of distribution (Fig. 10). It can be characterized as a high-subarctic/temperate transcontinental type (for the terminology, see SCOGGAN 1978). *A. pulcherrima* ranges from Alaska north to the Arctic Coast in the region of the Mackenzie River Delta, east through Northwest Territories, central and N Saskatchevan, N Manitoba, N Ontario to N Quebec and northern coast of the Gulf of St. Lawrence; it was also reported from few stations in Anticosti Island. As far as the gradient North-South is concerned, *A. pulcherrima* ranges from Alaska through Yukon Territory, British Columbia and Alberta to N Washington, Idaho, Montana and Colorado. The distribution of *A. pulcherrima* being generally discontinuous, it is not quite clear at the time being whether the stations corresponding to the southernmost range of the taxon are still situated within the main area or, in fact, stay outside it.

A rather distinct difference in appearance of populations was noted between boreal/subarctic vs temperate areas. Northern populations of *A. pulcherrima* frequently were large, widespread and sometimes fairly concentrated within a given local area (e.g. Pelly Mts in Yukon, Muncho Lake in British Columbia or Banff National Park in Alberta). Southern populations, on the contrary, were apparently rare and small (e.g. the site RM 13 at Warm Spring Creek, Wind River Range, Wyoming). Further studies within the whole distribution area of *A. pulcherrima* are required for a better understanding of the intriguing pattern observed in the course of the present study.

Antennaria anaphaloides has a temperate western distribution (Fig. 10). Its general area is much smaller than that of *A. pulcherrima*; it ranges from SW British Columbia and Alberta south to Wyoming and Colorado and west to Nevada and Oregon. Populations of *A. anaphaloides* are usually small or medium-large at their best, particular individuals being most frequently scattered within a given site. The only more conspicuous stands of *A. anaphaloides* were observed by the author within the uppermost subalpine vegetation belt in Colorado, where *A. anaphaloides* occurs as the sole representative of the *Carpaticae* at higher altitude (e.g. the site RM 33 in vicinity of Cumberland Pass on the Continental Divide, about 3400 m a.s.l.).

Antennaria lanata also has a general distribution of a temperate western type (Fig. 10). The area of this subalpine/alpine taxon seems, on the whole, to be rather well-defined: it ranges from Olympic Mts through N Cascades to Rocky Mts. *A. lanata* reaches from British Columbia and Alberta south to Washington and NE Oregon; it is very well represented in Idaho and Montana. Southern limits of occurrence of *A. lanata* correspond to the Beartooth Plateau at the border of Montana and Wyoming. It is interesting to note that *A. lanata* occurs very abundantly within the Plateau and its surroundings but is not seen anymore farther south.

Compared to the total area of the *Carpaticae* in North America, the area of *A. lanata* is rather small; however, populations of this taxon occur rather frequently throughout the area and often are not only wide-spread but exceedingly dense, a great many individuals occurring within given sites and frequently dominating their general aspect (Fig. 15).

Antennaria eucosma has a distribution area approaching a low-subarctic eastern type (Fig. 10). The taxon seems to be confined to Newfoundland as well as few sites in Anticosti Island. Except for the large population occurring at Table Mtn. (the type locality) and a medium-large colony at Big Brook in northern Newfoundland, populations of *A. eucosma* are exceedingly small. The precise situation in Anticosti Island is not known, but the limited occurrence of *A. eucosma* seems in general to be reflected not only in its limited area of distribution and the actual number of populations, but also in the total number of individuals.

3.3. *Ecology*

Precise ecological requirements of North American *Carpaticae* are not yet fully assessed, but the data gathered so far suggest some trends in ecological differentiation of particular taxa.

3.3.1. *Antennaria pulcherrima*

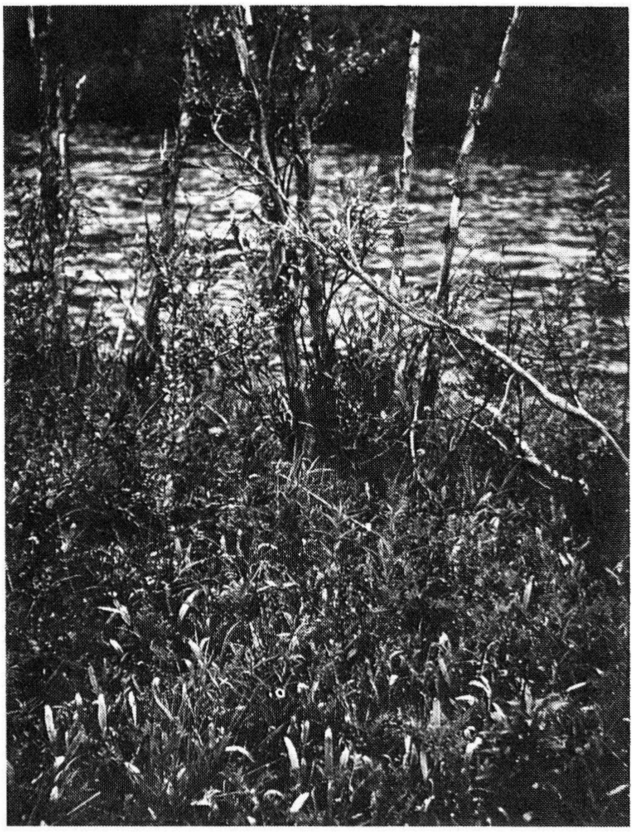
A. pulcherrima mostly occurs within montane and subalpine vegetation belt, stations above timberline being infrequent and confined to high mountain areas sometimes influenced by the proximity of glaciers (e.g. Columbia Icefields). It is interesting to note that the taxon was reported from a broad altitude range in Mackenzie District of Northwest Territories (900-2100 m a.s.l., specimens collected by JOHNSON and MUNRO in 1962, presently at Vascular Plant Herbarium, Biosystematic Research Institute, Ottawa).

A. pulcherrima seems to have a distinct preference for well-watered, mostly fine-textured, alluvial soils often subject to intermittent flooding (Table 2). Its representative niche apparently corresponds to river flats or stream/river banks; the taxon frequently occurs in willow shrub thickets. A striking affinity in ecological requirements observed in stations of *A. pulcherrima* so far apart as Yukon Territory and Wyoming (Figs 11-12) and inhabited by populations representing two different levels of polyploidy viz. 8x and 4x is of particular interest. Further studies in sites of *A. pulcherrima* in Central and S Rocky Mts as well as eastern part of its range should be most interesting.

