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Wissenschaftliche Beiträge von Teilnehmern

Observations on the variability of Trientalis europea L. in Finland, Norway and Poland

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The XIIIth International Phytogeographical Excursion through Finland and Norway offered a good opportunity for studying the effects of increasing geographical latitude on plants. Taking advantage of this opportunity the author made some observations on the phytosociological value of *Trientalis europaea* and on the variability of this species in different environments. For comparison some analogical data from Poland are included.

The basis of the present study is formed by more than 550 herbarium specimens of *Trientalis*, collected throughout the whole course of the excursion, as well as field notes and some phytosociological relevés. Only at the end of her stay in Finland the author was informed that *Trientalis europaea* had recently been studied in that country by H. Hiirsalmi (1961 ms.), a student of Prof. A. Vaarama at the Turku University. "The work has been mainly directed for explication of the features and variation in the reproductive biology of the species" (Vaarama in litt.). The observations presented here — though preliminary — are of a somewhat different character and concern a larger part of the geographical area of *Trientalis europaea.*

The author would like to express her deep gratitude to the Polish Academy of Sciences for giving her the opportunity to participate in the XIIIth IPE, as well as to Prof. A. Vaarama and Mr. A. Hiirsalmi who were so kind as to send the summary of the paper on *Trientalis* in preparation for printing. Sincere thanks are also due to the organizers and to the participants of the XIIIth IPE for their help in collecting herbarium material and to Prof. J. Jentys-Szaferowa for her methodical advice.

Distribution and ecology of the species

In Europe *Trientalis europaea* is most abundant in the coniferous forest zone, but it occurs also in some adjacent regions northward, especially in Scandinavia, as well as southward, roughly as far as the Alps and the Carpathians (maps of distribution: Kulczyński 1924, Lipmaa 1938, Meusel 1943, Hultén 1950, Tolmachev 1954).

In Poland *Trientalis europaea* is a common plant in the lowlands, but it has only scattered localities in the mountains, where it grows in the spruce forests of the Vaccinio-Piceion alliance in the upper montane zone, in the subalpine communities of *Pinus mughus* (Pinion mughi alliance), and in some peat bogs. In the Polish lowlands it occurs most abundantly in the

mixed oak-pine forests of the Pineto-Quercion alliance and in the coniferous forests of the Vaccinio-Piceion alliance: in fresh pine stands and—in the north-eastern part of the country—in pine-spruce stands. Therefore it must be considered as a characteristic species of the Vaccinio-Piceetalia order (Medwecka-Kornaś 1959).

The Finnish localities of *Trientalis europaea* may be divided into two main groups: those situated in the forest zones and those beyond the northern conifer forest limit, in the zone of subarctic and arctic-alpine vegetation. In south-western Finland *Trientalis* occurs in mixed oak-spruce forests where some species of Vaccinio-Piceetalia and some species of the Querco-Fagetea meet (e.g. in Tammisto near Helsinki). In the coniferous forest zone it is very common in spruce stands and in fresh pine stands (Myrtillus type, Oxalis-Myrtillus type, etc.) It occurs more rarely in the Vaccinium vitis-idaea type and does not penetrate into dry pine forests dominated by lichens, similarly as in Poland. In the Finnish boreal zone *Trientalis europaea* may be regarded—as in Poland—as a characteristic species of the Vaccinio-Piceetalia order, in spite of the fact that it occurs sometimes also in peat bogs.

Beyond the coniferous forest limit, in Fjeld Lapland, *Trientalis* becomes very common and may be found in birch woods of *Betula tortuosa*, in shrub communities of *Salix lapponum*, *Betula nana* etc., in tall-herb communities, in woodless heaths, in peat bogs, in snow-beds, on river borders, along roadsides, etc. (Söyrinki 1939, Kalliola 1939). Its ecological scale, astonishingly wide in northern Finland, seems to be still wider in the oceanic region of northern Norway (Fjord Lapland and Maritime Lapland according to Kalela's 1961 division). In Troms Fylke *Trientalis* grows in a great variety of plant communities, even on rocky seashores, home fields and meadows, in the lowland down to the flood limit and up to the wood limit or even higher (Benum 1958). It reaches the northernmost treeless extremities of Europe (Magerö). Therefore beyond the northern forest limit *Trientalis europaea* cannot be regarded as a characteristic species of anyone phytosociological unit.

The part of the geographical area of *Trientalis europaea* under discussion extends through different climatic regions and soil regions of Europe. The life conditions of *Trientalis* are much more uniform in the forest zones than beyond the northern limit of the conifer forests, where the significance of orographic factors and microclimate (especially of the snow factor) becomes very important. The light conditions are another very important factor in the North (on the latitude of 70° N the sun remains over the horizon for 70 days). The amount of light accessible to *Trientalis* in the subarctic zone is even higher, as the plant grows there in open places and not in the forest shadow, as it does in the South.

