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SLOPE AND DUNE VEGETATION OF NORTH JUTLAND

I. HIMMERLAND

BY

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I. Introduction.

After the investigation of the slopes, hills, and coastal fields of Sealand (see BÖCHER 1945) a desire naturally arose to undertake similar investigations in Jutland. As the area of study North Jutland was chosen, the large number of steep coastal slopes in the Limfjord regions and the chalk hills in Thy, the Hanherreder, and Himmerland offering particularly many interesting and suitable localities.

We have divided our material of investigations of the slope and dune vegetation into two sections, one dealing with the Himmerland localities (the present paper), the other with the Hanherreder and Thy (the neighbourhood of Svinklöv, Bulbjerg and Hanstholm).

In order to avoid misunderstandings it should at once be emphasized that the term slope and hill vegetation is used to denote the dry or half-dry grass-herb vegetations on hills and slopes. Wood and *Calluna* heath on the hills have only been included when bordering on the grass-herb vegetation and showing certain characteristic or interesting stages of transition.

The material has been arranged partly topographically, partly according to plant communities. In the topographical section we call attention to the placement of the communities in the terrain and to the problems connected with the vegetation complexes of the various localities.

The first-mentioned of the authors has planned the investigations and during the preparation of the material particularly looked after the soil analyses, the systematic arrangement of the material and the preparation of the MS. The second author has determined the mosses collected, while the third has determined the lichens. The hepatics have been determined by Miss EVA CLAUSEN, M.Sc., to whom we offer our cordial thanks. The analyses in nature have been undertaken by all the three authors. We take the opportunity of offering our respectful thanks to the CARLSBERG FOUNDATION for grants towards performance of our investigations, and to the RASK ØRSTED FOUNDATION for a grant towards the translation of the paper into English.

II. The Area Investigated.

Himmerland is enclosed in the north by the Limfjord, in the east by the Kattegat, in the west by Lovns Bredning and Hjarbæk Fjord, and in the south by Mariager Fjord and the Skalsaa Valley. On the survey map, Fig. 1, we have shown

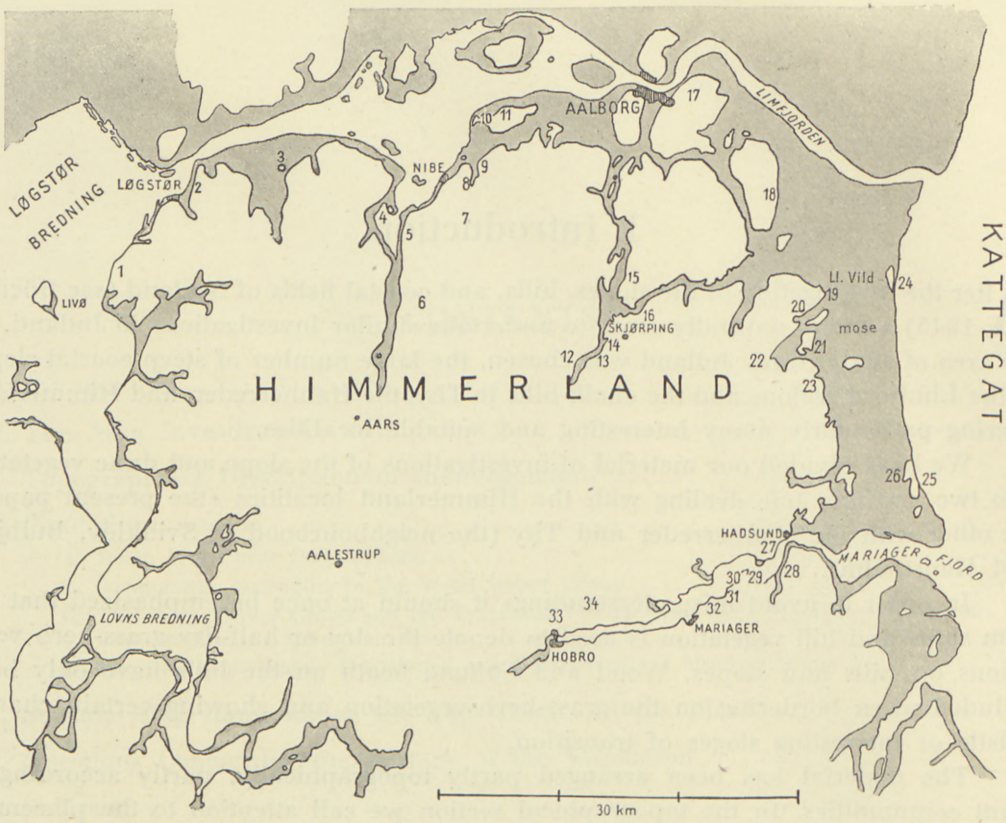


Fig. 1. Survey map of Himmerland. The marine foreland (saltwater alluvium) is rendered with a grey shade (according to Axel Jessen 1920). Further the localities investigated, nos. 1—34, are marked off.

the situation of the localities investigated and the boundaries of the Ice Age deposits. The marine foreland with the valley systems connected with it (former fiords) is represented with a grey shade. The great majority of our localities are situated on old sea or fiord slopes, now separated from the saltwater by an often very broad marine foreland. Other localities are situated on steep hillsides along the river valleys, while very few are found on dry hills inland. The important topographical main feature, the Litorina slope with the broad foreland, is clearly seen in a number of the figures in the following text. Localities near river banks are also represented (Figs. 12—13). Besides, the reader is referred to the thorough discussion of the extension of the Tapes-Litorina sea in North Jutland by Axel Jessen (1920).

Deposits from the Cretaceous Period play a great part in the majority of places investigated. These consist partly of white chalk, partly of later formations (Danien), cf. Ødum (1926) and Nordmann (1943).

The chalk deposits are overlain by Ice Age deposits, particularly diluvial sand. In the steep slopes this depositing is frequently seen, and it leads to a very characteristic zonation of the vegetation. In many steep slopes (e. g. numerous river banks inland) the soil is exclusively sandy. Clayey slopes are also found, although more rarely, the diluvial sand on the whole covering the largest area of this region. In the calcareous localities the soil consists either of chalk (often with some humus) or of sand with numerous pieces of chalk in it (Fig. 2). The latter perhaps is the more frequent.

Fig. 2. Steep slope north of Klithuse (Loc. 10). Sand with pieces of chalk in it. T. W. B. phot. 1943.

The steep slopes of Himmerland more than those of Sealand are devoid of tree growth. Apart from the central Roldskov and the tract of Solbjerg-Skelum the province is very poorly wooded, a fact probably connected with civilization in the country of the ancient Cimbrians being very old. Brøndsted's map shows that the greater part of the diluvial area is closely set with ancient barrows. Only the central wooded area, the Roldskov, and certain minor clayey parts exhibit few or no barrows. So the area does not offer many possibilities of studying the transition between wood and scrub and the open grass-herb vegetation. Parallels of the mixed hardwood forests of Sealand found on coastal slopes are seen particularly in the east, e. g. near Gudumlund, Lille Brøndum and on Mulbjergene. Farther west there is a typical slope wood near Nibe (Lundbæk, see Wiinstedt 1931). There are many remnants of wood or scrub on the banks of the river valleys; the vegetation on the fringes of and near these, however, is mostly of so oligotrophic and heathlike a character, that it may be ignored in this connexion.

Besides, on an analogy with conditions in Sealand it must be assumed that the woody vegetation on the slopes is of the earliest origin, and that only comparatively few spots with unsettled soil (landslip) or a particularly high content of calcium in the soil (cf. Carsten Olsen 1943) are naturally woodless. We shall return to these facts below.

III. Topographical Description of the Vegetation.

The localities are mentioned in a numerical order, i. e. from west to east and south-east, cf. Fig. 1. For the meaning of danish words see p. 76.

1. **Næsby Dale south of Løgstør.** An about 3 km. long seaside slope with fine side-ravines running NW.—SE. or SW.—NE. The west-facing steep slope especially consists of clay and may be almost bare. Mostly, however, it is covered with sea-buckthorn scrub. Both this slope and the side ravines are grazed fairly extensively. Along the northernmost part the west-facing slopes are characterized by considerable landslips. *Tussilago farfarus* makes its appearance on the bare clay. The *Hippophaës* scrubs are influenced by manure from horses and cattle: *Rubus caesius, Galium aparine, Urtica dioeca, Dactylis glomerata,* and *Poa trivialis* are the principal species under and between the bushes. Otherwise *Crataegus monogyna* and *Sambucus nigra* are the only ligneous plants found, and at the bottom further *Geum urbanum* and *rivale, Cirium lanceolatum, Sonchus asper, Anthriscus silvester, Veronica chamaedrys, Clinopodium vulgare,* and *Holcus lanatus* occur. On damp soil appear *Solanum dulcamara, Valeriana excelsa, Filipendula ulmaria, Ranunculus repens, Lathyrus pratensis,* and *Prunella vulgaris.* The sea-buckthorn scrubs continue into the side valleys (Figs. 3—4). Here *Rosa canina* and *Crataegus oxyacantha* appear, too, and at the bottom *Fragaria vesca* in abundance.

The tree- and shrubless vegetation in the two side-valleys is interesting and was thoroughly examined. Exposure to sun and wind seems to be decisive of the occurrence of several species. Most striking is the distribution of *Chrysanthemum leucanthemum* and *Geranium sanguineum.* Both are nearly exclusively found on south- or southwest-facing slopes, but succeed each other so that the geranium species occurs closest to the fiord and the oxe-eye daisy only somewhat into the valleys. *Bellis perennis* and *Plantago media,* on the other hand, are evidently more frequent on the north-facing slopes.

In the northern valley three communities on the sunny side were analyzed and one on the shady side. Inmost on the sunny side we find the *Chrysanthemum* vegetation (Table 4, no. 15), which in the upper part, near the uppermost, driest ridge is superseded by a *Sedum acre-Potentilla reptans* sociation (Table 6, no. 7), which is rich in therophytes and fairly open. Nearest to the fiord on the windy side the slope is adorned with a dense, low *Geranium sanguineum* sociation (Table 4, no. 1 and Fig. 4 in the background). In spite of the fact that the vegetation covers 80 per cent. of the ground only, annuals were missing, a fact which is probably due to seeds and faded plants simply being blown away. The vegetation of the slope facing the north-east (Table 8, no. 17) is very different from the others on the south-facing side. It is a dense grass vegetation very rich in species.

In the southern side valley west of the restaurant the sunny side is not grazed. Here, not far from the shore, there is a *Geranium sanguineum* sociation reminding of a Sealandish slope with high perennials; upwards, on drier soil, it is replaced by a *Filipendula hexapetala* sociation. The soil here is non-calcareous (*p*H 6.0), whereas it contains 10 per cent. $CaCO_3$ (*p*H 7.5) on the *Geranium* slope. The analyses are mentioned in more detail in Table 4, nos. 2 and 11. The opposite side here, too, exhibits a more meadowy flora with a dense grass-covering. The clay here is overlain by sand, which marks the vegetation. The clayey soil is characterized by *Carex flacca, Plantago media, Primula veris,* and *Tussilago,* while the sandy soil was dominated by *Festuca rubra, Agrostis tenuis, Anthoxanthum, Poa pratensis, Rumex acetosa,* and *Trifolium medium.*

Filipendula hexapetala, too, is found in the northern side valley, on sandy soil on the uppermost part of the sunny side. It should be noted that *Geranium sanguineum* in other places, e. g. near Lendrup, is growing abundantly on slopes facing the north-west. Thus it

Fig. 3. Næsby Dale: The northern, large side ravine. The south-facing slope is dominated by *Chrysanthemum leucanthemum*, the slope facing north by sea-buckthorn scrub and dense grass-cover. T. W. B. phot. 1943.

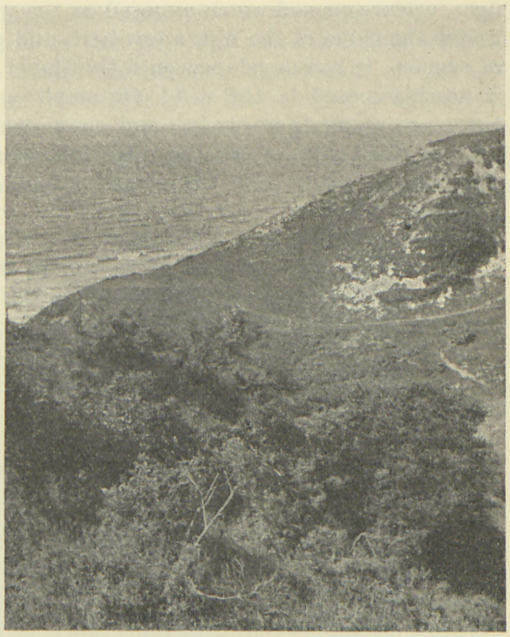


Fig. 4. The mouth of the side ravine shown in Fig. 3. In the foreground sea-buckthorn scrub, in the background the wind-swept southwest-facing slope and Løgstør Bredning. T. W. B. phot. 1943.

might be supposed to be dependent on the drying by the wind and the reduced competition connected with it. This agrees with the fact that it is missing in the protected parts of the side valleys. There is, however, the possibility that the cattle particularly go to the heads of the valleys and that this is the chief cause of the distribution.

2. **The steep slope south of Aggersund.** The west-facing, rather steep, tree- and shrubless slope extends a little more than one km. along the Løgstør-Fjerritslev road, and is separated from the fiord by a narrow foreland, chiefly littoral meadow, but near the foot of the slope, where the soil is drier and sandy, covered with a dry grass vegetation. The soil of the slope consists of diluvial sand, which often contains much chalk. On the uppermost part of the slope the calcareous soil is overlain by a layer of sand of varying depth. At the foot of the slope there is also sand overlying the chalk soil. Pure chalk soil is found only in and near the chalk pit of Aggersund.

A profile transect laid across the slope cuts through a number of communities stretching as narrow zones along the slope. On the plane field near the road below the slope there is first a *Festuca ovina* vegetation (with *Galium verum*, *Achillea millefolium*, *Trifolium campestre*, *Hylocomium squarrosum*, and a few specimens of *Veronica spicata* besides 25 other species). The soil is acid, with *p*H 5.5. The soil near the slope is more sheltered, a little more humid and with traces of chalk (*p*H 6.5); here there is an *Agrostis tenuis-Camptothecium* sociation (Table 7, no. 5). Three zones may be distinguished on the slope: below, a dry fairly high grass vegetation on loose, sandy, but rather calcareous soil (16 per cent. $CaCO_3$, *p*H 7.7; Table 5, no. 10). Next follows a *Briza media-Festuca ovina* sociation, a low, dense vegetation on a fairly

firm, calcareous soil much exposed to the wind (Table 5, no. 11), and at the top, immediately below the ridge of the hill, a low herb and grass vegetation with great richness in and density of species. It has developed on a thin layer of soil poor in chalk above a purer chalk soil, and is much exposed to the wind. On small open spots of ground between the tussocks of grass there are many therophytes, and some small rosettes of *Draba incana* (see further Table 5, no. 12). Sheltered behind the ridge follows a dense, dry grass vegetation, in some places with *Pulsatilla vulgaris* or a few specimens of *Rosa spinosissima*. This uppermost zone was not examined in detail near the vegetation profile, but somewhat farther to the north, where *Pulsatilla pratensis* and *Hypochoeris maculata* made their appearance, too, the former in great abundance (Table 7, no. 4). Here, again, the soil is sandy with a low content of chalk and *p*H 6.9. From here also originates an analysis of the slope with *Geranium sanguineum* dominating (Table 4, no. 3). The soil here was more sandy than in the corresponding place near the profile.

The two species of pasque-flower occur only on the ridge or near it, and nowhere enter in the same vegetation. *Pulsatilla pratensis* is connected with rich sandy soil, but hardly, like *P. vulgaris*, occurs on calcareous soil. *Reseda lutea* was found on the slope only, on chalk near the chalk pit, where it is frequent. *Draba incana* was seen only in the vegetation mentioned, where its occurrence perhaps is connected with the reduced competition caused by wind and drying up.

3. **Marbjerg near Kjølby.** This locality in the Stone Age formed a small holm off the coast. Now it is a hill 40 m. in height, which on all sides is surrounded by flat saltwater alluvium. The hill is chiefly planted, but the steep western slope bears a carpet of *Deschampsia flexuosa*, which from the distance may be seen as a reddish-brown spot of colour. Near the NW. corner of the hill there has been a landslip. At the top there is an old slope from the landslip, covered with *Hippophaës rhamnoides*, below this a fresh landslip. Here it is seen that the hill is built up of calcareous diluvial sand overlain by moraine sand (and some clay). The calcareous sand (*p*H 7.7, $CaCO_3$ percentage 3.6) is loosened and is blown together below the slope. Connected with the accumulations of sand there is a vigorous growth of *Arabis hirsuta*.

Somewhat farther to the north the slope is terraced. On the unsettled soil there is a somewhat mosaic-like vegetation dominated by *Fragaria vesca* and *Avena pratensis*. The large tussocks of the latter has probably been of importance for the formation of the terraces. The greatest differences appear in the bottom layer: In some places we here find *Ctenidium molluscum* or *Camptothecium lutescens*, in others *Hylocomium triquetrum* and *Pseudoscleropodium purum*, cp. Table 8, no. 18.

4. **St. Nicolajs Bjerg near Sebbersund.** This small sandy hilly tract was also an island in the Stone Age, situated in the then two km. broad side-fiord of the Limfjord. Now the locality is surrounded by and connected with the continent by a marine foreland. On the west-facing sides pasture and civilization seem to have been least influential. Our investigations were restricted to this side. Fig. 2 in Plate II gives some impression of the locality. Most northerly (in the background in the figure) there are a few small remnants of scrub consisting of *Crataegus oxyacantha*, *Prunus spinosa*, and *Rosa canina* and with a narrow marginal growth with *Anthriscus silvester*, *Scrophularia nodosa*, and *Astragalus glycyphyllus*, etc. They are surrounded downwards by a luxurious *Geranium sanguineum* sociation (Table 4, no. 8) and upwards by a peculiar, heath-like, dense grass vegetation with *Scorzonera humilis* in abundance (Table 8, no. 20). This, again, farther upwards is replaced by a poor *Festuca ovina-Desch. flexuosa-Armeria* sociation on rather dry soil. Here we find, for the first time, the feature very characteristic of Himmerland: The rich soil overlain with a poor soil and a corresponding zonation of vegetation. Soil samples from the three zones from below upwards showed *p*H 6.1, 4.9, and 4.8.

Farther south the difference between the upper and the lower slope vegetation is also great, but less conditioned by the quality and pH of the soil. The frequent occurrence of *Viscaria vulgaris* on the upper part probably indicates an incipient exhaustion of the soil, but the difference between the upper and the lower vegetation is no doubt chiefly conditioned by the degree of humidity of the soil. At the top there is a dry vegetation rich in therophytes (Table 6, no. 11) or a curious low and dense *Fragaria viridis* sociation (Table 4, no. 10). At the bottom there is a luxurious *Geranium sanguineum* vegetation or in the most humid places

Fig. 5. The south-facing slope of Storbjerg near Djørup. In the *Phleum phleoides* vegetation in the foreground flowering *Filipendula hexapetala* and *Hypochoeris maculata* are seen. In the background heather-covered hills with juniper shrubs and aspen. T. W. B. phot. 1943.

a fine vegetation of tall perennials, such as *Geranium sanguineum*, *Heracleum*, *Filipendula hexapetala* and several others (see Table 4, no. 7 and Fig. 2 in Plate II foreground).

Among details concerning the distribution of the species it may be mentioned that *Scorzonera humilis* was clearly connected with the transition between the poorer and the richer soil and that *Helianthemum nummularium* showed a certain preference for the scrubs, being found particularly round these.

5. **Storbjerg near Djørup.** The slopes along the fiord south of Sebbersund are covered with a rather uninteresting grass vegetation in which there are small spots of heath and aspen scrub. The grass vegetation varies between a dry, oligotrophic *Calamagrostis epigeios* sociation poor in species, a fairly dry *Desch. flexuosa-Holcus lanatus-Rumex acetosa* sociation, and a half-dry *Festuca rubra-Poa pratensis-Rumex acetosa* sociation (the latter on shady sides in small side valleys). Among species requiring more nutrition only *Avena pratensis* and *Filipendula hexapetala* are found; they occur on fresh soil near landslips.

In the side valley north of Djørup, on the other hand, there is on the south-facing valley slope below Storbjerg a very interesting and fascinating distribution of the vegetation.

The side valley running east-west here again is cloven by small hollows running north-south. One of these is seen in the background in Fig. 5. In the hollows there are aspen scrub and some juniper, while the interjacent hills as a rule are covered with heather. On one slope (in front in Fig. 5) the heather, however, is completely superseded by a botanical oasis, *i. a.* in the form of a *Phleum phleoides-Carex caryophyllea-Pulsatilla vulgaris-Hypochoeris maculata-Hypnum cupressiforme* sociation rich in species. The zonation of the vegetation from above downwards here again is mainly due to increasing value and pH of the soil. A thin *Callunetum* at the top and on the upper part of the slope, poor in species, is followed by a small transitional zone characterized by *Scorzonera humilis* together with a few specimens of *Pulsatilla vulgaris*, *Hypochoeris maculata*, and *Galium verum* (*p*H 4.3), and next we find the dense south slope vegetation rich in species (Table 6, no. 4) on soil with *p*H 6.3. In the steepest places this is dissolved into an open dry-slope, a *Phleum-Sedum acre-Tortula ruralis* sociation covering about 75 per cent. of the ground. Farthest down at the meadows there is again a little heath or *Deschampsia flexuosa* sociation. We found a very few particles of chalk in the sand in this place, which is rich in species, but the soil sample from here contained no chalk.

The temperature on this steep, sunlit slope was found to be (on the 27th of June 1943 at 16.45) 37° C. in the grass, 39° C. in the *Tortula* cushions, and 45° C. at the surface of naked spots of ground. At breast height in the shade there were at the same time 21° and in the soil at a depth of 20 cm. 23°. At the bottom of the grass in the meadow below were measured 19° and on the surface of naked dry peat soil in the meadow 25°. A microclimate of this kind is one of the conditions of the above-mentioned richness in species of the vegetation; the other is the richer soil. On the other sunny sides of the valley there was only heath, and abundance of spotted cat's ear indicated a somewhat richer soil.

Here, too, *Helianthemum nummularium* was found in connexion with low scrubs of *Salix repens* and *Populus tremula.*

6. **Hills near Skivum Krat.** The Halkær Aa and the Sønderup Aa fall into the fiord south of Sebbersund. The latter river rises not far from Rold Skov and runs through a beautiful erosion valley to the former branch of the fiord (tunnel valley) through which also the Halkær Aa runs. The sides of the erosion valley are to a great extent covered with oak scrub or low forest, further with heather and thin grass vegetation. The scrub was described by WIINSTEDT (1931, pp. 418—19), who amongst other things gives prominence to great growths of *Calamagrostis arundinacea* in the bottom vegetation and mentions a number of species in and near the scrub which are of particular interest in connexion with the vegetation on slopes and hills. These are *Sedum telephium*, *Clinopodium vulgare*, *Galium boreale*, *Carex montana*, *Campanula trachelium*, *C. cervicaria* (edge of scrub, only a few individuals), *Geranium sanguineum*, *Agrimonia odorata*, *Selinum carvifolium*, and *Melica nutans.* All these species have a more or less easterly distribution, and this is just the case of a large number of species of the slope and hill flora. Several of the species mentioned also grow on bare hills, others preferably occur on the fringes of the wood. It is not improbable that many of the continental slope plants originally exclusively belonged to open light spots at or near the edges of woods.

A south-facing fringe of scrub some distance south of Højris water-mill was particularly interesting in this connexion. Between low oaks, a little hazel, aspen, and juniper there is here a dry sand vegetation dominated by *Festuca ovina*, *Sedum acre*, *Thymus serpyllum*, and *Achillea millefolium.* Among continental-subcontinental species there are here *Sedum telephium*, *Arabis hirsuta*, *Avena pratensis*, *Filipendula hexapetala*, *Pulsatilla vulgaris*, *Pimpinella saxifraga*, *Hypericum perforatum*, *Phleum nodosum*, *Trifolium arvense*, and *Arenaria serpyllifolia.* The oceanic-suboceanic element is represented by *Calluna*, *Filago minima*, *Jasione montana*, *Aira caryophyllea*, and *A. praecox.* Among widely distributed species there are, besides the dominant ones, *Galium verum*, *Hierac. pilosella*, *Plantago lanceolata*, *Lotus corniculatus*, *Agrostis tenuis*, and others, and among mosses and lichens *Ceratodon purpureus*,

Hypnum cupressiforme, Polytrichum piliferum, Camptothecium lutescens, Tortula subulata, Weisia microstoma, Barbula fallax, and *Cladonia fimbriata.* The vegetation was very local. It was only seen on a steep sandy south-facing slope along a stretch of 2—300 square metres.

On a dry east- and south-facing hill north-west of the watermill of Højris there were no continental species, but a characteristic pasture community characterized by juniper and *Antennaria dioeca* and otherwise dominated by *Festuca ovina, Deschampsia flexuosa, Thymus serpyllum, Hieracium pilosella, Lotus, Luzula campestris,* and *Hypnum cupressiforme.* There are several oceanic species here (*Genista anglica, Trifolium campestre* and *T. dubium, Aira praecox,* and *Sieglingia decumbens*) and further *Campanula rotundifolia, Veronica officinalis, Agrostis tenuis, Cladonia tenuis, C. furcata,* and others. The *p*H of the soil was 4.9.

A similar pasture community on acid soil is found in various variants on many slopes of river valleys. At Kobbe's water-mill near St. Ajstrup the hills thus also were quite grey with cat's-foot cudweed, but *Calluna, Genista anglica,* and *Arnica montana* here were more conspicuous. In a particularly steep area there were some specimens of *Viscaria vulgaris,* a species which also stands the fairly good heath soils.

7. **Hills near Voxlev and Klæstrup.** The Binderup Aa in this place passes some very steep slopes facing the east and south. The soil below consists of chalk, above of sand. On the Klæstrup hills a profile was examined from the overlying poor sand vegetation (Tab. 6, no. 12) through a transitional vegetation, where some chalk has been added to the sand (Table 5, no. 9), to a typical chalk vegetation (Table 5, no. 8) near the foot of the slope. The difference in acidity between the sand and the chalk vegetation is very great. The difference in flora is also considerable and is primarily due to the chemical properties of the soil, to a less degree to the increasing humidity of the soil downwards.

The steep chalk escarpment near Voxlev (see Plate IV, Fig. 1) is covered by *Echium vulgare.* The slope is terraced, and the terraces are grazed by cattle. The soil is very unsettled, and the total covering by the vegetation amounts to 50 or 60 per cent. only. Besides *Echium, Poa compressa* and *Ranunculus repens* dominate. Other species found here are *Senecio jacobaea* and *S. vernalis, Chrysanthemum leucanthemum, Tussilago, Hieracium pilosella, Sonchus asper, Centaurea scabiosa, Taraxacum sp., Artemisia campestris, Verbascum nigrum, Calamintha, Daucus, Pimpinella saxifraga, Agrimonia eupatoria, Ononis repens, Medicago lupulina, Sedum acre, Geranium molle, Papaver argemone, Ranunculus bulbosus, Cerastium caespitosum, Dactylis, Phleum nodosum, Festuca rubra* and *F. ovina.* In England similar immigration stages with *Echium* and *Senecio jacobaea* have been described, cp. TANSLEY (1939). At Voxlev there is sand above the chalk at the top of the slope, and here belong small fragments of a *Phleum phleoides-Sedum acre* sociation with abundant *Artemisia campestris, Galium verum, Hieracium pilosella, Thymus serpyllum,* and *Arenaria serpyllifolia.*

The vegetation round the chalk pit at Hulemølle is influenced by civilization. *Medicago sativa* here extends over large heaps of dug-out fragments of lime. These are dark with *Verrucaria nigrescens* and *V. muralis.*

8. **Hills near the stamp mill of Binderup.** The Binderup Aa here glides close to the rather steep east-facing side of the valley (see Fig. 15). It is steepest at the mill (the youth hostel), where the soil contains some particles of chalk. Here the flora suddenly changes character. The calcareous area is characterized by three sociations, in the first place a *Calamagrostis epigeios* sociation poor in species, with scattered specimens of *Filipendula hexapetala, Calamintha, Valeriana officinalis, Hypericum perforatum, Linum catharticum,* and at the bottom *Campylium chrysophyllum, Thuidium philiberti,* and *Camptothecium lutescens.* It is shaded earlier in the afternoon than the other sociations. These occur above each other: at the top a very dry open *Phleum phleoides-Sedum acre-Camptothecium* sociation (Table 6, no. 5) and

below this a slope vegetation more characterized by high perennials (Table 6, no. 6). Both at midsummer time are only shaded from about 16 o'clock.

The contrast between calcareous and non-calcareous vegetation appears from a comparison between the lists of species Table 6, nos. 5 and 6 and the following lists originating respectively from a slope facing north-east and from facing south-east in one of the small cuts into the side of the valley seen in the foreground in Fig. 13. Both vegetations are variants of the oligotrophic, acid pasture vegetation. The dominant species are marked with a !.