Some authors (e.g. PORSILD 1943) considered *A. pulcherrima* as restricted to calcareous soils. It seems, however, that soil moisture level has a commanding influence on patterns of occurrence of the taxon and the soil parent material might represent a collateral factor. Some aspects of reproductive strategy of *A. pulcherrima* are in favour of this assumption (URBANSKA, in preparation).

A. pulcherrima occasionally occurs in well-developed soils with rather dense vegetation cover. It seems possible that the taxon may well respond to a higher nutrient content of the soil, but is not sufficiently competitive to establish itself successfully in numerous sites of that type.

Abb. 11-12. Typische Standorte von A. pulcherrima. 11. Yukon Territory: Alluvialflächen des Rose River (YU 3). 12. Wyoming, Fremont Co., Wind River Range: Sandbank der Warm Springs Creek (RM 13). A. pulcherrima wächst im Vordergrund und in den Weidenbüschen.

11 

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Figs 11-12. Representative sites of *A. pulcherrima*. 11. Yukon Territory: alluvial flats of Rose River (YU 3). 12. Wyoming, Fremont Co., Wind River Range: sandy bank of Warm Springs Creek (RM 13). *A. pulcherrima* in foreground as well as in willow shrub thickets. Author's photos, 14 Aug. 1980 and 14 Aug. 1978, respectively.

Table 2. Collection sites of *Antennaria pulcherrima*

Fundorte von A. pulcherrima

Sample code	Site description	Date
AL 1	Alaska, Northway Road: willow shrub thicket at the roadside. Also in the neighbouring burnt spruce forest. Mossy alluvial soil.	30 Jul. 1980
AL 2	Alaska, Mt. MacKinley National Park: Wonder Lake, moist lake shore at N end of the lake. about 630 m a.s.l.	1 Aug. 1980
AL 3	Alaska, Tenana River at Big Delta: among *Equisetum arvense* along the road and in the neighbouring alder thicket. Moist silty soil.	2 Aug. 1980
AL 4	Alaska: in a muskeg, about 16 km E of Fairbanks.	4 Aug. 1980
NT 1	Alaska, North Tongass National Forest: wet alluvial soil at the Haines airport.	28 Jul. 1980
YU 1	Yukon Territory: Pelly Mts.: W bank of Nisutlin River, on wet alluvial soil in a willow shrub thicket. 916 m a.s.l.	12 Aug. 1980
YU 2	Yukon Territory, Pelly Mts.: Canol Road Mile 90, in moist gravel at the roadside and also among willow shrubs. About 1330 m a.s.l.	13 Aug. 1980
YU 3	Yukon Territory, Pelly Mts.: Canol Road Mile 94, alluvial flats of Rose River, among willow shrubs. About 1330 m a.s.l.	14 Aug. 1980
YU 4	Yukon Territory, Boulder Creek: disturbed rocky stream bed. Locally in shallow pockets of fine-textured alluvial soil. About 1350 m a.s.l.	15 Aug. 1980
YU 5	Yukon Territory, about 2 km of Boulder Creek: alluvial flats of Lapie River.	15 Aug. 1980
YU 6	Yukon Territory, about 8 km of Boulder Creek: in very wet gravel off the road.	15 Aug. 1980
SWY	Yukon Territory: Mile 1148 Alaska Highway, about 1.6 km W of Edith Creek. In a willow shrub thicket, on mossy soil.	29 Jul. 1980
BC 1	British Columbia, Muncho Lake Provincial Park: Mile 1148 of Alaska Highway, in willow shrubs.	17 Aug. 1980
BC 2	British Columbia, Muncho Lake Provincial Park: E shore of the lake, in willow shrub dominated vegetation on moist gravelly soil.	17 Aug. 1980
BC 3	British Columbia, Muncho Lake Provincial Park: E slope with scattered willow shrubs. Rather dry soil with patches of loose gravel.	17 Aug. 1980

Table 2. (continued - *Forts.)*

Sample code	Site description	Date
BC 4	British Columbia, Alaska Highway Mile 401.5: flat surface with scattered willow shrubs and a spruce forest in background. Moist gravelly soil.	18 Aug. 1980
BC 5	British Columbia, road to Summit Pass within the Stone Mtn. Provincial Park: between hummocks and willow shrubs, on moist soil. About 1350 m a.s.l.	18 Aug. 1980
BC 6	British Columbia: road descending from Summit Pass to Tetsa River. Among willow shrubs on a moist gravel.	18 Aug. 1980
BC 7	British Columbia, Yoho National Park: Takkawa Falls: silty flats with willow shrubs, partly also between spruce trees. About 1570 m a.s.l.	24 Aug. 1980
BC 8	British Columbia, Yoho National Park: established bar along Kicking Horse River. Locally dense willow thicket, moist gravelly/silty soil. About 1230 m a.s.l.	24 Aug. 1980
ALB 1	Alberta, Jasper National Park: moist sandy meadow just on the left bank of Athabasca River, about 5 km W of Jasper. Some willow shrubs.	21 Aug. 1980
ALB 2	Alberta, Jasper National Park: left bank of Alabasca River, between willow shrubs and spruces. Moist alluvial soil.	21 Aug. 1980
ALB 3	Alberta, road to Pocahontas: moist meadow on fine alluvial soil. Disturbed vegetation.	21 Aug. 1980
ALB 5	Alberta, about 8 km N of the Jasper National Park entrance. Moist, exceptionally well-developed, fine textured forest soil. Dense vegetation off the road.	23 Aug. 1980
ALB 6	Alberta, Jasper National Park: Flats of Athabasca River about 10 km W of Athabasca Falls. Among willow shrubs and saplings on silty soil.	23 Aug. 1980
ALB 7	Alberta, Jasper National Park: on a stream bank about 12 km E of junction between Rd 93 and 93a in the park. Moist openings in willow shrub thicket.	23 Aug. 1980
ALB 7a	Alberta, Jasper National Park: about 10 km E of site ALB 7: in openings of spruce forest, moist alluvial soil.	23 Aug. 1980
ALB 8	Alberta, Columbia Icefields: moist rocky slope at the roadside. About 2330 m a.s.l.	23 Aug. 1980
ALB 9	Alberta, Banff National Park: silty river bank at the valley bottom.	23 Aug. 1980