Tab. 1 Biometrical data for studied samples of *Trientalis europaea* L.[1]

	Localities	Lat. N	Long. E (approximative)	number of specimens	length of the stem in cm		length of the peduncle in cm	
					extr.	mean	extr.	mean
1.	Niepołomice	50° 2′	20° 14′	60	4,5–13,0	9,24	1,1–3,0	2,24
2.	Bielany	50° 3′	19° 50′	57	3,5–12,0	7,02	1,2–4,4	3,02
3.	Tammisto	60° 15′	24° 54′	10	9,2–15,5	12,25	2,7–4,2	3,42
4.	Otaniemi	60° 12′	24° 56′	55	3,0–18,0	9,43	1,4–4,6	2,78
5.	Vaikonjoki	63° 14′	28° 53′	11	4,5–10,0	6,41	2,3–3,2	2,75
6.	Koli	63° 6′	29° 25′	9	12,0–17,0	15,17	2,3–4,4	3,56
7.	Vuotso	68° 6′	27° 3′	59	5,0–12,0	8,46	1,8–5,4	3,31
8.	Kevo	69° 45′	27° 0′	14	5,0–10,0	7,50	2,2–4,3	3,36
9.	Utsjoki (birch wood)	69° 55′	27° 0′	17	4,5– 9,5	6,76	2,1–3,8	2,52
10.	Petsikkotunturi	68° 26′	27° 30′	15	1,8– 5,0	3,03	1,3–3,2	2,47
11.	Karasjok	69° 29′	25° 30′	30	2,2– 7,7	3,94	1,9–4,5	3,27
12.	Mt. Jøvaren	69° 52′	20° 56′	17	1,5– 7,0	4,75	2,3–3,3	2,88
13.	Mt. Javreoaive	69° 36′	21° 16′	9	3,3– 5,2	4,60	2,7–4,2	3,39
14.	Børselv	70° 19′	25° 31′	27	0,6– 7,3	3,29	1,3–4,5	2,73
15.	Honningsvåg	70° 59′	26° 0′	2	2,6– 3,2	2,90	2,9–4,0	3,45
16.	Burfjord River	69° 55′	22° 10′	3	6,5–13,8	9,91	3,0–3,7	3,33
17.	Stabbursdalen	70° 10′	24° 42′	18	4,5–14,5	10,44	3,1–5,1	3,94
18.	Utsjoki (burned place)	69° 55′	27° 0′	31	4,0– 9,5	6,87	2,0–5,5	3,16
19.	Utsjoki (roadsides)	69° 55′	27° 0′	46	2,0–14,0	7,36	2,5–5,3	3,69
20.	Kevo Valley	69° 22′	27° 0′	17	4,5–13,0	8,59	2,9–5,0	3,54
21.	Frognerseteren	60° 25′	10° 45′	32	9,5–27,5	16,25	2,3–5,1	3,85
22.	Reisa Valley	69° 23′	21° 46′	37	11,5–23,5	17,38	3,2–6,3	4,54

Areas of collection

Southern Poland, 12.V.1962.

1. Niepołomice near Kraków, fresh stand of *Pinus silvestris*.
2. Bielany near Kraków, pine-oak forest (Pineto-Quercetum).

Finland, mixed and conifer forest zones, 13.VII.–22.VII.1961.

3. Tammisto near Helsinki, mixed forest of *Picea excelsa* (dominant), *Quercus robur* and *Betula verrucosa*.
4. Otaniemi near Helsinki, fresh spruce forest with *Betula verrucosa*.
5. Vaikonjoki (about 80 km NE of Kuopio), peat bog.
6. Koli (near lake Pielisjärvi), spruce forest with *Athyrium crenatum*.
7. Vuotso, spruce-pine forest on the northern limit of *Picea excelsa*.

Finnish Lapland and Norway, 22.VII.–8.VIII.1961.

extr. = extreme values, mean = arithmetic means. Detailed descriptions of studied characters and localities in the text (pp. 3 and 4)