Only or mainly on the side facing south-east	On both sides	Only or mainly on the side facing north-east
Hieracium pilosella!	Deschampsia flexuosa!	Poa pratensis!
Festuca ovina!	Achillea millefolium	Rumex acetosa!
Agrostis tenuis!	Festuca rubra	Pseudoscleropodium purum!
Lotus corniculatus!	Anthoxanthum odoratum	Hylocomium squarrosum!
Plantago lanceolata	Ranunculus bulbosus	— splendens!
Thymus serpyllum	Galium pumilum	— triquetrum
Carex arenaria	Calluna vulgaris	Dicranum scoparium
Knautia arvensis	Sieglingia decumbens	Vaccinium myrtillus
Galium verum	Trifolium medium	Potentilla erecta
Erophila verna	— repens	Lathyrus montanus
Trifolium procumbens	Vicia cracca	Galium saxatile
— arvense	Antennaria dioeca	Varonica chamaedrys
Genista tinctoria	Ononis repens	— officinalis
Carex caryophyllea	Cerastium caespitosum	Arnica montana
Filipendula hexapetala	Pimpinella saxifraga	Scorzonera humilis
Hypochoeris maculata		Ranunculus acer
Hypnum cupressiforme		Prunella vulgaris
		Cirsium acaule
		Briza media
		Cynosurus cristatus
		Holcus lanatus

9. **Litorina slope north of Skindbjerg.** Formerly this locality was very interesting. According to Wiinstedt (1931, p. 417) the following species amongst others were found here: *Medicago falcata, Gentiana amarella, Polygala amarella, Arabis hirsuta, Thymus chamaedrys,* and in one place half a score of specimens of *Draba incana.* Now the planting of spruce has led to the extermination of numerous species and, in fact, the original vegetation has practically disappeared. Only nearest to a chalk pit on the Aalborg road a remnant is left (Table 8, no. 14) with a rich moss vegetation and some specimens of *Polygala amarella.*

10—11. **The slopes between Klithuse and Nørholm.** These localities are situated on a former island in the Limfjord (Fig. 1). The slopes consist of sand with numerous scraps (Fig. 2) or smaller fragments of chalk in it. Only at the chalk pit near Klithuse with a very calcareous soil. As a whole the locality is unique because of its abundance in beautifully developed and interesting types of vegetation and ought to be protected against planting. An action for preservation has already been instituted on that account. In Carsten Olsen's work of 1921 there is one vegetation analysis from Klithuse (Table 33, no. 297).

There are particularly two kinds of vegetation: the slope vegetation characterized by chalk and the abundant vegetation on sandy soil (sand-alvar) above the slope. As for the latter it is much varied and rich in species. Physiognomically it is mostly dominated by *Pulsatilla pratensis* and later in summer by *Geranium sanguineum* (cp. Plate III, Fig. 2). On some spots near very low scrubs of *Rosa canina* and *Salix repens* the grass carpet is adorned with *Helianthemum nummularium. Pulsatilla vulgaris* is also found above the slope, but only on some few and small spots near Klitgaarde. On those spots the vegetation has a slightly different character from that in the *P. pratensis* sand-alvar (Table 7, nos. 1—3). Particularly

the species *Armeria vulgaris*, *Anthyllis vulneraria*, and *Trifolium procumbens* are more abundant. A special type is completely dominated by *Phleum phleoides*. It is found on the ridge and the uppermost flat part of the low, dry southern slope at Klithuse (Table 6, no. 2). The soil here is richer and drier. The vegetation downwards on the slope itself is replaced by a *Brachypodium pinnatum* sociation (Table 3, no. 6).

The vegetation on this south-facing slope and the open vegetation on chalk near the chalk pit farthest west (Table 5, no. 16) differs from the other slope sociations by occurring on dry soil. All the slope vegetations facing north or north-west are found on medium dry,

Fig. 6. The north-facing slope at Klithuse. Below an *Avena elatior* sociation poor in species, above a grass slope rich in species, *i. a.* with many flowering specimens of *Leontodon hispidus*. T. W. B. phot. 1943.

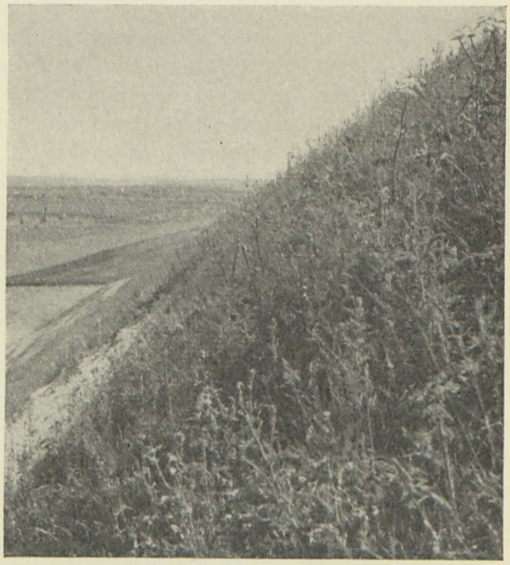


Fig. 7. North-facing slope at Nørholm. Below an open slide of sand and fragments of chalk; above this a tall slope vegetation characterized by *Centaurea scabiosa* and *Heracleum sphondylium*. T.W. B. phot. 1943.

half moist soil. In some of them the moss carpet is greatly reduced because of sand-drift. The sand originates from the area behind the ridge, where German soldiers have dug out the beautiful sand-alvar vegetation as turf. At present *Filipendula hexapetala* forms an interesting pioneer vegetation on the dug-out surface. The vegetations in Table 3 all originate from the north-facing slopes. The various sociations succeed each other, and it is very difficult to form an opinion which circumstances condition this alternation in the carpet of vegetation. In Fig. 6 we see a characteristic transition between a grass slope rich in species and an *Avena elatior* sociation on the nethermost part of the slope. The latter is found on somewhat looser soil than the vegetation above and perhaps may be considered a stage in a succession from vegetation on landslips to vegetation on stable soil. At Nørholm this succession was more conspicuous (see below). The grass slope rich in species contains sociations dominated by *Brachypodium pinnatum*, *Briza media*, *Campanula persicifolia*, *Inula salicina*, *Crepis praemorsa*, or *Silene nutans*.

In spite of the fact that the soil is of the same sort the picture of the vegetation is greatly changed as we pass from Klithuse towards the east to Nørholm (Loc. 11). The slope here is covered by a changing grass cover dominated by *Avena elatior* (Table 3, no. 2), *Festuca*

rubra (no. 3), or by a fairly tall vegetation of perennials characterized by *Heracleum* or *Centaurea scabiosa* (no. 4). As compared with the Klithuse locality the Nørholm slopes are steeper (see Fig. 7) and the soil looser and apt to slide. The unsettled character of the soil must be considered a principal reason for the difference between the two sections of the slope.

On the open landslips an initial vegetation immigrates which is dominated by *Taraxacum* sp. or *Senecio jacobaea*. Other prominent species are *Ranunculus acer*, *Chrysanthemum leucanthemum*, and *Sonchus asper*.

The *Avena elatior* sociation is probably a rather early stage in the overgrowing, or it is dependent on a loose soil apt to slide and form terraces. In contrast to this the *Festuca rubra-Dactylis* moss vegetation is found on a stabler soil. In one place the slope both above and below an area with *Festuca rubra-Dactylis* is steeper and dominated by *Avena elatior*. The sand below *Festuca rubra-Dactylis* is less calcareous, perhaps a sign that a leaching has taken place here. In another less steep place there is a stable soil with *Avena pratensis-Festuca-Dactylis*. In such places there is also an incipient abundance of species (*Koeleria pyramidata*, *Hieracium auricula*, *Campanula glomerata*, etc.) as on the Klithuse slope. The vegetation characterized by *Heracleum* and *Centaurea* curiously enough is attached to the uppermost part of the slope.

12. **The slopes at Oplev.** In the Stone Age saltwater here went more than 20 km. into the country in a south-going tunnel valley. The Oplev and Ræbild slopes (Ræbild Bakker) are situated at the head of this former fiord. While the Ræbild Bakker on the whole are covered with heaths, there are both grass and heather and transitional types between these on the Oplev hills, where there is chalk in the subsoil. A peculiar distribution of plant communities is found at Trindhat Høj. Here the top plateau bears a dry grass vegetation rich in species, while the slope facing north-east downwards is heath. Thus it here looks as if the content of nutrition in the soil may locally rise from below upwards in the terrain. The grass vegetation is dominated by *Festuca ovina*, *Anthoxanthum*, *Sedum acre*, *Thymus serpyllum*, *Hieracium pilosella*. Further *Pulsatilla vulgaris*, *Artemisia campestris*, *Festuca duriuscula*, *Phleum nodosum*, *Trifolium dubium*, *Scleranthus perennis*, *Arenaria serpyllifolia*, *Galium verum*, *Tortula ruralis*, and *Polytrichum juniperinum* are frequent. On east-facing slopes we further find spots of heather, on which there are large numbers of *Viscaria vulgaris*, *Pulsatilla vulgaris*, and *Genista tinctoria*. The transition between the dense *Pulsatilla* sand-alvar and a dry *Corynephorus* field poor in species is formed by the following sociation, which was observed on an east-facing slope near Oplev Krat (the figures denote degree of covering):

Suboceanic species: *Jasione montana* 3, *Hypochoeris radicata* 1, *Calluna*, *Teesdalia nudicaulis*, *Aira praecox*, *Filago minima*, *Aphanes microcarpa* (all + — 1). Subcontinental species: *Avena pratensis*, *Hypochoeris maculata*, *Pimpinella saxifraga*, *Genista tinctoria*, *Hypericum perforatum*, *Viscaria vulgaris* (all +). Widely distributed: *Deschampsia flexuosa*, *Festuca ovina*, *Hieracium pilosella*, *Rumex acetosella* (2), *Agrostis tenuis*, *Achillea millefolium* (1), *Anthoxanthum*, *Luzula campestris*, *Plantago lanceolata*, *Veronica officinalis*, *Cerastium caespitosum* (+). Lichens and mosses: *Cladonia rangiformis*, *furcata*, *chlorophaea*, *Polytrichum juniperum*, *piliferum*, *Hypnum cupressiforme* (+ — 1).

The part of Oplev Krat situated closest to Trindhat Høj consists of oak with scattered beech, hazel, and hawthorn. On the fringe occur *Prunus spinosa*, *Avena elatior*, and *Anthriscus silvester*, and further such species as *Phleum phleoides*, *Hypochoeris maculata*, and *Pulsatilla vulgaris*.

On the opposite side of the valley, a short distance south of Skillingbro, there is an interesting spot of vegetation near an old chalk pit. A road is cut down north of the pit and the vegetation is found as a stripe on the south-facing steep slope along the road. The soil is only slightly acid (*p*H 6.4); undoubtedly it is more acid in the vegetations situated above,

which are characterized by such species as *Calluna*, *Pteridium aquilinum*, and *Pinus silvestris*. As appears from Table 4, no. 14, the vegetation along the road exhibits a rather peculiar constellation of species. It is a *Carex montana-Hierac. pilosella-Weisia microstoma-Thuidium philiberti* sociation, where a high frequency of *Agrostis canina* and *Sieglingia* indicates poorness of the soil.

13. **The chalk escarpment near Lille Blaakilde.** Not far from the source of Blaakilde there are glades in the scrub standing on the slope. The bare spots are covered by a meadow-like chalk vegetation. In several places the chalky ground is completely bare of plants. In CARSTEN OLSEN's paper of 1921 there is a single analysis from this slope (Table 33, no. 296).

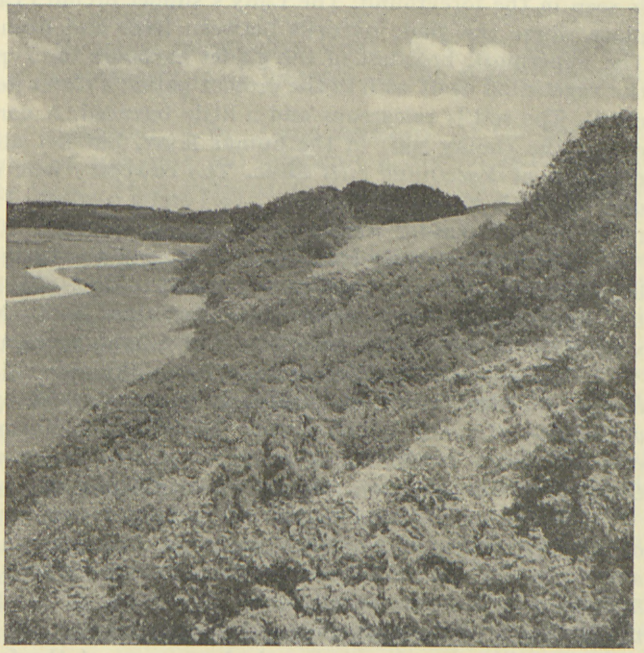


Fig. 8. The northwest-facing slope at Lille Blaakilde. Scrub of *Rhamnus cathartica* and *Juniperus* surrounding an area with grass-herb vegetation. In the background Lindenborg Aa [river]. T. W. B. phot. 1943.

The scrub is dominated by *Rhamnus cathartica*. Besides this we find *Frangula alnus*, *Viburnum opulus*, *Sorbus aucuparia*, *Pyrus malus*, *Quercus robur*, *Rosa canina* and *tomentosa* and *Juniperus communis*. Under the bushes there are particularly *Paris quadrifolia*, *Geranium robertianum*, *Geum rivale*, *Urtica dioeca*, *Ctenidium molluscum*, and *Hylocomium triquetrum*.

The epiphytic flora in the scrub is very abundant. The trunks and the twigs are rather densely grown with the lichens *Pertusaria amara* and *pertusa* (both only on the trunks), *Parmelia fuliginosa* var. *laetevirens*, *P. subaurifera*, *P. sulcata*, *Ramalina farinacea*, *Evernia prunastri*, *Physcia stellaris*, *adscendens*, *tenella*, and *leptalea*, *Xanthoria parietina*, *Opegrapha atra*, *Lecidea olivacea*, *Lecanora carpinea*, *crassula* and *subfuscata*, and *Phlyctis argena*. The moss flora here includes *Neckera complanata*, *Antitrichia curtipendula*, *Hypnum cupressiforme*, *Amblystegium serpens*, *Isothecium* cfr. *myurum*, *Zygodon viridissimus* var. *occidentalis*, *Ulota bruchii*, *Orthotrichum pulchellum*, *stramineum*, *striatum* and *octoblephare*, and the hepatics *Frullania dilatata*, *Metzgeria furcata*, and *Radula complaneta*.

The three analyses from the open parts (Table 8, no. 1—3) show three degrees of growth on the chalky soil. No. 2 is situated on the open chalky gravel and in a place where the soil is liable to slide. In no. 3 we still see the white soil everywhere between grass and herbs. In no. 1 the soil is nearly completely covered.

14. **The Lady's slipper orchid locality at Buderupholm** (cf. JAC. HARTZ in Bot. Tidsskr. 29, p. 447). In the same valley, but farther north, the slope facing north-west is overgrown with a beech-forest. The beeches as at Møns Klint have a crooked, often greatly moss-grown trunk and rarely attain to any great diameter of the trunk. On the forest-floor the vegetation varies greatly. A *Rubus saxatilis* sociation poor in species and a *Calamagrostis arundinacea*

sociation are frequently found. In one fairly great area the soil is calcareous. The place is botanically characterized by an *Equisetum hiemale* growth below the calcareous part of the slope, which, for that matter, is easy to find, as the foresters have erected a tall, dense fence round the whole of the interesting area. Inside the fence there are several glades in the beech-forest, and here, thanks to the fence, there is an abundant growth of *Cypripedium calceolus* and a few specimens of *Cephalanthera rubra*. Both thrive best in the half-open places. The Lady's slipper orchid prefers to have an open sky above it, but bushes and trees in the neighbourhood which throw a shadow over the place of growing. In Plate I, Fig. 1 one of the glades is seen in the foreground. The Lady's slipper orchid (Table 1, no. 2) here is found just in the place where the glade narrows between trees and bushes in the background of the picture. The uppermost, broadest of the glades harbours the type most interesting in connexion with the vegetation dealt with in the present paper, a *Carex flacca-Rubus saxatilis* sociation (Table 1, no. 1). The soil is calcareous and a little terraced. A dark humus layer formed by the mosses covers the chalky soil. In the humus layer, but not absolutely connected with it, there are rhizomes of *Vaccinium vitis idaea*. The cowberry here reaches a frequency percentage of 40 on a soil with *p*H 7.2 (the humus layer) and a content of chalk of 12.4 per cent. Also the occurrence of *Hylocomium schreberi* (Frequency per cent. 90) is remarkable.

The four analyses from the enclosure of the Lady's slipper orchids give a fairly copious impression of both the vegetation exposed to light (Table 1, no. 1) and what might be termed the *Cypripedium* forest-fringe vegetation (nos. 2—3). No. 4 is an example of a forest-floor vegetation in one of the scrublike, fairly light beech-areas on the middle of the hillside.

The epiphyte vegetation on tree trunks and old stumps is also peculiar and remind of that on Møns Klint. It is especially characterized by *Antitrichia curtipendula*, *Anomodon viticulosus*, *Hypnum cupressiforme*, *Neckera complanata*, and *Frullania tamarisci*, to which may be added *Isothecium myurum*, *Zygodon viridissimus* var. *occidentalis* (incl. f. *stirtoni*), *Orthotrichum stramineum*, *Campylium hispidulum* var. *sommerfeltii*, and *Metzgeria furcata*.

The lichens *Pyrenula nitida*, *Opegrapha viridis*, and *Lecanora glabrata* cover great parts of the bark of the trunks. Other species are *Arthopyrenia gemmata*, *Arthonia radiata*, *Opegrapha atra*, *herpetica*, *pulicaris*, *subsiderella*, *Graphis scripta*, *Lecidea olivacea*, *Pertusaria leioplaca*, *leptospora*, and *Lecanora subfuscata*. The thalli of the lichens were often black-spotted from the stromata of the bark fungus *Dichaena faginea*. On thin twigs *Arthonia punctiformis* and *Lecidea olivacea* are growing, and above moss at the foot of the trunks, *Peltigera praetextata* and *Cladonia fimbriata*.

South-east of this locality is Havedalen, which in the west is bounded by Bjergeskov and Vedstedskov, in the east by Skørping Lund. From this place a vegetation analysis has been published by Carsten Olsen (1921, Table 33, no. 295).

15. **Dybdal Bjærg near Voldsted.** The road from Voldsted to Elleshøj passes through a side-valley of the broad Østeraa Valley, which towards the north continues the Lindenborgaa Valley. Between the side-valley and the main valley Dybdal Bjærg is situated, a botanically rich and valuable locality. The sloping area was formerly used for the grazing of sheep; now only the level areas in front of the slope are used for grazing of untethered horses. We made detailed examinations of the slope facing north-east, from which there are four frequency determinations (Table 8, nos. 9, 10, 15, 19).

The uppermost steep slope differs from the rest. Here a number of heath plants dominate (*Vacc. myrtillus*, *Desch. flexuosa*, *Molinia coerulea*) together with such species as *Filipendula hexapetala*, *Hypericum maculatum*, and *Salix repens*. There is here a surface layer resembling raw humus (*p*H 4.9) above gravelly moraine sand (*p*H 5.5). The vegetation varies greatly, *Filipendula*, *Molinia*, *Galium boreale*, or *Vacc. myrtillus* dominating in various places. Among remarkable species we may mention *Carex ericetorum* and *montana* (cf. further Table 8, no.17).

Below, about the middle the slope is often less steep and the sandy soil calcareous. In one place (Table 8, no. 13) the soil was neutral and slightly calcareous (0.3—3 per cent. $CaCO_3$). Here *Pulsatilla vulgaris* is subdominant in a *Briza-Koeleria-Avena pratensis-Hylocomium* sociation. In another place (Table 8, no. 9) the percentage of chalk in the uppermost part of the soil rich in humus is 36, while it reaches 45 at a depth of 4—10 cm. Here the dominants are *Carex flacca* and *Camptothecium lutescens*, and such species as *Crepis praemorsa*, *Cineraria integrifolia*, and *Sanguisorba minor* begin to appear. Finally there is close to a chalk pit a vegetation (Table 8, no. 10) developed on typical chalky soil. In the surface layer 56 and at a depth of 4—10 cm. 70 per cent. $CaCO_3$ were measured. At a depth of 15 cm. there was practically pure chalk. The vegetation is a *Briza-Carex flacca-Crepis praemorsa* sociation with scattered specimens of *Cineraria integrifolia*. There are a few specimens of *Pulsatilla vulgaris*. In this locality it is obviously most frequent on the slightly calcareous sandy soil.

The lowest part of the slope is characterized by *Avena pratensis*. At the foot of the slope there is an area with a less sloping and drier soil (probably a cone of sand originally deposited by water flowing down the slope). Here *Filipendula hexapetala* is physiognomically dominant.

16. **Skindbjerg.** WNW. of Skindbjerg a long ravine opens into the valley of the Lindenborg Aa. On its sides the chalk either reaches the surface or is covered by a thin layer of moraine material. The side of the valley facing west is covered with a low, very open scrub, in which *Juniperus* plays the principal part. *Prunus spinosa* and (particularly upwards) *Populus tremula* dominate in spots. Further *Rosa* cfr. *glauca* is of importance, while *Rhamnus cathartica* and *Frangula alnus* are less conspicuous. Between the bushes there are spaces open to light; the vegetation here appears from Table 8, no. 12.

The scrub in many places has been cut down. Afterwards *Juniperus* is shooting again, forming small groups of low bushes. Decumbent stems remain around the bushes together with dry branches which have been left scattered on the ground. Thus, the vegetation developed here (Table 3, no. 13) is protected both climatically and from the grazing cattle. The dead needles form a thin layer over the chalky soil.

The analysis recorded in Table 3, no. 13 was made in a place where *Crepis praemorsa* was comparatively abundant, found together with such species as *Campanula persicifolia*, *Origanum vulgare*, and *Geum rivale*. The *Crepis* species may also be found a little inside the edge of larger scrubs, where it receives less light, but where, because of the reduced competition, it may spread into large rosettes over nearly bare soil. Curiously enough it was not frequent along the edge of larger patches of scrub which had not been cut down; hence it might seem as if the influence of civilization in the form of the dead stems and branches were of a certain importance for it. The vegetation has a bottom layer of *Hylocomium triquetrum*, a species which was nearly absent in the open spaces. The density of species is slight, but the number of species is high (77). A number of physiognomically important plants, which would also be constants if a larger space had been used for the examination of frequency, have reached low values only (*Cineraria integrifolia*, *Arabis hirsuta*, *Campanula persicifolia*, *Fragaria vesca*, *Pulsatilla vulgaris*).

On the northern side of the valley of Lindenborg Aa, too, the chalk reaches the surface. North-west of the mouth of the side valley just mentioned the slope is covered with different grass-herb sociations, in which amongst others *Polygala amarella* and other calciphilous plants practically always enters. Further there are isolated bushes of juniper in changing abundance. The slope is accessible to the cattle grazing in the valley. From this slope originates the analysis in Table 8, no. 13, which has been made near the foot of the slope, some three metres above the bottom of the valley. Farther up the vegetation is characterized by a drier soil, with more specimens of *Festuca ovina*, *Thymus serpyllum*, perhaps more specimens of

Poterium and distinctly less *Polygala amarella*. Besides *Barbula fallax brevifolia* is abundant, and there are sporadic individuals of *Weisia* cfr. *microstoma* (sterile) and *Thuidium abietinum*.

17. **Vejgaard-Nr. Tranders and Dybdal near Aalborg.** Round the church of Nr. Tranders and north-west of it there are some dry hills rising rather high above the surrounding country. The soil is sandy and rather poor. Near the church the natural vegetation is now in part spoiled by planting of spruce and digging of gravel. One of the finest features here is an east-facing slope at the wall of the churchyard. Here *Filipendula hexapetala* and *Camptothecium lutescens* dominate, and the vegetation poor in species e. g. include *Viscaria vulgaris*, *Artemisia campestris*, *Avena pratensis*, *Carex arenaria*, *Sedum acre*, and *Phleum nodosum*. In other places near the church we found *Pulsatilla pratensis*, *Alyssum alyssoides*, *Galium boreale* and *pumilum*.

The small steep hill Rævebakke near Vejgaard is more interesting. This particularly applies to the plateau above, which is not very much influenced by civilization. On the part of the plateau sloping a little towards the south-west the ground in July is yellow with dominant *Genista tinctoria* together with *Potentilla argentea* (Table 7, no. 14). Nowhere else *Genista tinctoria* was found in quite a corresponding way. It is true that approaches to this occurred (see p. 22), but in such cases the bottom was always more oligotrophic, the dyers' broom thus being forced back by the heather. On the northern exposure *Genista tinctoria* was practically missing.

According to our plans Dybdal near Aalborg (at Rørdal) was also to have been examined closely. This, however, was impossible because of German military barriers. So we applied to MARTIN HANSEN, schoolmaster, of Aalborg, who has described the flora of several chalk pits round the town (MARTIN HANSEN 1942), asking him, if possible, to offer a description of Dybdal. The following text is exclusively based on MARTIN HANSEN's MS.

Dybdal is a V-shaped glacial valley of about a mile's length with a mainly east-west course. The sides are fairly steep. The soil consists of white chalk overlain by a mostly thin layer of moraine deposits and vegetable mould. The sides of the valley to a great extent have been planted with Norway spruce or deciduous trees. At the fringe of the plantation amongst others the following species are found: *Galium mollugo*, *aparine* and *boreale*, *Torilis japonica*, and *Anthriscus silvester*. In glades on the sunny side and in a fire lane amongst others the species *Pimpinella saxifraga*, *Carlina*, *Plantago media*, *Campanula glomerata* occur. In the plantation a spot of *Inula salicina* is being shaded to death by tall spruce; here, among interesting species, is also *Polygonatum officinale*. Where the slope of the valley on top borders on cultivated soil, there are some specimens of *Veronica spicata*, which are being quelled by the tall grass.

The most interesting end of Dybdal is that at which the valley turns north-east towards Rørdal. The sides here are unplanted. The only tree growth on the side sloping towards the south-east is a couple of wild apple-trees and shrubs of rose and sloe. A conspicuous feature is the large number of tufts of *Geranium sanguineum*, which is very sparsely represented on the opposite side of the valley. Other species in the tall grass are *Campanula persicifolia*, *Verbascum nigrum*, *Allium vineale* and rather large spots with *Rubus caesius*.

While the south-east slope must have formed the sheltered side in the glacial stream and the chalk therefore here is covered with heavier layers of sand, the opposite eroded slope is steeper, and here the chalky soil is bare or covered with a thin layer of mould only. This slope facing north-east several years ago exhibited *Prunella grandiflora*. In spite of repeated search, once together with the first finder of it, MARTIN HANSEN has not found this rarity in recent years, but he states that near the foot of the slope there are some specimens probably of the hybrid *Prunella vulgaris* × *grandiflora*. *Origanum vulgare*, which is rare in this neighbourhood, and *Brachypodium pinnatum* grow on the same slope.

Curiously enough such species as *Koeleria pyramidata*, *Cineraria integrifolia*, and *Silene nutans* are not found in Dybdal near Aalborg[1].

18. **The chalk slopes at Gudumholm.** Wiinstedt (1922, 1938) in two reports on excursions has described the flora of this interesting locality. The slope is a steep east-facing erosion slope from the period of the Litorina sea. Below it appears as a pure chalk slope with a sparse pioneer flora. In other places the steep screes of chalk gravel are covered with an *Echium* vegetation similar to that from Voxlev formerly described. An analysis of such an *Echium* sociation with scattered specimens of *Reseda luteola* is found in Table 5, no. 17. Among other vegetations, which may probably be considered stages in the overgrowing of the slope, there is a rather uniform *Avena elatior* sociation, here growing in pure chalk, and a *Poa compressa* sociation, often with *Hieracium auricula*. Nearer to the crest of the slope there are some almost quite stabilized patches of vegetation; here e. g. *Avena pratensis* dominates (Table 5, no. 6).

The sociologically most interesting places are without doubt the short V-shaped ravines running across the longitudinal direction of the slope. In dry places, i. e. on the slopes facing south-east, there are various communities rich in *Sanguisorba minor* (see Table 5, nos 4—5), in which such species as *Linum catharticum* and *Cladonia subrangiformis* abound together. The slope facing north-east (Table 8, no. 4) has a denser vegetation richer in grass. The analysis was made on the slope opposite to one of the southeast-facing slopes analyzed (Table 5, no. 4). *Linum catharticum*, which otherwise as a rule is most prominent on northern exposures (see Böcher 1945), only covers 40 per cent., while it covers 90 per cent. on the side facing south-east. This is probably due to the reduced competition on the drier side (Total covering 95 per cent. as against 100 per cent. on the north-east exposure) and the higher capacity of chalky soil to retain water.

19. **Kærlingebjerg.** This 37 m. high slope in the Litorina sea stood out as a headland. From here there is a splendid view of the former marine area, which is now filled up by the largest raised bog of Denmark but one, the Lille Vildmose (Figs. 1 and 10). A few steps from the foot of the chalky slope some exhaustion of the soil is already evident and at a distance of 250 metres from the slope the lagg zone of the bog begins. Large parts of the slope constitute a loose scree of limestone, partly with flakes of sliding-down grass mats from the coherent vegetation at the crest of the slope (Fig. 10), partly with various pioneer sociations in the loose material. A *Ranunculus repens* sociation on the east-facing scree is particularly important. On a north-east exposure there are two stages. The *Echium* sociation mentioned from other localities occurs on very loose material and seems to be succeeded by a *Festuca rubra-Ranunculus acer-Hieracium pilosella-Camptothecium-Thuidium abietinum* sociation.

The place where the slope turns to the north-west is particularly interesting; it offers a good example of the influence of exposure. While on the east-facing slope (Fig. 10 in the foreground) there is a flora influenced by drought and with *Sedum acre* and therophytes (see

[1] After we had finished our MS. we got, because of the termination of the war, an opportunity of visiting Dybdal ourselves. As a supplement of Martin Hansen's description it may be mentioned that the slope facing east is covered with a dense high perennial vegetation, which is physiognomically dominated by *Centaurea scabiosa* and *jacea*, *Agrimonia eupatoria*, *Senecio jacobaea*, but the most abundant plant of which no doubt is *Rubus caesius*. Further we here noted the following species: *Ononis repens*, *Knautia*, *Heracleum sphondylium*, *Daucus carota*, *Anthriscus silvester*, *Campanula rotundifolia*, *glomerata*, *rapunculoides*, and *persicifolia*, *Viola hirta*, *Plantago media*, *Verbascum nigrum*, *Geranium sanguineum*, *Hypericum perforatum*, *Sanguisorba minor*, *Ranunculus acer* and *repens*, *Poa pratensis* and *compressa*, *Agrostis gigantea*, *Avena elatior*, *Dactylis*, *Pseudoscleropodium purum*, *Eurhynchium swatzii*, and *Fissidens taxifolius*.

On the slope facing west there is a luxuriant *Origanum-Geranium sanguineum* vegetation with large spots of *Brachypodium pinnatum* (Table 3, no. 5) or interrupted by an almost quite pure *Brachypodium pinnatum* vegetation. The soil perhaps was somewhat more calcareous under these spots of grass. We, too, tried to find *Prunella grandiflora*, but in vain.

