Geographical distribution

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5. Geographical distribution

The geographical distribution of the studied diploid taxa is presented in Figs. 6 - 11.

Cardamine granulosa (Fig. 6)

The actual area of this taxon seems to be confined to the hill region in the surroundings of Turin, Piedmont. The most of other reports are rather doubtful. It can be assumed that *C. granulosa* might still occur in southern Piedmont; however, the authors have not seen any material from this region. LÖVKVIST (1956) has previously reported similar plants from the surroundings of Pisa. The authors have some diploid plants collected from three hatitats in Tuscany; they are not included into the present investigations yet at least the colour of their petals is different from that of *C. granu-*

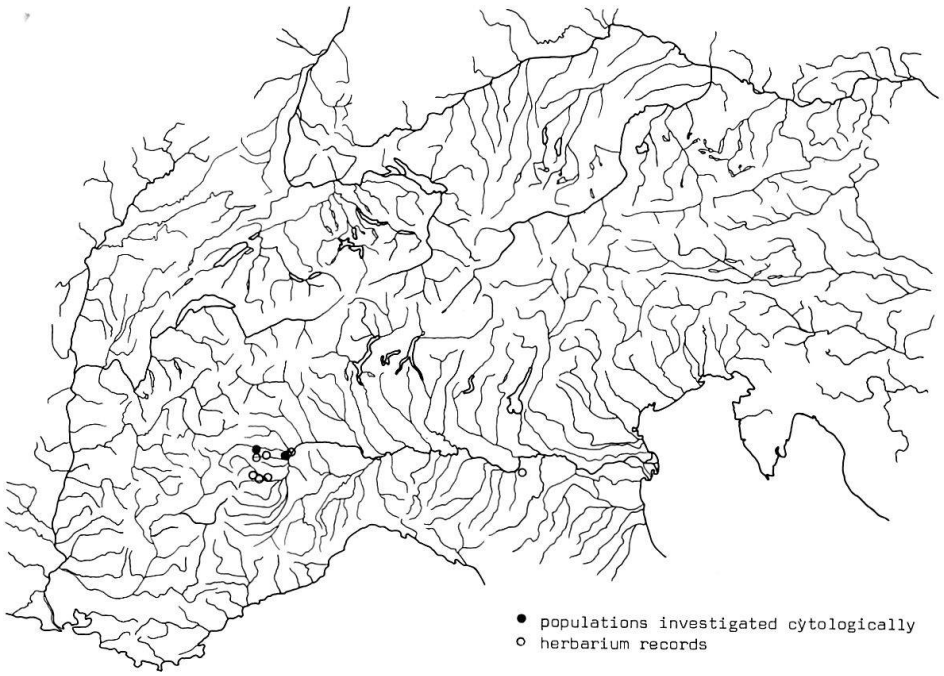

Fig. 6. Geographical distribution of *Cardamine granulosa*

losa (violet versus white). On the other hand, we have seen herbarium specimens from Guastalla (Emilia) which belong to *C. granulosa:* the plants might have arisen from seeds that were incidentally brought down from the Piedmont by the Po river.

Cardamine Matthioli (Fig. 7)

According to the bibliographical data, *C. Matthioli* has its main center of geographical distribution in the eastern part of Central Europe, being especially frequent in Hungary. It spreads from lower situated stations in Romania and Bulgaria towards the Eastern Alps and occurs south of the Alpine ridge up to the western part of the Piedmont. It should be noted that in the regions situated south of the Alps, *C. Matthioli* occurs in a series of minute, disjunct areas; in spite of numerous previous records,