length of the longest leaf in cm		width of the longest leaf in cm		number of leaves in the main whorl		number of alternate leaves below		total number of leaves		number of peduncles		specimens with verticils below the main whorl	specimens with verticils above the main whorl
extr.	mean	extr.	mean	extr.	mean	extr.	mean	extr.	mean	extr.	mean	%	%
2,30–6,50	4,27	0,80–1,85	1,29	5–10	7,50	0–3	1,69	6–13	9,00	1–4	2,30	1,66	1,66
2,30–5,70	4,15	0,70–1,90	1,36	6–9	6,84	1–5	1,96	7–13	8,86	1–2	1,35	–	1,77
3,20–7,30	5,46	1,10–2,60	1,86	5–8	6,80	1–3	2,10	7–11	8,90	1–2	1,50	–	–
3,00–7,20	4,49	0,75–2,80	1,69	5–8	6,24	1–3	1,67	6–27	8,25	1–2	1,22	9,91	–
3,50–5,00	4,13	1,20–1,85	1,55	5–8	6,09	1–4	1,73	6–17	8,64	1–2	1,36	18,18	–
5,80–9,80	7,46	1,95–3,30	2,53	6–9	6,88	2–4	2,33	8–11	9,22	1–2	1,77	–	–
2,00–6,30	3,75	0,75–2,30	1,47	5–9	5,88	0–3	1,49	6–11	7,37	1–2	1,17	–	–
2,50–4,60	3,64	0,80–2,00	1,49	6–9	7,00	6–9	2,07	7–12	9,07	1–3	2,36	–	–
1,35–2,70	2,05	0,55–1,05	0,81	5–6	5,24	0–2	1,00	5–7	6,23	1–2	1,06	–	–
1,20–2,65	1,76	0,60–1,10	0,80	4–6	5,00	0–2	0,93	5–7	5,93	0–2	0,60	–	–
1,15–4,70	2,48	0,50–1,35	0,85	5–8	6,06	0–3	1,53	6–10	7,60	1–3	1,77	–	–
1,20–3,90	2,61	0,40–1,35	0,99	4–6	4,59	0–2	0,89	4–7	5,46	1–1	1,00	–	–
1,20–2,05	1,65	0,60–0,85	0,72	5–6	5,10	0–1	0,67	5–7	5,77	1–2	1,11	–	–
0,95–4,40	2,19	0,45–2,00	0,90	4–7	4,81	0–2	1,17	4–7	5,59	1–2	1,11	–	–
0,90–1,55	1,72	0,80–0,80	0,80	5–5	5,00	1–2	1,50	6–7	6,50	1–1	1,00	–	–
3,50–5,65	4,64	1,75–2,55	2,15	6–8	7,33	2–4	3,33	8–17	13,67	1–1	1,00	67,00	67,00
2,45–5,60	3,71	1,00–2,25	1,48	5–7	6,50	1–3	1,55	6–18	8,33	1–4	1,65	5,20	5,20
3,00–6,20	4,51	1,45–2,50	1,85	5–9	6,67	2–6	3,16	7–22	11,59	1–3	1,39	32,22	–
2,80–7,40	5,42	1,00–3,70	2,04	5–11	7,63	1–6	3,37	9–36	17,67	1–3	1,90	58,72	58,72
3,00–7,40	5,04	1,05–2,60	1,81	6–9	7,65	1–6	3,41	9–30	15,29	1–3	1,65	41,18	35,29
4,70–8,25	6,59	1,00–3,80	2,25	5–9	6,84	0–4	2,31	6–26	11,25	1–3	1,72	25,00	15,62
3,80–3,19	5,74	0,60–3,30	1,84	4–8	5,89	0–4	2,05	6–11	7,99	1–3	1,54	–	–

8. Kevo (between Inari and Utsjoki), heath wood of *Betula tortuosa* with single pines.
9. Utsjoki, heath wood of *Betula tortuosa*.
10. Petsikkotunturi fjeld near Ivalo, 334 m above sea level; heath vegetation with small single birches.
11. Karasjok region, large fjeld with heath vegetation and small birches.
12. Mt. Jøvaren (S of Reisenfjord), alpine vegetation above the upper birch limit, 100 m above sea level.
13. Mt. Javreoaive (near Nordreisa), birch wood near its upper limit, about 200 m above sea level.
14. Børselv on Porsanger Fjord, dolomite hill; snow-bed in birch wood.
15. Honningsvåg on the island Magerøy, tree-less arctic-alpine vegetation.
16. Burfjord River valley (near Kvaenangen Fjord), birch-pine forest on gentle slope.
17. Stabbursdalen Valley near Porsanger Fjord, the northernmost pine locality; fresh wood of *Betula tortuosa*.

18. Utsjoki, burned place in heath wood of *Betula tortuosa*.
19. Utsjoki, bare sands and gravels along roadsides.
20. Kevo River valley (between Inari and Utsjoki), humid birch wood.
21. Frognerseteren near Oslo, large clearing with single trees in a forest of *Picea excelsa*.
22. Reisa Valley (northern Norway), humid wood of *Betula tortuosa*.

Method of biometrical analysis

The herbarium material used for analysis was collected mechanically, without choosing more or less exuberant specimens. Unfortunately the samples are not equally large; the most representative are the data obtained from the most copious ones. Special attention was paid to the features of the habitus of *Trientalis*, because they reflect the best the influence of the life conditions. In each specimen the following characters were studied:

1. length of the stem from the soil surface (where the stem becomes green or brownish) to the main whorl of leaves,
2. length of the longest peduncle,
3. length of the longest leaf (including petiole) in the main whorl,
4. width of the same leaf in its widest part,
5. number of leaves in the main whorl,
6. number of alternate leaves on the main stem below the main whorl (only leaves longer than 4 mm were counted),
7. total number of leaves (including main whorl, alternate leaves on the main stem and all additional whorls),