Table 5, no. 7), the slope facing north-east is covered with a dense *Koeleria pyramidata-Briza-Festuca ovina-Ctenidium molluscum* sociation, in which amongst others the calcicolous lichen *Cladonia subrangiformis* enters, as also *Pulsatilla vulgaris, Campanula glomerata* and others (Table 8, no. 5). In another place the slope facing north-east is covered with a dense *Briza-Avena pratensis-Festuca rubra-Medicago lupulina* sociation, in which amongst others some scattered *Cineraria integrifolia, Campanula persicifolia,* and *Primula veris.*

As usual there is at the top a thin sandy layer with a particular flora. *Thymus serpyllum, Artemisia campestris,* and *Phleum phleoides* are more or less closely connected with the sand.

Fig. 9. South-facing chalky slope near Smidie. In the foreground pioneer vegetation of *Senecio jacobaea.* In the background a *Sanguisorba minor* sociation on the slope and the Vildmose. T. W. B. phot. 1943.

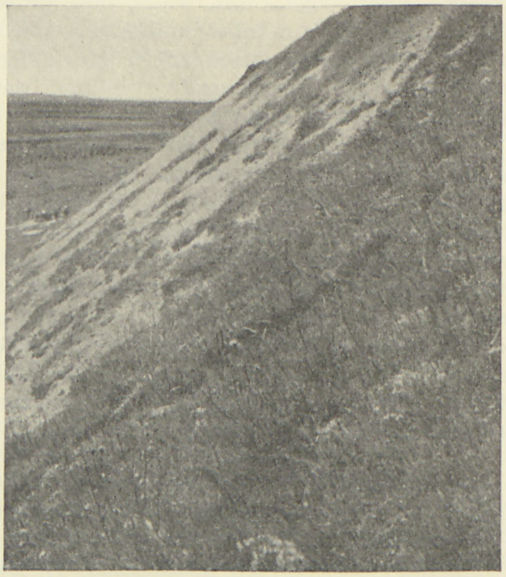


Fig. 10. Kærlingebjerg with the Vildmose in the background. In the foreground an *Avena pratensis-Koeleria-Sedum acre-Camptothecium* sociation. At the foot of the slope a herd of Jutlandish horses. T. W. B. phot. 1943.

20. **Slopes and heights east of Sdr. Kongerslev.** This locality has been discussed in some detail by Böcher (1944), and hence we may here content ourselves with a summary mention. In a small valley running transversely to the coastal slope of the Litorina Period (cf. Fig. 1) there are scrubs of *Cornus sanguinea, Rhamnus cathartica, Prunus spinosa, Crataegus monogyna* and *oxyacantha, Euonymus europaea, Sambucus nigra,* and *Rosa canina.*

On the floor of the scrubs there are some *Convallaria majalis* or *Convallaria-Paris quadrifolia* sociations and an abundance of *Anomodon viticulosus.* On the ground and on branches and twigs we further in the scrub on the western side of the valley noted the following cryptogams: *Pseudoscleropodium purum, Ctenidium molluscum, Thuidium abietinum* and *philiberti, Camptothecium lutescens, Homalia trichomanoides, Campylium hispidulum* var. *sommerfeltii, Homomallium incurvatum, Eurhynchium swartzii, Orthotrichum stramineum* and *octoblephare, Frullania dilatata, Radula complanata,* and, at the edge of the scrub on dug-out chalk, *Jungermania badensis.* On the twigs we observed the lichens *Xanthoria parietina,* rather black from the imperfect fungus *Coniosporium physciae,* further *Physcia ascendens* and *leptalea,* and the crustaceous lichens *Lecidea olivacea, Lecanora carpinea* and *Caloplaca cerina. Physcia orbicularis* var. *virella* and *Xanthoria parietina* were found at the base of the trunks. Among

the Phanerogams *Campanula trachelium* and *Clinopodium vulgare* are found in the fringe of the scrub. Outside the scrub on the side facing south-west there is a dry chalky slope with a *Sanguisorba minor* sociation (Table 5, no. 1), while outside the scrub on the opposite side there are three different sociations. First, a *Convallaria* sociation exposed to the light (Table 8, no. 8) with *Polygonatum officinale*; next, two grass vegetations of great density and with an abundance of species, one of which (Table 8, no. 6) is situated on drier soil than the other (Table 8, no. 7) and contains *Pulsatilla vulgaris* abundantly.

The dry top rising east of the valley has an essentially different vegetation, which is due to a depositing of a layer of sand above the chalk. There is here an *Anthyllis* sociation on previously cultivated terrain and a *Phleum phleoides-Sedum acre* sociation (*Cladonia subrangiformis*!) on the south-facing side of an ancient barrow. The other top, which is west of the valley, is quite yellow with a vigorous *Anthemis tinctoria* sociation. The area has been ploughed. There were two stages: In the first stage *Anthemis* was very vigorous and the soil was not covered with moss. The chief plants here were *Echium vulgare* (see Plate IV, Fig. 2,) *Daucus carota, Chrysanthemum leucanthemum, Reseda lutea, Phleum nodosum, Poa compressa, Ranunculus repens,* and *Bryum argenteum.* The later stage, with moss covering the ground, besides by *Anthemis* was dominated by *Anthyllis vulneraria, Ranunculus repens, Centaurea scabiosa,* and *Campylium chrysophyllum*; amongst other mosses may be mentioned *Eurynchium swartzii, Camptothecium lutescens, Barbula unguiculata* and *fallax* var. *brevifolia,* and *Pottia lanceolata.* Besides, various ploughed spots exhibited different floras: in some places *Daucus carota* dominated, in others *Chrysanthemum leucanthemum.* On minor spots *Matricaria inodora* or *Alyssum alyssoides* were dominant. From the list of the flora we may further mention *Verbascum nigrum, Sonchus asper, Carduus crispus, Senecio vernalis* and *jacobaea, Malva silvestris, Calamintha acinos, Leontodon autumnalis, Potentilla reptans,* and *Medicago lupulina.*

21. **The south-facing slope at Smidie.** South of the Kongerslev locality there were formerly two islands. On one, where Kongstedlund is now situated, there is in and round a chalk pit on the south-facing slope a vigorous and abundant growth of *Papaver rhoeas, Campanula trachelium, Daucus, Senecio jacobaea* and others, and at the road an unusually luxurious growth of *Conium maculatum.*

The southern island at Smidie is more interesting. This particularly applies to the chalk slope on the southern side (see Fig. 9). The loose scree is dominated by *Senecio jacobaea, Sanguisorba minor,* and *Daucus.* Here there are also scattered specimens of *Cineraria integrifolia.* Where the carpet of vegetation is stabilized, there is farthest west an *Avena pratensis-Arabis hirsuta-Onobrychis viciifolia-Camptothecium-Thuidium abietinum* sociation (Table 5, no. 3); farther east a *Sanguisorba minor* sociation (Table 5, no. 2) dominates over a wide area.

The analysis was made on the 3rd of July 1943, a day with a cool north wind and clear sunshine. At the top of the slope to windward the thermometer at 14.30 showed 20° C. In the layer of herbs on the south-facing slope shaded by the vegetation the temperature was 31° C., and in a dense tussock of grass 41° C. Under dry grass near the ground we measured 50° C. and a little below the sunlit surface of the soil 53° C. Finally, at a depth of 5 cm. below the surface the temperature was 30° C.

The chalk here, too, was overlain by sand. The *Sanguisorba* sociation on top of the slope suddenly, on a sandy slope, changes into a *Phleum phleoides-Artemisia campestris-Hieracium pilosella* sociation, in which *Avena pratensis, Sedum acre, Calamintha, Centaurea jacea, Dactylis,* and *Achillea millefolium* are frequent. North-west of the chalk slope the layer of sand is thicker. Here the slopes are quite yellow with tussocks of *Sedum acre,* and the level sand-field areas on the plateau on top are dominated by *Avena pratensis, Festuca ovina,* and *Galium verum,* and *Pimpinella saxifraga, Viscaria vulgaris,* and *Dianthus deltoides* are frequent.

22. **The hilly terrain between Svanfolk and Bælum.** This very undulating terrain consists of poor diluvial sand, and hence large parts of it is covered with heather. The heath on the hills, however, is not the characteristic vegetation of heath hills as developed e. g. on Ræbild Bakker. It bears a stamp of being younger, and at any rate the soil seems to be richer, for it exhibits a number of herbs more or less foreign to heath. North-east of Bælum we may, e. g. at the transition between heather and grass, find *Artemisia campestris*, *Viscaria*, *Chrysanthemum leucanthemum*, *Galium verum*, *Hypericum perforatum*, *Genista tinctoria*, and *Pulsatilla vulgaris*. *Empetrum nigrum* and species of *Vaccinium* are missing in the south-facing heath, while such species as *Deschampsia flexuosa*, *Genista tinctoria*, *G. anglica*, *Hypochoeris maculata*, *Antennaria dioeca*, *Luzula multiflora*, *Festuca rubra*, *Carex ericetorum*, and *Hieracium umbellatum* are frequent.

A particularly good illustration of the transition from dry grass vegetation to heath is found in Table 7, no. 13. It originates from a hilltop immediately east of Bøthule Bridge. The heather here, in spite of a great density of shoots, is not very prominent compared with the two species of broom, the grass, and the herbs. Here, too, *Pulsatilla vulgaris* occurs.

The same transitional vegetation may be modified in various ways. On a high hilltop a little farther north and west of Spamøllevad Bridge there is a more humid type on a north-east-facing slope. Physiognomically the place is dominated by grasses, *Genista tinctoria*, and *Rumex acetosa* (Table 8 no. 22). Apart from *Genista tinctoria* the vegetation may be used as an example of the usual oligotrophic half-humid pasture vegetation of the tract. This and a more dry type poor in species (*Deschampsia flexuosa-Agrostis* sociation) form spots in the heath on the hills east of Svanfolk. Here there are also sandy grass-fields with rather a peculiar flora. In a carpet chiefly of *Dactylis*, *Jasione*, *Rumex acetosella*, with some specimens of *Trifolium repens* and *campestre*, *Agrostis tenuis*, *Campanula rotundifolia*, and *Hieracium pilosella* there is an abundance of *Herniaria glabra*, *Artemisia campestris*, *Arenaria serpyllifolia*, *Trifolium arvense*, and scattered specimens of *Trifolium striatum*, *Calamintha acinos*, and *Erigeron acer*.

23. **Lille Brøndum.** This village is situated high. West of the village there is a steep grass-covered slope down towards a small erosion valley. The area is grazed and the vegetation is greatly influenced by this. The soil consists of sand mixed with clay. The grass carpet consists of *Cynosurus*, *Anthoxanthum*, *Desch. flexuosa*, *Agrostis tenuis*, and *Poa pratensis*, *Briza*, *Phleum nodosum*, and *Holcus lanatus*. Important herbs are *Rumex acetosa*, *Hypochoeris radicata*, *Pimpinella saxifraga*, *Plantago lanceolata*, *Cerastium caespitosum*, *Stellaria graminea*, *Achillea millefolium*, *Trifolium repens*, *T. medium*, and *Hypericum maculatum*, a typical pasture vegetation.

A small hillside with a sand-pit is more interesting. The place is called "Bjerget" (the mountain) and is situated east of the village with a wide view of the Vildmose towards the former island Tofte Bøge. The soil is poor, gravelly or sandy. The vegetation consists partly of a *Pulsatilla vulgaris* sand-alvar rather poor in species (Table 7, no. 10), partly of vegetations related to "grey dunes". Such vegetations have made their appearance on the sides of the sand-pit. The dry south-east side of the pit is dominated by *Corynephorus* (Table 7, no. 12). On the south-east slope there is a lichen heath with *Pulsatilla vulgaris* (Table 7, no. 11), while the north-facing slope is dominated by *Agrostis tenuis*.

A little farther east we find the sea slope from the Litorina Period. This is here wooded, as in the "island" near Gudumlund. Only a minor area was fairly recently ridded of the tall trees. Here there is scrub of hazel, hawthorn, spindle-tree, sloe, and rose, and various communities of perennials and grass, which are characterized by the fortuitousness distinguishing early stages of succession. *Agropyrum repens*, *Avena elatior*, *Dactylis*, *Urtica dioeca*, and *Hypericum maculatum* form various sociations, in which enter such species as *Heracleum sphondylium*, *Melandrium album*, *M. dioecum* × *album*, *Stachys silvaticus*, *Campanula trachelium*, *Anthriscus silvester*, *Rumex crispus*, *Artemisia vulgaris*, and *Holcus mollis* and *lanata*.

24. **Mulbjergene near the Kattegat.** Near the fishing-village Dokkedal a long row of hills rise above the flat country, which was formerly sea-bottom. The former island Muldbjergene has erosion slopes both towards the east and towards the west. The east-facing slopes are the highest by far (Plate I, Fig. 2), rising to a height of about 50 m. above sea-level. On some of the slopes there is oak scrub or low mixed oak wood.

Near Dokkedal a valley cuts through the hills, the southernmost part round Gulhøj thus being isolated from the large hilly area. The road through the valley is cut deep into drift-sand, which is also deposited east of the valley near the sea. Sand-drift has probably also influenced the forms of the landscape in several places on the hills. Fresh erosion is found here and there along the road (Fig. 11). In a single place near this the soil may be studied more closely. Below drift-sand to a depth of half a metre follows clearly stratified glacial sand, which is often very calcareous. In a sample from one of the most calcareous layers of sand we measured 15 per cent. $CaCO_3$ and *p*H 8.0. In comparison it may be stated that a sample from a depth of 20 cm. into the drift-sand showed 0.5 per cent. $CaCO_3$ and *p*H 7.2.

Fig. 11. South-facing slope east of Dokkedal, cf. Table 7, no. 8. The bright spots in the foreground are cushions of *Sedum acre*. *Ammophila arenaria* is seen farther back. T. W. B. phot. 1943.

The addition of chalk in the lower strata of the soil is beautifully reflected in the vegetation. On the slope seen in Fig. 11 the chalk thus is much in evidence in the lowest section. Here the surface of the soil showed 0.1 per cent. $CaCO_3$ (*p*H 7.2) and the percentage at a depth of 20 cm. was 1.1 (*p*H 7.3). The vegetation is characterized by a bottom layer consisting of *Thuidium abietinum* and *Cladonia subrangiformis* (see Table 5, no. 15). Above this vegetation there is another vegetation (Table 7, no. 8; *p*H 6.0) on slightly acid more arid soil, which proved to contain only traces of chalk. Here *Rhacomitrium canescens* and *Cladonia furcata* dominate in the bottom layer. In the height of summer it is dominated by *Sedum acre* and *Thymus serpyllum*. It is best compared with dune vegetations on Skallingen (Iversen 1936) and near Rørvig (Böcher 1945) with abundant *Thymus*. In particularly dry places the vegetation becomes still richer in lichens and looks like a grey *Cladonia* dune. *Cladonia furcata* and *rangiformis* dominate here (Table 7, no. 7).

On top of the hills above the valley side facing south the vegetation becomes poorer at the same time as the soil becomes more acid. From this area originate the analysis Table 7, no. 6 (a *Festuca ovina-Thymus-Pulsatilla pratensis-Hylocomium* sociation) and the analysis Table 7, no. 9. The latter, from an *Ammophila* vegetation on the top of a hill, is situated on rather acid soil (*p*H 4.8). The opposite slope is not so interesting. For comparison we made a single analysis here, which is rendered in Table 8, no. 21. It is a dense grass-*Hylocomium* sociation on acid soil (*p*H 5.3), in which the occurrence of *Webera cruda* and the chalk moss *Mnium stellare* may give rise to some wonderment.

The fine east-facing slopes (Plate I, Fig. 2) bear a vegetation quite different from the one found in the valley, a vigorous vegetation rich in perennials here alternates with scrub

of roses, sloe, juniper, oak, aspen, and hawthorn (both species). The whole picture reminds greatly of Sealandish sea-slope localities, and as in Sealand certain of the high perennials are mainly found along the fringes of the scrubs. This, e. g., applies to *Galium boreale* and *Anthriscus silvester*. A border vegetation characterized by *Anthriscus*, about 10 steps from the scrub, is rendered in Table 4, no. 5. An instance of the vegetation of the tree- and bushless slope is seen in the same table (no. 4). It is a luxurious *Geranium sanguineum* slope, where only *Avena pratensis* and a few straws of *Dactylis* and *Phleum phleoides* and flowers of *Campanula persicifolia* are able to assert themselves, but which contains many species in a rather shaded bottom flora under *Geranium sanguineum*.

At the crest of the slope the bottom becomes drier, as appears from a great luxuriousness of *Sedum acre*, *Artemisia campestris*, and *Anthyllis*. In some places there is a space at the top sloping gently towards the east. Here the vegetation, as in the valley, takes the character of sand-alvar; the very dense *Festuca ovina-Avena pratensis* sociation is adorned with numerous heads of *Hypochoeris maculata* or of *Anthyllis* and *Thymus* as also with low individuals of *Geranium sanguineum*.

Pulsatilla pratensis was found in most of our analyses. *P. vulgaris*, however, was also found on the hillsides, and it seemed that it was particularly frequent on the poor soils at the tops of the hills. In several places it was seen together with small spots of heather.

25—26. **Als near the Kattegat.** Like Mulbjergene the tract round Als was an island in the Litorina Period (see Fig. 1). The east-facing slopes on the whole are low and not very steep. In the highest place a gorge cuts into the slopes. In front of the mouth of the gorge there is a low hill. North of the gorge in the direction of the sea Als church is situated, and on the slopes below this two analyses were made (the place is seen in a photograph rendered in Danmarks Naturfredningsforenings Aarsskrift 1943—44). One analysis (Table 6, no. 3) was made on a dry half-open soil on the south-facing slope of the gorge rather near to its mouth, the other (Table 4, no. 9) in the *Avena pratensis* carpet covering the whole east-facing slope, but close to the mouth of the gorge, which is of a special character with a great density of the physiognomically prominent *Filipendula hexapetala*. In both analyses *Thalictrum dunense* and *Phleum phleoides* are important elements.

It is probable that the local luxuriousness of the vegetation in the gorge and on the east-facing slopes closest to it are conditioned by the dust rich in nutrition which is raised from the road, etc., at the bottom of the gorge. At any rate the slope vegetation north and south of the mouth is poorer. It is true that northwards *Avena pratensis* holds its own on the uppermost part of the slope, but it is replaced downwards by a *Deschampsia flexuosa-Anthoxanthum* sociation with an abundance of *Dicranum scoparium*. Southwards *Avena pratensis* is also much conspicuous as long as the slope is high; as it becomes less steep, the dominance changes, *Festuca ovina* replacing *Avena pratensis*. *Festuca ovina* at last forms a pasture with a few spots of heather, thyme, and reindeer-moss.

On the western side of the same Litorina island there are fine slopes at Ravnsbjerg (Loc. 26). Rather large areas are here covered with *Geranium sanguineum*, and *Viscaria vulgaris* and *Turritis glabra* are abundant (see Table 4, no. 6). In another place *Calamagrostis epigeios* is dominant. Other species found here are *Prunus spinosa*, *Rosa* sp., *Rubus caesius*, *Astragalus glycyphyllus*, *Filipendula hexapetala*, *Primula veris*, *Melandrium album*, and *Carex hirta*.

27—28. **Hadsund on the Mariagerfjord.** North of the fiord (Loc. 27) few observations were made of interest in connexion with the vegetation of the other localities. On the hills west of Tygeslund there is a dry, poor grass area, where amongst other species *Artemisia campestris* and *Gnaphalium arenarium* are found. Considerable areas are covered with an *Euphorbia cyparissias* sociation, in which amongst others there are some specimens of *Orni-*

thopus perpusillus, which in a floristic respect does not particularly remind of the *Euphorbia cyparissias* vegetation from Rørvig in Sealand described in Böcher 1945, p. 98.

South of the fiord (Loc. 28), nearly a mile south of the bridge, there is a slope facing WNW. with rather an interesting vegetation. At the foot of the slope the soil is less dry (a *Briza* sociation), but the steep upper part is very dry and bears a half-open vegetation on terraced, loose gravelly soil. The most important community is dominated by *Thymus serpyllum*, *Hieracium pilosella*, and *Festuca rubra*, but also includes many specimens of *Anthyllis*, *Sedum acre*, *Tortula ruralis*, and *Hypnum cupressiforme*. Other species found here are *Alyssum alyssoides*, *Arenaria serpyllifolia*, *Phleum nodosum*, *Artemisia campestris*, *Pimpinella saxifraga*, *Agrimonia eupatoria*, *Arabis hirsuta* with a continental-subcontinental distribution, and *Galium verum*, *Plantago lanceolata*, *Knautia*, *Daucus carota*, *Cerastium caespitosum*, *Ononis repens*, *Ranunculus bulbosus*, and *Trifolium campestre* with a wide or somewhat westerly range. The following mosses and lichens were found: *Thuidium abietinum*, *Camptothecium lutescens*, *Campylium chrysophyllum*, *Tortula subulata*, *Encalypta vulgaris*, *Barbula convoluta*, *fallax typica*, *unguiculata*, *recurvirostris*, *Pottia intermedia*, *sabuletorum*, *Cladonia pyxidata*, *Peltigera rufescens*, and *Collema* sp. The *p*H in the soil was measured at 7.9 and the percentage of chalk at 1.2.

At Aamøllen a little farther south there is an east-facing slope. Here, too, the soil is very gravelly, but also rich in limestone. Nevertheless the uppermost, 20 cm. deep layer of the soil is leached and slightly podsolized. The vegetation is nearly closed, a carpet of *Deschampsia flexuosa*, *Agrostis tenuis*, *Festuca ovina*, *Thymus*, and *Hieracium pilosella*, in which also *Plantago lanceolata*, *Achillea millefolium*, *Calluna*, *Pimpinella saxifraga*, *Campanula rotundifolia*, *Anthoxanthum*, *Luzula campestris*, *Cerastium semidecandrum*, *Saxifraga granulata*, *Ranunculus bulbosus*, *Galium pumilum*, *Trifolium medium*, *Lotus*, *Rumex acetosa*, *Sieglingia decumbens*, *Camptothecium lutescens*, *Hylocomium splendens*, and *Thuidium philiberti*.

29. **Slope east of the cement factory Kongsdal.** The large factory (established in 1874) is situated at the extreme end of a small peninsula north of the town of Assens. East of the factory there is a grassy slope facing NNE. The steepest places only show an inclination of some 30 degrees. They are covered with the relatively most luxurious vegetation. Here an analysis of the lower section of the slope was made (Table 8, no. 16). This is a typical grass slope rich in species, in the height of summer physiognomically characterized by *Leontodon hispidus*. Among the dominants there are numerous widely distributed meadow-plants.

30. **The old chalk-pits north of Fladbjerg.** On the west side of the peninsula the tip of which is occupied by the cement factories Dania and Cimbria, there is a pasture area half a mile long, in part grown with scrubs, and set with overgrown chalk-pits originating from the time of Christian III, Frederick II, and Christian IV (the middle of the 16th to the middle of the 17th cent.). In Dahlerup's Beskrivelse af Mariager Klosters og Bys Historie [Description of the history of the monastery and town of Mariager] (1882, pp. 110—114) the great importance of lime-burning to Mariager and its surroundings is mentioned. During the reigns of the kings mentioned there were rather considerable exports of lime besides supplies to the surrounding country. Fuel for the lime-burning was provided from the surrounding woods, which gradually were cut down so that the lime-burning had to be given up. After 1708 it had practically ceased.

The growth of shrubs in the areas with the old chalk-pits consists of *Crataegus oxyacantha* and *monogyna*, *Prunus spinosa*, *Rhamnus cathartica*, *Rosa canina*, *Cornus sanguinea*, and *Juniperus communis*, chiefly prickly shrubs, which now and then unite into dense scrubs, where a single beech, ash, or elm has risen in the air defended against the cattle by the thorns. Under the shrubs there may be a vegetation of *Hedera helix*, *Geranium robertianum*, or *Anomodon viticulosus*. Between shrubs and fragments of scrub there is grassland, if anything, a varied

rich pasture flora. In the pits the southern exposures may be characterized by *Thymus serpyllum*, *Ononis repens*, and *Chrysanthemum leucanthemum*, while the northern exposures exhibit *Primula veris*, *Prunella vulgaris*, and *Fragaria vesca*. The pasture vegetation is found both on the original flat part above the low coastal slope and on this slope. Here the flora, however, is of a somewhat different character, a species like *Cineraria integrifolia* entering the vegetation (see the instance in Table 8, no. 11).

In the southermost part of the terrain a valley running west-east cuts in right from the fiord. Transversely to the north- and south-facing slopes there is a number of very small ridges with interjacent hollows. These are artificial, having arisen by the former digging of lime just mentioned. On the ridges there is a very interesting vegetation, which differs from that already mentioned by being situated on a less calcareous soil. Originally there was a sandy, gravelly cover over the calcareous soil. Where this cover has been preserved there is an approach to a sandy dry-slope with *Calamintha acinos* (and other species) on the open spots. The vegetation of the ridges appears from the three examples in Table 5, nos. 13—14 and Table 4, no. 18. The first example (Table 5, no. 13) is dominated by *Cladonia subrangiformis* and is situated on the driest soil. Then follows an *Avena pratensis-Festuca ovina-Thymus-Camptothecium* sociation (no. 14) and on the least dry soil a vegetation rich in *Helianthemum* and mosses with abundant *Primula veris* and further such species as *Calluna*, *Agrostis canina*, and *Sieglingia decumbens*, which indicates a certain powerty of the soil (Table 4, no. 18). The *p*H was about 6.1, and only traces of chalk were left, while there were respectively 0.8 and 2.3 per cent. $CaCO_3$ and *p*H 7.4—7.5 in the other vegetations on drier soil. The vegetation rich in *Helianthemum* was on the north side of the valley, the others on the south side and nearer to the fiord.

31. **The edge of the wood of Hov.** In the fringe of this wood, close to the fiord, there is an interesting zonation. On the low, steep slope there is a beech scrub; below this there is a fringe of juniper and then, still on the terrain slightly sloping west, we find a fringe some few metres broad dominated by *Helianthemum nummularium* (Table 4, no. 12). Finally there is a flat, half moist area stretching right down to the ditch along the Hadsund-Mariager road. Along the ditch and in the plane area we found both *Pulsatilla pratensis* and *vulgaris*. Farther west they dominate on minor areas. Here *Anthemis tinctoria* is seen along the road.

32. **Slope near the limestone quarry of Mariager.** On the uppermost part of the fairly steep coastal slope facing north-west between Petersminde and the limestone quarry and lime-kiln of Mariager a single analysis was made (Table 3, no. 12). The vegetation is dominated by *Campanula persicifolia*, *Fragaria vesca*, *Viola canina*, *Pseudoscleropodium purum*, *Anomodon*, *Camptothecium*, and *Homalia trichomanoides*. On the lower part of the slope, which is a little steeper and with scattered shrubs of hawthorn and sloe, both *Campanula persicifolia*, *Homalia*, and *Anomodon* disappear. The soil here is more unsettled, with small terraces from slides. *Tussilago farfarus* makes its appearance and *Ctenidium molluscum* becomes more frequent.

33. **Hodal near Hobro.** The steep slopes on the sides of this valley running north-south bear a poor vegetation. Some rather large parts of it may be covered with *Deschampsia flexuosa*. At a curve of the valley about a mile north of Hobro there is a dry, terraced, and half-open slope yellow with *Sedum acre*. Here are small spots with *Pulsatilla vulgaris* and *Veronica spicata* (Table 6, no. 13). Below the steep slope follows a less steeply sloping, more humid area richer in nutrition and covered with a varied *Briza media-Agrostis tenuis-Cynosurus* vegetation with abundance of *Cirsium acaule*, *Filipendula hexapetala*, *Prunella*, *Potentilla reptans*, *Ononis repens*, *Trifolium pratense* and *dubium*, some specimens of *Campanula*

glomerata, Lotus corniculatus, Veronica chamaedrys, Equisetum arvense, Festuca ovina, F. elatior, Poa pratensis, Agrimonia eupatoria, Primula veris, and *Geranium dissectum.*

A steep, elevated, west-facing slope near Hobro is particularly dominated by *Festuca ovina* and *Galium verum* and includes an abundance of *Avena pratensis, Viscaria vulgaris,* and *Pulsatilla vulgaris* (Table 6, no. 14). Here, too, the soil was sandy and poor.

34. **Hjerrisdal north-east of Hobro.** The fine, in some places rather steep slopes in this erosion valley bear a rather oligotrophic flora. The vegetation is peculiar in many ways.

Fig. 12. South-facing slope near the water-mill in Hjerrisdal. In the foreground flowering *Sedum boloniense,* in the background juniper in oligotrophic grass vegetation. T. W. B. phot. 1943.

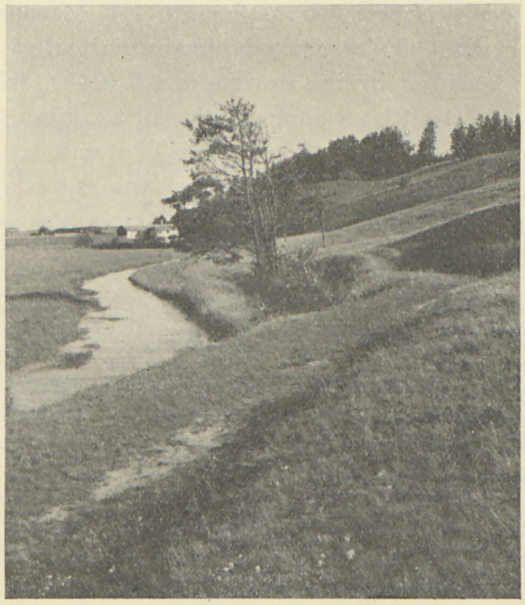


Fig. 13. The hillsides near the stamp-mill at Binderup Aa. Oligotrophic pastures and slope vegetation on slightly calcareous soil, cf. text p. 12. T. W. B. phot. 1943.

