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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

C. granulosa is concerned, only two measurements could have been taken, both values being 5.0.

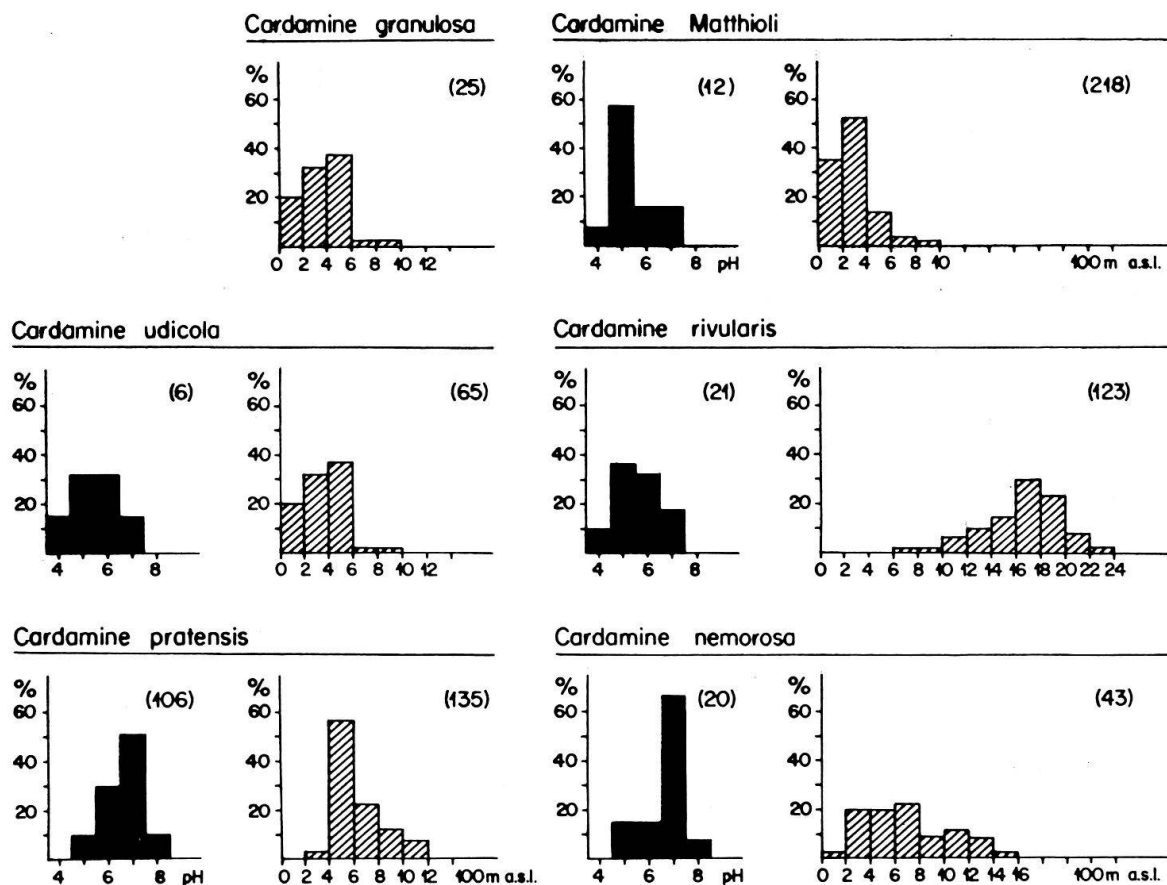


Fig.12. Ecological distribution of diploid taxa of the *C. pratensis* group. Black columns refer to pH values of the soil, shaded ones- to the altitude a.s.l. Numbers in brackets are those of stations investigated in field; data concerning the altitude comprise as well the herbarium records.

5. *Altitude above sea level* (Fig. 12.) *C. Matthioli* decidedly is a lowland taxon that probably does not occur at altitudes higher than 850 m. a.s.l. (Perrero, Piedmont). *C. granulosa* seems to occur within similar altitude limits as *C. Matthioli*; the present investigations confirm the data of LÖVKVIST (1956). *C. udicola*, *C. pratensis* and *C. nemorosa* mainly occur within the colline zone and in the lower montane zone. Rare occurrence of *C. pratensis* in low situated habitats is apparently due to the fact that the stations situated lower than at 400 m.a.s.l. do not occur at all in the investigated area of distribution of the diploid taxon.

The uppermost altitude limit for the diploid *C. udicola*, *C. pratensis* and *C. nemorosa* comport about 1000 m.a.s.l., 1200 m.a.s.l. and 1500 m.a.s.l., respectively. The only diploid taxon occurring within the subalpine zone is *C. rivularis*; lower situated stations of this species occur within high mountain ridges (e.g. Valley of the Inn); the highest known Alpine station was recorded from Styria (Wölzer Tauern, Hohenwart, 2360 m.a.s.l. GZU).

Each of the studied diploid taxa shows its maximal frequency in different types of vegetation; they can as well enter some neighbouring associations, especially when competition is not too strong.