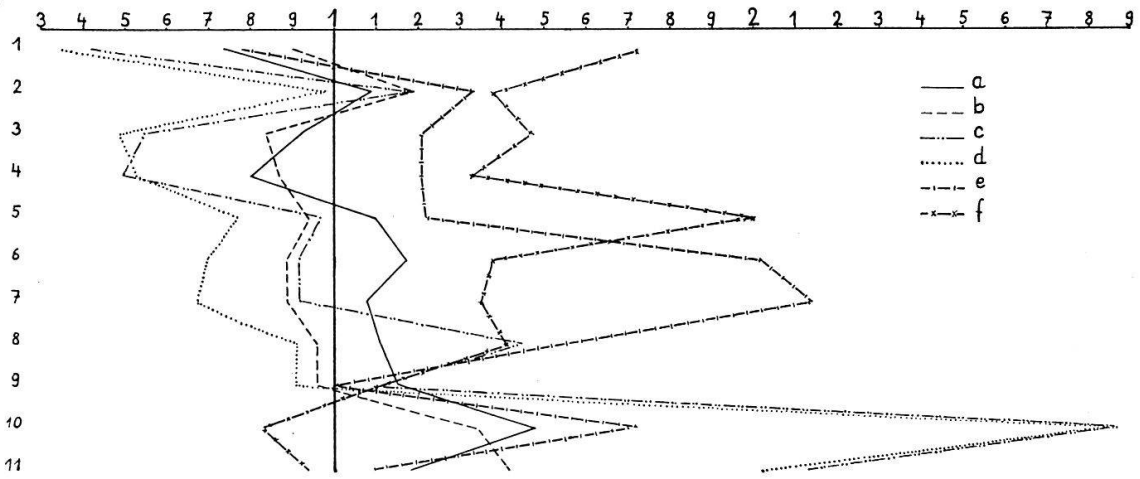

Fig. 1. Comparison of the local samples of *Trientalis europaea* from: a = Bielany, b = Vuotso, c = Karasjok, d = Børselv, e = Utsjoki (roadsides), and f = Frognerseteren with the sample from Otaniemi near Helsinki. Numbers on the left mark the studied characters (numeration according to the text p. 3 and 4).

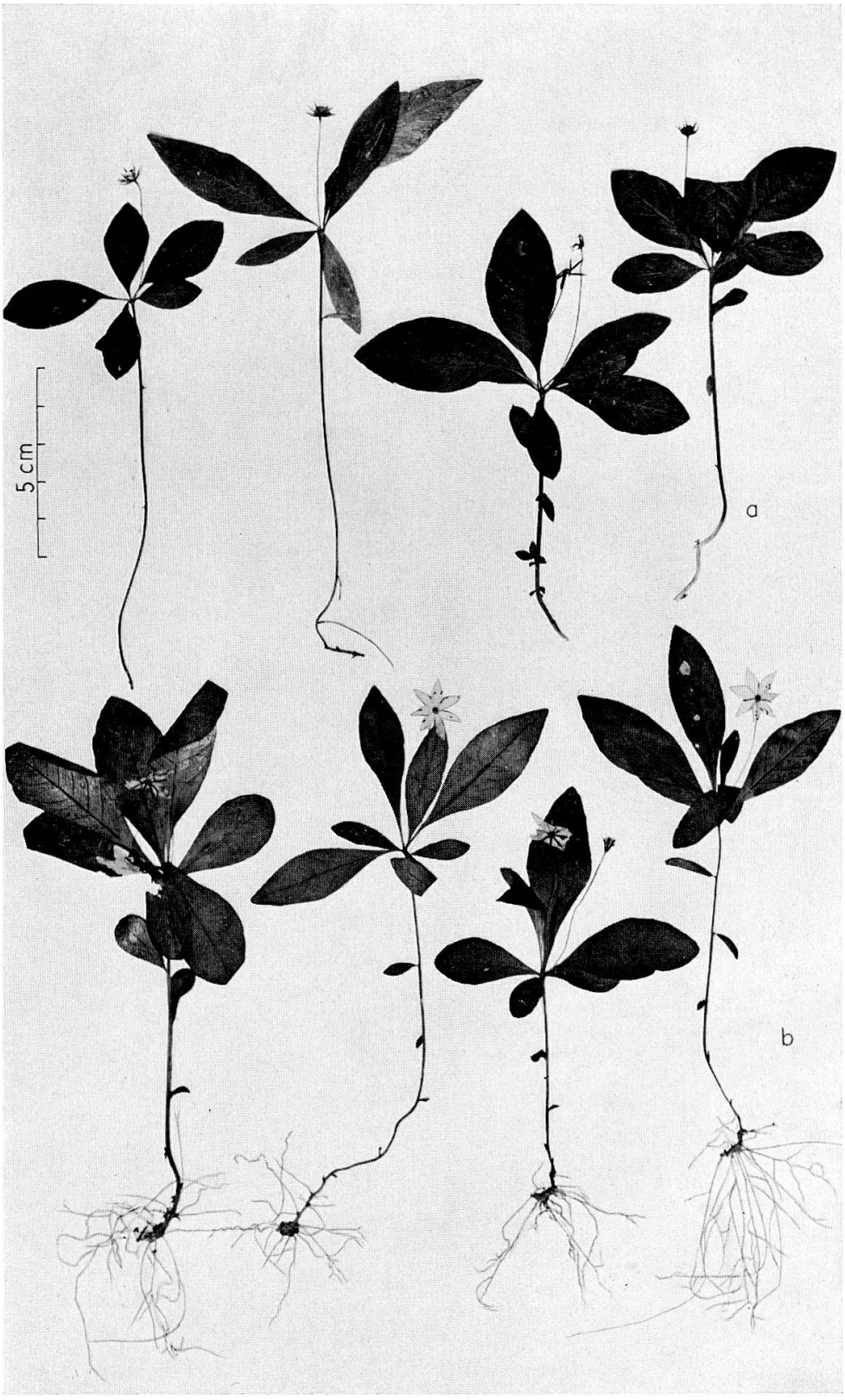

Fig. 2. "Normal" form of *Trientalis europaea:* a = Otaniemi near Helsinki, b = Bielany near Kraków.