There are typically heath-like areas with bracken in rather large growths about the grass carpet. Heather plays a comparatively small part. On a slope facing north-west *Arnica montana* is physiognomically dominant in a *Deschampsia flexuosa-Agrostis canina* sociation, in which the heath flora is represented by *Vaccinium myrtillus, Genista anglica, Calluna, Hypericum pulchrum,* and *Lathyrus montana.* Everywhere there are juniper shrubs and not a few specimens of *Anemone nemorosa,* see further Table 8, no. 21. The soil here is very acid (*p*H 4.2). Not far from here there is a south-facing slope of quite a different character (Fig. 12). From the slope there is a view of an old water-mill. The river here passes close to the slope, which is half-open, with small terraces and slides. The soil is gravelly and richer (*p*H 6.1). The slope shines bright yellow with dense *Sedum boloniense* (*S. mite*) (Table 6, no. 8). *Sedum acre* is neither found here nor elsewhere in the valley, which is probably due to chance. *S. boloniense* appears as quite a wild species. It probably long ago immigrated to the slope from the garden of the water-mill. At present it is not found there. Farther north there is another, south-facing slope of a somewhat more oligotrophic character (*p*H 5.2—5.4). The soil is very loose and gravelly; the vegetation covers 30 per cent. only on the upper side of the small terraces, but 80 per cent. on the steep sides of these. Both these half-open and a neighbouring

closed vegetation were analyzed (Table 6, nos. 9—10). They are distinguished by an abundance of lichens and mosses, thus *Peltigera erumpens* and *Cladonia cervicornis*.

IV. Plant Communities.

In the localities examined nearly a hundred analyses have been made in selected, particularly typical places. The placement of the various analyses in the terrain appears from Section III. Measurements of the hydrogen ion concentration of the soil (measured electrometrically) and of the content of $CaCO_3$ of the soil (measured by the development of CO_2 in PASSON's apparatuses, see WIEGNER-PALLMANN 1938) are included in all examinations. Further the total covering of the vegetation, on a rough estimate, is stated, as also for sloping soils exposure and degree of inclination. The method of analysis is a simplified form of the method of frequency determination invented by RAUNKIÆR and later modified by BÖCHER (RAUNKIÆR 1909 and 1934 p. 201, BÖCHER 1935, 1943).

The figures given are degrees of frequency found by the examination of 10 circular sample areas within the vegetation in question, each of 0.1 m^2. A statement that a certain species has the frequency 3 means that it has been found in 3 out of the 10 sample areas. For species with a frequency of 6—10 a figure is further added which denotes the frequency found with use of a smaller circle concentrical with the circle of 0.1 m^2, but with a radius only one fourth of the larger circle, thus with an area of about 0.006 m^2. In practice a stick is used, with a metal radius fixed to it. The stick is planted in the vegetation, and by moving the radius it is found, which plants are growing inside the circle (see Fig. 2 in BÖCHER 1935). In the tables a plus denotes that the species enters in the vegetation, but was not found in any of the sample areas. A note of exclamation after a rather low frequency value denotes physiognomical dominance.

The *p*H of the calcareous soils is rarely higher than 7.4. As it might be imagined that the kinhydrone method was less exact in analyses of such soils, we made colorimetrical determinations of five typical calcareous soils. As appears from Table 1, the difference between values measured electrometrically and values measured colorimetrically was not great, and at any rate there seems to be no reason to fear that the values found electrometrically should be too low. TANSLEY (1939) states the average *p*H value to be about 7.5 for the top of the soil in English chalk grassland communities.

Table 1.

Soil	Total carbonate per cent.	*p*H colorimetrically	*p*H electrometrically	Difference in *p*H
Voldsted, Loc. 15	70	7.1	7.3	0.2
Gudumholm, Loc. 18	41	7.1	7.3	0.2
Blaakilde, Loc. 13	74	7.2	7.4	0.2
Kongerslev, Loc. 20	65	7.2	7.3	0.1
Nørholm, Loc. 11	16	7.3	7.4	0.1

The following communities have been defined floristically-phytogeographically. A number of geographical guiding species playing a decisive part at the classification have been selected. These species have been mentioned separately for each community. In the Tables all species have been classified according to geographical distribution. Fair-sized groups have been separated out, such as continental-subcontinental, oceanic-suboceanic, and indifferent-widely distributed species, but we have not gone into detail as regards the distribution of individual species. See further Böcher 1943 and 1945.

A. Beech Wood near Buderupholm.

(Open beech wood with boreal- or montane-continental species.)

As an introduction to the fully illuminated communities we shall mention the vegetation of the lady's-slipper orchid locality at Buderupholm. As stated in the preceding section (p. 15) the wood is here set with numerous narrow glades and a single fairly broad one. The wood stands on a cool north-west sloping hillside, and the soil is calcareous and not dry. Conditions thus remind of those found on numerous illuminated north-facing slopes, but an important difference is that the humidity of the air probably is somewhat higher in the lady's-slipper orchid locality, where also the effect of shadow is felt considerably. Our four analyses from the locality (Table 2) are thus arranged that the most fully illuminated vegetation is on the left and that most shaded on the right. Among the species there is a number with boreal, rather northern or montane and also more or less continental distribution (*Calamagrostis arundinacea, Cypripedium calceolus, Carex digitata, C. montana, Vaccinium vitis idaea,* and *Pirola secunda*), others with boreal-montane, non-continental distribution (*Vaccinium myrtillus, Rubus saxatilis, Geranium silvaticum, Ctenidium molluscum*). Only two species of phanerogams (*Hedera helix* and, only just, *Fagus silvatica*) are suboceanic, but there are several hygric-oceanic mosses (e. g. *Hylocomium loreum*). One species only is fairly southern (*Stellaria holostea*). The boreal-montane element of the flora seems to characterize the vegetation very well, but an insertion of it in a regional phytogeographical vegetational group meets with certain difficulties, as there does not to our knowledge exist analyses from similar localities in the other Scandinavian countries. Lady's-slipper orchid is reported from copses and lövängar (meadow surrounded by hazel, ash, etc.) in Sweden, which does not amount to very much. In Germany it is most frequent on montane, calcareous localities, where it is often found on partly illuminated soil together with other orchids (Hegi). The communities in which it enters very much resemble the vegetation described by Meusel (1939) under the name of "Buchenheidewald", which in Central Europe has developed on northern exposures and contains some species from the illuminated *Seslerietum* and further some boreal-montane woody plants. Important points of similarity with our Jutlandish vegetation is the abundance of *Convallaria majalis, Anemone hepatica, Rubus saxatilis, Hylocomium triquetrum* and *splendens* and the rather frequent occur-

Table 2.

Analysis no.		1	2	3	4
Locality no.	Annuals	14	14	14	14
Exposure		NW	NW	NW	NW
Slope		20	20	25	20
*p*H at top of soil		7.2	7.4	7.4	7.4
*p*H at a depth of 15 cm.		7.2	—	—	—
$CaCO_3$, percentage at top of soil		12.4	41.0	52.0	46.0
$CaCO_3$, percentage at a depth of 15 cm.		14.9	—	—	—
Density of species		19.8	14.3	12.1	7.2
Number of species		46	34	39	18
Total covering in per cent.		100	100	100	95—100
1. Calamagrostis arundinacea	—	5	2	—	10_3
Carex digitata	—	4	3	4	3
— montana	—	2	—	—	1
Cypripedium calceolus	—	—	3	1	+
Vaccinium vitis idaea	—	4	—	—	—
— myrtillus*	—	+	—	—	—
Pirola secunda	—	—	2	3	—
Geranium silvaticum*	—	+	6_0	—	—
Rubus saxatilis*	—	**10_8**	**10_9**	9_2	6_1
2. Melica nutans	—	6_1	10_4	6_4	1
Poa angustifolia	—	1	—	—	—
Cephalanthera rubra	—	—	—	+	—
Convallaria majalis	—	10_2	+	—	10_{10}
Myosotis silvatica	—	—	+	—	—
Heracleum sibiricum	—	+	4	—	1
Rhamnus catharticus	—	—	+	—	—
Hypericum maculatum	—	1	—	—	—
Anemone hepatica	—	9_1	10_1	10_5	**9_6**
3. Hedera helix	—	9_4	10_1	**10_{10}**	5
Fagus silvatica	—	—	—	1	—
4. Agropyrum caninum	—	—	—	+	—
Poa nemoralis	—	—	6_0	1	—
Luzula pilosa	—	3	3	3	—
Lactuca muralis	—	—	—	1	—
Hieracium vulgatum	—	+	+	2	—
Asperula odorata	—	—	—	—	1
Sanicula europaea	—	+	7_2	2	3
Frangula alnus	—	—	+	+	—
Viola riviniana	—	4	6_0	5	3
Oxalis acetosella	—	—	—	1	—
Anemone nemorosa	—	10_4	10_4	**10_8**	10_4
5. Festuca rubra	—	8_1	3	2	—
Dactylis glomerata	—	—	2	+	—
Poa pratensis	—	—	1	—	+
Briza media	—	—	—	4	—

Table 2 (continued).

Analysis no.		1	2	3	4
Locality no.		14	14	14	14
Exposure		NW	NW	NW	NW
Slope		20	20	20	20
*p*H at top of soil		7.2	7.4	7.4	7.4
*p*H at a depth of 15 cm.		7.2	—	—	—
$CaCO_3$, percentage a top a soil	Annuals	12.4	41.0	52.0	46.0
$CaCO_3$, percentage at a depth of 15 cm.		14.9	—	—	—
Density of species		19.8	14.3	12.1	7.2
Number of species		46	34	39	18
Total covering in per cent.		100	100	100	95—100
Carex flacca	—	**10_8**	—	5	—
Taraxacum sp.	—	—	—	1	—
Chrysanthemum leucanthemum	—	1	—	—	—
Knautia arvensis	—	—	1	—	—
Galium pumilum	—	9_4	4	4	2
Veronica officinalis	—	+	2	1	—
— chamaedrys	—	2	4	4	—
Vicia cracca	—	1	1	—	—
Fragaria vesca	—	4	6	2	2
Potentilla erecta	—	+	—	—	—
Rosa sp.	—	+	—	—	—
Linum catharticum	×	1	—	—	—
Juniperus communis	—	+	1	+	—
6. Hylocomium schreberi	—	**9_7**	—	—	—
— splendens	—	**10_{10}**	**10_8**	7_4	—
— loreum*	—	**10_{10}**	—	1	—
— triquetrum	—	**10_7**	9_4	8_7	5
Ctenidium molluscum	—	—	—	3	—
Eurhynchium striatum	—	—	—	3	—
Pseudoscleropodium purum*	—	**10_{10}**	6_3	3	—
Thuidium tamariscinum*	—	2	—	1	—
Neckera complanata	—	—	—	1	—
Fissidens adiantoides	—	—	—	1	—
Dicranum scoparium	—	7_4	1	—	—
Rhodobryum roseum	—	4	—	—	—
Mnium cuspidatum (L.) Neck. neque Hedw.	—	**9_6**	—	1	—
Frullania tamarisci*	—	1	—	—	—
Lophocolea bicuspidata	—	**10_{10}**	—	—	—
Plagiochila asplenioides	—	1	—	—	—
7. Cladonia impexa	—	+	—	—	—
— fimbriata	—	1	—	—	—
Peltigera malacea	—	+	—	—	—

Groups of species: (1) Montane or boreal continental (subcontinental) species. Boreal non-continental species are marked with an asterisk. — (2) Other continental (subcontinental) species. — (3) Suboceanic species. — (4) Widely ranging indifferent woodland plants. — (5) Widely ranging indifferent species, not particularly connected with woods. — (6) Bryophytes (those marked with an asterisk are oceanic). — (7) Lichens.

rence of such species as *Carex flacca, C. montana, C. digitata, Cephalanthera rubra, Pirola secunda,* and *Hedera helix.* It will be an interesting task to search for similar communities in Norway and Sweden. In Denmark there are numerous places in the wood on the cliff of Møn which also approach the concept of "Buchenheidewald", although the boreal-montane element is not so much in evidence as at Buderupholm. In England there are ecologically related types of vegetation, some of which perhaps belong to the same regional group of vegetation, cf. e. g. TANSLEY's description of the *Fagetum calcicolum.*

B. Communities Belonging to the Wood-Steppe Group.

The series of communities to be discussed in this section are connected with light woods or edges of woods with a flora of an essentially different character. These are illuminated communities more characterized by drought and containing species which are good representatives of the so-called wood-steppes (the relatively northern dense steppes rich in perennials, which are often found surrounded by scrub or light wood). These are particularly found in Eastern and Central Europe. There are descriptions of corresponding forms of vegetation from Sealand and Mön (BÖCHER 1945, 1946).

In Himmerland the chief geographical guiding species of this group are: *Geranium sanguineum, Campanula persicifolia, Filipendula hexapetala, Viola hirta,* and the somewhat rarer species *Fragaria viridis, Polygonatum officinale, Brachypodium pinnatum, Inula salicina, Campanula glomerata,* and *Origanum vulgare.*

There are two floristically and ecologically distinct main types. One is found on calcareous, often north-facing slopes and shows a clear relationship with the group of the widely distributed boreal-montane meadow plants (the grass-slopes p. 61), the other on east- and west-facing, sandy slopes and in certain respects approaches the communities of the steppe-alvar group. We shall first discuss the former type, as this approaches nearest to the vegetation on calcareous soil at Buderupholm mentioned under A (See particularly Table 2, no. 1).

The *Brachypodium pinnatum-Inula salicina* Type.

This type was only found on the Klithus slopes (Loc. 10) and at Aalborg (Loc. 17). In Table 3, where the analyses are listed (nos. 5—12) we have, however, included a mossy *Campanula persicifolia* sociation from the neighbourhood of Mariager (no. 14) and a vegetation with frequent occurrence of *Crepis praemorsa* from Skindbjerg (no. 13). In spite of all these vegetations are floristically and ecologically closest connected with the *Brachypodium-Inula* type. The moisture-loving plants are rather frequent in comparison with the following type, and the plants preferring a dry soil are scarce. Another characteristic feature is the dominance of mosses in the understorey: lichens are missing almost completely. The vegetation clearly reminds of grass-slopes on

chalky or clayey soil (Table 8). The grass-slopes, however, differ by their greater abundance of mosses (particularly *Ctenidium molluscum*), a higher frequency of meadow plants and want or reduction of species of the wood-steppe (e. g. *Campanula persicifolia*). The transition, however, is quite smooth: the *Convallaria-Polygonatum officinale-Ctenidium* sociation (Table 8, no. 8) may with equal right be referred to the community of the wood-steppe and to the grass-slopes. A species like *Carex flacca* is common to the *Brachypodium-Inula* type, the grass-slope, and the vegetation on the most illuminated part of the *Cypripedium* locality (Table 2, no. 1).

The six analyses Table 3, nos. 7—12 show some remarkable mutual differences. The first two with *Brachypodium pinnatum* as dominant have a flora suggesting a greater aridity than the last three, which as regards number and density of species approach nearest to the grass-slopes. A special position is held by the spot dominated by *Crepis praemorsa* (no. 8 and Plate III, Fig. 1), where the great density of shoots of this species causes decrease of a number of other species. *Brachypodium pinnatum*, which is most frequent in the somewhat drier places, may also occur as dominant on west-facing slopes (Table 3, no. 5) or even south-facing slopes, but here on the lower, somewhat more humid part of the slope (Table 3, no. 6).

In Table 3 we have also included the *Avena elatior* or *Festuca rubra* sociations at Klithus and Nørholm (nos. 1—3, cf. p. 13), considered as stages in a succession, further (no. 4) the vegetation characterized by high perennials (*Heracleum sphondylium, Centaurea scabiosa*) on the upper part of the Nørholm slope (Fig. 7). *Heracleum sphondylium* is a western species and there are practically no wood-steppe species. The vegetation probably is a transitional stage between the continental and the non-continental communities rich in perennials which belong to wood-edges and open, not too dry places. Similar communities rich in *Heracleum sphondylium* are seen elsewhere in Jutland, thus in the western Limfjord area and at Gasbjerg in Thy. *Heracleum sphondylium* for that matter also enters in the typical woodsteppe-like community at Sebbersund (Table 4, Plate II, Fig. 2).

The *Inula salicina* sociation (no. 11) is a fairly typical wood-steppe vegetation, but closely attached to calcareous soil. It is found in Sealand at Klinteby and in the wood of Allindelille. But the *Brachypodium pinnatum* sociation has been found neither in Sealand nor Møn. Possibly this vegetation in Denmark is a North Jutlandish specialty. In England *Brachypodium pinnatum* enters as dominant in the vegetation on flat limestone areas in Northhampshire (Hepburn 1942). This vegetation has several species in common with the Jutlandish one, but amongst other features it differs from it by dominance also of *Bromus erectus*, which, however, is chiefly found on somewhat drier spots than *Brachypodium pinnatum*. The occurrence both in England and on the slope at Klithuse, which in our day is completely without shrub- and tree-growth, shows that *Brachypodium pinnatum* in these regions does not belong exclusively to dry glades or wood-edges of a xerophilous character as in Central Europe. This fact, however, is far from unique. Such species as *Silene nutans* and *Geranium sanguineum* like *Brachypodium pinnatum* are used by German botanists

Table 3.

Analysis no.		1	2	3	4	5	6	7	8	9	10	11	12		13	14
Locality no.		10	11	11	11	17	10	10	10	10	10	10	10		16	32
Exposure		NNW	N	N	NNW	WSW	SSW	NNE	NW	NW	NW	NW	NNW	Per-	WSW	WNW
Degree of sloping		35	45	45	45	35	30	25	25–30	30	30	30	30	cen-	20	35–40
*p*H (Figures in ordinary brackets refer to a depth of 20 cm., figures in square brackets to a depth of 5—15 cm.)	Annuals	7.6	7.6	7.0 [7.4]	7.4	7.4	7.4	7.3	7.5	7.0	7.2 (7.3)	— (7.3)	7.0	tage con-	7.2	7.3
$CaCO_3$, percentage		45.1	18.0	11.5 [19.5]	51.0	25.0	16.7	2.7	4.0	15.0	0.1 (24.0)	— (53.0)	9.0	stancy	46.0	24.0
Density of species ($\frac{1}{10}$ m²)		10.1	9.0	11.6	8.7	12.0	17.3	15.0	15.4	13.3	22.0	24.4	21.0	nos.	21.3	17.0
Number of species		32	20	35	25	33	39	36	38	39	45	52	48	7–12	77	27
Total covering in per cent.		90	100	100	100	100	100	100	100	100	100	100	100		95–100	100
1. Brachypodium pinnatum	—	—	—	—	—	**10_{10}**	**10_{10}**	**10_9**	**10_8**	5	—	1	—	67	—	—
Carex montana	—	—	—	—	—	—	—	—	—	—	—	—	—	0	3	—
Inula salicina	—	+	—	—	—	—	—	—	—	—	2	**10_6**	1	50	—	—
Campanula persicifolia	—	2	—	—	—	3	—	10_1	10_5	6_0	+	+	7_2	**100**	—	**10_{10}**
— glomerata	—	—	+	—	2	1	+	3	3	3	6_0	6_0	1	**100**	—	—
Galium boreale	—	1	—	—	—	—	—	—	—	—	—	—	+	17	—	—
Origanum vulgare	—	—	—	—	—	2	—	—	—	—	—	—	—	0	1	—
Primula veris	—	4	4	6_0	—	4	—	+	4	5	10_4	10_4	10_3	**100**	3	10_1
Geranium sanguineum	—	—	—	—	—	8_3	+	—	2	1	—	—	—	33	—	—
Filipendula hexapetala	—	—	—	—	—	3	10_5	8_3	1	+	—	—	+	67	**10_6**	—
Rubus caesius	—	—	—	—	—	+	—	—	—	—	—	—	—	0	—	—
Agrimonia eupatoria	—	—	—	—	—	+	—	—	—	—	—	—	—	0	—	+
Viola hirta	—	—	—	—	—	2	—	—	—	—	—	2	—	17	5	—
2. Herminium monorchis	—	—	—	—	—	—	—	—	—	—	—	—	—	0	+	—
Crepis praemorsa	—	—	—	—	—	—	—	—	—	**10_8**	10_3	3	3	67	8_1	—
Cineraria integrifolia	—	—	—	—	+	—	—	1	—	1	2	5	3	**83**	2	—
Carlina vulgaris	—	—	—	—	—	—	—	—	—	—	—	—	—	0	+	—
Cirsium acaule	—	—	—	—	—	1	7_1	3	—	4	8_2	4	5	**83**	5	—
Plantago media	—	—	—	—	—	—	+	3	+	1	7_1	6_2	6_1	**100**	1	—
Polygala amarella	—	—	—	—	—	—	—	—	—	—	—	—	—	0	+	—
Trollius europaeus	—	3	—	—	—	—	—	—	—	—	—	—	—	0	—	—
3. Koeleria pyramidata var. danica	—	—	—	—	—	2	9_4	7_3	6_2	+	8_4	7_2	10_1	**100**	+	—
Phleum phleoides	—	—	—	—	—	—	1	+	—	—	—	—	—	17	—	—
— nodosum	—	—	—	7_1	—	—	1	8_1	3	—	—	—	+	50	—	—
Poa angustifolia	—	—	—	—	**10_9**	—	2?	—	—	2	—	—	—	17	—	—
Avena pratensis	—	1	—	1	1	4	**10_8**	9_5	7_2	1	8_2	8_2	10_3	**100**	7_3	10_1
— pubescens	—	+	—	—	—	—	—	—	—	—	7_4	4	—	33	—	—
Carex caryophyllea	—	—	—	—	—	—	**10_8**	—	—	1	8_2	7	—	50	1	—
Centaurea scabiosa	—	1	—	—	6_2!	6_0	5	—	—	10_1	5	5	3	67	2	—
— jacea	—	2	+	—	2	4	3	2	1	3	3	5	3	**100**	2	—
Calamintha acinos	×	—	—	—	—	—	1	—	—	—	—	—	—	0	+	—
Pimpinella saxifraga	—	7_0	4	+	4	—	2	—	—	3	2	3	3	67	5	+
Hypericum perforatum	—	—	—	—	—	2	—	—	—	—	—	—	—	0	+	—
Helianthemum nummularium	—	—	—	—	—	—	—	—	—	—	—	—	—	0	2	—
Sanguisorba minor	—	—	—	—	—	—	—	—	—	—	—	—	—	0	3	—
Pulsatilla vulgaris	—	—	—	—	—	—	—	—	—	—	—	—	—	0	1	—
Arabis hirsuta	—	—	—	—	—	—	2	—	—	—	—	—	—	0	3	—
Silene nutans	—	—	—	—	—	—	—	—	—	—	7_2	8_3	9_4	50	—	—

4. Briza media	—	—	—	1	—	—	4	5	10_8	5	10_7	10_2	10_2	**100**	5	—
Poa trivialis	—	6_1	—	—	—	—	—	—	—	—	—	—	—	0	—	—
Festuca elatior	—	—	9_3	1	—	—	—	—	2	1	7_2	7_1	4	**83**	—	—
Carex flacca	—	—	—	1	1	1	10_5	+	+	9_1	10_0	10_3	10_2	**100**	3	10_3
Leontodon hispidus	—	1	—	—	—	—	8_4	—	—	2	1	4	+	67	+	—
Senecio jacobaea	—	—	+	1	+	1	—	—	—	1	—	—	—	17	2	+
Bellis perennis	—	—	—	—	—	—	—	—	—	—	—	—	—	0	+	—
Succisa pratensis	—	—	—	—	—	—	—	—	—	—	—	—	—	0	4	—
Chrysanthemum leucanthemum	—	+	+	1	—	3	5	—	1	2	1	1	1	**83**	2	—
Prunella vulgaris	—	—	—	—	—	—	—	—	1	—	—	—	—	17	3	—
Heracleum sphondylium	—	—	7_1	—	2!	+	—	—	—	—	—	—	—	0	—	—
Lathyrus pratensis	—	—	—	—	—	—	—	—	+	2	9_3	5	10_4	**83**	—	—
Trifolium pratense	—	—	—	—	—	—	—	—	—	—	+	7	—	33	+	—
Fragaria vesca	—	—	—	—	—	—	—	—	—	—	—	—	—	0	2	10_8
Geum rivale	—	—	—	—	—	—	—	—	—	—	—	—	—	0	2_1	—
Linum catharticum	×	—	—	—	—	—	8_2	—	3	—	—	2	—	33	3	—
Ranunculus acer	—	6_0	1	8_3	6_1	5	—	+	1	4	3	5	5	**100**	—	10_3
Rumex acetosa	—	6_0	—	1	—	—	—	5	6_1	7_1	6_1	5	5	**100**	—	—
5. Avena elatior	—	$\mathbf{10_7}$	$\mathbf{10_7}$	7_1	8_4	+	—	—	—	1	2	5	1	67	—	7_2
Festuca rubra	—	6_2	$\mathbf{10_7}$	$\mathbf{10_{10}}$	4	6_0	+	$\mathbf{10_{10}}$	$\mathbf{10_{10}}$	$\mathbf{10_9}$	$\mathbf{10_6}$	$\mathbf{10_7}$	10_2	**100**	—	10_3
— ovina	—	—	—	—	—	—	7_3	—	3	—	+	3	3	67	—	—
Poa pratensis	—	3	+	—	—	6_2	—	5	3	—	2	3	3	**83**	+	9_3
Agropyron repens	—	—	10_3	—	7_0	—	—	—	—	—	—	—	—	0	—	—
Dactylis glomerata	—	3	8_2	$\mathbf{10_6}$	5	7_2	5	8_3	5	—	4	7_3	10_0	**83**	7_3	8_3
Luzula campestris	—	—	—	—	—	—	—	3	—	1	—	—	—	33	—	—
Hieracium pilosella	—	—	—	+	—	—	—	4	3	1	—	6_1	1	**83**	—	—
— umbellatum	—	—	—	—	—	—	—	2	—	1	1	1	—	67	—	—
Achillea millefolium	—	4	1	2	—	—	—	9_2	10_2	$\mathbf{10_6}$	8_2	9_2	7_2	**100**	—	—
Taraxacum sp.	—	1	6_2	3	—	3	—	—	—	—	—	—	1	17	4	—
Tragopogon pratensis	—	—	—	1	+	—	+	—	—	—	—	—	—	0	—	—
Solidago virga-aurea	—	—	—	—	—	4	—	—	—	—	1	3	1	50	—	—
Cirsium lanceolatum	—	—	—	—	—	—	—	—	—	—	—	—	—	0	1	—
Campanula rotundifolia	—	6_1	3	8_4	—	+	8_3	3	1	3	7_0	2	4	**100**	8_3	9_4
Galium verum	—	3	4	1	—	1	7_3	7_4	4	8_2	9_4	8_2	10_1	**100**	2	—
— pumilum	—	1	—	2	+	—	9_3	7_2	6_3	—	3	2	5	**83**	4	8_3
Knautia arvensis	—	—	—	—	+	—	1	3	8_1	3	5	5	8_0	**100**	+	+
Plantago lanceolata	—	—	—	—	—	—	1	1	5	1	1	5	4	**100**	4	—
— maritima	—	—	—	—	—	—	—	—	—	—	—	1	—	17	—	—
Veronica chamaedrys	—	3	—	1	1	—	—	—	—	—	—	—	1	17	+	—
— officinalis	—	—	—	—	—	—	—	—	—	—	—	—	—	0	2	—
Thymus serpyllum	—	—	—	—	—	—	—	2	4	—	—	—	—	33	—	—
Daucus carota	—	—	—	—	—	—	+	—	1	—	—	—	—	17	+	—
Torilis japonicus	—	—	—	—	—	—	—	—	—	—	—	—	—	0	+	—
Frangula alnus	—	—	—	—	—	—	—	—	—	—	—	—	—	0	2	—
Anthyllis vulneraria	—	—	—	—	—	—	+	+	—	—	+	3	—	50	—	—
Lotus corniculatus	—	—	—	—	—	—	1	+	—	—	—	—	3	33	+	+
Ononis repens	—	—	—	—	—	—	7_1	1	—	—	—	—	—	17	—	—
Medicago lupulina	×	—	—	—	—	—	—	9_3	1	1	2	2	2	**100**	4	5
Vicia cracca	—	—	1	—	+	—	—	2	3	3	4	—	3	**83**	6_1	—
Rosa cfr. glauca	—	—	—	—	—	—	—	—	—	—	—	—	—	0	1	—
Potentilla reptans	—	—	—	—	—	—	—	—	—	—	—	—	—	0	—	1
Saxifraga granulata	—	—	—	+	—	—	—	—	2	—	—	—	—	17	—	—
Polygala vulgare	—	—	—	—	—	—	—	—	—	—	—	—	—	0	2	—
Viola canina	—	—	—	—	—	—	—	—	—	—	—	—	—	0	7_3	$\mathbf{10_8}$

(To be continued)

Table 3 (continued).