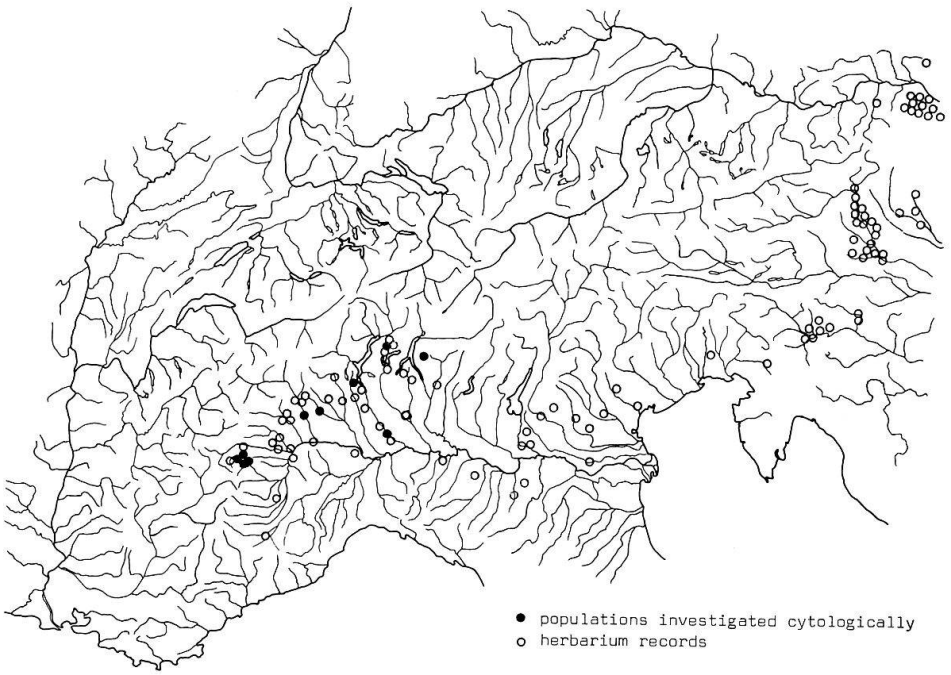

Fig. 7. Geographical distribution of diploid *Cardamine Matthioli*

the present authors found there only rare, small and isolated populations. Solely in the surroundings of Pinerolo (Piedmont) is *C. Matthioli* still relatively frequent.

Cardamine udicola (Fig. 8)

Only two regions in which diploid *C. udicola* occurs are actually known: 1) the surroundings of the Lake of Thun and 2) southern Ticino. However, the herbarium data point to a wider original distribution of this taxon. It should be added that numerous stations, ecologically similar to those of the diploids, are actually inhabited by the tetraploids (2n=32) or the pentaploids (2n=40) which have rather wide geographical distribution; it

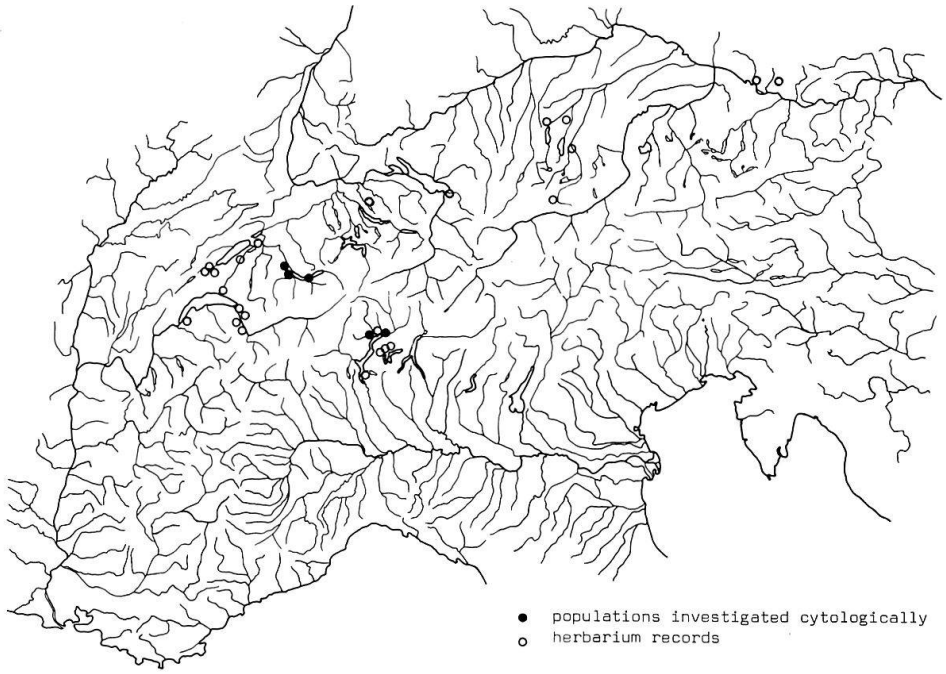

Fig. 8. Geographical distribution of diploid *Cardamine udicola*

seems rather significant that out of three stations studied by the present authors in the surroundings of the Lake of Thun, two comprised not only diploids but also numerous tetraploid plants of *C. udicola*. Morphological and genetical affinities between diploids and tetraploids remain to be further investigated.