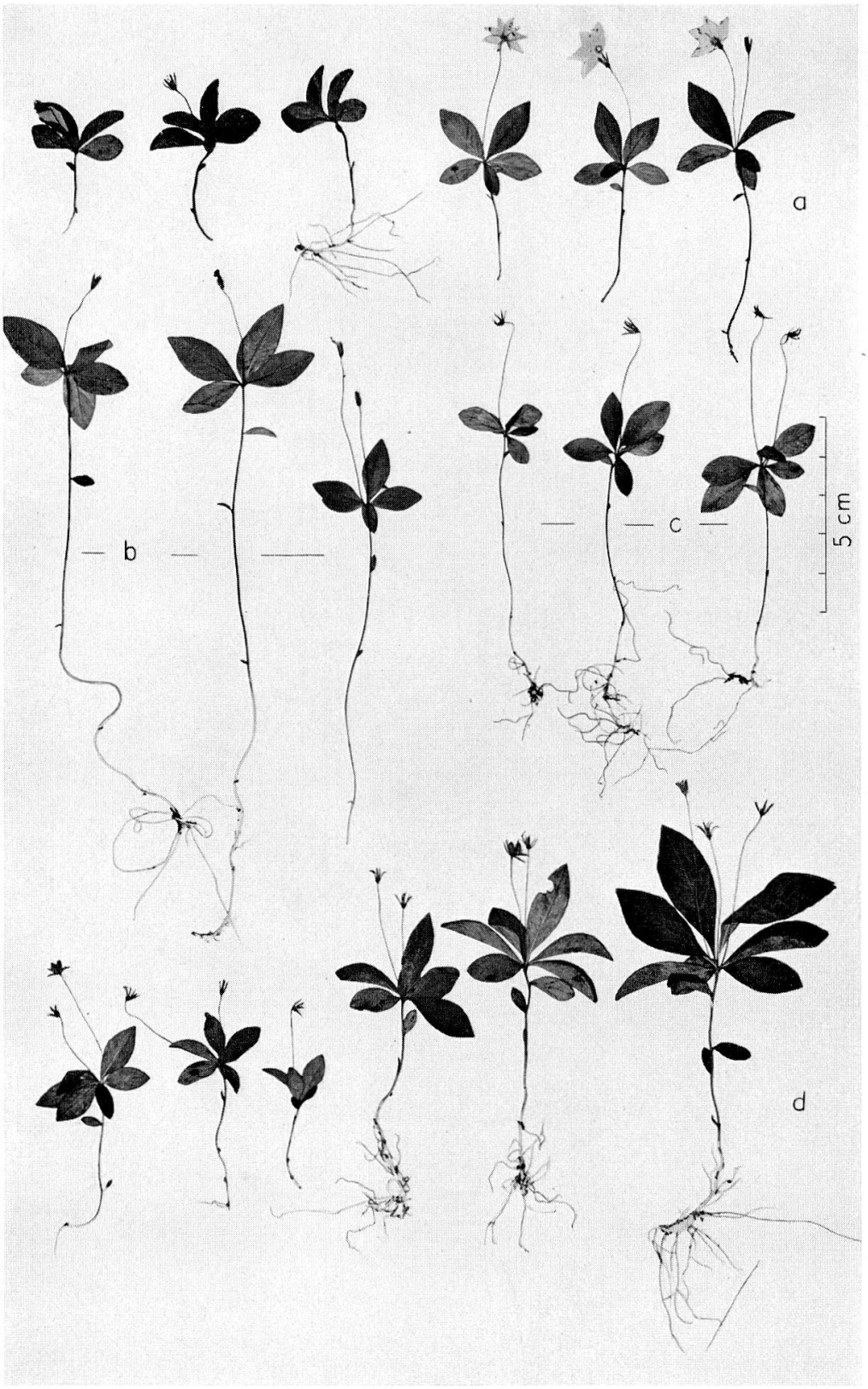

Fig. 3. "Diminutive" form of *Trientalis europaea:* a = Petsikkotunturi fjeld near Ivalo, b = Utsjoki (birch wood), c = Jovreoaive, d = fjeld near Karasjok.