Analysis no.		1	2	3	4	5	6	7	8	9	10	11	12		13	14
Locality no.		10	11	11	11	17	10	10	10	10	10	10	10		16	32
Exposure		NNW	N	N	NNW	WSW	SSW	NNE	NW	NW	NW	NW	NNW		WSW	WNW
Degree of sloping		35	45	45	45	35	30	25	25–30	30	30	30	30	Per-	20	35–40
*p*H (Figures in ordinary brackets refer to a depth of 20 cm.,)		7.6	7.6	7.0 [7.4]	7.4	7.4	7.4	7.3	7.5	7.0	7.2 (7.3)	— (7.3)	7.0	centage	7.2	7.3
$CaCO_3$, percentage (figures in square brackets to a depth of 5–15 cm.)	Annuals	45.1	18.0	11.5 [19.5]	51.0	25	16.7	2.7	4.0	15.0	0.1 (24.0)	— (53.0)	9.0	constancy	46.0	24.0
Density of species ($\frac{1}{10}$ m²)		10.1	9.0	11.6	8,7	12.0	17.3	15.0	15.4	13.3	22.0	24.4	21.0	nos.	21.3	17.0
Number of species		32	20	35	25	33	39	36	38	39	45	52	48	7–12	77	27
Total covering in per cent.		90	100	100	100	100	100	100	100	100	100	100	100		95–100	100
Ranunculus repens	—	—	—	1	7_3	—	—	—	—	—	—	—	—	0	—	—
— bulbosus	—	—	—	—	—	—	4	—	2	—	—	—	—	17	+	—
Anemone nemorosa	—	—	—	—	—	—	—	—	—	—	—	—	—	0	8_1	—
Cerastium caespitosum	—	—	—	3	—	—	—	+	4	1	3	2	+	**100**	—	—
Polygonum sp. (juv.)	×	1	—	—	—	—	—	—	—	—	10_1	2	—	33	—	—
Populus tremula	—	—	—	—	—	—	—	—	—	—	—	—	—	0	2_2	—
Juniperus communis	—	—	—	—	—	—	—	—	—	—	—	—	—	0	1	—
6. Hylocomium triquetrum	—	—	—	2	1	—	—	—	—	—	—	—	—	0	$\mathbf{10_{10}}$	—
— splendens	—	—	—	—	—	—	—	—	—	—	—	—	—	0	3	—
Ctenidium molluscum	—	—	—	—	—	7_2	—	—	—	—	—	—	—	0	4	1
Calliergonella cuspidata	—	2	—	3	1	—	—	—	—	—	—	1	2	33	—	—
Eurhynchium swartzii	—	1	5	$\mathbf{10_8}$	$\mathbf{9_6}$	$\mathbf{10_{10}}$	—	—	3	—	—	1	1	50	1	1
Pseudoscleropodium purum	—	5	8_5	$\mathbf{10_9}$	$\mathbf{10_8}$	4	1	—	4	—	6_1	$\mathbf{10_7}$	7_4	67	$\mathbf{10_8}$	$\mathbf{10_{10}}$
Brachythecium velutinum	—	—	—	—	—	—	4	—	—	—	—	—	—	0	—	—
— cfr. salebrosum	—	—	—	—	—	—	—	—	+	—	—	—	—	17	—	—
Camptothecium lutescens	—	—	—	—	—	$\mathbf{10_9}$	$\mathbf{10_{10}}$	—	—	—	—	—	—	0	9_3	$\mathbf{10_{10}}$
Anomodon viticulosus	—	—	—	—	—	—	—	—	—	—	—	—	—	0	—	$\mathbf{10_9}$
Thuidium philiberti	—	—	—	5	—	—	—	—	—	—	—	1	—	17	+	—
Homalia trichomanoïdes	—	—	—	—	—	—	—	—	—	—	—	—	—	0	—	$\mathbf{10_9}$
Neckera complanata	—	—	—	—	—	—	—	—	—	—	—	—	—	0	5	—
Fissidens adiantoïdes	—	—	—	—	—	—	—	—	1	—	—	—	—	17	4	1
Barbula unguiculata	—	—	—	+	1	—	—	—	—	—	—	—	—	0	—	—
— convoluta	—	1	—	—	—	—	—	—	—	—	—	—	—	0	—	—
Pottia davalliana	—	—	—	+	—	—	—	—	—	—	—	—	—	0	—	—
Mnium undulatum	—	$\mathbf{10_8}$	—	3	+	—	—	—	—	—	2	3	4	50	—	—
Cladonia fimbriata	—	—	—	—	—	—	—	—	—	—	—	—	—	0	2	—

Groups of species: (1) Continental-subcontinental species connected with wood-steppe and related communities. — (2) The same, but further boreal-montane and connected with meadows. — (3) Other continental-subcontinental species. — (4) Widely ranging species connected with meadows. — (5) Other widely ranging species. — (6) Mosses and lichens. In this and the following tables the species within the first groups are arranged as follows: (1) Monocotyledons, (2) sympetalous plants, (3) choripetalous plants, and (4) gymnosperms and pteridophytes.

as guiding species for the wood-steppe. In Denmark both *Geranium sanguineum* and *Silene nutans* occur in dry dune as well as in coastal field communities (the so-called shingle-alvar, see BÖCHER 1945). The phenomenon may be due to the cooler, more humid climate in Denmark and in the British Isles.

At a comparison with foreign vegetation our Jutlandish community seems to be very closely related to MEUSEL's "*Brachypodium pinnatum*-Weiderasen", which is a semi-natural vegetation developed on treeless north-facing slopes on calcareous soil in the west within the area under investigation. Important species are *Koeleria pyramidata, Briza media, Carex flacca, Cirsium acaule,* and *Sesleria coerulea,* which is characteristic of non-sunny sides.

The *Geranium sanguineum-Filipendula hexapetala* Type.

This type is found in several localities chiefly on east- and west-facing slopes. The soil is drier and often more acid than in the preceding type. Particularly fine examples are found in Locs. 4 and 24, cf. Plates I, Fig. 2 and II, Fig. 2 and Table 4, nos. 4 and 7. A comparison between this type and the preceding one (Tables 3 and 4) shows several considerable floristic differences. A remarkable feature thus is the complete absence of *Koeleria pyramidata* and the rare occurrence of *Campanula glomerata* in the *Geranium-Filipendula* type. Further, such plants preferring dry soil as *Phleum phleoides* and *nodosum* and *Camptothecium lutescens* here reach higher values. The occurrence and values of the meadow plants (Group of Species 5) show that within the *Geranium* sociations there are two subtypes, one found on more humid, calcareous soil (nos. 1—3) and another on drier soil, poorer in chalk (nos. 4—8).

In Table 4 two groups of sociations have been accounted for, one dominated by *Geranium* (nos. 1—8) and the other by *Filipendula hexapetala* (nos. 9—11). The latter was found only on slightly acid sandy soil. The main ecological difference between the groups, however, is hardly to be sought in the chemical conditions of the soil, but in the degree of humidity, which must be supposed to be highest in the *Geranium* group. This also agrees with the particularly frequent occurrence of such xerophilous species as *Carex caryophyllea, Festuca ovina, Potentilla verna,* and *Sedum acre* in the *Filipendula* group.

The *Geranium-Filipendula* type approaches very near to the Sealandish vegetation which has been described under the name of continental high perennial slope, and the floristic composition of which shows several important correspondences with wood steppe communities. The corresponding Himmerland community is floristically poorer, and the characteristic eastern species are often more scattered than in Sealand. A remarkable feature is the absence of *Cynanchum vincetoxicum, Malva alcea,* and *Asparagus officinalis,* and the rare occurrence of *Origanum vulgare.* The floristic decline that can be ascertained may be highly due to the climate, which in Himmerland is less continental than in East Denmark. Conditions of the soil, however, are hardly without importance, the sandy soils in Jutland clearly being more acid than corresponding Sealandish soils, a fact which may be due to greater leaching.

Table 4.

Analysis no.		1	2	3	4	5	6	7	8		9	10	11	12	13	14	15
Locality no.	Animals	1	1	2	24	24	26	4	4	Percentage constancy nos. 1–8	25	4	1	31	30	12	1
Exposure		SW	S	W	E	E	WSW	W	WNW		E	W	SW	W	ENE	S	SW
Slope		30	35	30	35	30	35–40	35–40	40		40	40	30	5–10	20	40	40
*p*H		7.6	7.5	7.2	6.0	6.4	5.9	6.7	6.1		6.8	6.6	6.0	7.5	6.1	6.4	7.7
$CaCO_3$, percentage		9.0	10.0	8.3	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	7.3	0.01	0.0	11.0
Density of species ($\frac{1}{10}$ m.²)		12.3	17.1	22.4	14.9	10.5	11.7	14.0	19.0		15.5	17.6	18.3	20.2	31.3	16.7	16.0
Number of species		36	48	50	46	37	34	37	50		28	45	52	46	60	47	40
Total covering in per cent.		80	95	100	100	100	100	100	100		100	80	100	100	95–100	95–100	80
1. Geranium sanguineum	—	**10_6**	**10_6**	10_4	**10_9**	**10_7**	**10_9**	**10_7**	10_3	**100**	—	5	—	—	—	—	—
Filipendula hexapetala	—	2	4	—	10_2	7_0	1	7_3	10_1	**88**	**10_{10}**	**10_6**	**10_6**	—	—	—	—
Campanula persicifolia	—	—	—	—	10_2	9_4	—	—	—	25	—	—	—	—	—	—	—
— glomerata	—	—	—	+	—	—	—	—	—	13	—	—	—	—	—	—	—
Origanum vulgare	—	—	—	—	—	—	—	4	—	13	—	—	—	—	—	—	—
Clinopodium vulgare	—	—	—	+	—	—	—	—	—	13	—	—	—	—	—	—	—
Galium boreale	—	—	—	—	—	1	—	—	—	13	—	—	—	—	—	—	—
Primula veris	—	—	1	2	1	—	—	10_4	—	50	—	—	+	1	10_1	—	—
Astragalus glycyphyllus	—	—	—	—	—	—	—	+	—	13	—	—	—	—	—	—	—
Rubus caesius	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	—	2
Fragaria viridis	—	—	—	—	—	—	—	7_2	—	13	—	10_1	—	—	—	—	—
Agrimonia eupatoria	—	—	3	—	—	—	—	4	—	25	—	—	+	—	—	—	1
Sedum telephium	—	—	—	—	+	+	—	—	—	25	—	—	—	—	—	—	—
Viola hirta	—	2	3	3	—	—	—	—	—	38	—	—	—	—	—	—	—
Thalictrum minus	—	—	—	—	6_1	2	—	—	—	25	7_2	—	—	—	—	—	—
Polygonatum officinale	—	—	—	—	1	—	—	—	—	13	—	—	—	—	—	—	—
Carex montana	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	**10_{10}**	—
2. Helianthemum nummularium	—	—	—	—	—	—	—	—	**10_6**	13	—	—	—	**10_{10}**	10_3	—	—
3. Phleum phleoides	—	—	—	—	7_3	1	—	—	—	25	8_1	—	—	—	—	—	—
— nodosum	—	4	3	**10_7**	2	+	4	1	4	**100**	5	10_2	+	—	—	—	10_4
Poa angustifolia	—	—	1	—	1	—	—	8_4	—	38	—	—	—	5	1	2	—
Avena pratensis	—	9_4	**10_8**	**10_6**	10_3	3	5	—	**9_6**	**88**	**10_7**	**10_6**	**10_6**	1	**10_6**	—	—
— pubescens	—	—	—	—	2	+	—	—	—	25	1	3	—	—	—	+	1
Calamagrostis epigeios	—	—	—	—	—	—	6_1	9_3	—	25	—	—	—	—	—	—	—
Carex caryophyllea	—	2	6_4	1	5	2	—	—	7_1	75	**10_8**	10_3	**10_8**	6_4	7_5	9_3	—
Allium vineale	—	—	—	—	+	+	—	—	—	25	—	—	—	—	—	—	—
Centaurea scabiosa	—	—	5	—	3	+	+	+	+	75	—	—	+	—	—	—	2
— jacea	—	4	8_3	7_1	—	—	—	3	+	63	—	—	5	—	—	—	—
Pimpinella saxifraga	—	—	2	—	2	4	1	—	3	63	2	2	—	4	+	+	—
Hypericum perforatum	—	—	3	—	—	—	—	4	2	38	—	—	1	2	—	—	—
Genista tinctoria	—	—	—	—	1	—	—	—	—	13	—	—	—	—	—	—	—
Vicia angustifolia	×	—	—	—	—	—	—	—	—	0	—	1	—	—	—	—	—
Trifolium arvense	×	—	—	—	—	—	—	—	—	0	+	2	+	—	—	—	—
Potentilla verna	—	—	1	—	—	—	—	—	—	13	—	10_5	**10_8**	—	—	—	—
Saxifraga tridactylites	×	—	—	+	—	—	—	—	—	13	—	—	—	—	—	—	—
Arabis hirsuta	—	—	—	1	—	+	—	+	—	38	—	2	2	+	—	2	—
Turritis glabra	—	—	—	—	—	—	6_0	—	—	13	—	—	—	—	—	—	—
Erophila verna	×	—	—	1	—	—	—	—	—	13	—	1	+	—	—	—	—
Pulsatilla vulgaris	—	—	—	—	—	—	—	—	—	0	—	—	—	—	8_2	—	—

Arenaria serpyllifolia	×	—	4	9_2	—	—	—	—	—	25	—	5	3	—	1	—	—
Cerastium arvense	—	—	—	—	—	—	—	—	—	0	—	—	—	10_4	—	—	—
Viscaria vulgaris	—	—	—	—	1	—	7_3	—	+	38	—	+	—	—	—	—	—
4. Cirsium acaule	—	3	4	1	—	—	—	—	—	38	—	—	—	—	3	+	—
Carlina vulgaris	—	—	1	—	—	—	—	—	—	13	—	—	—	—	1	—	—
Plantago media	—	—	1	1	—	—	—	—	+	38	—	—	1	—	+	—	—
Trifolium medium	—	—	+	—	—	—	—	—	1	25	—	—	—	—	5	1	—
5. Briza media	—	+	1	7_1	3	+	—	—	9_2	75	—	1	1	—	5	7_3	1
Poa trivialis	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	—	2
Festuca elatior	—	5	1	—	—	—	—	—	—	25	—	—	—	—	—	—	6_1
Carex flacca	—	5	8_4	1	—	—	—	—	—	38	—	—	—	—	5	—	4
Chrysanthemum leucanthemum	—	+	—	+	—	—	—	1	+	50	—	—	—	3	+	—	**10_{10}**
Bellis perennis	—	1	—	6_2	—	—	—	—	—	25	—	—	—	—	—	—	4
Succisa pratensis	—	—	—	+	—	—	—	—	—	13	—	—	—	—	—	3	—
Prunella vulgaris	—	7_1!	+	8_2	—	—	—	—	1	50	—	—	—	2	—	+	8_2
Lathyrus pratensis	—	—	—	—	—	—	1	2	—	25	—	—	—	—	—	—	1
Trifolium pratense	—	+	—	+	—	—	—	—	1	38	7_2	—	—	1	—	—	—
— repens	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	—	2
Potentilla erecta	—	—	—	—	—	—	—	—	—	0	—	—	—	—	1	1	—
Fragaria vesca	—	2	2	—	—	—	—	—	—	25	—	—	—	—	3	—	7_1
Linum catharticum	×	—	—	1	—	—	—	—	—	13	—	—	—	7_1	2	3	—
Alchemilla pubescens	—	—	—	—	—	—	—	—	—	0	—	—	—	+	7_1	—	—
Rumex acetosa	—	—	—	—	+	—	2	2	3	50	—	—	1	—	—	+	—
6. Festuca rubra	—	10_5	4	**10_{10}**	—	2	10_5	2	1	**88**	—	1	**10_8**	10_3	8_2	1	—
— ovina	—	+	6_3	—	4	2	1	1	9_5	**88**	6_3	10_5	**10_7**	—	**10_9**	8_3	4
Poa pratensis	—	—	1	**9_6**	—	—	5	—	4	50	7_3	2	—	10_3	—	—	5
Anthoxanthum odoratum	—	—	—	—	1	—	—	1	10_4	38	—	—	—	1	1	—	—
Dactylis glomerata	—	2	3	10_0	9_2	6_1	10_3	**10_6**	5	**100**	3	1	+	1	—	—	5
Agrostis stolonifera	—	—	—	—	6_1	—	—	1	9_4	38	—	—	—	9_4	—	—	—
— tenuis	—	—	—	4	—	4	—	—	—	25	1	—	2	—	5	—	—
— canina	—	—	—	—	5	6_1	—	—	—	25	—	—	—	—	—	—	—
Agropyron repens	—	—	—	—	—	—	7_1	—	—	13	—	—	2	—	—	—	—
Lolium perenne	—	—	—	9_2	—	—	—	—	—	13	—	—	—	—	—	—	5
Deschampsia flexuosa	—	—	—	—	6_5	+	—	—	—	25	—	—	—	—	—	—	—
Cynosurus cristatus	—	—	—	7_0	—	—	—	1	6_2	38	—	—	—	—	—	—	+
Bromus mollis	×	—	—	—	—	—	—	—	—	0	—	5	+	—	—	—	7_1
Carex hirta	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	—	3
Luzula campestris	—	—	—	—	1	—	—	2	5	38	**10_6**	2	4	2	4	6_0	—
Hieracium pilosella	—	1	—	3	—	—	7_2	—	4	50	10_5	3	10_2	2	10_5	**10_8**	**8_6**
— umbellatum	—	—	—	+	—	—	—	—	—	13	—	—	—	—	—	—	—
Solidago virga-aurea	—	—	—	—	—	—	—	—	3	13	—	—	—	—	—	2	—
Achillea millefolium	—	**9_6**	**9_6**	9_2	3	7_3	+	1	+	**100**	1	1	2	**10_6**	**10_6**	8_2	—
Taraxacum sp.	—	3	2	7_2	—	—	+	—	—	50	2	2	1	—	3	1	4
— erythrospermum	—	—	—	—	—	—	—	—	—	0	—	1	1	—	—	—	—
Matricaria inodora	—	—	—	—	—	—	3	—	—	13	—	—	—	—	—	—	—
Campanula rotundifolia	—	—	5	1	2	5	—	—	4	63	4	—	1	4	7_2	1	—
Knautia arvensis	—	—	2	—	+	1	—	1	3	63	—	—	—	—	4	—	—
Galium verum	—	4	8_3	9_3	7_1	4	10_2	4	4	**100**	10_3	6_1	10_3	—	8_3	**10_7**	5
— pumilum	—	3	4	1	1	—	—	—	—	50	—	—	—	1	8_2	1	+
Plantago lanceolata	—	9_0	2	10_3	—	—	—	4	6_0	63	—	4	5	3	2	9_1	2
Veronica chamaedrys	—	—	—	—	—	—	+	5	—	25	—	—	1	1	—	—	1
— officinalis	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	2	—

*9

(To be continued)

Table 4 (continued).

Analysis no.		1	2	3	4	5	6	7	8	9	9	10	11	12	13	14	15
Locality no.		1	1	2	24	24	26	4	4		25	4	1	31	30	12	1
Exposure		SW	S	W	E	E	WSW	W	WNW		E	W	SW	W	ENE	S	SW
Slope		30	35	30	35	30	35–40	35–40	40		40	40	30	5–10	20	40	40
*p*H		7.6	7.5	7.2	6.0	6.4	5.9	6.7	6.1		6.8	6.6	6.0	7.5	6.1	6.4	7.7
$CaCO_3$, percentage		9.0	10.0	8.3	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	7.3	0.01	0.0	11.0
Density of species ($\frac{1}{10}$ m.²)		12.3	17.1	22.4	14.9	10.5	11.7	14.0	19.0		15.5	17.6	18.3	20.2	31.3	16.7	16.0
Number of species		36	48	50	46	37	34	37	50		28	45	52	46	60	47	40
Total covering in per cent.		80	95	100	100	100	100	100	100		100	80	100	100	95–100	95–100	80
Veronica arvensis	×	—	—	1	—	—	—	—	—	13	—	—	1	—	—	—	2
Thymus serpyllum	—	2	1	2	—	—	—	—	—	38	—	—	1	—	10_2	+	—
Daucus carota	—	—	—	—	—	—	—	—	—	0	—	—	—	6_2	—	+	—
Geranium dissectum	×	—	—	—	—	—	—	—	—	0	—	—	—	—	—	—	4
Anthyllis vulneraria	—	+	—	—	—	—	—	—	1	25	—	2	5	1	2	—	—
Medicago lupulina	×	9_3	10_4	10_3	—	—	—	—	—	38	10_1	2	—	**10_7**	—	—	9_1
Vicia cracca	—	—	—	—	—	—	—	—	—	0	—	—	—	1	—	1	—
— hirsuta	—	—	—	—	—	—	+	—	—	13	—	—	—	—	—	—	—
Lotus corniculatus	—	7_3!	—	1	1	—	—	—	—	38	—	—	1	—	6_2	3	3
Potentilla reptans	—	1	1	—	—	—	—	—	—	25	—	—	—	3	—	—	**10_8**
Sedum acre	—	1	1	—	—	—	—	—	—	25	—	—	10_5	—	—	—	—
Viola canina	—	—	1	7_1	—	+	—	9_3	2	63	—	1	1	—	2	—	—
Polygala vulgaris	—	—	—	—	—	—	—	—	+	13	—	—	—	—	+	—	—
Cerastium caespitosum	—	+	—	1	—	—	—	—	—	25	—	2	—	—	1	—	+
Rumex acetosella	—	—	—	—	—	—	—	—	—	0	—	—	1	—	—	—	—
Equisetum arvense	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	—	4
7. Prunus spinosa	—	1	—	—	—	—	—	—	2	25	—	—	—	—	—	—	—
Crataegus oxyacantha	—	—	—	—	1	—	—	+	—	25	—	—	—	—	—	—	—
Rosa canina	—	—	—	—	+	—	—	+	—	25	—	—	—	—	—	—	—
— tomentosa	—	—	—	—	1	—	—	—	—	13	—	—	—	—	—	—	—
Juniperus communis	—	—	—	—	+	+	—	—	—	25	—	—	—	—	—	+	—
Carex muricata	—	—	—	—	—	—	—	1	—	13	—	—	—	—	—	—	—
Heracleum sphondylium	—	—	—	—	—	—	—	10_2	—	13	—	—	—	—	—	—	—
Anthriscus silvester	—	—	—	+	—	8_2	1	—	—	25	—	—	—	—	—	—	—
Pteridium aquilinum	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	+	—
8. Sieglingia decumbens	—	—	—	—	1	—	—	—	—	13	—	6_0	—	—	8_1	9_5	—
Holcus lanatus	—	—	—	—	—	—	—	—	1	13	—	—	—	—	—	—	—
Aira praecox	×	—	—	—	—	—	—	—	—	0	—	2	6_1	—	—	—	—
Carex arenaria	—	—	—	—	—	—	—	—	—	0	+	2	—	—	—	—	—
Armeria vulgaris	—	—	—	—	+	—	—	—	—	13	1	2	1	—	—	—	—
Calluna vulgaris	—	—	—	—	—	—	—	—	—	0	—	—	1	—	1	1	—
Myosotis versicolor	×	—	—	1	—	—	1	—	—	25	—	—	—	—	—	—	—
Lathyrus montanus	—	—	—	—	—	—	—	—	3	13	—	—	—	—	5	—	—
Trifolium campestre	×	—	—	—	—	—	—	—	1	13	—	3	4	—	—	2	—
Ononis repens*	—	1	2	—	—	+	1	3	+	75	—	1	—	3	—	—	—
Saxifraga granulata*	—	—	—	—	—	—	—	—	1	13	1	5	1	—	+	—	—
Ranunculus bulbosus*	—	4	3	10_3	—	—	—	—	—	38	5	9_4	9_3	8_3	9_2	1	6_1

9. Hylocomium splendens	—	—	—	—	3	—	—	—	—	13	—	—	—	6_2	2	1	—
— squarrosum	—	—	—	—	5	3	—	—	3	38	—	2	—	1	3	—	—
— triquetrum	—	—	—	—	4	—	—	6_2	3	38	—	—	—	—	7_2	2	—
Hypnum cupressiforme	—	—	—	—	—	—	—	—	7_5	13	4	2	7_3	1	7_5	8_6	—
Campylium chrysophyllum	—	—	1	—	—	—	—	—	—	13	—	—	—	**10_9**	—	—	—
Calliergonella cuspidata	—	—	—	—	—	—	—	—	—	0	—	—	—	—	6_3	—	—
Eurhynchium swartzii	—	—	2	6_2	—	1	—	—	+	50	—	—	—	**9_8**	—	—	5
Pseudoscleropodium purum	—	—	—	—	1	7_2	1	—	9_4	50	—	—	—	**9_6**	**10_4**	**9_7**	—
Brachythecium velutinum	—	—	—	—	—	—	1	—	—	13	—	—	—	—	—	—	—
Camptothecium lutescens	—	+	**9_6**	6_1	6_2	2	+	6_0	**10_9**	100	**10_{10}**	**10_{10}**	5	**10_{10}**	**10_{10}**	**10_6**	4
Thuidium philiberti	—	—	—	—	—	—	—	—	—	0	**10_8**	—	—	**8_7**	**10_7**	**10_8**	—
Climacium dendroïdes	—	—	—	—	—	—	—	—	—	0	—	—	—	—	8_1	—	—
Fissidens adiantoïdes	—	—	5	4	—	1	+	—	2	63	—	—	5	—	9_5	1	—
Pleuridium subulatum (Hedw.) Lindb. neque (Huds.) Rabenh.	—	—	—	—	—	—	—	—	—	0	—	—	2	—	3	—	—
Ceratodon purpureus	—	—	—	—	—	—	7_2	—	—	13	—	—	—	—	—	—	—
Dicranum scoparium	—	—	—	—	—	—	—	—	—	0	—	—	—	—	2	—	—
Barbula unguiculata	—	—	1	—	—	—	—	—	—	13	—	—	—	1	—	—	2
— convoluta	—	—	—	—	—	—	—	—	—	0	—	—	—	4	—	+	—
— fallax var. brevifolia	—	—	3	—	—	—	—	—	—	13	—	—	—	4	—	—	—
Weisia microstoma	—	—	—	—	1(?)	—	—	—	2	25	—	—	5	—	5	**10_8**	—
Phascum cuspidatum	—	—	—	—	—	1	—	—	—	13	—	—	—	—	—	—	—
Pottia sp.	—	—	—	2	—	—	—	—	—	13	—	—	—	—	—	—	1
Tortula subulata	—	—	—	—	—	—	5	—	—	13	—	—	1	—	—	—	—
— ruralis	—	—	—	—	—	—	—	—	—	0	—	—	—	—	1	—	—
Bryum spp.	—	—	—	—	—	—	—	—	—	0	—	—	—	+	—	2	—
Rhodobryum roseum	—	—	—	—	—	—	—	—	—	0	—	—	—	—	**8_7**	—	—
Mnium cuspidatum (L.) Neck. neque Hedw.	—	—	—	—	5	6_5	3	—	—	38	—	—	—	—	**9_6**	1	—
Lophocolea bicuspidata	—	—	—	—	—	—	—	—	—	0	—	—	—	—	**10_8**	—	—
Riccardia sp.	—	—	—	—	—	—	—	—	—	0	—	—	—	1	—	—	—
10. Collema pulposum	—	—	1	—	—	—	—	—	—	13	—	—	—	—	—	—	—
Cladonia furcata	—	—	—	—	—	—	—	—	—	0	—	1	—	—	—	—	—
— rangiformis	—	—	—	—	—	—	—	—	—	0	—	4	3	—	—	—	—

Groups of species: (1) Continental-subcontinental species connected with wood-steppe and related communities. — (2) see Text. — (3) Continental-subcontinental species. — (4) The same connected with meadows. — (5) Widely ranging species connected with meadows. — (6) Other widely ranging species. — (7) Widely ranging ligneous and herbaceous plants connected with the wood. — (8) Suboceanic species and species with a tendency of distribution towards the west (marked with an asterisk). — (9) Bryophytes. — (10) Lichens.

Communities Ecologically and Floristically Related to Those of the Wood-Steppe Group.

Sociations rich in *Helianthemum nummularium*. It is interesting to follow this species from place to place. In Sealand it is not particularly selective. Here it is found on dry half-open sunny sides (e. g. on the slope south of Selsø), on slopes facing east, west, and even north, or on spots of heather on fairly poor soil. In Central Germany on the other hand it seems to be most frequent in communities on north-facing slopes (see MEUSEL 1939, pp. 109 and 234). In most places in Himmerland we found the sun-rose in connexion with scrub or at the edges of woods (Locs. 4, 5, 10, 31). This connexion, indeed local, with shrub- and tree-growth, however, does not justify a mere reference of the sun-rose vegetations to the wood-steppe group, hence we have chosen to treat it apart, though connected with this group. The apparent difference between the attitudes of *Helianthemum nummularium* in the various places might be most easily explained on the assumption of race-biological differences, but of such we have no certain knowledge.

Helianthemum nummularium appears as a dominant partly together with *Geranium sanguineum* (no. 8), partly without this species (nos. 12—13). These last analyses show fairly close floristic correspondences (see the figures for *Achillea millefolium*, *Camptothecium lutescens*, *Pseudoscleropodium purum*, and *Thuidium philibertii*). The number and density of species in no. 13 reaches a climax with 60 species and no less than 31 species per 0.1 m².

The *Carex montana-Weisia microstoma* sociation (Table 4, no. 14) is also classified in connexion with the wood-steppe group. *Carex montana* is dominant e. g. in Polish wood-steppes on north- and east-facing slopes (KULCZYNSKI & MOTYKA 1936) and in continental wood-edge vegetation (Sealand, see RAUNKIÆR 1934, pp. 220—231). In Jutland the species is particularly known from oak scrub and certain heath hill-sides (BÖCHER 1943). In Table 14 it enters in a vegetation occurring on rather dry soil. See also its occurrence in Table 8, nos. 12 and 19.

The *Chrysanthemum leucanthemum* sociation (Table 4, no. 15; Plate II, Fig. 1) is a community influenced by civilization and belonging to half-dry soil on a sunny side near scrub. Genuine wood-steppe species are practically completely missing. In return there is an abundance of widespread meadow plants. Floristically the vegetation therefore approaches very near to the grass-slopes, to which group *Chrysanthemum leucanthemum* itself is also attached, e. g. in Sealand.

C. The Steppe Alvar Group and the Transition to Dry Grass-Herb Vegetations with Submediterranean or Suboceanic Species.

In what follows we shall try to give an account of the rather complicated complex of vegetations developed on dry and warm soil in Himmerland. It should be emphasized that the ecological investigation particularly on one point is unsatisfactory, inasmuch

as no analyses of the water economy in the various communities have been made. There is here an interesting object of future research. There are several analyses made by crude methods in the papers by BÖCHER from Sealand and Møn. These show that the concept of "dry soil" covers several degrees. Soils rich in humus or fine-grained are most aqueous, but need not for that reason contain greater accessible quantities of water than coarse-grained mineral soils. In some cases, however, they seem to be more humid also from the point of view of the plants. Thus when *Chrysanthemum leucanthemum*, as mentioned above, may grow abundantly on a warm sunny side, this is no doubt due to the fact that the soil is clayey, to which perhaps should be added the fact that it is slightly supplied with water oozing out slowly. Calcareous, south-facing soils in this country are chiefly found in Himmerland and on Høje Møn. In both places it appears that meadow plants play a fairly great part in the vegetational carpet, and that many plants preferring a dry soil, amongst others the vernal therophytes, are remarkably rare. This last feature is also found in the characteristic species on the steppe-alvar group (see below). Consequently the communities occurring on south-facing chalky slopes both floristically and ecologically hold a special position: They slightly approach the communities occurring on more humid grass-slopes facing north. Intermediary forms between these and the chalk-slope vegetation with southern exposure are found on west- and east-facing calcareous slopes (see Table 5, nos. 6—10).