Table 2. (continued - *Forts.)*

Sample code	Site description	Date
ALB 10	Alberta, Banff National Park: river flats and the neighbouring willow shrub thicket. Moist sandy/ silty soil.	24 Aug. 1980
RM 13	Wyoming, Fremont Co. Wind River Range: moist sandy bank of Warm Springs Creek. About 2800 m a.s.l.	14 Aug. 1978
RM 34	Colorado, Gunnison Co.: by East River, between Cothic and Crested Butte. Moist stream bank, partly among willow shrubs.	25 Aug. 1978

3.3.2. *Antennaria anaphaloides*

Antennaria anaphaloides occurs, in general, within a very wide altitude bracket ranging from plains and foothills zones to about timberline. However the occurrence of the taxon in particular vegetation belts seems to be partly related to the actual latitude of given areas. In SW British Columbia and Alberta, *A. anaphaloides* mostly occurs in grassland and open dry woods, whereas farther south it is frequently observable at higher elevations. For instance in Colorado, *A. anaphaloides* was reported from about timberline (e.g. near Cumberland Pass, 3400 m a.s.l.). Nothwistanding the altitude differences, *A. anaphaloides* shows a preference for open and sunny sites with loose, permeable soils. Sites of the taxon are frequently characterized by the occurrence of sagebrush (Fig. 13), the scattered individuals of *A. anaphaloides* being often observed in shelter of the shrub. Interestingly enough, the most densely populated stands of *A. anaphaloides* were observed by the author at highest altitudes reached by the taxon in S Colorado (Fig. 14). *A. anaphaloides* is apparently well-adapted to a prolonged period of dryness, as indicated by its reproductive strategy (URBANSKA, in preparation).

Abb. 13-14. Typische Standorte von A. anaphaloides. 13. Idaho, Custer Co., Lost River Range, Double Spring Pass: Trockener offener Hang mit vereinzelten Artemisia-Büschen (RM 11). 14. Colorado, Gunnison Co.: sonniger, steiniger, südexponierter Hang in der Nähe des Cumberland Passes (RM 33)

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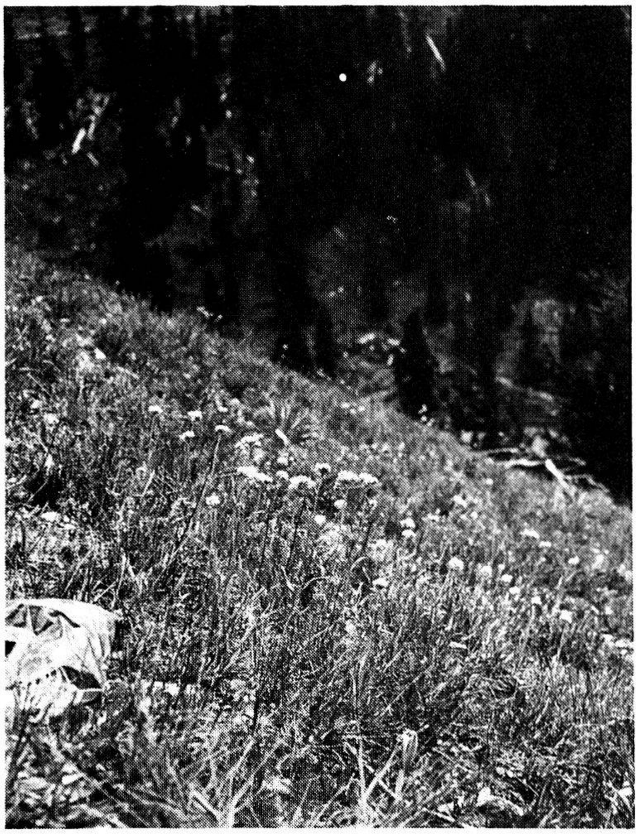

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Figs 13-14. Representative sites of *A. anaphaloides*. 13. Idaho, Custer Co. Lost River Range, Double Spring Pass: dry open hillside with scattered sagebrush (RM 11). 14. Colorado, Gunnison Co.: sunny SW-facing steep slope near Cumberland Pass (RM 33). About 3400 m a.s.l. Author's photos, 12 Aug. and 28 Aug. 1978, respectively.

Table 3. Collection sites of *Antennaria anaphaloides*

Fundorte von A. anaphaloides

Sample code	Site description	Date
RM 11	Idaho, Custer Co., Lost River Range, Double Spring Pass: dry open hillside with scattered sagebrush.	12 Aug. 1978
RM 12	Idaho, Custer Co., Lost River Range, descent from Double Spring Pass towards Chilly: hillside with scattered sagebrush, very dry sandy soil.	12 Aug. 1978
LA 3	Montana, Granite Co., Anaconda-Pintlar Range: on grassy ridge, 2190 m a.s.l.	8 Aug. 1980
RM 14	Montana, Gallatin Co.:Spanish Basin, dry hilltop with scattered few poplar and spruce trees. Very abundant sagebrush. Loose, gravelly/sandy soil.	19 Aug. 1978
RM 28	Wyoming, Big Horn Co. road to Granite Pass: sagebrush hill near Granite Creek. Dry, sandy soil. About 2550 m a.s.l.	19 Aug. 1978
RM 29	Wyoming, Big Horn Co. Burgess Junction: flat pasture on dry, gravelly soil. About 2410 m a.s.l.	19 Aug. 1978
RM 30	Wyoming, Fremont Co. Owl Range: Birdseye Mtn. Just about the summit. 2220 m a.s.l.	20 Aug. 1978
RM 31	Wyoming, Fremont Co. Wind River Range, road to Moccasin Lake. Mountain meadow with scattered sagebrush on dry gravelly soil. About 2970 m a.s.l.	21 Aug. 1978
RM 32	Colorado, Garfield Co. White River Plateau: dry meadow near Deep Creek lookout. About 2700 m a.s.l.	24 Aug. 1978
CO 4	Colorado, Moffat Co. Dinosaur National Monument: Roundtop Mtn., near fire lookout on N slope. Rocky sandstone and limestone, very steep slope. 2800 m a.s.l.	12 Aug. 1973
CO 1	Colorado, Gilpin Co. Rolling Pass, W slope. Alpine vegetation on dry, rocky soil. About 3400 m a.s.l.	5 Aug. 1973
CO 2	Colorado, Gilpin Co. in the valley near Tolland: dry hill. About 2700 m a.s.l.	5 Aug. 1973
CO 3	Colorado, Larimer Co., about 11 km E of Aspen Lodge. Dry grassland on sandy soil. About 2400 m a.s.l.	5 Aug. 1973
RM 33	Colorado, Gunnison Co.: open steep slope at timberline near Cumberland Pass. Dry gravelly soil. About 3400 m a.s.l.	28 Aug. 1978