Cardamine rivularis (Fig. 9)

Principal area of distribution of this taxon corresponds to the mountains of Central and Southern Europe. It occurs also in Bulgaria (the Rila Mts, the Rhodope Mts), in Romania (SE Carpathians) as well as in the Appenines (Emilia). There are some records of *C. pratensis* from mountains of Yugoslavia and Greece; however, the authors have not seen any herbarium material from this latter region. On the other hand, some diploid plants found in Central France (Mt. Mézenc, Mt. Aigoual) appear to be similar to *C. rivularis*. LÖVKVIST (1956) has referred to some stations of *C. rivularis* from the Pyrenees; however, the authors have neither found any plants of this taxon in nature, nor have seen them in the herbarium material. According to the recent report of BERNARD (personal communication), diploid plants belonging to *C. rivularis* occur in the Vosges (Etang Noir du Frankental).

The area of distribution of diploid *C. rivularis* within the Alps is remarkably discontinous. This taxon is rather frequent in the Eastern Alps, above all in Styria. It also occurs in numerous stations situated within the middle part of Northern Alps between Säntis and Reuss. By contrast, only a few localities of the diploid have been found hitherto in NW Alps.

It seems probable that this situation is at least partly caused by a competition from polyploid mountain types belonging to the *C. pratensis* group.

Tetraploid plants morphologically similar to *C. rivularis* were found in numerous stations. In most of the studied habitats they formed populations that were cytologically uniform; only once a tetraploid plant has

been found within otherwise diploid population (see p. 81). However, the pollen tests performed on an ample herbarium material suggest an occurence of such mixed populations within rather a wide geographical range. It should be added that tetraploids are particularly frequent in the middle part of the Northern Alps, between the Glarus Alps and Haute Savoie; on the other hand, there are some large parts of the Alps, in particular in Central and Southern Alps, where no mountain plants belonging to the *C. pratensis* complex are known.

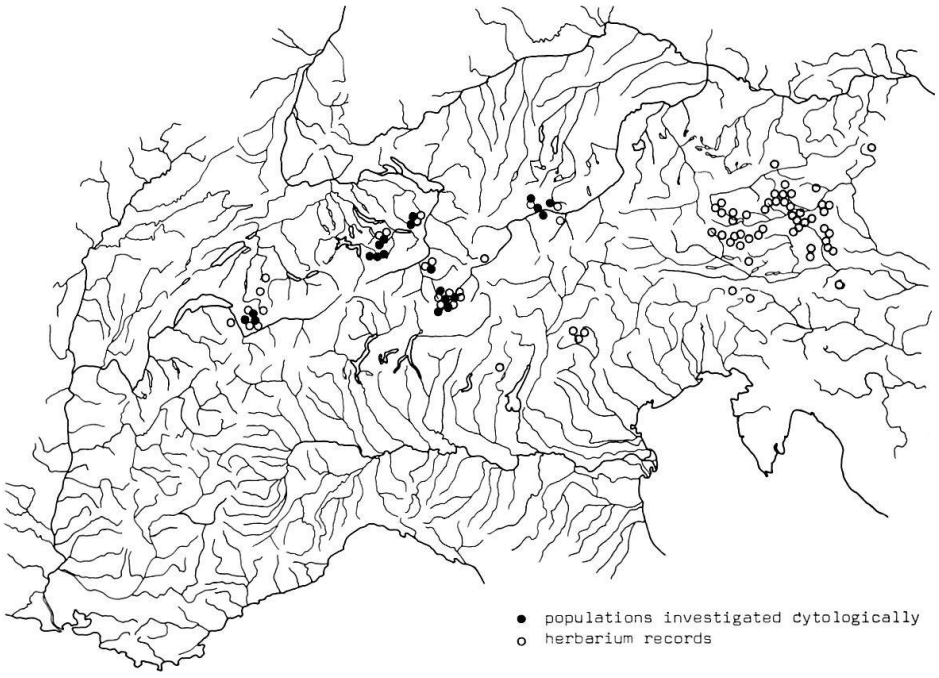

Fig. 9. Geographical distribution of diploid *Cardamine rivularis*

The plants from Tyrol, formerly assigned to *C. rivularis* (Table 4, Fig. 9), have recently been re-examined. Some of their morphological characters resemble rather *C. udicola*; on the other hand, their chromosomes represent the *C. rivularis* type. This material is to be futher investigated.