As characteristic species within the vegetational complex treated here the following are used:

1) For the steppe-alvar group: *Phleum phleoides, Poa angustifolia, Avena pratensis, Artemisia campestris, Gnaphalium arenarium, Veronica spicata,* and *Pulsatilla pratensis,* species of a continental distribution and connected with steppes, the Baltic alvar vegetations, and related dry grassland communities.

2) For the group of grass-herb vegetations with southern, in part submediterranean plants preferring dry soil: *Festuca glauca, Calamintha acinos, Alyssum alyssoides, Saxifraga tridactylites, Sanguisorba minor* (particularly ssp. *muricata*), and *Cladonia subrangiformis.* These species have a more southern than continental distribution, and it is even doubtful whether we may attribute a tendency towards continental distribution to *Saxifraga tridactylites* (cf. HOFF 1943).

3) For the group of grass-herb vegetations with suboceanic plants preferring dry soil: *Corynephorus canescens, Aira praecox, Carex arenaria, Filago minima, Hypochoeris radicata, Jasione montana,* and *Teesdalia nudicaulis,* species with their chief distribution in *Corynephoreta* and related communities in Western and Central Europe.

4) It may in future prove expedient also to operate with a group characterized by indifferent, non-continental or non-oceanic species. For such a group particularly *Sedum acre, Thymus serpyllum, Bromus mollis* and others might serve as a kind

Table 5.

Analysis no.		1	2	3	4	5		6	7	8	9	10		11	12	13	14	15		16	17
Locality no.		20	21	21	18	18		18	19	7	7	2		2	2	30	30	24		10	18
Exposure		SSW	S	SSE	SE	SE	Per-	ESE	ESE	ESE	E	W	Per-	W	W	SE	SE	SSE	Per-	W	S
Slope		30	30	30	25	20	centage	30	30	30	40	35	centage	30	25	30	30	30	centage	40	45
*p*H		7.2	7.6	7.3	7.3	7.4	con-	7.3	7.4	7.6	7.2 7.6	7.7	con-	7.1	7.3	7.4	7.5	7.2 7.3	con-	7.4	7.4
$CaCO_3$, percentage	Annuals	60	40	36	67	62	stancy	41	15	42	3 12	16	stancy	2.3	20	0.8	2.3	0.1 1.1	stancy	52	79
Density of species ($\frac{1}{10}$ m.²)		13.4	10.1	12.6	25.6	18.8	nos.	15.5	14.5	14.0	21.0	19.3	nos.	20.3	22.6	27.5	20.7	16.9	nos.	9.8	10.3
Number of species		41	37	24	46	42	1–5	32	40	30	49	48	6–10	45	55	44	50	29	11–15	34	26
Total covering in per cent		80	65	90	95	95		95	85	70	85	80		100	100	95	95	100		50	30
1. Avena pratensis*	—	**10_7**	10_2	10_5	10_3	10_4	**100**	**10_6**	**10_8**	2	9_0	10_3	**100**	10_4	10_4	10_4	**10_8**	1	**100**	10_5	—
Koeleria pyramidata var. danica	—	9_5	2	5	**10_7**	**10_6**	**100**	7_4	**10_7**	9_5	10_5	4	**100**	8_4	10_3	—	—	—	40	3	—
Phleum nodosum	—	—	—	—	—	1	20	—	8_4	10_4	10_2	10_2	**80**	+	4	—	2	—	60	—	—
Calamagrostis epigeios	—	—	—	—	—	—	0	—	—	—	—	—	0	—	—	—	—	9_5	20	—	—
Poa compressa	—	—	—	—	2	—	20	5	—	—	—	—	20	—	—	—	—	—	0	—	10_2
— angustifolia	—	—	—	—	—	—	0	—	—	—	—	—	0	—	—	—	—	**10_6**	20	—	—
Carex caryophyllea	—	+	—	—	—	—	20	—	—	—	8_2	2	40	2	2	10_3	9_4	—	**80**	—	—
Artemisia campestris*	—	1	1	—	+	—	60	—	—	6_1	4	3	60	5	6_1	—	—	5	60	—	—
Gnaphalium arenarium*	—	—	—	—	—	—	0	—	—	—	—	—	0	—	—	—	—	9_3	20	—	—
Centaurea jacea	—	4	10_5	10_3	10_4	10_1	**100**	7_2	1	1	3	1	**100**	10_3	4	—	4	—	60	2	3
— scabiosa	—	10_4	+	—	1	1	**80**	—	1	—	—	—	20	—	—	3	—	—	20	7_2	2
Veronica verna	×	—	—	—	—	—	0	—	—	—	—	—	0	—	—	—	—	2	20	—	—
Calamintha acinos*	×	+	—	+	3	—	60	6_0	3	3	1	1	**100**	1	—	—	—	—	20	3	—
Echium vulgare	—	—	—	—	—	—	0	—	—	—	—	—	0	—	—	—	—	—	0	—	8_2!
Pimpinella saxifraga	—	3	—	—	4	9_3	60	10_4	5	—	2	1	**80**	—	1	1	—	—	40	3	7_0
Hypericum perforatum	—	+	—	+	—	—	40	1	—	—	1	+	60	—	1	—	—	—	20	—	—
Vicia lathyroides	×	—	—	—	—	—	0	—	—	—	—	—	0	—	—	—	—	8_3	20	—	—
Onobrychis viciifolia	—	—	—	8_2	—	—	20	—	—	—	—	—	0	—	—	—	—	—	0	—	—
Medicago sativa	—	—	—	—	1	—	20	—	—	—	—	—	0	—	—	—	—	—	0	—	—
Trifolium arvense	×	—	—	—	—	—	0	—	—	—	—	—	0	—	—	—	—	9_3	20	—	—
Sanguisorba minor coll.	—	10_5	10_2	5_2	10_5	**10_6**	**100**	—	—	—	—	—	0	—	—	—	—	—	0	—	—
Saxifraga tridactylites*	×	—	—	—	—	—	0	—	—	—	—	6_0	20	3	5	2	2	—	**80**	—	—
Reseda luteola	—	—	—	—	—	—	0	—	—	—	—	—	0	—	—	—	—	—	0	—	1
Erophila verna	×	—	—	—	—	—	0	—	—	2	6_0	4	60	—	1	—	1	—	40	—	—
Arabis hirsuta	—	+	+	10_4	—	—	60	—	+	—	—	10_0	40	7_4	9_4	—	1	+	**80**	—	—
Pulsatilla pratensis*	—	—	—	—	—	—	0	—	—	—	—	—	0	—	—	—	—	10_2	20	—	—
— vulgaris	—	9_2	—	—	—	—	20	—	+	—	—	—	20	—	+	9_1	8_2	—	60	—	—
Silene nutans	—	2	—	1	6_0	—	60	1	—	—	—	—	20	—	—	—	—	—	0	—	—
Arenaria serpyllifolia	×	1	2	—	2	—	60	—	10_5	8_3	9_0	5	**80**	7_1	8_1	9_1	7_4	9_2	**100**	—	—
2. Primula veris	—	1	—	—	—	—	20	—	1	—	—	—	20	—	—	—	+	—	20	—	—
Filipendula hexapetala	—	7_2	+	—	—	—	40	—	—	—	—	—	0	—	—	4	2	—	40	—	—
Agrimonia eupatoria	—	4	—	—	—	—	20	—	—	1	1	—	40	—	—	—	—	—	0	—	—
Viola hirta	—	3	—	—	2	—	40	—	—	—	—	—	0	—	—	—	—	—	0	+	—
Thalictrum minus var. dunense	—	—	—	—	—	—	0	—	—	—	—	—	0	2	7_2	—	—	—	40	—	—
— simplex	—	—	—	—	—	—	0	1	—	—	—	—	20	—	—	—	—	—	0	—	—
3. Cineraria integrifolia	—	1	—	+	6_2	2	**80**	3	—	—	—	—	20	7_2	3	—	—	—	40	1	—
Cirsium acaule	—	6_1	3	7_2	—	2	**80**	2	4	+	3	+	**100**	—	1	2	2	—	60	—	—

Carlina vulgaris	—	—	—	—	—	1	20	1	—	—	—	1	60	6_0	5	—	—	—	40	1	—
Plantago media	—	—	—	—	8_1	2	40	—	—	—	—	+	20	2	—	—	3	—	40	—	—
4. Festuca ovina	—	+	—	—	**10_7**	3	60	8_1	3	4	10_5	—	**80**	**10_{10}**	**10_{10}**	**10_6**	**10_8**	—	**80**	3	—
— rubra	—	2	1	2	—	10_4	**80**	6_0	4	1	+	**10_6**	**100**	10_3	4	—	8_5	9_2	**80**	3	9_2
Poa pratensis	—	—	—	—	—	—	0	—	—	—	—	—	0	—	—	1	3	—	40	—	—
Dactylis glomerata	—	10_3	+	4	2	5	**100**	3	4	—	8_2	10_0	**80**	3	1	—	—	—	40	—	—
Agrostis tenuis	—	—	2	—	—	—	20	—	—	—	7_2	—	20	—	1	—	3	—	40	—	—
Avena elatior	—	—	—	2	—	—	20	—	—	—	—	—	0	—	—	—	—	—	0	—	—
Bromus mollis	×	—	—	—	—	—	0	—	—	—	—	—	0	—	—	2	3	—	40	—	—
Luzula campestris	—	—	—	—	—	—	0	—	—	—	3	—	20	—	2	—	1	—	40	—	—
Hieracium pilosella	—	3	6_2	—	**9_6**	5	**80**	7_3	**10_6**	6_4	8_3	**10_8**	**100**	**10_8**	**10_{10}**	10_0	**9_8**	4	**100**	3	1
— auricula	—	1	—	—	10_5	3	60	8_4	—	—	—	—	20	—	—	—	—	—	0	—	10_5
Taraxacum sp.	—	—	—	—	2	1	40	—	2	3	1	9_4	**80**	—	1	—	—	—	20	1	3
— erythrospermum	—	—	—	—	—	—	0	—	—	—	—	—	0	—	—	7_1	3	—	40	—	—
Sonchus asper	×	—	+	—	—	—	20	—	—	+	—	—	20	—	—	—	—	—	0	—	1
Tragopogon pratensis	—	—	—	—	+	1	40	+	—	—	—	—	20	—	—	—	—	—	0	+	—
Leontodon autumnalis	—	—	—	—	—	—	0	—	—	—	—	6_1	20	1	—	—	—	—	20	—	2
Tussilago farfarus	—	—	—	—	—	—	0	—	—	—	—	—	0	—	—	—	—	—	0	1	+
Solidago virga-aurea	—	+	—	—	—	—	20	—	—	—	—	—	0	8_3	4	—	—	—	40	—	—
Achillea millefolium	—	—	—	5	8_3	1	60	4	+	2	8_3	10_2	**100**	6_1	1	8_1	3	—	**80**	2	—
Campanula rotundifolia	—	4	+	10_4	10_3	9_2	**100**	6_2	1	—	1	1	**80**	—	—	—	1	—	20	7_2	9_4
Knautia arvensis	—	3	+	—	—	—	40	—	+	—	+	—	40	—	—	1	—	—	20	2	—
Galium verum	—	3	+	—	5	1	**80**	9_3	5	—	9_3	8_2	**80**	4	9_4	10_2	8_4	10_4	**100**	2	—
— pumilum	—	—	1	6_0	9_5	5	**80**	—	—	—	2	9_5	40	10_4	**10_9**	—	—	+	60	7_0	1
Plantago lanceolata	—	—	—	—	9_1	3	40	5	—	—	1	2	60	1	2	2	+	—	**80**	3	—
Veronica arvensis	×	—	—	—	—	—	0	—	—	—	—	—	0	—	1	—	—	—	20	—	—
Linaria vulgaris	—	—	—	—	—	—	0	—	—	—	—	—	0	—	2	—	—	—	20	—	—
Odontites verna	×	—	—	—	—	—	0	—	—	—	—	1	20	—	—	—	—	—	0	—	—
Thymus serpyllum	—	—	—	—	7_3	3	40	8_5	+	1	7_3	+	**100**	—	4	9_5	**10_8**	6_1	**80**	5	—
Daucus carota	—	3	4	6_0	4	6_2	**100**	4	—	1	4	6_1	**80**	1	5	—	—	—	40	3	+
Anthyllis vulneraria	—	3	1	—	—	+	60	—	+	1	—	—	40	+	6_1	1	1	—	**80**	—	—
Lotus corniculatus	—	1	+	1	9_2	8_3	**100**	—	5	—	+	—	40	1	5	1	7_2	—	**80**	2	2
Medicago lupulina	×	3	2	—	—	**10_6**	60	4	8_2	3	9_4	9_3	**100**	**10_7**	**10_6**	10_2	10_3	2	**100**	1	—
Vicia cracca	—	—	—	1	—	—	20	—	—	—	—	—	0	—	—	—	—	—	0	+	—
Melilotus sp.	—	—	—	—	7_2	1	40	—	—	—	—	—	0	—	—	—	—	—	0	—	—
Trifolium pratense	—	—	—	—	—	6_1	20	—	—	—	2	1	40	—	—	—	—	—	0	—	—
Potentilla reptans	—	—	—	—	—	—	0	—	—	—	—	—	0	—	—	—	1	—	20	—	—
Sedum acre	—	—	—	—	3	—	20	3	**10_8**	—	2	—	60	2	—	**10_6**	8_2	10_5	**80**	2	—
Cerastium caespitosum	—	—	—	—	—	—	0	—	1	—	1	—	40	—	—	—	+	—	20	—	—
— semidecandrum	×	—	—	—	—	—	0	—	—	—	2	1	40	+	1	1	6_4	—	**80**	—	—
5. Briza media	—	3	—	—	—	6_5	40	—	+	—	9_1	—	40	**10_9**	1	5	7_2	3	**100**	—	—
Festuca elatior	—	—	—	—	—	—	0	—	2	5	9_5	3	**80**	—	—	—	—	—	0	—	—
Carex flacca	—	7_1	—	—	—	**10_6**	40	—	4	—	—	—	20	—	—	—	—	—	0	—	—
Chrysanthemum leucanthemum	—	—	—	—	9_1	3	40	5	—	—	1	2	60	1	2	2	+	—	**80**	3	—
Senecio jacobaea	—	4	8_1	3	8_0	1	**100**	7_1	4!	—	—	4	60	—	—	—	—	—	0	3	7_4
Bellis perennis	—	—	—	—	—	—	0	—	—	—	—	+	20	—	—	—	—	—	0	—	—
Succisa pratensis	—	1	—	—	—	—	20	—	—	—	—	—	0	—	—	—	—	—	0	—	—
Euphrasia stricta	—	—	—	—	9_1	—	20	—	—	—	—	—	0	—	—	—	—	—	0	—	—
— cf. borealis	—	—	—	—	—	—	0	—	—	—	—	—	0	—	3	—	—	—	20	—	—
Prunella vulgaris	—	—	—	—	3	1	40	—	—	—	—	1	20	—	—	—	—	—	0	—	—
Gentiana amarella	—	—	—	—	5	—	20	—	—	—	—	—	0	—	—	—	—	—	0	—	+
Linum catharticum	×	1	1	—	9_2	9_1	**80**	—	—	—	—	6_1	20	2	9_2	—	—	—	40	8_0	5
Rumex acetosa	—	—	—	—	—	—	0	—	—	—	1	—	20	—	—	—	—	—	0	—	—

(To be continued)

Table 5 (continued).

		1	2	3	4	5		6	7	8	9	10		11	12	13	14	15		16	17
Analysis no.																					
Locality no.		20	21	21	18	18		18	19	7	7	2		2	2	30	30	24		10	18
Exposure		SSW	S	SSE	SE	SE	Per-	ESE	ESE	ESE	E	W	Per-	W	W	SE	SE	SSE	Per-	W	S
Slope		30	30	30	25	20	cen-	30	30	30	40	35	cen-	30	25	30	30	30	cen-	40	45
*p*H		7.2	7.6	7.3	7.3	7.4	tage con-	7.3	7.4	7.6	7.2 7.6	7.7	tage con-	7.1	7.3	7.4	7.5	7.2 7.3	tage con-	7.4	7.4
$CaCO_3$, percentage	Annuals	60	40	36	67	62	stan-	41	15	42	3 12	16	stan-	2.3	20	0.8	2.3	0.1 1.1	stan-	52	79
Density of species ($\frac{1}{10}$ m.^{2})		13.4	10.1	12.6	25.6	18.8	cy	15.5	14.5	14.0	21.0	19.3	cy	20.3	22.6	27.5	20.7	16.9	cy	9.8	10.3
Number of species		41	37	24	46	42	nos.	32	40	30	49	48	nos.	45	55	44	50	29	nos.	34	26
Total covering in per cent		80	65	90	95	95	1–5	95	85	70	85	80	6–10	100	100	95	95	100	11–15	50	30
6. Draba incana	—	—	—	—	—	—	0	—	—	—	—	—	0	—	4	—	—	—	20	—	—
7. Sieglingia decumbens	—	—	—	—	—	—	0	—	—	—	1	—	20	—	—	—	—	—	0	—	—
Carex arenaria	—	—	—	—	—	—	0	—	—	—	—	—	0	—	—	—	—	3	20	—	—
Myosotis versicolor	×	—	—	—	—	—	0	—	—	—	—	3	20	—	1	—	—	—	20	—	—
Armeria vulgaris	—	—	—	—	—	—	0	—	—	—	—	—	0	8_0	4	—	—	2	60	—	—
Trifolium campestre	×	—	—	—	—	—	0	—	—	—	—	2	20	—	1	—	—	—	20	—	—
— dubium	×	—	—	—	—	—	0	—	—	—	—	—	0	—	4	—	—	—	20	—	—
Ononis repens*	—	+	4	—	2	—	60	1	+	1	+	+	**100**	—	—	1	3	—	40	—	—
Saxifraga granulata*	—	—	—	—	—	—	0	—	—	—	—	1	20	—	—	—	—	—	0	—	—
Ranunculus bulbosus*	—	—	—	—	3	—	20	3	**10_8**	—	2	—	60	2	—	**10_6**	8_2	10_5	**80**	2	—
8. Ctenidium molluscum	—	—	—	—	—	3	20	—	—	—	—	—	0	—	—	—	—	—	0	—	—
Hypnum cupressiforme	—	—	—	—	—	—	0	—	—	—	—	5	20	**10_9**	**10_7**	9_3	6_1	7_4	**100**	—	—
Campylium chrysophyllum	—	—	+	—	—	—	20	—	1	**10_6**	—	—	40	—	—	—	—	—	0	—	—
Eurhynchium swartzii	—	1	—	—	—	—	20	—	—	—	—	—	0	—	—	—	—	—	0	—	—
Pseudoscleropodium purum	—	—	—	—	—	—	0	—	1	—	7_1	—	40	—	—	—	—	—	0	—	—
Brachythecium velutinum	—	1	—	—	—	—	20	—	—	—	—	—	0	—	—	—	—	—	0	—	—
Camptothecium lutescens	—	—	**10_6**	**10_{10}**	**10_{10}**	**10_{10}**	**80**	**10_{10}**	**10_9**	**10_6**	2	8_2	**100**	**9_6**	9_4	**10_8**	**10_9**	—	**80**	2	—
Thuidium abietinum	—	—	8_1	**10_7**	—	—	40	—	5	—	—	—	20	+	—	**10_{10}**	—	**10_{10}**	60	—	—
— philiberti	—	—	—	—	—	—	0	—	—	—	—	—	0	—	1	—	—	—	20	—	—
Fissidens adiantoïdes	—	—	—	—	4	2	40	+	—	—	2	2	60	5	—	—	5	—	40	—	—
Ditrichum flexicaule	—	—	—	—	—	—	0	—	—	—	—	—	0	—	—	6_2	—	—	20	—	—
Rhacomitrium canescens	—	—	—	—	—	—	0	—	—	—	—	—	0	—	—	—	—	4	20	—	—
Barbula hornschuchiana	—	—	—	—	—	—	0	—	—	—	—	—	0	—	—	2	—	—	20	—	—
— unguiculata	—	—	1	—	—	—	20	—	1	10_4	10_1	3	**80**	+	1	—	—	—	40	—	—
— convoluta	—	—	—	—	—	—	0	—	—	—	—	—	0	+	—	**10_9**	4	—	60	—	—
— fallax var. brevifolia	—	—	1	—	4	2	60	—	—	**10_8**	—	—	20	—	2	9_2	4	—	60	—	—
Weisia crispa	—	—	—	—	—	1	20	—	—	—	—	—	0	—	—	—	—	—	0	—	—
Pottia lanceolata	—	—	1	—	—	—	20	—	—	8_0	6_0	—	40	—	—	4	4	—	40	—	—
Tortula subulata	—	—	—	—	—	—	0	—	—	—	—	2	20	—	—	—	—	—	0	—	—
— ruralis	—	—	—	—	—	—	0	—	—	—	—	—	0	—	3	**10_7**	—	3	60	1	—
Encalypta vulgaris	—	—	—	—	1	—	20	—	—	—	—	—	0	4	1	2	1	—	**80**	—	—
Bryum spp.	—	—	—	—	—	—	0	—	—	—	—	+	20	2	3	10_3	1	—	**80**	—	—
Mnium cuspidatum (L.) Neck. neque Hedw.	—	—	—	—	—	—	0	—	—	—	2	—	20	—	—	—	—	—	0	—	—
9. Verrucaria acrotella	—	—	7_0	—	—	—	20	—	—	—	—	—	0	—	—	—	—	—	0	—	4
— cfr. caesiospila	—	—	—	—	—	—	0	—	—	—	—	—	0	—	—	—	—	—	0	—	5

— muralis	—	—	1	—	—	—	20	—	—	9_2	—	—	20	—	—	—	—	—	0	—	—
— nigrescens	—	—	—	—	—	—	0	—	—	9_4	—	—	20	—	—	—	—	—	0	—	—
Collema cfr. furvum	—	—	1	—	+	—	40	—	—	—	—	—	0	—	—	—	—	—	0	2	5
— pulposum	—	—	—	—	—	—	0	—	—	4	3	—	40	—	—	—	—	—	0	—	—
Peltigera canina	—	—	—	—	—	—	0	—	—	—	—	—	0	+	—	—	—	3	40	—	—
— rufescens var. incusa	—	—	—	—	—	—	0	—	—	—	—	—	0	—	—	10_3	+	—	40	—	—
Bacidia sabuletorum	—	—	—	—	—	—	0	—	—	—	—	—	0	—	—	2	—	—	20	—	8_1
Cladonia subrangiformis	—	—	—	—	9_4	—	20	—	1	—	—	—	20	—	—	10_2	2	**10_9**	60	—	—
— rangiformis	—	—	—	—	—	—	0	—	—	—	—	—	0	—	—	10_2	4	1	60	—	—
— pyxidata	—	—	—	—	—	—	0	—	—	—	—	—	0	—	—	**10_7**	1	—	40	—	—
Lecanora albescens	—	—	—	—	—	—	0	—	—	—	—	—	0	—	—	—	—	—	0	—	+
— crenulata	—	—	—	—	—	—	0	—	—	—	—	—	0	—	—	—	—	—	0	—	+
— gibbosula	—	—	2	—	—	—	20	—	—	—	—	—	0	—	—	—	—	—	0	—	—
10. Nostoc commune	—	—	—	—	1	1	40	—	—	—	—	—	0	—	—	—	—	—	0	—	—

Groups of species. (1) Continental-subcontinental species; those marked with an asterisk are especially characteristic of the community of the steppe group. — (2) Continental-subcontinental species connected with wood steppe and similar communities. — (3) The same connected with meadows. — (4) Widely ranging species. — (5) The same connected with meadows. — (6) Subarctic-boreal species. — (7) Suboceanic species and species with a tendency of distribution towards the west (marked with an asterisk). — (8) Bryophytes. — (9) Lichens. — (10) Algae.

of guiding species, the chief criterion of such a group, however, being the absence of western, eastern and southern species preferring dry soil.

In the Himmerland communities there is a preponderance now for one, now for another of these groups of regional guiding species (cf. the ecogeographical types in BÖCHER 1945). The preponderance, however, is rarely very great, hence some of the material may be considered transitional vegetations. In the theory of regional vegetations such transitional communities are hardly of so great importance as the communities which may clearly be referred to some larger group of communities. But, apart from the local interest connected with them, they are of the highest value to ecological considerations. Particularly in transitional communities we often find extreme points for the occurrence of some species which is either completely absent or is frequent in the types of vegetation which clearly may be referred to one of the larger groups. Botanists using character species at the treatment of vegetations too frequently commit the error of disregarding the kinds of spots of vegetation containing an equal mixture of character species of different communities. Thus their accounts lose much in objectivity already at the choice of spots analyzed and we miss ecologically interesting intermediate types.

The *Sanguisorba minor* Type.

This community has developed on south-facing, very calcareous soil. The vegetation is never quite close and the density of species rarely exceeds 20, cf. further Table 5, nos. 1—5. Besides *Sanguisorba minor* coll., the species *Koeleria pyramidata, Avena pratensis, Centaurea jacea,* and *Camptothecium lutescens* are very frequent. The rather high figures of constancy and frequency for the species of groups 3 and 5 are remarkable. Among the vernal therophytes only *Arenaria serpyllifolia* shows low frequencies; but *Medicago lupulina, Linum catharticum,* and *Calamintha acinos* reach considerable values. Among the species characteristic of the steppe-alvar group only there are *Avena pratensis* with high values and *Artemisia campestris* with low ones. As *Avena pratensis,* i. a. by its frequency in meadowlike communities (see Table 8), is the very least important of the guiding species of the steppe-alvar group, it is evident that the *Sanguisorba minor* type cannot be referred to this group.

No doubt *Sanguisorba minor* coll. is the species most characteristic of this type of vegetation. The wild subspecies of the collective species, ssp. *dictyocarpa* (Spach) Gams, in Sealand has not been found on south-facing slopes, and in Central Germany is most frequent in the north-facing *Seslerietum* (MEUSEL). Ssp. *muricata* (Spach) Gams, on the other hand, has in Sealand been found in dry overgrown fields near Rørvig (BÖCHER 1945, p. 98) and it has been found on south-facing calcareous slopes on Høje Møn. In the Jutlandish localities examined by us, as a rule both subspecies were present promiscuously, although one species might dominate in some places, the other in others. Any regularity in the distribution could not be observed and the morphologically typical *dictyocarpa* was dominant as regards frequency both on

southern and northern exposures near Kongerslev. Probably it is not excluded that the two subspecies may hybridize. If so, an interchange of genes may cause physiological characters from the southern subspecies *muricata* to be conveyed to morphologically pure *dictyocarpa* individuals, which are thus enabled to thrive on the dry southern exposures. Nor is it, however, precluded that Himmerland is so far north in the area of the species that it becomes a *Sydberg* (south-slope) species. HEGI suggests that the collective species originally was a Mediterranean plant. It should also be rembered that *Sanguisorba minor* belongs to the species whose roots strike deep (see the illustration in ANDERSON 1927 and TANSLEY 1939), and that this fact in connexion with the rather high precipitation and humidity of the air in Himmerland may be of importance to its occurrence on the southern exposures.

Together with other southern species such as *Onobrychis viciifolia* (Table 5, no. 3) and *Calamintha*, *Sanguisorba minor* will carry the vegetation into a group of communities occurring on dry warm calcareous soil and characterized by submediterranean species. For this group, in which amongst others the vegetation of Høvblege on Møn may be included (see BÖCHER 1946), the submediterranean rocky heath in Central Germany (see MEUSEL) perhaps may be considered a particularly typical representative. Also this occurs on calcareous slopes facing south and west. In England there are undoubtedly communities related to the *Sanguisorba minor* vegetation of Himmerland. According to TANSLEY (1939, p. 538) *Sanguisorba minor* is moderately exclusive, very abundant or locally dominant in the chalk grassland.

In Table 5, nos. 16 and 17 two pioneer vegetations on open chalk gravel in the scree are included (cf. Locs. 10 and 18). These in the case of arid slopes remind ecologically of the vegetation belonging to the *Sanguisorba* type.

The *Koeleria pyramidata-Phleum nodosum* Type.

A community on less dry and warm calcareous slopes, particularly such facing west or east, cf. Table 5, nos. 6—10. Besides *Phleum nodosum* the species *Festuca elatior* and *Barbula unguiculata* are abundant in this type, which, for that matter, is difficult to characterize. Undoubtedly it is most closely related to the *Sanguisorba minor* type. Common features are the *Camptothecium* carpet, the high constancy and frequency of *Koeleria pyramidata*, and the half-open calcareous soil.

The *Phleum phleoides* Type.

This vegetation (Table 6, nos. 1—5) is found on neutral slightly basic or slightly acid soil on dry sandy slopes, particularly on southern exposures. As appears from the topographical chapter it has often developed on the sandy soil which in the slopes overlies the calcareous soil. Of all Jutlandish slope communities the *Phleum phleoides* type occurs on the loosest and driest soils. Floristically it corresponds to the open or nearly close continental dry-slope communities in Sealand. Here *Phleum phleoides* and *Artemisia campestris* in fact are the chief species. The latter is remarkably scarce

Table 6.