Table 3. (continued - *Forts.*)

Sample Code	Site description	Date
BC 10	British Columbia, Douglas Lake Road: in open dry pine woods. About 750 m a.s.l.	26 Aug. 1980
BC 11	British Columbia, Crow Range, about 19 km N of Aspen Grove: open dry aspen-conifer forest. About 690 m a.s.l.	26 Aug. 1980
BC 12	British Columbia, Aspen Grove, on the road to Princeton: open aspen wood on dry soil.	26 Aug. 1980
BC 13	British Columbia, about 8 km S of Aspen Grove: open, dry aspen-conifer forest.	26 Aug. 1980
BC 14	British Columbia, about 5 km farther south from BC 13: grassy vegetation at the edge of aspen-conifer forest.	26 Aug. 1980

A. anaphaloides was sometimes observed in coniferous forests within the subalpine vegetation belt. Those stations are of a particular interest in view of a possible contact of *A. anaphaloides* with *A. lanata*. During the whole field work, the present author has seen only once the two taxa in the same site and it was just an open coniferous forest in N Washington (Table 4, sample code NC 6).

According to some herbarium data, *A. anaphaloides* is also supposed to occur occasionally in moist, shady sites that seem to be representative of *A. pulcherrima*. Such places should be given a particular attention in further investigations.

As far as the type of substratum is concerned, precise requirements of *A. anaphaloides* were not yet fully assessed. No marked preferences were revealed so far, but the problem should be investigated in detail.

3.3.3. *Antennaria lanata*

A. lanata occurs in subalpine and alpine vegetation belt. Corresponding to differences in climatic conditions occurring between various parts of Olympic Mts., N Cascades and Rocky Mts., the whole altitude bracket of *A. lanata* is large ranging approximately from 1440 m a.s.l. (e.g. sites at

Mt. Adams, Washington) to about 3000 m a.s.l. (summit of Clay Butte, Beartooth Range, Montana/Wyoming).

A. lanata usually avoids the most extreme, wind-exposed places. It was frequently observed in rocky ledges as well as some protected scree slopes, but populations of the taxon are there usually small and fairly localized. The representative sites of *A. lanata* correspond to open coniferous forests about the timberline as well as mountain meadows (Fig. 15) and early snowbanks. The taxon apparently has its ecological optimum in gravelly or sandy loam soils that are snow-covered in winter and moderately- to rather well-drained in summer. Our field observations suggest that a protection from temperature fluctuations as well as a sufficient amount of soil moisture are particularly important to *A. lanata* early in season, during initial and pre-reproductive life phases. The subsequent flowering and seed-setting do not seem to be greatly affected by a rather low moisture regime.

Fig. 15. A representative site of *A. lanata*. Washington, Clallam Co., Olympic Mts. National Park, Hurricane Drive (MO 3). Large meadow merging with an early snowbank. Very abundant *A. lanata* in foreground. Author's photo, 28 Jul. 1978.

Typischer Standort von A. lanata. Washington, Clallam Co., Olympic Mts. National Park, Hurricane Drive (MO 3). Wiese mit relativ früh ausaperndem Schneetälchen. A. lanata sehr häufig im Vordergrund.

Table 4. Collection sites of *Antennaria lanata*

Fundorte von A. lanata

Sample code	Site description	Date
OG 1	Alberta, Jasper National Park: Wilcox Pass area, moist meadow at N end of Nigel Lake. 2250 m a.s.l.	8 Jun. 1974
ALB 4	Alberta, Jasper National Park: Signal Mtn., NE slope, timberline meadow. About 2100 m a.s.l.	22 Aug. 1980
OG 2	Alberta: Kananaskis Valley, Marmot Creek: small meadow within the timberline forest. 2250 m a.s.l.	13 Aug. 1974
BC 9	British Columbia, Mt. Revelstoke: large meadow about timberline. *A. lanata* very abundant. About 1900 m a.s.l.	25 Aug. 1980
BC 15	British Columbia, Apex Mts.: open slope at timberline. About 2000 m a.s.l.	26 Aug. 1980
NC 3	Washington, Okanogan Co.: Slate Peak, on a small open ridge about 60 m from the summit. About 2000 m a.s.l.	30 Jul. 1978
NC 4	Washington, Okanogan Co.: descent from Slate Peak towards Harts Pass. Large moist depression on SW-facing slope. About 1900 m a.s.l.	30 Jul. 1978
NC 5	Washington, Okanogan Co.: Harts Pass, in open coniferous forest. About 1860 m a.s.l.	30 Jul. 1978
NC 6	Washington, Okanogan Co.: Tiffany Mtn., Freezout Ridge: in open coniferous forest. About 1950 m a.s.l.*	30 Jul. 1978
NC 7	Washington, Okanogan Co., Freezout Ridge: large openings in coniferous forest. Very abundant. About 2000 m a.s.l.	30 Jul. 1978
NC 1	Washington, Skagit Co.: Sahale Arm above Cascade Pass: half-open alpine vegetation on a dry ridge.	29 Jul. 1978
NC 2	Washington, Skagit Co.: Cascade Pass: small, *Carex nigricans*-dominated depression.	29 Jul. 1978
NC 10	Washington, Pierce Co. Mt. Rainier National Park: Glacier Vista SW-facing ridge, in an early snow-bank. About 1800 m a.s.l.	1 Aug. 1978
NC 11	Washington, Pierce Co., Mt. Rainier National Park: Paradise Park. About 1650 m a.s.l.	1 Aug. 1978
NC 12	Washington, Pierce Co., Mt. Rainier National Park: Clover Lake, moist lake side. About 1500 m a.s.l.	1 Aug. 1978

* the only site where *A. lanata* and *A. anaphaloides* were observed close to each other

Table 4 (continued - *Forts.*)