Cardamine pratensis (Fig. 10)

C. pratensis is the only diploid taxon that has rather a well-defined area of distribution. It occurs just north of the Alps having its center around the Lake of Constance. One might roughly describe the area of distribution of diploid *C. pratensis* as corresponding to the terrains covered by the glacier of the Rhine during the last glaciation. This area extends only a little further northwards through the Jura to Rottweil and eastwards to Lech and the Valley of the Inn, where diploid *C. pratensis* occurs in some isolated stations.

The area of *C. pratensis* appears somewhat fragmentated at its borders, especially in the eastern part and in the regions where the diploid comes

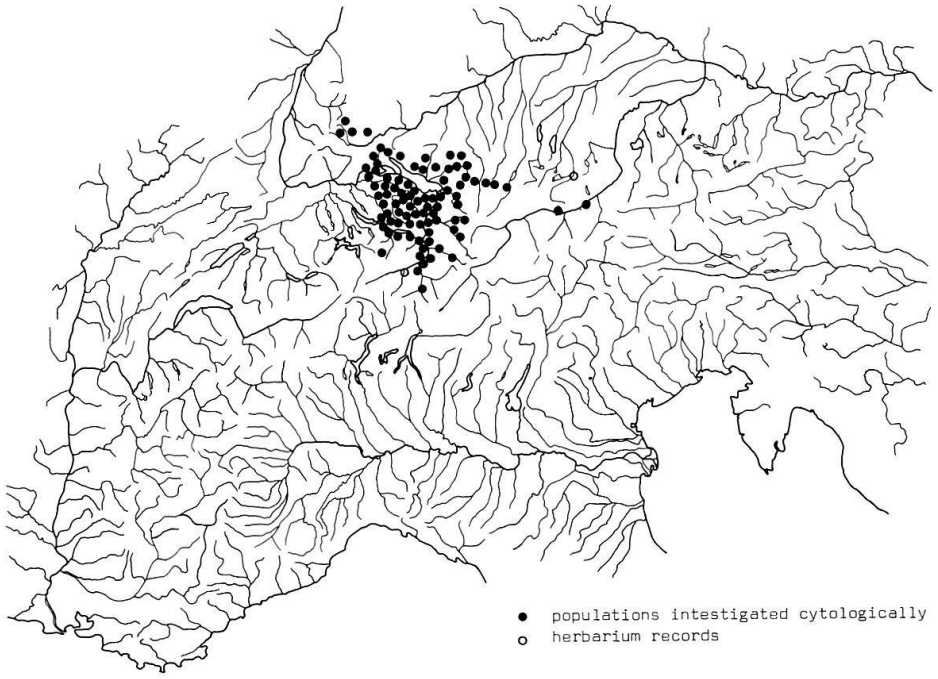

Fig. 10. Geographical distribution of diploid *Cardamine pratensis*

into contact with polyploid types, widely distributed in Europe; however in hilly regions where not too acid soils occur, the diploid *C. pratensis* is apparently an efficient competitor towards the other representatives of the complex.

Cardamine nemorosa (Fig. 11)

The distribution of diploid *C. nemorosa* is very difficult to follow up in view of the fact that the only reliable criteria for determination of the diploid plants seem to be cytological control and the pollen test. It should be mentioned that 30 chromosomic plants, occurring sometimes in the