Analysis no.		1	2	3	4	5		6	7	8	9	10	11	12	13		14
Locality no.		20	10	25	5	8	Per-	8	1	34	34	34	4	7	33	Per-	33
Exposure		SSW	SW	SSE	S	SE	cen-	ESE	S	S	SSW	SSW	WSW	ESE	SE	cen-	W
Slope		35	25	40	35	45	tage	45	35	40	30–50	30	35	30	35	tage	35
*p*H		6.9	7.2	6.5	6.3	7.8	con-	7.6	6.8	6.1	5.4	5.2	5.3	4.9	5.0	con-	5.1
$CaCO_3$, percentage		0.01	0.5	0.0	0.0	1.5	stan-	1.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	stan-	0.0
Density of species ($\frac{1}{10}$ m.²)	Annuals	21.6	13.5	13.5	20.9	13.4	cy	18.7	11.7	10.6	18.3	20.2	23.8	14.2	21.3	cy	12.5
Number of species		37	26	36	46	43	nos.	51	38	42	63	43	49	38	57	nos.	38
Total covering in per cent.		80	100	90	100	65	1–5	70	85	85	30–80	85	100	95	75	9–13	95
1. Phleum phleoides*	—	**10_6**	**10_8**	6_1	10_5	10_5	**100**	2	—	—	—	—	—	—	—	0	—
— nodosum	—	—	—	7_2	—	+	40	10_1	8_4	1	—	—	—	+	+	40	—
Avena pratensis*	—	10_2	**10_8**	8_2	10_2	10_4	**100**	10_1	—	7_1	10_4	10_2	10_2	1	1	**100**	10_3
— pubescens	—	—	—	1	1	—	40	2	—	—	—	—	—	—	—	0	—
Poa angustifolia*	—	—	—	10_4	—	8_2	40	—	—	—	—	—	—	—	—	0	—
Koeleria pyramidata var. danica	—	10_3	8_3	3	—	—	60	—	—	—	—	—	—	—	—	0	—
Calamagrostis epigeios	—	—	—	—	—	5	20	6_1	—	—	—	—	—	—	—	0	—
Festuca glauca*	—	—	**10_6**	—	—	—	20	—	—	—	—	—	—	—	—	0	—
Carex caryophyllea	—	—	10_4	—	10_5	—	40	—	—	4	4	5	**10_8**	10_5	+	**100**	6_2
— ericetorum	—	—	—	—	6_0	—	20	—	—	—	—	—	—	—	—	0	—
Artemisia campestris*	—	—	—	5	—	6_2	40	1	—	—	—	—	—	—	—	0	—
Hypochoeris maculata	—	—	—	—	10_3	—	20	—	—	—	—	—	—	—	—	0	—
Centaurea jacea	—	—	—	—	—	—	0	2	2	—	1	—	—	—	—	20	—
— scabiosa	—	—	—	—	—	—	0	1	—	—	—	—	—	—	—	0	—
Erigeron acer	—	—	—	—	1	—	20	—	—	—	—	—	—	—	—	0	—
Veronica spicata*	—	—	—	—	8_1	—	20	—	—	—	—	—	—	—	3	20	—
— verna	×	—	—	1	—	—	20	—	—	—	—	—	—	—	8_2	20	—
Calamintha acinos	×	9_2	2	—	—	+	60	8_1	—	—	—	—	—	—	—	0	—
Myosotis micrantha	×	1	—	4	1	—	60	—	—	—	2	1	—	—	1	60	—
— cfr. hispida	×	—	—	—	—	3	20	—	—	—	—	—	—	—	—	0	—
Pimpinella saxifraga	—	—	—	—	3	1	40	8_0	—	—	2	—	8_3	+	+	**80**	1
Hypericum perforatum	—	—	—	—	—	2	20	3	—	—	—	—	1	—	—	20	2
Vicia lathyroides	×	—	—	6_2	—	—	20	—	—	—	—	—	—	—	—	0	—
— angustifolia	×	—	—	—	—	—	0	—	—	—	—	—	3	—	—	20	2
Trifolium arvense	×	5	—	3	6_2	2	**80**	—	—	—	+	—	2	—	4	60	—
— medium	—	—	—	—	—	1	20	2	—	—	—	—	—	—	+	20	—
Potentilla verna	—	—	—	—	—	—	0	—	—	—	—	—	9_2	—	—	20	—
— argentea	—	—	—	+	1	—	40	—	—	—	—	—	—	—	+	20	—
Saxifraga tridactylites	×	5	—	—	—	—	20	—	—	—	—	—	—	—	1	20	—
Arabis hirsuta	—	—	2	—	—	1	40	2	—	—	+	—	—	—	—	20	—
Erophila verna	×	—	—	1	3	8_3	60	2	4	—	5	—	—	—	7_2	40	—
Pulsatilla vulgaris	—	4	—	—	10_5	—	40	—	—	—	—	—	—	—	5	20	6_2
Viscaria vulgaris	—	4	—	—	—	—	20	—	—	—	—	—	10_0	—	—	20	6_0
Dianthus deltoides	—	—	—	—	—	—	0	—	—	—	—	—	—	—	—	0	2
Arenaria serpyllifolia	×	8_0	4	1	10_2	7_2	**100**	7_1	10_3	6_1	6_0	—	+	—	8_1	60	—
2. Brachypodium pinnatum	—	—	3	—	—	—	20	—	—	—	—	—	—	—	—	0	—
Filipendula hexapetala	—	—	3	1	—	—	40	3	4	—	—	—	+	—	1	40	—
Geranium sanguineum	—	—	—	—	1	—	20	—	—	—	—	—	1	—	—	20	—
Thalictrum minus var. dunense	—	—	—	7_3	—	—	20	—	—	—	—	—	—	—	—	0	—

3. Sieglingia decumbens	—	—	—	—	—	—	0	—	—	—	1	+	—	—	1	60	—
Aira praecox	×	—	—	—	—	—	0	—	—	—	1	10_1	6_2	—	+	**80**	+
Carex arenaria	—	—	—	4	—	1	40	—	—	—	—	—	5	—	—	20	—
Filago minima	×	—	—	—	—	—	0	—	—	—	1	5	—	—	—	40	—
Jasione montana	—	—	—	—	—	—	0	—	—	—	+	2	—	—	2	60	—
Myosotis versicolor	×	—	—	—	—	—	0	—	—	—	—	—	+	—	—	20	+
Armeria maritima	—	—	—	6_2	—	—	20	—	—	—	—	—	10_3	—	—	20	—
Calluna vulgaris	—	—	—	—	—	—	0	—	—	—	1	1	—	5	+	**80**	—
Trifolium campestre	×	—	—	2	+	3	60	1	—	—	4	+	6_0	+	4	**100**	+
— dubium	×	9_0	—	—	—	—	20	—	—	—	—	—	—	—	2	20	—
Genista anglica	—	—	—	—	—	—	0	—	—	—	—	—	—	+	—	20	—
Lathyrus montanus	—	—	—	—	—	—	0	—	—	—	—	—	—	1	—	20	—
Ononis repens*	—	—	7_4	—	2	2	60	7_0	—	1	—	—	—	+	—	20	—
Saxifraga granulata*	—	—	—	1	—	—	20	—	—	—	1	—	8_4	—	—	40	1
Ranunculus bulbosus*	—	—	6_1	—	—	—	20	1	2	2	—	—	7_2	2	+	60	2
Teesdalia nudicaulis	×	—	—	—	—	—	0	—	—	—	+	4	3	—	1	**80**	—
4. Deschampsia flexuosa	—	—	—	—	—	—	0	—	—	—	1	—	—	**10_8**	+	60	1
Agrostis canina	—	1	—	—	—	—	20	—	—	—	6_2	6_1	—	**10_8**	—	60	3
— tenuis	—	—	—	3	—	—	20	—	2	+	1	—	9_4	—	**10_8**	60	10_5
Festuca ovina	—	10_3	3	2	10_1	+	**100**	1	+	1	8_5	10_3	**10_9**	**10_9**	9_3	**100**	**10_8**
— rubra	—	—	—	—	—	—	0	3	**10_8**	4	3	2	—	1	5	**80**	—
Dactylis glomerata	—	—	—	4	—	1	40	—	4	—	—	—	—	—	—	0	—
Poa pratensis	—	—	—	—	1	—	20	1	5	5	+	—	—	2	**10_8**	60	1
Anthoxanthum odoratum	—	—	—	—	—	—	0	—	1	—	—	—	—	2	—	20	1
Agropyrum repens	—	—	—	1	—	—	20	—	—	—	—	—	—	—	+	20	—
Bromus mollis	×	—	—	—	—	—	0	—	—	+	6_1	4	—	—	1	60	+
Carex leporina	—	—	—	—	—	—	0	—	—	—	—	—	—	2	—	20	—
Luzula campestris	—	—	—	—	—	—	0	—	1	—	—	3	1	10_3	1	**80**	+
Hieracium pilosella	—	**10_7**	10_3	**8_6**	9_5	4	**100**	7_2	4	4	**10_6**	**10_8**	10_4	7_2	10_2	**100**	**9_7**
— umbellatum	—	—	—	—	+	—	20	—	—	—	—	—	—	10_2	—	20	—
Achillea millefolium	—	6_0	—	5	—	5	60	7_2	9_3	—	3	5	1	**10_6**	10_5	**100**	3
Senecio vernalis	×	—	—	—	—	1	20	1	—	—	—	—	—	—	—	0	—
Circium lanceolatum	—	—	—	—	—	+	20	—	+	—	—	—	—	—	—	0	—
Taraxacum sp.	—	—	—	—	5	—	20	1	2	2	—	—	2	—	2	40	—
Campanula rotundifolia	—	7_4	3	—	4	—	60	1	—	4	2	1	2	5	+	**100**	3
Valerianella locusta	×	—	—	—	—	—	0	—	1	—	—	—	—	—	—	0	—
Knautia arvensis	—	—	—	—	—	—	0	1	—	2	1	2	—	2	+	**80**	—
Galium verum	—	9_1	10_4	**10_8**	9_2	3	**100**	4	3	1	3	1	**10_7**	8_3	9_3	**100**	**10_7**
— pumilum	—	—	1	2	—	—	40	1	1	—	2	—	—	2	—	40	—
Veronica arvensis	×	1	—	—	—	—	20	—	1	—	—	—	+	—	—	20	+
— serpyllifolia	×	—	—	—	—	—	0	—	1	—	—	—	—	—	—	0	—
— officinalis	—	—	—	—	—	—	0	—	—	—	—	—	—	2	—	20	1
— chamaedrys	—	—	—	+	—	—	20	—	—	—	—	—	—	—	—	0	1
Linaria vulgaris	—	—	—	—	1	—	20	—	—	—	—	—	—	—	—	0	—
Plantago lanceolata	—	—	1	3	2	—	60	—	1	—	1	2	3	—	—	60	5
Thymus serpyllum	—	3	—	—	1	5	60	—	1	8_5	**10_9**	10_3	—	—	5	60	4
Daucus carota	—	—	—	—	—	+	20	8_2	—	—	—	—	—	—	—	0	—
Geranium dissectum	×	—	—	—	—	—	0	—	1	+	—	—	—	—	—	0	—
Vicia hirsuta	×	—	—	2	—	—	20	—	—	—	—	—	—	—	—	0	—
— cracca	—	—	—	—	—	—	0	2	—	—	—	—	—	—	—	0	—
Anthyllis vulneraria	—	4	—	—	8_3	—	40	1	—	—	1	—	—	—	—	20	—
Medicago lupulina	×	6_0	1	—	—	5	60	7_1	2	—	—	—	—	—	—	0	—
Lotus corniculatus	—	—	—	—	8_0	+	40	2	2	—	1	3	+	2	—	**80**	—
Aphanes arvensis	×	—	—	—	—	—	0	—	—	—	—	—	1	—	—	20	—

(To be continued)

Table 6 (continued).

Analysis no.		1	2	3	4	5		6	7	8	9	10	11	12	13		14
Locality no.		20	10	25	5	8	Per-	8	1	34	34	34	4	7	33	Per-	33
Exposure		SSW	SW	SSE	S	SE	cen-	ESE	S	S	SSW	SSW	WSW	ESE	SE	cen-	W
Slope		35	25	40	35	45	tage	45	35	40	30–50	30	35	30	35	tage	35
*p*H		6.9	7.2	6.5	6.3	7.8	con-	7.6	6.8	6.1	5.4	5.2	5.3	4.9	5.0	con-	5.1
$CaCO_3$, percentage		0.01	0.5	0.0	0.0	1.5	stan-	1.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	stan-	0.0
Density of species ($\frac{1}{10}$ m.²)	Annuals	21.6	13.5	13.5	20.9	13.4	cy	18.7	11.7	10.6	18.3	20.2	23.8	14.2	21.3	cy	12.5
Number of species		37	26	36	46	43	nos.	51	38	42	63	43	49	38	57	nos.	38
Total covering in per cent.		80	100	90	100	65	1–5	70	85	85	30–80	85	100	95	75	9–13	95
Potentilla reptans	—	—	—	—	—	—	0	—	$\mathbf{9}_6$	—	—	—	—	—	—	0	—
— erecta	—	—	—	—	—	—	0	—	—	—	—	—	—	2	—	20	—
Sedum acre	—	$\mathbf{10}_6$	—	—	7_3	$\mathbf{10}_6$	60	+	$\mathbf{10}_9$	—	—	—	+	—	$\mathbf{10}_7$	40	—
— boloniense	—	—	—	—	—	—	0	—	—	$\mathbf{10}_{10}$	—	—	—	—	—	0	—
Viola canina	—	—	—	—	—	—	0	—	2	—	—	—	—	2	—	20	—
Arabidopsis thaliana	×	—	—	—	4?	—	20	—	1	—	+	1	—	—	6_1	60	—
Scleranthus annuus	×	—	—	—	—	—	0	—	—	—	—	—	—	—	9_3	20	—
Cerastium caespitosum	—	—	—	—	—	—	0	—	2	—	+	—	—	—	—	20	—
— semidecandrum	×	2	—	—	3	—	40	—	—	—	3	3	3	—	$\mathbf{10}_6$	**80**	—
Rumex acetosella	—	—	—	—	—	1	20	—	—	2	1	10_5	4	10_5	3	**100**	—
Populus tremula	—	—	—	—	2	—	20	—	—	—	—	—	—	—	—	0	—
5. Briza media	—	—	—	—	—	+	20	7_1	1	1	—	—	—	—	—	0	—
Festuca elatior	—	—	—	—	—	3	20	7_2	—	—	—	—	—	—	—	0	—
Carex flacca	—	—	4	—	—	—	20	—	2	—	—	—	—	—	—	0	—
Leontodon hispidus	—	—	—	—	—	—	0	—	1	—	—	—	—	—	—	0	—
Chrysanthemum leucanthemum	—	—	—	—	—	3	20	10_1	1	—	—	—	—	—	—	0	—
Bellis perennis	—	—	—	—	—	—	0	—	5	—	—	—	—	—	—	0	—
Trifolium repens	—	—	—	—	—	—	0	—	1	—	—	—	—	—	—	0	—
Linum catharticum	×	—	—	—	—	—	0	1	—	—	—	—	—	—	—	0	—
Rumex acetosa	—	—	—	3	—	—	20	3	—	2	—	—	+	+	—	40	1
6. Hylocomium schreberi	—	—	—	—	—	—	0	—	—	—	—	—	$\mathbf{10}_{10}$	—	—	20	—
— splendens	—	—	—	—	—	—	0	1	—	—	—	—	—	—	—	0	—
— squarrosum	—	—	—	—	—	1	20	1	—	—	—	$\mathbf{10}_8$	—	—	—	20	—
Ctenidium molluscum	—	2	—	—	—	—	20	—	—	—	—	—	—	—	—	0	—
Hypnum cupressiforme	—	6_1	—	—	$\mathbf{10}_8$	—	40	—	—	5	9_4	9_2	8_2	2	$\mathbf{10}_6$	**100**	7_4
Campylium chrysophyllum	—	—	—	—	—	—	0	4	—	—	—	—	—	—	—	0	—
Eurhynchium pulchellum	—	—	—	—	—	—	0	—	—	—	2	—	—	—	—	20	—
— swartzii	—	—	—	—	—	—	0	2	—	—	—	—	—	—	—	0	—
Pseudoscleropodium purum	—	—	9_5	—	—	1	40	3	—	—	—	—	—	1	—	20	6_1
Camptothecium lutescens	—	10_5	$\mathbf{10}_{10}$	6_0	—	$\mathbf{10}_9$	**80**	10_4	—	5	—	—	5	5	3	60	—
Thuidium abietinum	—	2	2	—	1	1	**80**	3	—	—	1	—	+	+	—	60	—
— philiberti	—	—	—	—	—	—	0	3	—	—	—	—	—	—	—	0	—
Fissidens adiantoïdes	—	+	—	—	3	—	40	1	—	4	7_1	—	2	—	2	60	1
Ceratodon purpureus	—	—	—	—	—	—	0	—	—	—	2	$\mathbf{10}_7$	4	3	8_1	**100**	6_3
Dicranum scoparium	—	—	—	—	—	—	0	—	—	—	3	6_1	$\mathbf{10}_9$	—	—	60	—
Rhacomitrium canescens	—	—	—	—	—	—	0	—	—	—	1	4	—	—	—	40	—
Barbula unguiculata	—	4	—	—	2	1	60	—	—	6_2	—	—	—	—	—	0	—
— convoluta	—	3	—	—	—	—	20	—	—	—	—	—	—	—	—	0	—
Weisia microstoma	—	—	4	—	—	—	20	—	—	3	4	—	—	—	—	20	—

Pottia intermedia	—	—	—	—	2	—	20	—	—	2	3	—	—	—	—	20	—
Tortula subulata	—	—	—	1	2	—	40	—	—	3	10_7	—	—	—	—	20	2
— ruralis	—	5	1	+	8_2	6_3	**100**	—	—	—	3	—	1	—	9_7	60	—
Encalypta vulgaris	—	10_1	—	—	1	—	40	—	—	3	2	—	—	—	—	20	—
Bryum argenteum	—	—	—	—	—	—	0	—	—	—	—	—	—	—	1	20	—
— spp.	—	2	—	8_3	—	1	60	—	—	1	+	—	—	—	2	40	2
Rhodobryum roseum	—	—	—	—	—	—	0	—	—	—	—	—	2	—	—	20	—
Polytrichum piliferum	—	—	—	—	—	—	0	—	—	—	5	10_{10}	—	1	5	**80**	—
— juniperinum	—	—	—	—	1	—	20	—	—	—	—	—	7_5	—	4	40	
7. Verrucaria acrotella	—	—	—	—	—	—	0	—	—	1	1	—	—	—	—	20	—
— muralis	—	—	—	—	—	—	0	5	—	—	—	—	—	—	—	0	—
— nigrescens	—	4	—	—	—	—	20	—	—	—	—	—	—	—	—	0	—
Microglaena muscorum	—	—	—	—	—	—	0	—	—	1	—	—	—	—	—	0	—
Peltigera canina	—	—	—	—	—	—	0	—	—	—	—	—	3	—	—	20	—
— rufescens	—	5	—	—	—	1	40	—	—	—	—	—	—	—	2	20	—
— erumpens	—	—	—	—	—	—	0	—	—	2	3	1	—	—	—	40	—
Lecidea coarctata	—	—	—	—	—	—	0	—	—	—	1	5	—	—	—	40	—
— uliginosa	—	—	—	—	—	—	0	—	—	—	1	—	—	—	—	20	—
Cladonia tenuis	—	—	—	—	—	—	0	—	—	—	—	5	—	—	—	20	—
— sylvatica	—	—	—	—	—	—	0	—	—	—	—	6_2	—	—	—	20	—
— impexa	—	—	—	—	—	—	0	—	—	—	—	2	—	—	—	20	—
— pleurota	—	—	—	—	—	—	0	—	—	—	1	+	—	—	—	40	—
— furcata	—	—	—	—	3	—	20	—	—	—	1	10_9	10_9	—	2	**80**	—
— subrangiformis	—	10_8	—	—	—	—	20	—	—	—	—	—	—	—	—	0	—
— rangiformis	—	9_3	—	—	9_5	—	40	—	—	+	6_2	9_3	10_6	—	3	**80**	—
— cariosa	—	—	—	—	—	—	0	—	—	+	—	—	—	—	—	0	—
— cervicornis	—	—	—	—	—	—	0	—	—	—	4	3	—	—	—	20	—
— pyxidata	—	—	—	—	—	—	0	—	—	2	—	6_1	—	—	2	40	—
— chlorophaea	—	—	1	—	—	—	20	—	—	—	—	—	—	—	—	0	—
— fimbriata	—	—	—	—	—	1	20	—	—	1	9_6	4	2	2	1	**100**	—
— foliacea var. alcicornis	—	—	—	—	—	—	0	—	—	—	1	1	—	—	—	20	—
Lecanora Hageni	—	—	—	—	—	—	0	—	—	+	—	—	—	—	—	0	—
Cornicularia aculeata	—	—	—	—	+	—	20	—	—	—	1	—	—	—	—	20	—
Caloplaca pyracea	—	—	—	—	—	—	0	—	—	+	—	—	—	—	—	0	—
Buellia punctiformis	—	—	—	—	—	—	0	—	—	+	—	—	—	—	—	0	—
Physcia tenella	—	—	—	—	—	—	0	—	—	+	—	—	—	—	—	0	—

Groups of species: (1) Continental-subcontinental species; those marked with an asterisk are especially characteristic of the community of the steppe group. — (2) Continental-subcontinental species connected with wood steppe and similar communities. — (3) Oceanic-suboceanic species and species with a tendency of distribution towards the west (marked with an asterisk). — (4) Widely ranging indifferent species. — (5) The same connected with meadows. — (6) Bryophytes. — (7) Lichens.

in Himmerland and on the whole it seems that the vegetation of Himmerland must be considered as a floristically very much diluted type among the steppe-like communities of Europe. *Phleum phleoides* is also found in a few places in England, and hence there is a possibility of still more exhausted forms in this country. TANSLEY (1939, p. 512) states that *Artemisia campestris, Veronica spicata,* and others are found only in Breckland, but he does not offer any descriptions of the vegetations of the communities in question. However, prospects of some such descriptions by Dr. WATT are held out.[1]

In relation to Sealand the absence of *Potentilla arenaria, P. heptaphylla, Pulsatilla pratensis, Gnaphalium arenarium, Tunica prolifera,* and *Medicago minima* is remarkable. The most interesting of the analyses (no. 4) originates from Storbjerg near Djørup. Here both *Pulsatilla vulgaris* and *Carex ericetorum,* which are absent in the corresponding Sealandish communities, are present.

The *Pulsatilla pratensis-Veronica spicata* Type.

This community has developed on dry sandy soil, as a rule rich in humus. Chalk is absent or present in small amounts only. *p*H is about 7 or as low as 5.3. The vegetation is mostly close, with a well developed cryptogamous layer of mosses or lichens or both. As in the corresponding Sealandish *Pulsatilla pratensis* sand-alvar there are a number of subtypes, each of which is best characterized through the understorey. Table 7, nos. 1—5 show the composition of 5 spots rich in *Camptothecium lutescens.* In the first three *Avena pratensis* and *Geranium sanguineum* are very frequent (see Plate III, Fig. 2). The vegetations rich in *Camptothecium* belong to richer soil than those rich in *Hylocomium splendens, Hypnum cupressiforme,* and *Cladonia* or *Rhacomitrium* and *Cladonia* (Table 7, nos. 6—8). Among these the former were found on level comparatively humid soil, the latter on south-facing, drier soil on the Mulbjerge. Here also occurs a last kind with *Cladonia subrangiformis* and *Thuidium abietinum* in the understorey. The soil here is basic and rather calcareous and the vegetation (Table 5, no. 15), with *Poa angustifolia* as a dominant, forms a transition to the dry communities on southern exposures. The sociations rich in *Camptothecium* (Table 7, nos. 1—5) floristically constitute a whole, as appears from the figures of constancy for such species as *Koeleria pyramidata, Phleum nodosum, Dactylis, Plantago lanceolata, Medicago lupulina,* and *Briza media.* As compared with the Sealandish sand-alvar sociations the occurrence of *Koeleria pyramidata* and *Cladonia subrangiformis* is remarkable. As a whole the Sealandish vegetation, however, is no doubt richer than the Jutlandish one. Thus it contains *Astragalus danicus, Seseli libanotis,* and in some places also *Phleum phleoides,* even as a dominant.

The *Pulsatilla vulgaris* Type.

This community, too, includes subtypes with different understoreys. It is difficult to discover the ecological conditions causing now *Pulsatilla pratensis,* now *P. vulgaris*

[1] During the war we could not study the interesting paper of WATT on the Breckland grass heath (WATT 1940). None of the grassland types described in this paper, however, contain *Phleum phleoides, Artemisia campestris,* or *Veronica spicata.*

to be dominant. A vegetation with both species of pasque-flower was observed only at one occasion (*viz.* Loc. 31, p. 26). Also the sociations rich in *P. vulgaris* are often found on soils rich in humus. They may be level or south-facing, they may be calcareous and basic and they may also be very acid. Neither microclimate nor acidity can be the cause of the different distribution of the pasque-flowers. Conditions obviously are most complicated. Table 7, nos. 10—13 show four analyses with *P. vulgaris* from acidic soils. The first corresponds very well to the *P. vulgaris* sand-alvar at Dragør and Villingebæk, respectively on Amager and in Sealand (Böcher 1945). The last one (Table 7, no. 13) approaches heath, *Calluna* being dense, although low and without any importance physiognomically. In many places *Pulsatilla vulgaris* was seen at the edge of heaths in the same way as at Villingebæk (see Böcher 1943, Fig. 17). In Sealand and in dune areas on the point of the Skaw we may also find *P. pratensis* at the edge of the heath. This was not seen in Himmerland. In Sealand *P. vulgaris* is absent in the large number of different slope vegetations on calcareous, sandy, basic or slightly acid soil. In Jutland it is found on all kinds of slopes, even on north-facing slopes on chalk (Table 8). These facts would seem to indicate that *P. pratensis* is more selective in Jutland than in Sealand (it shuns the heaths) and that *P. vulgaris* is most selective in Sealand (found only on acid soils there). This would go very well with the fact that *P. pratensis* is a continental species and that the Danish *P. vulgaris* belongs to a western, subcontinental subspecies (ssp. *germanica*) of the collective species *P. vulgaris*. On account of the geographical distribution of *P. vulgaris* the sociations rich in this species come to belong to a type of a less continental character and a type of sand-alvar in which the steppe element is very greatly reduced.

The two analyses Table 5, nos. 13—14 also include *P. vulgaris*. This is a dense *Festuca ovina-Hypnum cupressiforme* sociation rich in species on calcareous sand rich in humus and on a rather dry soil. The vegetation, perhaps particularly physiognomically, reminds of the sand-alvar, and may be considered a transitional form between this and the vegetation of the dry calcareous slopes (perhaps especially the *Koeleria-Phleum* type). Here, the layer of cryptogams is peculiar (see especially no. 13, which again includes *Thuidium abietinum* and *Cladonia subrangiformis*). We have included no. 12 from the Løgstør slope in the same transitional type. Here *Pulsatilla vulgaris* is rare in the area analyzed, but it is found abundantly in the close vicinity on apparently corresponding soil. As mentioned above (p. 8), the rare species *Draba incana* enters in no. 12. Analysis no. 11 on the slope below no. 12 further mediates the transition to the dry chalk-slope vegetation (no. 10).

The *Genista tinctoria* Type.

Of this only a single analysis from a dry hilltop near Aalborg (Loc. 17, Table 7, no. 14). The analysis is interesting because it shows us the continental species *Genista tinctoria* as dominant in a community which is anything but heathlike. Outside this country this is undoubtedly a fairly frequent phenomenon, but in Denmark the dyer's

Table 7.