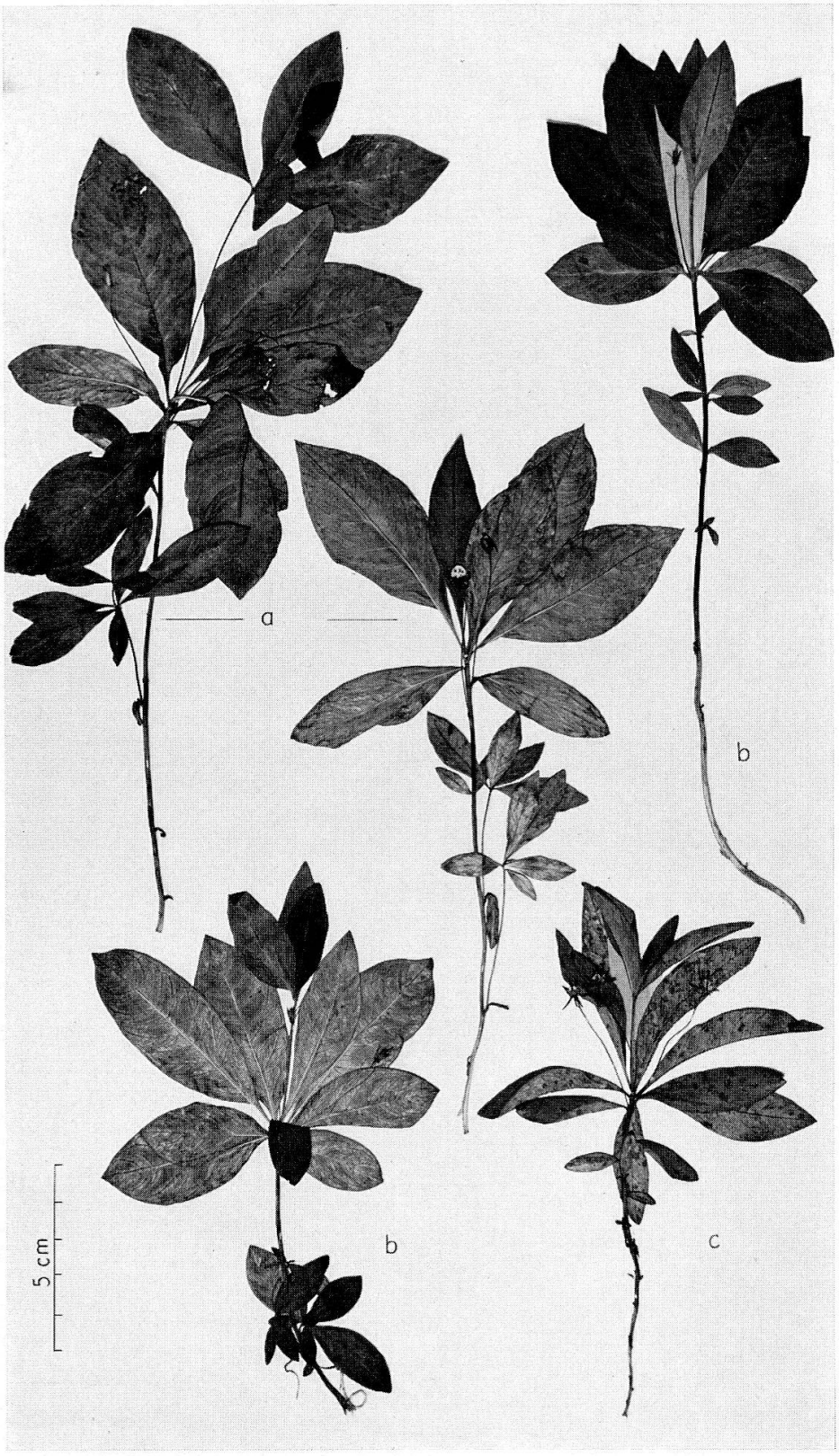

Fig. 4. "Ramose" form of *Trientalis europaea:* a = Frognerseteren near Oslo, b = Utsjoki (roadsides), c = Kevo River valley near Utsjoki.