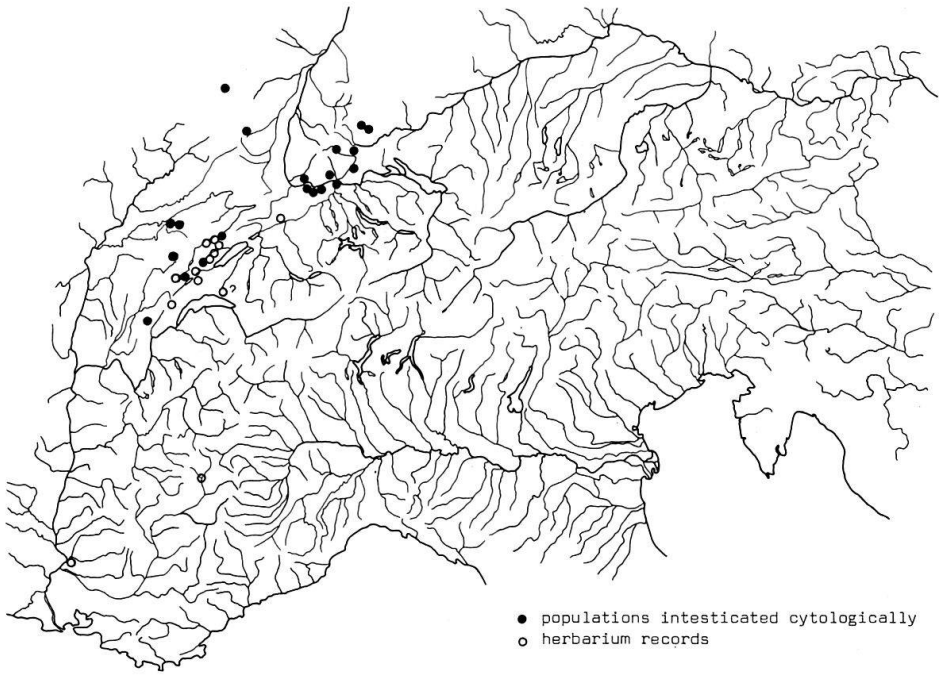

Fig. 11. Geographical distribution of *Cardamine nemorosa*

forests, have rather different ecological requirements as compared to the diploids: they usually grow in more acid and wetter soils. However, the edaphic preferences do not seem to draw sufficient distinctions between the diploids and the polyploids.

As far as the studied region is concerned, *C. nemorosa* appears to be distributed along the Jura ridge and nearly always stays out of the areas covered by the ice sheet during the last glaciation. An isolated station was found in the Vosges (Hohneck). According to rather well-documented, recent reports of DERSCH (1969), *C. nemorosa* occurs as well in Central Germany (Niedersachsen and Hessen).

The list of localities of diploid taxa belonging to *Cardamine pratensis* s.l.

The list given below comprises the authors' own collections marked by asterisks (*) as well as the loan materials. The abbreviations used in brackets correspond to those published in the Index Herbariorum (1964). Most of our specimens will be transferred to the Herbarium of the Swiss Federal Institute of Technology, Zurich.

Cardamine granulosa

Italy

Piemonte : Torino (FI,G,LAU,M,TO), Stupinigi (FI,G,GZU,PAD,TO,Z *), Cremum (TO), Trana (FI) Giaveno (PAD,TO), Venaria Reale (TO), Pinerolo (TO), San Francesco su Avigliana (M,PAD,TO,*), Sacra di San Michele (G), San Germano Chisone (G,GE,M), Pramollo (FI,G,GE,GR).

Emilia : Guastalla (FI).

Cardamine Matthioli

Austria

Niederösterreich and surroundings of Vienna: Mannersdorf (W), Mariabrunn

(GZU,LI), Purkersdorf (FI,GZU,M,W,WU,Z), Weidlingau (FI,GZU,LAU,LI,TO,W), Hainbach (FI,GZU,LAU,RUEB,W,Z), Mauerbach (FI), Wienerwald (W), Zwerndorf (W), Tulnerbach (W), Rekawinkel (W), Pressbaum (FI, GZU,LAU,LI, M, RUEB, W,Z), Altenburg (W), Pfalzau (FI), Achau (W), Breitenfurth (G,M,W,WU), Steinbach (M,W,Z), St. Poelten (VER,W), Feldsberg (WU), Oberbergen (GZU), Neuwaldegg (GZU), Penzing (GZU), Hütteldorf (GZU), Kahlenberg (GZU).

Steiermark : Ruckerlberg (FI,GZU,LAU,LI,RUEB W,Z), Ragnitztal (GZU, W), Graz (GZU), Stifting (GZU), Weinitzen (GZU), Spielfeld (GZU), Gaisberg (GZU), Drassling (GZU), Waltendorf (GZU), Gösteringertal (GZU), Andritzgraben (GZU), St. Peter b. Graz (GZU), Hartberg (GZU), Pernegg (GZU), Saggau (GZU), St. Georgen a.d. Stiefing (GZU), Stainz (GZU), Leibnitz (GZU), Fürstenfeld (GZU), Stubenberg (GZU), Niederschöckel (GZU), Gasselberg (GZU), Krems (GZU), Wenisbuch (GZU), Premstätten (GZU), Lustbüchel (GZU), Autal (GZU), Deutsch-Landsberg (GZU), Heiligenkreuz (GZU), Gleinstätten (GZU), Schönau (GZU), Maria Grün (GZU).