Cardamine granulosa. Half-shadow conditions occurred in both stations studied by the present authors. In the first site, plants of *C. granulosa* were growing in rather not too intensively managed forest meadows and were particularly frequent at the border of a mixed *Castanea*-forest. In the second station, *C. granulosa* grew in a moist soil, at the border of the *Populus*-plantation.

Cardamine Matthioli. Between Pinerolo and Perosa (Piedmont), *C. Matthioli* appears rather frequently in fertilized, manured meadows belonging to the *Arrhenatherion*. By contrast, all other stations studied in the course of the present work proved to be of a different type: *C. Matthioli* was found in wet meadows and swamps rather rich in nutrients and did not occur in neighbouring fertilized meadows. The vegetation within the wet sites represented no stable associations and *C. Matthioli* formed there only small and isolated populations; it can be assumed that this taxon is at the point of extinction in this part of its area. It should be added that the only fo-

rest station of *C. Matthioli* was found by the authors near Pavia: the isolated population of *C. Matthioli* was growing among poplars, in a moist soil.

Cardamine udicola occurred in reed meadows or bogs where the nutrient contents were very low. Plants from the surroundings of the Lake of Thun as well as those from Magadino occurred within the *Caricetum elatae* s.l.; those from Ascona were found in an open shore vegetation growing in a sandy soil.

Cardamine rivularis. Phytosociological affinities of *C. rivularis* are rather well marked: at higher altitudes it occurred most frequently on lake shores or around creeks, within the *Caricion canescenti-fuscae*. Sometimes it was also observed in neighbouring, moist or mossy meadows.

Cardamine pratensis. Diploid *C. pratensis* occurred most frequently in the *Arrhenatherion*, the *Trisetum-Polygonion*, as well as in some associations which bridge these alliances with the *Cynosurion cristati*. It entered sometimes moist meadows in the regions where the polyploids of the group and *C. rivularis* do not occur. Very seldom one could find *C. pratensis* in forests roads or at the borders of the forests; it apparently came there from the adjacent meadows.

Cardamine nemorosa. *C. nemorosa* shows preference for not too dry, base rich stations inhabited by the *Fagion* and appears to avoid sunny sites. It can also be found in bushes bordering the forests and, on limestone-containing soil, under the *Picea*-trees. Single plants enter sometimes neighbouring fertilized meadows or pastures, wet meadows or the *Alnus*-shrubs. It should be noted, however, that in these untypical stations *C. nemorosa* does not seem to stand well the competition from polyploid types occurring around.

The isolated station from the Vosges (Hohneck) presents quite untypical ecological conditions for *C. nemorosa*; it grows there within tall herbs, in a place where the soil is irrigated by base rich water.

Ecological indicators and altitude zones of the diploid taxa

Ecological indicators evaluate the sites in terms of moisture, pH, nitrogen content etc. (ELLENBERG 1952, 1963). The following abbreviations are used below: F - humidity of the soil; R - pH value of the soil; N - the nitrogen content of the soil; L - the light amount. The numbers range from 1 to 5; in each case higher number represents higher indicator for the given factor. The altitude zones are specified according to Hess, Landolt and Hirzel (1967).

Cardamine granulosa: colline. F 3-4, N 3, R 37, L 3

Cardamine Matthioli: colline. F 3-4(4-5), N 3-4, R 2-3, L 4

Cardamine udicola: colline, montane. F 4-5, N 2, R 2-3, L 4

Cardamine rivularis: montane, subalpine. F 4-5, N 2, R 2-3, L 4

Cardamine pratensis: colline, montane. F 3-4, N 3-4, R 4, L 3-4

Cardamine nemorosa: colline, montane. F 3-4, N 3, R 4, L 2-3

7. Cytology

7.1 Chromosome numbers

The diploid level within the *Cardamine pratensis* group is represented by $2n=16$, the primary basic number being thus $x=8$. The present results stay in agreement with previous data (GUINOCHET 1946, MATTICK cit. acc. to TISCHLER 1950, LÖVKVIST 1953, 1956, DERSCH 1969, KUZMANOV and KOZUHAROV 1969, LANDOLT and URBANSKA-WORYTKIEWICZ 1971). It should be mentioned that LÖVKVIST assumed an occurrence of another primary basic number viz. 7 as being of evolutionary importance for the *C. pratensis* group. However, no 14 chromosomic plants have been found in the course of the present investigations; deviating chromosome numbers at the diploid level were invariably hyperdiploid ($2n=17,18,19,20$) and in most of the studied cases the resp. plants apparently represented polysomic types (URBANSKA-WORYTKIEWICZ and LANDOLT 1974).

The origin of the studied material is given in Tables 1 - 6. The studied diploid populations most frequently proved to be cytologically uniform (160 populations out of 208). Cytological variation observed in 48 populations was apparently conditioned not by a single factor but represented diverse aspects. At least three phenomena contributed to the formations of mixed populations: 1) local migrations, 2) gene flow, 3) aneusomy.