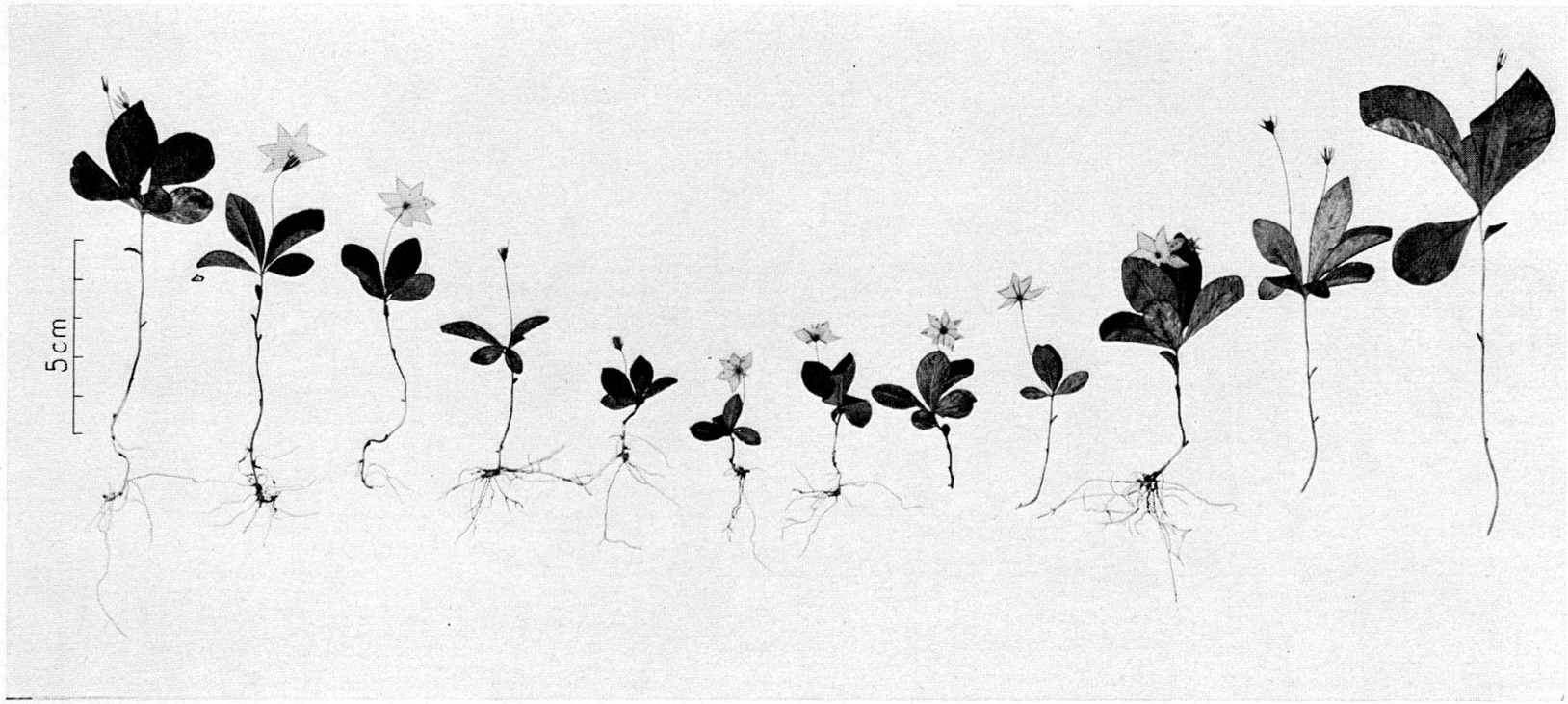

Fig. 5. Sample of *Trientalis europaea* from Børselv. Specimens arranged along a cross-section of a snow-bed, the most reduced ones occuring in the central part with most durable snow cover.

8. number of peduncles,
9. ratio of the length of the longest leaf to its width (character 3 to 4),
10. ratio of the length of the longest peduncle to the stem length (character 2 to 1),
11. ratio of the length of the longest peduncle to the length of the longest leaf (character 2 to 3),
12. percentage of specimens with additional verticils of leaves under the main whorl,
13. percentage of specimens with additional verticils of leaves above the main whorl.

The results of the measurements are assembled in Table 1. The extreme values express the degree of variability within each population, the arithmetic means show the differences among the populations.

In those specimens in which deviations from normal habitus appeared some additional characters were also taken into consideration.

The differences of habitus among the local samples studied are illustrated in the graph (fig. 1), constructed by using the method of JENTYS-SZAFEROWA (1949). Only the most numerous samples are included. As the unit of comparison the mean values of characters of the population from Otaniemi near Helsinki were adopted. For each character of the other samples the ratio $m : m_1$ of the mean of the ompared sample (m) to the mean of the standard unit (m_1) was calculated and marked in the system of coordinates. The vertical line of this system designated by cipher 1 represents the comparative unit, the values greater than 1 being marked with points on the right and those smaller than 1 on the left of this line. The points for each sample were joined by lines and thus the "line of shape" of every sample was obtained.

Morphological variability and distribution of the different forms

On the basis of the material studied three groups of populations of *Trientalis europaea* may be distinguished.

1. The populations from Poland and Finland south of the forest limit are composed only of individuals which may be considered as the most common "normal" form of *Trientalis europaea* (fig. 2). The simple, erect stem, 3–18 cm tall, bears 1–5 alternate leaves below a whorl of 5–10 larger leaves at the summit. The longest leaf in the main whorl is (2) 3–7 (10) cm long and 0,7–3,3 cm wide. The peduncles, 1–2 (4) in number, are usually shorter than the leaves or are only slightly longer. The lateral branches are lacking or are represented only by small initials.

2. The majority of populations studied in northern Finland and northern Norway belong to the second group, in which small individuals prevail (fig. 3). This "diminutive" form usually has very short stems of only (0,6) 1,5–10 cm. The leaves are very small – the longest ones in the main whorl 1–4 (5) cm long and 0,4–2 cm wide, the leaves below being usually less than 1 cm and not numerous (0–3). The peduncles, however, do not show any reduction of length and are therefore much longer than the leaves.

3. Some populations from the North (e.g. numbers 19 and 20) and one from the Oslo region (number 21) represent the third group, composed of exuberant individuals with very leafy stems. The longest leaves in the main whorl are here (2,5) 3–7,5 (8) cm long and 1–3,8 cm wide, the longest stem found attaining more than 27 cm. Many individuals of these populations are branched. In this "ramose" form (fig. 4) the stem bears 1–4 additional verticils of leaves below the main whorl in very short or somewhat longer (up to 6,5 cm) lateral branches. Additional verticils with a total of 20 leaves of different sizes per specimen were found. Often also 1 or 2 additional verticils on the stem above the main whorl develop—in its "first floor" there are 1–4 (usually 3) leaves, in the "second floor" 2–3 (4) leaves. The peduncles stand in the axis of leaves of the main whorl and are usually shorter than these leaves.

The three morphological forms of *Trientalis europaea* are not strictly separated. The "normal" form passes over gradually into the "diminutive" one toward the North; the samples from the vicinity of the northern conifer forest limit show an intermediary character (e.g. Vuotso). Within the area of distribution of the "diminutive" form individuals very similar to the "normal" form occur (fig. 5); also individuals with initial branches were found there (e.g. burned place in Utsjoki, sample number 18). In some specimens of the "normal" form initials of the lateral branches also were observed, even in the Kraków region. The population from the Reisa valley in North Norway is composed of very exuberant individuals which however resemble the "normal" form from Finland and Poland.