Yougoslavia

Slovenija * : Adelsberg (W), Ober. Radkersberg (W), Tüffer (FI,GZU, LAU,LI,RUEB,W,Z), Radizel (LJU), Ljubljana (LJU,W), Rogatec (LJU), Zavrč (LJU), Borl (LJU), Žička (LJU), Draža (LJU), Pernica (LJU), Biš (LJU), Ptuj (LJU), Hrastenice (LJU), Domžale (LJU), Klenik (LJU), Koseze (LJU), Mertui (LJU), Velika Nedelja (LJU), Celje (GZU).

Italy

Venezia Giulia : Fagagna (FI)

Veneto : Tregnago(VER), Verona (LAU,PAD,VER,W,ZT), Lugo (G,Z), San Martino (PAD), Battaglia (PAD), Castelfranco (PAD), Padova (FI,PAD), Vicenza (PAD), Mestre (PAD).

Emilia : Fontanellato (FI), Carpi (FI), San Savino (FI), Piacenza (FI).

Lombardia : Ponte di Dodici (FI,G,GE,LAU,PAD,W,Z,ZT), Castel d'Ario (VER), Mantova (PAD), San Giorgio-Mantova (FI), San Lanfranco (PAV), Bergamo (PAV), Ballabio (Z,*), Milano (FI), Pavia (FI,LAU,PAD,PAV,VER,W,*), Naviglio (PAV), S. Giuseppe in Valleggio (PAV), Lodigiano (PAV), Carbonara (PAV).

Piemonte : Borgo Ticino (PAV), Arona (*), Varallo (FI,GE), Oldenico (FI), Novarra (TO), Vercelli (FI,G), Sartirana (PAV), Crescentino (FI), Quinto(FI), Viverone (*),

* Plants from Slovenija very often have tinged petals and acute leaflets of lower cauline leaves.
They resemble in this respect *C. udicola*.

Candia Canavese (TO,*), Oropa (TO), Anzaso(FI), Ivrea (FI), Tavagnasco (FI), Cuorgné (G,Z), Torino (PAD,TO), Venaria Reale (FI), Montcalieri (PAD), Leini (TO), Druent (PAD), Front (FI), Stupinigi (TO), Castello Apertote (TO), Collegno (TO), Giaveno (TO), San Germano (FI,G,LAU,M,PAD,Z), Scalenghe (PAD), Pinerolo (FI,G,M,PAD,W,*), Villar Perosa (*), Perrero (G), Martiniana Po (FI), Valdieri (FI).

Switzerland

Ticino : Monte Ceneri (Z), Rivera (Z,*), Bironico (FI,LAU,Z), Origlio (G,LAU), Melano-Capolago (LAU).

Cardamine udicola

Austria

Oberösterreich : Hellmonsödt (LI), Neuhauserberg (LI).
Vorarlberg : Bregenz (ZT).

Germany

Bayern : Wildenroth (M), Moosach (M), Wolfrathshausen (M), Mittenwald (M).

Switzerland

Zürich : Schwerzenbach (ZT).
Bern : Fräschels (BERN), Geistsee b. Gurzelen (BERN,*), Gwatt (BERN,*), Weissenau (ZT,*).
Vaud : Entreroche(BERN,FI,G,GR,LAU,LUGANO,M,Z,ZT), Orbe (G, LAU), Bavois (G,LAU,ZT), Avenche (LAU), Vidy (BERN,ZT), Villeneuve (ZT), Roche (Z), Aigle (LAU).
Valais : Bouveret (Z), Vernayaz (Z), Massongez (Z).
Genève : Belotte (Z).
Ticino : Magadino (BERN,*), Muralto (G), Roncaccio (LUGANO), Locarno (FI,G,Z,ZT), Ascona (*), Muzzano (FI,G,LAU, LUGANO, RUEB,ZT), Ango (ZT), Ponte Tresa (LAU,ZT).

Italy

Lombardia : Angera (LAU).