Sample code	Site description	Date
N 13	Washington, Pierce Co., Mt. Rainier National Park: Sunrise Ridge, under coniferous trees at the top of the ridge.	1 Aug. 1978
NC 14	Washington, Pierce Co., Mt. Rainier National Park: Berkeley Park, open alpine slope. About 1950 m a.s.l.	1 Aug. 1978
MA 2	Washington, Yakima Co.: Hellroaring Meadow, E slope of Mt. Adams. Subalpine meadow, about 1800 m a.s.l.	15 Sept.1976
NC 15	Washington, Yakima Co.: Mt. Aix, krummholz zone, NW-facing steep slope. About 1900 m a.s.l.	2 Aug. 1978
MO 1	Washington, Clallam Co., Olympic Mts. National Park: Elk Mtn., early snowbed. 2030 m a.s.l.	28 Jul. 1978
MO 2	Washington, Clallam Co., Olympic Mts. National Park: descent from Elk Mtn. towards Obstruction Point: WSW-facing slope.	28 Jul. 1978
MO 3	Washington, Clallam Co., Olympic Mts. National Park: subalpine meadow merging with early snow-bank. Very abundant.	28 Jul. 1978
MO 4	Washington, Clallam Co., Olympic Mts. National Park: Hurricane Drive, early snowbank.	28 Jul. 1978
BM	Oregon, Wallowa Co., Blue Mts., Eagle Cap Wilder-ness: Mirror Lake, among rocky ledges near the lake. About 2250 m a.s.l.	5 Aug. 1978
BM 2	Oregon, Wallowa Co., Blue Mts., Eagle Cap Wilder-ness: in open coniferous forest. About 1900 m a.s.l.	5 Aug. 1978
BM 3	Oregon, Wallowa Co., Blue Mts., Eagle Cap Wilder-ness: subalpine meadow along the path from Two Pan Campground to Eagle Cap Basin. About 1700 m a.s.l.	5 Aug. 1978
RM 1	Idaho, Benewah Co., Freezeout Mtn.: small SE-exposed ridge at timberline. About 1800 m a.s.l.	4 Aug. 1978
RM 2	Idaho, Benewah Co., Long Hike Peak: large meadow below timberline on SE-facing slope. Very abundant. About 1900 m a.s.l.	4 Aug. 1978
RM 3	Idaho, Idaho Co., Wildhorse Lake: open coniferous forest about the lake. 2400 m a.s.l.	7 Aug. 1978
RM 4	Idaho, Idaho Co., Orogrande summit. Among rocks on rather dry soil. About 2300 m a.s.l.	7 Aug. 1978
RM 8	Idaho, Lemhi Co., Salmon Mtn., N slope: open coniferous forest. About 1800 m a.s.l.	11 Aug. 1978

Table 4 (continued - *Forts.*)

Sample code	Site description	Date
RM 9	Idaho, Lemhi Co.: Ajax Mtn., openings in coniferous forest. About 2000 m a.s.l.	11 Aug. 1978
RM 10	Idaho, Lemhi Co., Ajax Mtn.: below site RM 9, in open coniferous forest. About 1700 m a.s.l.	11 Aug. 1978
LA 1	Montana, Ravalli Co., Johnson Peak, Anaconda-Pintlar Range.	18 Sept.1974
MA 1	Montana, Rivalli Co., St. Mary Peak: in cirque above McCalla Lake. About 2500 m a.s.l.	5 Oct. 1975
RM 5	Montana, Rivalli Co., Trapper Peak: saddle just below the summit. Wind-exposed alpine tundra in rocky soil. About 2950 m a.s.l.	9 Aug. 1978
RM 6	Montana, Rivalli Co., Trapper Peak: moraine soil above timberline. About 2500 m a.s.l.	9 Aug. 1978
RM 7	Montana, Rivalli Co., Trapper Peak: open coniferous forest. About 1700 m a.s.l.	9 Aug. 1978
RM 15	Montana, Park Co., Daisy Park below Scotch Bonnet Mtn.: open alpine slope. About 2900 m a.s.l.	17 Aug. 1978
RM 16	Montana, Park Co., Daisy Park: moist depression in open alpine slope. About 2880 m a.s.l.	17 Aug. 1978
RM 17	Montana, Park Co.: subalpine meadow on path to Daisy Pass. About 2500 m a.s.l.	17 Aug. 1978
RM 18	Montana, Park Co.: in open coniferous forest along the path to Goose Lake. About 2500 m a.s.l.	17 Aug. 1978
RM 27	Montana, Carbon Co., Beartooth Plateau: immediately adjacent to the state-line Montana/ Wyoming, in a fellfield. About 3100 m a.s.l.	18 Aug. 1978
RM 19	Wyoming, Park Co., Clay Butte: wind-exposed, dry summit of the butte. 3000 m a.s.l.	18 Aug. 1978
RM 20	Wyoming, Park Co., Beartooth Lake: ledges and grassy terraces just above the lake. About 2760 m a.s.l.	18 Aug. 1978
RM 21	Wyoming, Park Co., Beartooth Lake: edge of mixed coniferous forest. About 2750 m a.s.l.	18 Aug. 1978
RM 22	Wyoming, Park Co. About 2 km of Beartooth Lake: among dwarf coniferous trees. About 2700 m a.s.l.	18 Aug. 1978
RM 23	Wyoming, Park Co., Beartooth Plateau, Island Lake: moist meadow and peat hummocks. About 2940 m a.s.l.	18 Aug. 1978
RM 24	Wyoming, Park Co., Beartooth Plateau: *Deschampsia caespitosa*-meadow. *A. lanata* very abundant. About 3000 m a.s.l.	18 Aug. 1978

Table 4 (continued - *Forts.*)

Sample code	Site description	
RM 25	Wyoming, Park Co., Beartooth Plateau: road from Long Lake to Beartooth Pass: *Deschampsia caespitosa*-meadow. About 3000 m a.s.l.	18 Aug. 1978
EF 1	Wyoming, Park Co., Beartooth Plateau: beneath *Pinus albicaulis* at the top of a ridge near Long Lake. 3040 m a.s.l.	29 Jun. 1974
EF 2a	Wyoming, Park Co., Beartooth Plateau: near Long Lake, in a S-facing slope with open coniferous forest. About 3030 m a.s.l.	29 Jun. 1974
EF 2b	Wyoming, Park Co., Beartooth Plateau: moist meadow near Long Lake. About 3013 m a.s.l.	29 Jun. 1974
RM 26	Wyoming, Park Co., Beartooth Pass: early snowbank. About 3250 m a.s.l.	18 Aug. 1978

Parent material of soils inhabited by *Antennaria lanata* correspond to both siliceous as well as carboniferous substrata. However, the best performance of *A. lanata* was actually observed in rather developed, frequently podsolic soils where a direct influence of substratum is modified by occurrence of organic litter as well as leaching processes. It seems therefore that principal factors determining the occurrence of *A. lanata* in given sites might be physical soil properties, snow cover depth and time of snowmelt and not the very chemical composition of the underlying rock.