The three morphological forms of *Trientalis europaea* occur mostly in different habitat conditions and show a different geographical distribution. The "normal" form is a forest plant and has the largest known area reaching from Poland to northern Finland. The "diminutive" form has a distinctly northern character. It was found only beyond the limit of the boreal forest on the fjelds of Lapland, especially in windy and relatively dry places, in the subarctic birch forest dominated by dwarf shrubs (*Phyllodoce coerulea*, *Empetrum nigrum*, etc.) producing a very compact layer of roots, in snow-beds, etc. Specimens similar to this form collected in Central European

mountains (Czechoslovakia: Rudohoři, 1200 m above sea level) are represented in the herbarium of the Botanical Institute in Kraków. The "ramose" form was found on the peripheries of the distribution of the "normal" form in the Utsjoki region, which has a continental subarctic climate, as well as in the Oslo region with a temperate oceanic climate. The growing places of the "ramose" form at Utsjoki were situated on the valley bottom, on alluvial river deposits, as well as on bare sand and gravel in dug places along roadsides. The last locality was situated in the neighbourhood of the locality of the typically "diminutive" form in birch wood. The "ramose" form from the Oslo region was collected on a large clearing in a spruce forest.

Discussion

The author's observations show that the species *Trientalis europaea* is much more variable than is usually assumed (Pax, Knuth 1905, Lüdi 1926). The range of this variability is rather narrow in Poland and in the forest zones of Finland, where the "normal" form occurs almost exclusively. However, this range of variability is much wider in northern Fennoscandia, where the species seems to have an especially high vitality and where both the small, but profusely flowering "diminutive" form and the exuberant "ramose" form occur.

The variability of *Trientalis* seems to be connected with the general climate, but it seems also to be greatly modified by local conditions of microclimate (e.g. the snow factor, fig. 5), and soil, plant competition, etc A proof of this fact is the existence of the "diminutive" form and the "ramose" form some few metres from one another in different habitats in the North (e.g. in Utsjoki, sample numbers 9 and 19).

The taxonomic status of the three forms of *Trientalis* described in this paper cannot yet be defined. According to the author's observations they seem to be rather modifications, formed under the influence of different environments. This seems to be indicated e.g. by the fact that individuals of the "normal" forest form from the vicinity of Kraków began to develop additional verticils of leaves after transplantation into a open place in the garden. Hiirsalmi (1961 ms.) however is of the opinion that there are obviously also genotypic differences among different populations of *Trientalis* The most common form of the forest zones is diploid, $2n = 160$ (cfr. Löve and Löve 1961), but the triploid was found "in the South in pioneer populations" and in Lapland it is perhaps in many places a dominating condition (Hiirsalmi op. cit.). It would be interesting to examine whether there exists any correlation between the chromosome numbers and the morphological

forms described in this paper. The present author intends to analyse some materials concerning this question and to discuss some problems of taxonomy in *Trientalis*, e.g. the relations of the Scandinavian forms to those described by Iljinski (1921) from the Leningrad region (for. *ramosa* Iljinski and for. *arcticaeformis* Iljinski).

Some data seem to indicate that there exists a parallel variability in other species of the genus *Trientalis*. A form with additional verticils was found in *T. borealis* of eastern North America (for. *pluriverticillata* Marie-Victorin and Rolland-Germain 1942, Lepage 1946). In *T. latifolia* of western North America individuals with adventitious branchlets on the stem are sometimes reported (Abrams 1951).

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Einige Vergleiche zwischen der temperaten und der borealen Waldvegetation

Von A. Scamoni

Die XIII. Internationale Pflanzengeographische Exkursion bot einen ausgezeichneten Einblick in die boreale Waldvegetation Finnlands, der wirksam durch die Veröffentlichungen von Kujala (1961), Kalela (1961) und Jalas (1961) ergänzt wurde. Es tauchte immer wieder die Frage auf, welche Beziehungen zur Waldvegetation der temperaten (syn. boreomeridionalen) Zone gegeben sind und ob ein solcher Vergleich überhaupt möglich ist.

In der borealen Zone geben Fichten-, Kiefern- und Birkenwälder der Landschaft das Gepräge, während im temperaten Bereich Laubwälder von *Fagus silvatica*, *Carpinus betulus*, *Quercus petraea* und *robur* im natürlichen Zustand bestimmend sind.

Abgesehen von der Verschiedenheit der Artengarnitur beider Bereiche, treten auch andere Kombinationen der Arten auf. Unterschiede in der ökologischen, somit auch soziologischen Amplitude von Arten (s. Passarge, 1958) machen sich bemerkbar.

So erscheint für die boreale Zone, wie bereits ausgeführt (siehe Scamoni und Passarge, 1959), eine eigene Vegetationsgliederung notwendig, da eine solche für den gesamten eurosibirischen Bereich unzweckmässig ist.

Es fragt sich, ob dennoch Beziehungen bestehen, ob man bestimmte Vegetationseinheiten in beiden Bereichen als vikariierende ansehen kann und welcher gegenseitige Einfluss in der Waldvegetation festzustellen ist.

Rein floristisch gesehen, dringen eine ganze Reihe von boreomeridionalen Arten (Meusel, 1943) nach Norden vor (siehe auch Kalela, 1960, Hultén, 1950), und recht viele boreale Arten sind im temperaten Bereich vorzufinden.

Für den vegetationskundlichen Vergleich ist eine solche floristische Betrachtung sehr wertvoll, muss aber durch den Vergleich der Listen und Tabellen der Vegetation ergänzt werden.

Auf die XIII. IPE zurückkommend, wäre die boreale Waldvegetation als Vergleichsbasis zu nehmen, deren Kenntnis aus Finnland uns durch die umfassenden Forschungen über die Waldtypen vermittelt wird.

Die geniale Konzeption des Waldtyps von Cajander (1909), die in Mittel-