Cardamine rivularis

Austria

Oberösterreich : Warscheneck (LI).
Steiermark : Schneeberge (W), Scharfes Eck (GZU,LAU,LI,RUEB,W,WU), Zirbitzkogel (GZU,W), Winterleitsee (GZU), Judenburg (GZU), Reitersee-Rottenmannertauern(W), Griesmeier Alm (GZU), Schönfeldspitze-Wözertauern(GZU), Pölsgraben (GZU), Franzstatt (GZU), Planner Alpe (GZU), Hohenwart-Niedere Tauern (GZU), Hohentauernpass (M), Schladminger Tauern (W), Stubalpe (FI,GZU,LI,M,W,WU), Almhaus Stubealpe (GZU), Koralpe (IB), Glashütten (GZU),

Grosses Kar (GZU), Weisswassergraben (GZU), Seekar (GZU), Bärental (GZU), Hühnerstützen (GZU), Reitalm (GZU), Moschkogel (W), Wolfsberg (W), Rosanintal-Gurktaler Alpen (GZU), Schilchernock (GZU), Kallwang (GZU), Obdach (GE), Griesstein (FI,W), St. Lambrecht (GZU), Kuhalpe (GZU), St. Lorenzen b. Knittelfeld (GZU), Rinseneck-Stangalpen (GZU).

Kärnten : Stangalpe (KL), Ebene Reichenau (KL), Waldkogel (KL), Wöllauer Nock (GZU), Katschtal-Hohe Tauern (GZU), Malta-Tal (KL), Himmelberg (KL), Forstalpe (KL), Rinsennock (KL), Winterleitental (KL), Saualpe (KL), Koralpe (KL,ZT), Wandspitze (KL).

Salzburg : Radstätter Tauern (GZU,WU), Passegger Alm (GZU), Taurachtal (WU).

Tirol : Obsteig (IBF), Amras (IBF), Seefeld (IB), Telfs (*), Fernsteinsee (*), Flirsch (*), Haiming (*), Silz (*).

Yougoslavia

Slovenija : Jelovica (LJU).

Italy

Veneto : Alpi Venete (PAD).

Trentino-Alto Adige: Lago di Andermole (PAD), Montalone (FI,PAD), Monti di Torcegno (FI,LAU).

Lombardia : Monte Cadi (FI).

Switzerland

Graubünden : Ftan (Z), Samaden (G,Z,ZT), Bevers (BERN,G,Z,ZT), Celerina (Z,ZT), Serlas (RUEB), Surpunt (RUEB,ZT), Lej da Staz (*), Pontresina (RUEB), St. Moritz (Z,ZT,*), Sils (G,Z,ZT), Silvaplanersee (ZT,*), Maloja (*), Tigias (*), Alp Flix (ZT), Lenzerheide Z,*), Parpan (ZT).

St. Gallen : Schönenbodensee (ZT), Schwendisee (*).

Appenzell : Schwägalp (*).

Glarus : Obersee (BERN), Oberalp (ZT).

Schwyz : Richisau (*), Pragelpass (*), Sihlseeli (ZT,*), Oberiberg (BERN).

Uri : Klausen (G,*), Urnerboden (*), Brunnital (*).

Bern : Jaunpass (BERN), Stierendungel (BERN,ZT), Lauenental (BERN).

Vaud : Bretaye (BERN,G,LAU), Chamossaire (G), Lac Chavonne (LAU,ZT), Thomalay (LAU), Sazième (LAU), Anzeindaz (LAU), Alpes d'Ollon (LAU), Le Pillon (LAU,*), Les Diablerets (*), Pierre de Moëlle (ZT,*).

France

Haute Savoie : Tourbière Autun (G).

Cardamine pratensis

Austria

Tirol : Vils (*), Innsbruck (*), Weer (*).
Vorarlberg : Nenzing (*), Braz(*), Klösterle (*), Bregenz (*), Hard (*), Dornbirn (*), Bödele (*), Vorder-Mellau (*), Schoppernau (*), St. Anton (*), St. Gallenkirch (*).

Liechtenstein : Nendeln (*), Balzers (*).