3.3.4. *Antennaria eucosma*

A. eucosma seems to be rather specialized ecologically. Its representative site corresponds to a limestone barren, only a single population being recorded upon serpentine (Dr. E. ROULEAU, personal communication). *A. eucosma* shows a preference for rather dry and wind-exposed sites. Some of its stations are situated close to the sea (Fig. 16) and may therefore be subject to an occasional salt spray.

Fig. 16. A representative site of *A. eucosma*: Pistolet Bay, Cook Harbour (NF 1), about 51°39'N; 55°53'W. Limestone barren on the shore. Author's photo, 24 Jul. 1982.

Typischer Standort von A. eucosma: Pistolet Bay, Cook Harbour (NF 1), ungefähr 51°39'N; 55°53'W. Kalkbank an der Küste.

Table 5. Collection sites of *Antennaria eucosma* in Newfoundland.

Fundorte von A. eucosma in Neufundland.

Sample code	Site description	Date
NF 1	Pistolet Bay, Cook Point: gravelly and peaty limestone barrens in a close proximity to the sea.	24 Jul. 1982
NF 2	Cape Norman, Boat Harbour: turfy limestone barren.	24 Jul. 1982
NF 3	Big Brook: limestone barrens on high shore, just above a narrow pebble beach. Very dry site.	24 Jul. 1982
NF 4	Cape St. George: limestone barrens and open slopes near the edge of the cliff. Dry, wind-exposed site.	25 Jul. 1982
NF 5	Port au Port, Table Mtn.: dry limestone upper slopes and tableland. 200-300 m a.s.l.	26 Jul. 1982

4. Discussion

Differentiation patterns revealed in the course of the present study suggest diversified speciation mechanisms that have operated within the *Antennaria carpatica* group in North America.

A. lanata and *A. anaphaloides* are partly allopatric; their distribution areas overlap within a rather limited region where tetraploid *A. pulcherrima* was also found. The occurrence of three tetraploid *Carpaticae* within the same area suggests a primary speciation centre. It is conceivable that each of the 28chromosomic taxa gradually developed adaptations to a different set of environmental conditions, the ecological differentiation eventually resulting in a rather pronounced spatial isolation. On the other hand, it is not excluded that hybridization on homoploid level might also have played a rôle in the differentiation of the group e.g. in the formation of *A. pulcherrima*.

Chromosome numbers as well as trends in geographical distribution and ecology obviously are useful for better assessment of speciation within the *Carpaticae*. It seems that also data on population appearance have an important informative value as far as the biological success of particular taxa and their further evolulutionary potential is concerned. Of the three tetraploid taxa within the group, *A. lanata* forms the largest and most densely populated stands. The excellent performance of the taxon was previously observed in Olympic Mts by BLISS (1969) and later in North Cascades by DOUGLAS and BLISS (1977) who distinguished a separate *A. lanata*-community type in high mountain vegetation of the latter region. The abundance of *A. lanata* in alpine meadows of the Beartooth Plateau was noted previously by JOHNSON and BILLINGS (1962). The taxon is apparently well-adapted to its representative biotopes throughout the whole area of its distribution.

Antennaria anaphaloides usually forms smaller and less conspicuous populations than *A. lanata*, except for stands observed at timberline in S Rocky Mts. Genetic make-up of the taxon apparently included adaptations both to a prolonged period of aridity as well as specific elements of a high mountain environment. It should be noted, however, that the timberline populations of *A. anaphaloides* occur in regions where *A. lanata* is not observable anymore; in high mountain sites within the Beartooth Plateau and northwards from the Plateau, competition from *A. lanata* is apparently too strong to allow the occurrence of *A. anaphaloides* at high elevations.

A. lanata and *A. anaphaloides* differ from one another in their adaptive features but both are apparently well-established in their respective ecological niches. Tetraploid *A. pulcherrima*, on the contrary, seems to be declining. Its populations being not only very rare and isolated but also small, the tetraploid race might be considered as genetically depleted (STEBBINS 1942). On the other hand, the octoploid *A. pulcherrima* is, to all appearances, very vigorous and frequently forms large, locally dense populations. This pattern of behaviour is particularly interesting when the harsh environment of the octoploids is taken into consideration. According to SOLBRIG (1980), population density tends to be low in environments with high physical stress in view of carrying capacity limits; consequently, competition is there less important. On the other hand, the physical stress is usually low in environments where density and competition are high. In former sites, heterozygosity is favoured through heterosis, whereas the latter ones promote outbreeding. Populations of the tall-growing octoploid *A. pulcherrima* apparently are able to withstand successfully both the physical stress and the competition for limited resources; it might be due to an advantageous combination of the obligate outbreeding and heterosis.

Karyological differentiation observed in *A. pulcherrima* represents a rather distict South-North gradient. Comparable phenomena, reported also from other regions (e.g. the Alps, the Pyrenees, FAVARGER 1962, 1964, KüPFER 1974) suggest possible differentiation pathways within given polyploid groups. In case of *A. pulcherrima*, octoploids might have been formed in the North and their further spread followed the retreat of the Wisconsin glaciers, colonizing the regions where tetraploid populations have long disappeared.

In spite of differences in geographical distribution, chromosome number as well as population appearance, tetraploids and octoploids of *A. pul-*

cherrima have striking ecological affinities. This aspect might be related to a possible autopolyploid origin of the 56chromosomic race, as autopolyploids are known to be ecologically similar to their diploid ancestors (e.g. *Achlys triphylla*, FUKUDA 1967). Preliminary observations on chromosome morphology in *A. pulcherrima* (URBANSKA unpubl.) suggest as well an autopolyploid character of the octoploid race.

Autopolyploidy was previously found within the *Carpaticae*. The Eurosiberian taxon of the group, *A. villifera*, is differentiated into two chromosomic races viz. tetraploids and hexaploids. Both 28- and 42chromosomic plants are scattered over Lapland (BERGMAN 1935, 1951, URBANSKA 1967a, b, ENGELSKJØN and KNABEN 1971) as well as Siberia, reaching eastwards to Chukotchka Peninsula (ZHUKOVA 1968, ZHUKOVA and TIKHONOVA 1971, 1973, ZHUKOVA, PETROVSKY and PLIEVA 1973, YURTSEV and ZHUKOVA 1982). Hexaploids occur generally more frequently than tetraploids but otherwise do not occupy a separate ecological niche. Data on population appearance from Siberia are not known; on the other hand, the author's field observations in North Scandinavia revealed some differences between tetraploids and hexaploids. Tetraploids formed exceedingly small populations often consisting of only male or only female clones, whereas hexaploid populations were relatively larger and frequently comprised both genders (URBANSKA 1967b,1970, URBANSKA unpubl.). Chromosome morphology of *A. villifera* as well as meiotic behaviour of hexaploids bring evidence of autopolyploid origin of the 42chromosomic race (URBANSKA 1967b,1970). It might be that this particular form of speciation occurred also in North America in *A. pulcherrima*.

Antennaria eucosma deserves a brief remark. The taxon represents the same level of polyploidy as do the northern populations of *A. pulcherrima*. It is not excluded that *A. eucosma* might have arisen as a result of quantum speciation from a peripheral population of *A. pulcherrima*; the two taxa undoubtedly are closely related. As suggested by numerous authors, peripheral i.e. geographically marginal populations are also marginal in ecological sense (e.g. ANTONOVICS 1976, LEWIS 1973, VASEK 1968). *A. eucosma* is ecologically rather specialized and seems to be adapted to extreme ecological conditions. It appears that very small populations of *A. eucosma* remaining isolated from the main distribution area of *A. pul-*

cherrima might well have developed under influence of genetic drift and/or unusually strong selective pressures. The importance of quantum speciation in plant evolution is generally recognized (e.g. LEWIS 1962, GRANT and GRANT 1960, GRANT 1981, SOLBRIG 1960). Still unknown data on chromosome numbers and behaviour of *A. pulcherrima* from eastern part of its distribution area are very important for getting a more complete picture of evolution within the group.

The few aspects presented above show that much information on the North American *Carpaticae* is still required. Further investigations in the group, both in the field as well as laboratory, offer numerous exciting possibilities. The study is in progress.

Summary

Chromosome number, geographical distribution, ecology and population appearance were studied in the North American taxa of *Antennaria carpatica* s.l.

A. lanata and *A. anaphaloides* proved to be uniformly tetraploid (2n=28), whereas differentiation was revealed in *A. pulcherrima:* large northern population of this taxon were octoploid, but rare, small southern colonies represented the tetraploid level.

A. pulcherrima has the largest total distribution area of all the North American *Carpaticae*; it can be characterized as high-subarctic/temperate transcontinental type. *A. anaphaloides* and *A. lanata* have a temperate western distribution and inhabit rather small areas, whereas *A. eucosma* approaches a low-subarctic eastern distribution type and its area is exceedingly restricted. The North American *Carpaticae* are largely allopatric, overlapping of some area being observed in a rather limited region.

It seems that physical soil properties (esp. soil moisture), snow cover depth and time of snowmelt represent principal factors determining the occurrence of most *Carpaticae*, the chemical composition of the substratum apparently playing a direct rôle only in *A. eucosma*. *A. pulcherrima* has a preference for well-watered, fine textured alluvial soils often subject to an intermittent flooding. Its representative niche corresponds to river bank with willow shrubs; tetraploid and octoploid populations have striking ecological affinities. *A. anaphaloides* is well-adapted to a prolonged period of aridity and mostly occurs in loose, permeable and dry soils frequently characterized by the occurrence of sagebrush. *A. anaphaloides* occurs as well about timberline, but only in Colorado where *A. lanata* is not observable anymore. *A. lanata* is a subalpine/alpine taxon; it occurs mostly in gravelly or sandy loam soils, snow-covered in winter and moderately- to well-drained in summer. Representative sites of *A.*

lanata are open coniferous forests, mountain meadows and early snowbanks. *A. eucosma* is mostly confined to dry limestone barrens, wind-exposed and sometimes subject to an occasional salt spray from the sea.

Data on population appearance, helpful for assessment of evolutionary potential of particular taxa as well as various facets of primary speciation within the *A. carpatica* group are briefly discussed.

Zusammenfassung

Von den nordamerikanischen Arten der *Antennaria carpatica*-Gruppe wurden die Chromosomenzahlen, die geographische Verbreitung, die Oekologie und das Populationsverhalten untersucht.

A. lanata und *A. anaphaloides* erwiesen sich als einheitlich tetraploid (2n=28), *A. eucosma* als oktoploid (2n=56). *A. pulcherrima* dagegen zeigte eine karyologische Differenzierung: Grosse Populationen dieser Art aus dem Norden waren oktoploid und seltene kleine Populationen aus dem Süden tetraploid.

A. pulcherrima ist von allen nordamerikanischen Arten der Gruppe am weitesten verbreitet. Sie hat eine transkontinentale Verbreitung in der hochsubarktischen Zone und in den Gebirgen südlich davon (high-subarctic temperate transcontinental type). *A. lanata* und *A. anaphaloides* haben eine westliche Verbreitung innerhalb der Gebirge der gemässigten Zone und besiedeln relativ kleine Areale; *A. eucosma* hat dem gegenüber eine östliche Verbreitung (Neufundland), ihr Areal ist extrem beschränkt. Die nordamerikanischen Arten von *A. carpatica* s.l. sind vorwiegend allopatrisch und ihre Areale überlappen sich nur begrenzt.

Es scheint, dass physikalische Bodeneigenschaften (besonders Bodenfeuchte) und Schneebedeckung (Dicke der Schneedecke, Ausaperungszeit) entscheidende Faktoren für das Aufkommen der meisten Arten sind. Die chemische Zusammensetzung des Muttergesteins spielt dagegen wahrscheinlich nur bei *A. eucosma* eine direkte Rolle. *A. pulcherrima* bevorzugt gut durchfeuchtete, feinkörnige alluviale Böden, die oft zeitweise überflutet werden; sie ist vorwiegend an mit *Salix* bewachsenen Uferbänken anzutreffen. Tetraploide und oktoploide Populationen verhalten sich ökologisch überraschend ähnlich. *A. anaphaloides* erträgt längere Trockenperioden und wächst hauptsächlich in lockeren, gut durchlässigen, trockenen Böden, zusammen mit *Artemisia*-Büschen. *A. anaphaloides* kann auch oberhalb der Waldgrenze angetroffen werden, aber nur in Colorado, wo *A. lanata* nicht mehr auftritt. *A. lanata* hat eine subalpine/alpine Verbreitung und gedeiht vor allem auf kiesigen oder sandigen Lehmböden, die im Winter schneebedeckt und im Sommer mässig bis sehr trocken sind. *A. lanata* kommt am häufigsten in offenen Nadelwäldern, auf Gebirgswiesen und in relativ früh ausapernden Schneetälchen vor. *A. eucosma* ist mehrheitlich auf trockene, windexponierte und gelegentlich von Meerwasser bespritze Kalkflächen beschränkt.