Germany

Bayern : Bad Tölz (M), Immenstadt (*), Ober Reute (*), Lindau (*), Opfenbach (*), Isny (*), Wengen (*), Nesselwang (*),Pfronten (*).
Baden-Württemberg: Degersee (*), Tettnang (*), Oberaschach (*), Horgen (*), Balgheim (*), Engen (*), Schiener Berg (*), Moos (*), Stetten (*), Baindt (*), Bad Waldsee (*), Tuttlingen (*), Balsheim (*), Bohlingen (*), Allensbach (*), Liggeringen (*), Beuren (*), Feldmoos (*), Krätermühlhöfe (*), Liptingen (*), Rottweil(*), Neufra (*).

Switzerland

Thurgau : Sonnental (*), Fischingen (*), Bichelsee (*), Balterswil (*), Aadorf (*), Münchwilen (*), Bettwiesen (*), Nettlen (*), Sulgen (*), Hauptwil (*), Pfyn (*), Homburg (*), Salen (*), Matzingen (*), Stettfurt (*), Sonnenberg (*), Freudenberg (*), Thundorf (*), Wolfikon (*), Strohwilen (*), Burghof (*), Hüttlingen (*), Eschikofen (*), Hüseren (*), Mülheim (*), Unter-Hörstetten (*), Hörhausen (*), Reckenwil (*), Lören (*), Steckborn (*).
Appenzell-Ausserroden: Urnäsch (*), Bühler (*), Landmarch (*), Wissegg (*), Rehetobel (*).
Appenzell-Innerroden : Gonten (*), Pfannenstil (*), Brülisau (*).
St. Gallen : Gams (*), Ricken (*), Kaltbruner Ried (*), Bertschis (*), Trübbach (*), Grabs (*), Wildhaus (*), Stein (*), Wattwil (*), Steinach (*), Oberwil (*), Mühlrüti (*), Sirnach (*), Wil (*), Niederwil (*), Brunnardern (*), Altstätten (*), Rheineck (*), Mörschwil (*), Schänis (*), Vättis (*).
Zurich : Elgg (*).
Glarus : Bilten (*), Linthal (*).
Graubünden : Pardisla (*), Andeer (*), Bonaduz (*), Bad Ragaz (*), Bad Serneus (*), Igis (*), Untervaz (*), Chur (*), Ilanz (ZT).

Cardamine nemorosa

Germany

Baden-Württemberg: Erzingen (*), Haagen (*), Wehr (*), Wutachschlucht (*), Wutachmühle (*), Achdorf (*), Balgheim (*).

Switzerland

Aargau	: Sisseln (*), Rheinfelden (*), Zurzach (*).
Solothurn	: Gärisch (LAU).
Neuchâtel	: La Chaux-de-Fonds (*).
Vaud	: Baulmes (*), Le Sentier (*), Risoux (ZT), Pétosan (LAU), St. Cergue (LAU), Grandsonne-dessus (LAU), Mont Tendre (LAU), Feyguire (?) (LAU).

France

Vaucluse	: Sorgues (M).
Hautes-Alpes	: Briançon (Z).
Ain	: Belleydouc (*).
Doubs	: Lac de St. Point (*), Les Prés-de-Vaire (*), Marais de Saône (*), Besançon (*).
Vosges	: Hohneck (*).
Meurthe et Moselle	: Nancy (*).

6. Ecology

The following ecological factors were studied:

1. *Soil humidity.* All the studied species avoid permeable and fast drying soils. Most of them grow in slightly moist sites; they can be found sometimes in wet stations where competition from polyploids does not seem to occur. *Cardamine rivularis* and *C. udicola* show a definite preference for stations characterized by rather a high water table.

2. *Nutrients content.* In general, most of the studied diploids grow in stations rather rich in nutrients. Only *C. rivularis* and *C. udicola* were most frequently found in stations where the soil was rather poor; this behaviour is probably influenced by competition.

3. *Light conditions. C. nemorosa* and *C. granulosa* represent shadow plants that pass most of their development at early spring time. Other species require most frequently open sites or places where the leaves receive the light after grazing or cutting.

4. *pH values of the soil* .(Fig. 12). Two groups were distinguished in the studied material: in the first one, represented by *C. nemorosa* and *C. pratensis*, pH values ranged most frequently from 6.5 to 7.5 and no sites with pH value lower than 5.0 were found. The second group, comprising the other taxa, showed pH values usually varying between 4.5 and 5.5. No stations with pH values higher than 7.0 were observed in this group. As far as