Angaben über das Populationsverhalten, die über das Evolutionspotential der *Antennaria carpatica*-Arten Auskunft geben können, sowie verschiedene Aspekte der primären Artbildung innerhalb der Gruppe werden kurz diskutiert.

References

ANTONOVICS J., 1976: The nature of limits to natural selection. Ann.Mo. Bot.Gard. *631*, 224-247.

BERGMAN B., 1935: Zur Kenntnis der skandinavischen *Antennaria*-Arten. Svensk Bot.Tidskr. *26*, 99-106.

\- 1951: On the formation of reduced and unreduced gametophytes of *Antennaria carpatica*. Hereditas *37*, 501-518.

BLISS L.C., 1969: Alpine community patterns in relation to environmental parameters. In: GREENIDGE K.N.H. (ed.), Essays in plant geography and ecology. Nova Scotia Mus. Halifax. 167-184.

DOUGLAS G.W. and BLISS L.C., 1977: Alpine and subalpine plant communities of the North Cascades Range, Washington and British Columbia. Ecol.Monogr. *47*, 113-150.

ENGELSKJØN T. and KNABEN G., 1971: Chromosome numbers of Scandinavian arctic-alpine plant species. III. Acta Borealia. A. Scientia. 3-30.

FAVARGER C., 1962: Contribution de la biosystématique à l'étude des flores alpine et jurassienne. Rev.Cytol.Biol.vég. *25*, 397-410.

\- 1964: Die zytotaxonomische Erforschung der Alpenflora. Ber.Deutsch. Bot.Ges. *77*, 73-83.

FUKUDA I., 1967: The biosystematics of *Achlys*. Taxon *16*, 308-316.

GRANT V., 1981: Plant speciation. 2nd ed. Columbia Univ.Press, New York. 563 pp.

\- and GRANT K., 1960: Genetic and taxonomic studies in *Gilia*. XI. Fertility relationships of the diploid Cobwebby *Gilias*. Aliso *4*, 435-481.

JOHNSON P.L. and BILLINGS W.G., 1962: The alpine vegetation of the Beartooth Plateau in relation to the cryopedogenic processes and patterns. Ecol.Monogr. *32*, 105-135.

KüPFER P., 1974: Recherches sur les liens de parenté entre la flore orophile des Alpes et celle des Pyrénées. Boissiera *23*, 1-322.

LEWIS H., 1962: Catastrophic selection as a factor in speciation. Evolution *16*, 257-271.

\- 1973: The origin of diploid neospecies in *Clarkia*. Amer.Natur. *107*, 161-170.

LöVE A., 1982: The IOPB chromosome number report I. Taxon *13*, 100-110.

\- and SOLBRIG O.T., 1964: The IOPB chromosome number report LXXV. Taxon *31*, 342-368.

PORSILD A.E., 1943: Material for a flora of continental NW Territories of Canada. Sargentia *4*, 1-79.

SCOGGAN H.J., 1978: The flora of Canada. I. Nat.Mus.Nat.Sci.Ottawa. 89 pp.

SOLBRIG O.T., 1960: Cytotaxonomic and evolutionary studies in the North American species of *Gutierrezia (Compositae)*. Contrib. Gray Herb. (Harvard Univ.) *188*, 1-63.

\- 1980: Genetic structure of plant populations. In: SOLBRIG O.T. (ed.), Demography and evolution in plant populations. Blackwell Sci Publ.Oxford. 49-65.

STEBBLINS G.L., 1942: The genetic approach to problems of rare and endemic species. Madrono *6*, 241-272.

URBANSKA K., 1959: Cytology of *Antennaria carpatica* and *A. dioica*. Acta Biol.Crac.Ser.Bot. *2*, 43-49.

- 1961: Embryological investigations in *Antennaria* Gaertn. I. Development of the ovules in *A. carpatica* (Wahlb.)Bl. et Fing. Acta Biol.Crac.Ser.Bot. *4*, 49-64.
- 1962a: Embryological investigations in *Antennaria* Gaertn. II. Development of the pollen of *A. carpatica* (Wahlb.) Bl. et Fing. Acta Biol.Crac.Ser.Bot. *5*, 97-102.
- 1962b: Embryological investigations in *Antennaria* Gaertn. III. Experimental hybrids between *A. carpatica* (Wahlb.) Bl. et Fing. and *A. dioica* (L.) Gaertn. Acta Biol.Crac.Ser.Bot. *5*, 103-116.
- 1967a:Cytological investigations in *Antennaria* Gaertn. from North Scandinavia. Acta Borealia Ser. A. Scientia. Tromsø. *22*, 1-14.
- 1967b: Embryological investigations in *Antennaria* Gaertn. IV. Microsporogenesis in *A. carpatica* from North Scandinavia. Acta Biol.Crac.Ser.Bot. *10*, 85-98.
- 1968a: Recherches cytologiques sur les populations alpiennes d' *Antennaria* Gaertn. Bull.Soc.bot.suisse *78*, 191-201.
- 1968b: A new hybrid of the Alpine Flora: *Antennaria carpatica x A. dioica*. Ber.Geobot.Inst.ETH, Stiftung Rübel *38*, 20-27.
- 1970: *Antennaria carpatica* (Wahlb.) Bl. et Fing. s.l. in Europe - a cytotaxonomical study. Ber.Geobot.Inst.ETH, Stiftung Rübel, *40*, 79-166.
- 1974: L'agamospermie, système de reproduction important dans la spéciation des Angiospermes. Bull.Soc.bot.France *121*, 329-346.

VASEK C.F., 1968: The relationship of two ecologically marginal sympatric *Clarkia* populations. Amer.Natur. *102*, 25-40.

YURTSEV B.A. and ZHUKOVA P.G., 1982: Chromosome numbers of the NE Yakutia (the drainage of the Indigirka River in its middle reaches). Bot. Zhurn, *67*, 778-787.

ZHUKOVA P.G., 1968: Chromosome number in some plant species from North-East of the USSR. III. Bot.Zhurn. *53*, 365-368.

- and TIKHONOVA A.D., 1971: Chromosome sumbers of certain plant species indigenous to the Chukotsky province. Bot.Thurn. *56*, 868-875.

-- 1973: The chromosome numbers of some Chukotchka plant species. II. Bot.Zhurn. *58*, 395-402.

- PETROVSKY V.V. and PLIEVA T.V., 1973: The chromosome numbers and taxonomy of some plant species from Siberia and Far East. Bot. Zhurn. *58*, 1331-1342.

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