Analysis no.		1	2	3	4	5		6	7	8	9	10	11	12	13		14
Locality no.		10	10	10	2	2	Per-	24	24	24	24	23	23	23	22	Per-	17
Exposure		—	—	—	—	—	cen-	E	S	S	S	—	SE	S	E	cen-	SW
Slope		0	0	0	0	0	tage	5	25	30	20	0	15	15	5	tage	15
*p*H		6.6	6,7	6.2	6.9	6.5	con-	5.3	6.5	6.0	4.8	5.8	4.9	5.6	5.0	con-	6.9
$CaCO_3$, percentage		0.0	0.0	0.0	2.8	1.1	stan-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	stan-	0.03
Density of species ($\frac{1}{10}$ m.²)	Annuals	15.3	16.7	15.3	18.9	18.7	cy	18.3	21.6	15.1	9.9	14.8	9.8	9.2	15.3	cy	13.0
Number of species		45	41	39	43	40	nos.	41	44	41	26	32	34	23	37	nos.	30
Total covering in per cent.		100	100	100	100	100	1–5	100	100	80–90	100	100	100	95	100	9–13	100
1. Avena pratensis*	—	9_6	**10_8**	**10_7**	6_1	6_2	**100**	10_4	10_3	8_0	+	—	—	—	7_2	40	—
— pubescens	—	3	—	—	3	—	40	1	—	—	—	—	—	—	1	20	—
Phleum phleoides*	—	+	—	3	—	—	40	—	1	+	—	—	—	—	—	0	—
— nodosum	—	7_3	6_2	—	7_1	10_2	**80**	1	—	—	—	—	—	—	—	0	7_5
Poa angustifolia*	—	—	—	—	—	2	20	—	—	—	—	—	—	—	—	0	9_3
— compressa	—	—	1	—	—	—	20	—	—	—	—	—	—	—	—	0	—
Koeleria pyramidata var. danica	—	3	7_2	6_2	2	+	**100**	—	—	—	—	—	—	—	—	0	—
Carex caryophyllea	—	3	2	4	—	10_5	**80**	—	—	—	—	—	—	—	—	0	—
— ericetorum	—	—	—	—	—	—	0	—	—	—	—	3	—	—	—	20	—
Artemisia campestris*	—	—	—	—	1	—	20	—	4	1	—	—	1	4	—	40	—
Hypochoeris maculata	—	—	—	+	2	—	40	—	—	—	—	—	—	—	3	20	—
Scorzonera humilis	—	—	—	—	—	—	0	—	—	—	—	—	—	—	+	20	—
Gnaphalium arenarium*	—	—	—	—	—	—	0	—	1	1	—	—	—	—	—	0	—
Centaurea jacea	—	—	—	—	—	1	20	—	—	—	—	—	—	—	—	0	—
— scabiosa	—	—	1	1	—	—	40	—	—	—	—	—	—	—	—	0	—
Veronica spicata*	—	—	—	—	—	1	20	—	—	—	—	—	—	—	—	0	—
Calamintha acinos	×	—	—	—	1	—	20	—	—	—	—	—	—	—	—	0	—
Pimpinella saxifraga	—	1	—	1	—	1	60	4	+	—	—	8_3	—	—	—	20	1
Genista tinctoria	—	—	—	—	—	—	0	—	—	—	—	4	—	—	6_2	40	10_4!
Trifolium arvense	×	2	3	—	—	—	40	3	9_1	3	—	3	+	+	—	60	—
Vicia lathyroides	×	—	—	—	—	—	0	—	—	—	—	—	2	1?	—	40	—
— angustifolia	×	—	1	—	—	—	20	—	—	—	—	—	—	—	—	0	—
Potentilla argentea	—	6_1	2	—	—	—	40	—	—	—	—	—	—	—	—	0	8_3
— verna	—	—	—	—	1	—	20	—	—	—	—	—	—	—	—	0	—
Saxifraga tridactylites	×	—	—	—	—	—	0	—	1	—	—	—	—	—	—	0	—
Alyssum alyssoides	×	—	—	—	1	—	20	—	—	—	—	—	—	—	—	0	—
Erophila verna	×	—	—	—	—	1	20	—	—	+	—	—	—	—	—	0	—
Arabis hirsuta	—	1	—	—	—	—	20	—	—	—	—	—	—	—	—	0	—
Pulsatilla pratensis*	—	2	8_0	6_1	9_4	—	**80**	10_5	10_3	8_0	+	—	—	—	—	20	—
— vulgaris	—	—	—	—	—	—	0	—	—	—	—	10_5	7_3	3	5	**80**	—
Dianthus deltoides	—	—	—	—	—	—	0	3	—	—	—	—	—	—	—	0	—
Arenaria serpyllifolia	×	1	5	+	8_2	6_2	**100**	—	3	+	—	1	—	—	—	20	—
2. Circium acaule	—	—	—	—	+	1	40	—	—	—	—	—	—	—	—	0	—
Campanula persicifolia	—	+	1	1	—	—	60	—	—	—	—	—	—	—	—	0	—
Galium boreale	—	1	—	—	—	—	20	—	—	—	—	—	—	—	—	0	—
Plantago media	—	+	—	—	—	6_1	40	—	—	—	—	—	—	—	—	0	—
Primula veris	—	—	+	1	—	—	40	—	—	—	—	—	—	—	—	0	—
Geranium sanguineum	—	**10_6**	10_4	10_4	—	—	60	—	—	—	—	—	—	—	—	0	—
Filipendula hexapetala	—	1	8_3	7_0	4	10_3	**100**	—	—	—	—	—	—	—	—	0	2
Thalictrum minus	—	4	—	—	—	—	20	—	3	—	+	—	—	—	—	20	—

3. Corynephorus canescens	—	—	—	—	—	—	0	—	—	+	5	—	—	7_2	—	40	—
Carex arenaria	—	—	—	—	1	—	20	9_4	9_2	**10_6**	10_4	—	—	—	7_2	40	—
Hypochoeris radicata	—	—	—	—	—	—	0	—	—	—	—	—	—	—	1	20	—
Jasione montana	—	—	—	—	—	—	0	—	—	—	—	—	2	3	—	40	—
Euphrasia micrantha	×	—	—	—	—	—	0	—	—	—	—	—	—	—	5	20	—
Armeria vulgaris	—	3	+	+	2	1	**100**	3	4	2	+	—	—	—	—	20	4
Calluna vulgaris	—	—	—	—	—	—	0	—	—	+	—	—	—	—	**10_9**	20	—
Lathyrus montanus	—	—	—	—	—	—	0	—	—	—	—	—	—	—	4	20	—
Genista anglica	—	—	—	—	—	—	0	—	—	—	—	—	—	—	8_3	20	—
Trifolium campestre	×	7_2	6_2	+	—	+	**80**	5	4	—	—	7_2	+	—	—	40	—
— dubium	×	—	—	—	1	—	20	—	—	—	—	—	—	—	—	0	—
Teesdalia nudicaulis	×	—	—	—	—	—	0	—	—	1	—	—	10_1	4	—	40	—
Ononis repens*	—	—	2	—	1	—	40	—	—	1	—	—	—	—	—	0	—
Saxifraga granulata*	—	1	—	—	—	+	40	—	—	—	—	—	—	—	—	0	—
Ranunculus bulbosus*	—	1	2	—	7_2	10_3	**80**	—	—	—	—	—	—	—	—	0	—
4. Festuca ovina	—	7_5	6_1	10_4	1	4	**100**	**10_9**	10_4	1	9_5	10_4	8_0	8_0	**10_9**	**100**	7_2
— rubra	—	**10_9**	**10_8**	1	**10_{10}**	**10_6**	**100**	+	10_3	9_4	10_5	**10_8**	1	+	1	**100**	9_5
Agrostis tenuis	—	2	6_2	+	2	**10_8**	**100**	—	2	1	3	**10_7**	+	2	4	**100**	4
— canina	—	—	—	—	—	—	0	—	—	—	—	9_5	4	6_1	3	**80**	—
Anthoxanthum odoratum	—	—	—	5	—	—	20	1	+	+	+	4	+	—	1	**80**	1
Poa pratensis	—	6_2	4	2	7_4	8_4	**100**	—	6_0	—	10_1	6_2	1	—	—	60	2
Deschampsia flexuosa	—	—	—	—	—	—	0	4	—	—	7_0	—	—	—	3	40	—
Ammophila arenaria	—	—	—	—	—	—	0	+	—	+	10_4	—	—	—	—	20	—
Dactylis glomerata	—	3	5	1	8_4	6_0	**100**	—	—	—	—	—	—	—	—	0	6_2
Agropyrum repens	—	6_4	1	—	—	—	40	—	—	—	—	—	—	—	—	0	—
Lolium perenne	—	—	—	—	—	9_2	20	—	—	—	—	—	—	—	—	0	—
Bromus mollis	×	—	—	—	—	—	0	—	1	—	—	—	—	—	—	0	—
Luzula campestris	—	1	1	7_3	—	5	**80**	2	—	—	—	8_3	+	—	6_4	60	1
Hieracium pilosella	—	—	—	5	4	7_2	60	9_4	3	2	1	2	7_2	1	—	**80**	7_3
— umbellatum	—	—	—	—	—	—	0	—	—	—	—	—	—	—	7_1	20	—
Taraxacum sp.	—	—	—	—	5	2	40	—	—	—	—	—	—	—	—	0	—
Leontodon autumnale	—	—	—	—	3	—	20	—	—	—	—	—	—	—	—	0	—
Solidago virga-aurea	—	—	—	1	—	—	20	—	—	—	—	—	—	—	—	0	—
Achillea millefolium	—	3	7_2	4	3	9_4	**100**	—	—	—	—	—	—	—	7_4	20	6_1
Campanula rotundifolia	—	1	—	3	1	1	**80**	+	—	—	2	8_1	—	—	6_2	60	6_3
— rapunculoides	—	—	—	—	—	—	0	—	—	—	—	—	—	—	—	0	7_4
Knautia arvensis	—	—	+	5	—	—	40	—	—	—	—	—	—	—	—	0	2
Galium verum	—	**10_9**	10_5	10_4	**10_6**	10_5	**100**	**10_6**	10_2	7_4	5	4	1	1	—	**80**	6_1
— pumilum	—	1	—	—	9_3	—	40	3	—	—	—	2	—	—	5	40	2
Veronica officinalis	—	—	—	—	—	—	0	—	—	—	—	—	—	—	1	20	—
— chamaedrys	—	2	1	—	—	—	40	—	—	—	—	—	—	—	—	0	—
— arvense	×	—	—	—	—	1	20	—	—	—	—	—	+	—	—	20	—
Euphrasia sp. (cfr. stricta)	×	—	—	—	—	—	0	8_2	—	—	—	2	—	—	—	20	3
Plantago lanceolata	—	2	+	2	2	8_3	**100**	—	—	—	—	—	—	—	—	0	—
Thymus serpyllum	—	—	—	1	**9_6**	—	40	**10_8**	10_3	**10_9**	2	3	—	6_2	2	**80**	—
Anthyllis vulneraria	—	—	—	7_0	1	—	40	—	—	—	—	1	—	—	—	20	1
Lotus corniculatus	—	—	—	4	2	—	40	7_1	3	9_2	+	3	+	—	4	**80**	4
Vicia cracca	—	—	—	—	—	—	0	5	—	—	—	—	—	—	7_1	20	—
Medicago lupulina	×	5	10_2	2	10_5	10_2	**100**	—	—	—	—	—	—	—	—	0	2
Potentilla erecta	—	—	—	—	—	—	0	—	—	—	—	—	—	—	2	20	—
Sedum acre	—	—	1	—	7_2	—	40	2	10_3	7_2	+	—	+	—	—	40	—
Viola canina	—	—	—	—	—	—	0	1	—	—	—	—	—	—	2	20	—
Polygala vulgaris	—	—	—	—	—	—	0	—	—	—	—	—	—	—	3	20	—
Arabidopsis thaliana	×	1	2	—	—	—	40	—	—	—	—	—	—	—	—	0	—

(To be continued)

Table 7 (continued).

Analysis no.		1	2	3	4	5		6	7	8	9	10	11	12	13		14
Locality no.		10	10	10	2	2	Per-	24	24	24	24	23	23	23	22	Per-	17
Exposure		—	—	—	—	—	ten-	E	S	S	S	—	SE	S	E	cen-	SW
Slope		0	0	0	0	0	tage	5	25	30	20	0	15	15	5	tage	15
*p*H		6.6	6.7	6.2	6.9	6.5	con-	5.3	6.5	6.0	4.8	5.8	4.9	5.6	5.0	con-	6.9
$CaCO_3$, percentage		0.0	0.0	0.0	2.8	1.1	stan-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	stan-	0.03
Density of species ($\frac{1}{10}$ m.²)		15.3	16.7	15.3	18.9	18.7	cy	18.3	21.6	15.1	9.9	14.8	9.8	9.2	15.3	cy	13.0
Number of species		45	41	39	43	40	nos.	41	44	41	26	32	34	23	37	nos.	30
Total covering in per cent.		100	100	100	100	100	1–5	100	100	80–90	100	100	100	95	100	9–13	100
Cerastium semidecandrum	×	+	—	—	8_2	—	40	—	8_1	3	—	—	—	—	—	0	1
— caespitosum	—	3	5	1	3	2	**100**	4	—	—	—	1	—	—	—	20	—
Stellaria graminea	—	—	—	—	2	—	20	1	—	—	—	—	—	=	—	0	—
Rumex acetosella	—	—	—	—	—	—	0	8_3	3	1	—	—	6_1	10_3	—	40	—
Equisetum arvense	—	3	1	—	—	—	40	—	—	—	—	—	—	—	—	0	—
5. Briza media	—	8_3	4	8_1	2	3	**100**	—	—	—	—	—	—	—	—	0	—
Festuca elatior	—	—	—	—	—	1	20	—	—	—	—	—	—	—	—	0	—
Carex flacca	—	—	—	8_3	—	—	20	—	—	—	—	—	—	—	—	0	—
Trifolium repens	—	—	1	—	—	2	40	—	—	—	—	2	—	—	—	20	—
Rumex acetosa	—	1	6_1	3	—	—	60	—	—	—	—	—	—	—	1	20	3
6. Hylocomium schreberi	—	—	—	—	—	—	0	1	—	—	10_6	—	—	—	—	20	—
— splendens	—	—	—	—	—	—	0	9_7	—	—	6_3	8_6	—	—	6_2	60	—
— squarrosum	—	—	—	—	—	3	20	9_5	—	—	—	7_3	—	—	—	20	—
— triquetrum	—	—	—	—	—	—	0	—	—	—	3	—	—	—	1	40	—
Hypnum cupressiforme	—	—	—	—	—	—	0	6_3	**10_7**	4	—	5	3	—	**9_7**	60	1
Pseudoscleropodium purum	—	1	1	3	—	—	60	—	—	—	—	—	—	—	—	0	—
Brachythecium cfr. rutabulum	—	—	—	—	—	—	0	—	—	—	—	—	—	—	1	20	—
Camptothecium lutescens	—	**8_7**	**10_7**	**10_{10}**	**10_{10}**	**8_7**	**100**	—	—	—	—	2	—	—	—	20	7_4
Thuidium abietinum	—	3	—	10_5	—	—	40	4	1	—	—	1	—	—	—	20	—
— philiberti	—	—	—	—	—	—	0	—	—	—	—	1	—	—	—	20	1
Ceratodon purpureus	—	—	—	—	—	—	0	6_1	3	3	—	—	—	+	—	20	—
Dicranum scoparium	—	—	—	—	—	—	0	—	—	—	3	—	—	—	—	20	—
Rhacomitrium canescens	—	—	—	—	—	—	0	—	1	**10_{10}**	—	—	**10_{10}**	**10_{10}**	—	40	—
Tortula subulata	—	—	—	—	—	—	0	—	2	—	—	—	—	—	—	0	—
— ruralis	—	—	—	—	3	—	20	—	—	2	—	—	+	—	—	20	—
Bryum argenteum	—	—	—	—	—	—	0	—	—	+	—	—	—	—	—	0	—
— spp.	—	—	—	—	—	1	20	—	3	—	—	—	—	—	—	0	—
Mnium undulatum	—	—	—	—	—	1	20	—	—	—	—	—	—	—	—	0	—
Polytrichum piliferum	—	—	—	—	—	—	0	+	—	2	—	—	3	2	—	40	—
— juniperinum	—	—	—	—	—	—	0	1	2	—	—	—	—	5	—	20	—
Lophocolea bicuspidata	—	—	—	—	—	—	0	—	—	—	—	—	—	—	3	20	—
Cephaloziella sp.	—	—	—	—	—	—	0	—	—	—	—	—	+	—	—	20	—
7. Peltigera canina	—	—	—	—	—	—	0	4	—	+	—	—	+	—	—	20	—
— rufescens	—	—	—	—	—	—	0	—	—	—	—	—	+	—	—	20	—
Lecidea granulosa	—	—	—	—	—	—	0	—	—	+	—	—	—	—	—	0	—

Cladonia tenuis	—	—	—	—	—	—	0	—	**10_8**	3	+	—	**10_8**	—	—	40	—
— mitis	—	—	—	—	—	—	0	—	5	10_5	—	—	7_1	5	—	40	—
— sylvatica	—	—	—	—	—	—	0	—	4	—	—	—	2	—	—	20	—
— impexa	—	—	—	—	—	—	0	—	1	1	—	—	—	—	—	0	—
— furcata	—	—	—	—	—	—	0	4	10_5	**10_{10}**	3	1	**10_7**	6_3	1	**100**	—
— scabriuscula	—	—	—	—	—	—	0	—	—	—	—	—	1	—	—	20	—
— rangiformis	—	—	—	—	—	—	0	+	9_5	9_5	—	2	1	7_1	—	60	—
— pyxidata	—	—	—	—	—	—	0	—	5	—	—	—	—	—	—	0	—
— chlorophaea	—	—	—	—	—	—	0	—	—	—	—	—	1	1	—	40	—
— fimbriata	—	—	—	—	—	—	0	5	—	—	+	—	—	—	—	20	—
— cornuto-radiata	—	—	—	—	—	—	0	—	1	—	—	—	—	—	—	0	—
— foliacea var. alcicornis	—	—	—	—	—	—	0	—	5	5	—	—	—	—	—	0	—
Cetraria crispa	—	—	—	—	—	—	0	—	+	—	—	—	—	—	—	0	—
Cornicularia aculeata	—	—	—	—	—	—	0	—	9_4	7_1	—	—	—	—	—	0	—

Groups of species: (1) Continental-subcontinental species; those marked with an asterisk are especially characteristic of the steppe group. — (2) Continental-subcontinental species connected with meadows or wood steppe or similar communities. — (3) Oceanic-suboceanic species; those marked with an asterisk are widely ranging species with an oceanic tendency. — (4) Widely ranging indifferent species. — (5) The same connected with meadows. — (6) Bryophytes. — (7) Lichens.

broom most belongs to rich heath. *Genista tinctoria* is rather frequently found in scrub or at the edges of woods in Central Europe and so it is questionable if the vegetation near Aalborg does not rather belong among the communities of the wood-steppe group; for the dyer's broom also enters in the *Geranium* slopes on the eastern exposures of the Mulbjerge (Table 4). Further it is frequent in the oligotrophic community of north-facing slopes mentioned in Table 8, no. 20 and occurs sporadically together with *Pulsatilla vulgaris* (Table 7, no. 10). Finally it is frequent in the community rich in heather in the same table no. 13.

The vegetation near Aalborg is found on neutral soil. It is rather natural even though *Campanula ranunculoides* enters in it. This species has presumably advanced from the cultivated soil round the hill.

The *Sedum acre* (*boloniense*) Type.

A community on very dry, sandy (or somewhat clayey) soil with neutral or slightly acid reaction. *Sedum acre* and the closely related introduced *S. boloniense* (*S. mite*) are wide-spread species. The vegetation is neither characterized by continental nor by Western European "dry land plants". *Sedum boloniense* is a southern species, but *Sedum acre* goes far north, even as far as Angmagssalik in East Greenland. In the two analyses (Table 6, nos. 7—8) both the continental and the oceanic element of the flora are greatly reduced. Ecologically the *Sedum acre*, if anything, is related to the *Phleum phleoides* type, which perhaps it supplants in very oceanic climates. *Sedum acre* among the wide-spread species is one of the most typical xerophytes (cf. IVERSEN 1936). Hence, and because it is dominant, it has been chosen for the name of the type. For that matter, as appears from the tables, it is also abundant in many of the other types.

Acidic Dry Grassland Types.

In Table 6, nos. 9—14 some analyses from dry-slopes on acid soil have been collected. Most of them originate from the neighbourhood of Hobro. A glance at the table shows that both suboceanic and a few continental species are rather abundantly represented here. These are obviously communities forming a transitional stage between the steppe-like communities of dry soil and communities of an oceanic character. They are closely related to the *Sedum acre* (*boloniense*) type, but seem to be distinct from this type by the higher frequency of the species in Group 3 and acidophilous plants like *Deschampsia flexuosa*, *Agrostis canina*, and *Rumex acetosella*. In the understorey *Hypnum cupressiforme*, *Ceratodon purpureus*, and *Cladonia fimbriata* show particularly high values of constancy. No. 10 with its vegetation rich in lichens in the understorey and its modest share of continental species begins to approach a typical suboceanic dry-slope. This also holds good of the *Deschampsia flexuosa-Agrostis canina* sociation no. 12. Strangely enough we did not find the fully developed type, which, however, may be due to the fact that the soil is not poor enough for a suboceanic dry-slope in our localities. In Sealand such a type has been found

on small spots, e. g. on the south-facing slope at Hanehoved near Frederiksværk (*Corynephoretum* rich in lichens and therophytes); but it is probably very rare. On the other hand there are in Himmerland in several places typically enough developed *Corynephorus* fields on level ground including all kinds of suboceanic therophytes and hemicryptophytes. These fields, however, are always found on formerly cultivated sandy areas on the plateau above the slopes and thus have been exposed to a greater leaching of the soil. The two analyses mentioned under the *Pulsatilla vulgaris* type (Table 7, nos. 11—12) from the poor sandy hill "Bjerget" east of Bælum is closely related to the vegetation of "grey dunes", which means communities of sandy fields rich in *Cladina-Cladonia destricta* or *Rhacomitrium canescens-Polytrichum piliferum*, which are also characterized by suboceanic therophytes. Our work on the vegetation from Thy and the Hanherreder will deal with such communities in more detail.

D. The Group of Widely Distributed and Boreal-Montane Meadow Plants.

Under this head we include two groups of communities diametrically opposite as regards floristics and edaphic conditions (*p*H, amount of lime), which, however, are held together by a certain uniformity respecting types of distribution and hydrotypes (in IVERSEN's terminology) and the degree of humidity of the soil and the cool, moist microclimate. Both of the two subgroups, which correspond to the subcontinental and the suboceanic grass-slope in Sealand are most frequently and best developed on northern exposures.

The *Cineraria integrifolia-Polygala amarella-Ctenidium molluscum* Type.

A very interesting community, which is particularly well developed in Himmerland. We have also analyses from a few places in Thy and the Hanherreder, but only in one locality these correspond completely to the Himmerland type. The community belongs to northern exposures and hence less dry chalky soil. As a consequence of the cooler microclimate and the greater humidity the flora is somewhat different from those of the communities described so far. The characteristic species belong to two categories, the wide-spread, neutro-basophilous and the boreal- or montane-continental meadow-plants. The latter category is the most interesting one. Within this category the *Polygala* species seems to be the best exclusive species, for, as mentioned, *Cineraria integrifolia* may be found in chalkhill vegetations of different types, and this also applies to *Crepis praemorsa*, which further in Sealand appears as a bog plant in a community which has practically no points of resemblance with the community on calcareous north-facing slopes of Himmerland. The very most important exclusive species, however, is the wide-spread, but in the south montane moss *Ctenidium molluscum*. Still, it should be added that this species is only characterizing when dominant, for as appears from the tables it may be found sporadically in other communities.

Table 8.

Analysis no.		1	2	3	4	5	6	7	8	9	10		11	12	13	14	15	16	17	18	19	20	21	22	23	
Locality no.		13	13	13	18	19	20	20	20	15	15		30	16	16	9	15	29	1	3	15	4	24	22	34	
Exposure		NW	NW	NW	N NE	NE	E NE	E NE	E NE	E NE	NE		W	W SW	SSE	W NW	NE	N NE	NE	W NW	E NE	W NW	N	NE	W NW	
Slope		30–35	40	35	25	40	25–30	25–30	25–30	30	30		25	20	27	25	30	30	30	40–45	45	25	25	20	20	
*p*H (Figures in brackets: at a depth of 4–10 cm.)		7.4	7.7	7.2	7.0	8.0	7.3	7.5	7.3	7.4 [7.4]	7.5 [7.3]		7.3	7.7	7.4	7.4	6.9 [7.1]	7.4	6.0	6.7	4.9 [5.5]	4.9	5.3	5.2	4.2	
$CaCO_3$, percentage.. (Without brackets: at top of soil)		74	75	61	53	3–20	59	65	59	36 [45]	56 [70]		76	22	44	6.6	0.3 [3.0]	0.2	0.0	0.5	0.0	0.0	0.0	0.0	0.0	
Density of species ($\frac{1}{10}$ m.²)		13.2	9.6	19.9	22.2	20.9	22.7	21 9	20.2	20.5	21.7		17.4	29.9	23.3	21.7	26.3	25.8	30.3	17.9	18.5	22.1	17.3	19.0	25.2	
Number of species		45	40	59	39	45	46	42	45	40	42		40	63	53	54	51	52	57	40	35	51	35	34	51	
Total covering in per cent.		100	50	80	100	95	90	95	100	100	100		50	95	95	95	95–100	100	100	90	100	100	100	100	100	
1. Herminium monorchis	—	—	—	—	—	—	—	—	—	—	—	0	—	1	—	—	—	—	—	—	—	—	—	—	—	0
Crepis praemorsa	—	—	—	—	—	—	—	—	—	1	10_5	20	—	2	—	—	—	—	—	—	—	—	—	—	—	0
Cineraria integrifolia	—	—	—	—	4	—	5	3	3	—	2	50	+	2	+	—	—	—	—	—	—	—	—	—	—	0
Cirsium acaule	—	4	—	—	10_3	1	—	1	2	8_1	7_0	70	—	10_2	5	+	—	—	—	2	—	—	—	—	—	0
Carlina vulgaris	—	1	+	3	—	—	1	+	—	2	2	70	2	—	5	2	3	—	—	—	—	—	—	—	—	0
Plantago media	—	+	+	1	8_4	1	5	5	+	1	9_1	**100**	—	2	+	—	+	—	10_5	3	—	—	—	—	—	0
Gentiana amarella	—	—	—	6_2	+	—	—	—	2	—	—	30	2?	—	—	—	1	—	—	—	—	—	—	—	—	0
Polygala amarella	—	6_0	1	6_0	—	—	5	5	1	—	—	60	—	1	4	3	—	—	—	—	—	—	—	—	—	0
2. Arnica montana	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	—	—	—	—	—	—	—	**10_7**	20
Trientalis europaea	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	—	—	—	—	—	—	—	8_4	20
Vaccinium myrtillus	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	—	—	—	10_5	8_4	—	2	—	60
3. Briza media	—	10_3	7_0	10_4	**10_6**	**10_9**	9_4	10_5	4	10_5	**10_6**	**100**	2	**10_9**	+	5	**10_8**	**10_8**	8_3	3	—	—	2	—	+	40
Deschampsia caespitosa	—	+	—	—	—	—	—	—	—	—	—	10	—	—	—	—	—	—	5	—	—	—	—	—	—	0
Festuca elatior	—	1	—	1	2	—	—	—	—	—	1	40	—	—	5	—	—	3	—	—	—	—	—	—	—	0
Carex flacca	—	—	2	—	4	10_5	6_2	**10_8**	8_1	**10_8**	10_6	**80**	9_2	9_5	6_1	—	6_2	8_0	8_2	5	+	—	—	—	—	20
Leontodon hispidus	—	4	—	+	4	—	—	—	—	—	1	40	8_1	6_2	—	—	—	10_5	—	—	—	—	—	—	—	0
Hieracium auricula	—	—	—	+	—	—	—	5	—	—	—	20	—	—	1	—	—	—	1	—	—	—	—	—	—	0
Senecio jacobaea	—	—	—	+	+	3	10_0	5	4	+	+	**80**	—	2	—	+	—	—	—	—	—	—	—	—	—	0
Chrysanthemum leucanthemum	—	1	2	4	—	—	—	—	—	—	—	30	3	3	+	2	—	2	+	—	+	1	—	—	—	40
Bellis perennis	—	—	—	—	—	—	—	—	—	—	—	0	—	—	+	—	—	—	1	—	—	—	—	—	—	0
Succisa pratensis	—	3	—	6_1	4	7_3	5	7_0	—	10_2	10_1	**80**	—	5	—	—	7_0	—	—	—	+	10_5	—	—	2	60
Prunella vulgaris	—	6_1	6_1	1	1	—	—	—	—	—	—	40	2	10_5	**10_9**	—	—	—	10_2	—	—	—	—	—	—	0
Trifolium pratense	—	—	—	—	7_1	—	—	—	+	1	6_2	40	—	—	2	4	—	4	2	—	—	—	—	—	—	0
— repens	—	—	—	—	—	+	—	—	—	—	—	10	—	—	—	—	—	—	9_4	—	—	—	—	+	1	40
Fragaria vesca	—	—	3	6_4	—	—	—	—	—	—	—	20	—	—	—	—	—	—	—	10_1	—	—	—	—	—	0
Geum rivale	—	—	2	1	—	—	—	—	—	—	—	20	—	—	—	—	—	—	—	—	—	—	—	—	—	0
Linum catharticum	×	+	3	4	4	10_5	2	6_0	6_2	8_0	8_1	**100**	8_1	9_2	8_2	6_2	10_3	10_2	—	+	—	—	—	—	—	0
Ranunculus acer	—	—	—	—	5	—	7_0	—	1	2	2	50	—	—	—	—	—	3	—	—	—	+	—	3	—	40
4. Molinia coerulea	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	—	—	—	10_4	—	—	—	—	20
Nardus stricta	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	—	—	—	—	—	—	—	1	20
Carex cfr. panicea	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	—	—	—	—	—	—	—	7_0	20
Potentilla erecta	—	—	—	—	—	—	—	—	—	1	—	10	—	—	—	—	2	—	+	—	10_0	7_3	—	4	**10_6**	**80**
Rumex acetosa	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	4	+	3	—	6_1	7_3	—	7_1!	6_2	**80**

Percentage constancy nos. 1–10 | Percentage constancy nos. 19-23

5. Carex montana	—	—	—	—	—	—	—	—	—	—	—	0	—	4	—	—	—	—	—	2	—	—	—	—	20
Polygonatum officinale	—	—	—	—	—	—	1	—	10_2	—	—	20	—	—	—	—	—	—	—	—	—	—	—	—	0
Campanula glomerata subsp. farinosa	—	3	1	2	—	8_1	10_3	9_2	5	—	—	70	—	—	—	—	—	—	—	—	—	—	—	—	0
— persicifolia	—	—	—	—	—	2	—	—	—	—	—	10	—	—	—	—	1	—	—	+	—	—	—	—	20
— trachelium	—	—	—	—	—	—	—	2	—	—	—	10	—	—	—	—	—	—	—	—	—	—	—	—	0
Valeriana officinalis	—	1	—	3	—	—	—	—	—	—	—	20	—	—	—	—	—	—	—	—	—	—	—	—	0
Galium boreale	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	—	—	4	—	—	—	—	20
Primula veris	—	6_0	+	**10_7**	1	4	6_1	2	8_3	9_1	8_0	**100**	—	3	—	—	7_0	9_2	—	4	2	—	—	—	20
Hypericum maculatum	—	—	3	1	—	—	—	—	—	—	—	20	—	—	—	—	—	—	—	—	—	—	—	—	0
Viola hirta	—	—	—	—	—	—	9_2	9_2	7_3	—	—	30	—	5	—	—	—	—	—	—	—	—	—	—	0
Helianthemum nummularium	—	—	—	—	—	—	—	—	—	—	—	0	—	**10_7**	—	—	—	—	—	—	—	5	—	—	20
Geranium sanguineum	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	—	—	—	—	1	—	—	20
Filipendula hexapetala	—	—	—	—	—	7_4	9_0	5	5	**9_6**	7_2	60	—	7_3	2	—	6_2	—	—	—	9_3	1	1	—	—	60
Agrimonia eupatoria	—	—	—	—	—	—	+	—	—	—	—	10	—	—	—	—	—	—	1	—	—	—	—	—	0
Thalictrum minus	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	—	—	—	—	—	2	—	20
6. Koeleria pyramidata var. danica	—	—	—	—	10_5	**10_{10}**	10_4	10_4	8_3	10_4	10_4	70	—	**10_6**	7_5	8_2	10_5	—	—	—	—	—	—	—	0
Avena pratensis	—	—	—	—	10_4	7_1	**10_6**	10_4	9_2	10_5	10_5	70	**10_7**	10_3	9_3	10_5	10_5	10_5	2	10_4	—	—	—	—	0
— pubescens	—	—	1	1	—	—	—	—	1	—	—	30	—	—	—	—	—	3	—	—	—	—	—	—	0
Poa angustifolia	—	—	—	7_2	—	—	—	—	—	—	—	10	—	—	—	—	—	—	—	—	—	—	—	—	0
Phleum nodosum	—	—	—	—	—	—	—	—	—	—	—	0	2	—	7_3	10_2	—	—	3	—	—	—	—	—	0
Carex caryophyllea	—	—	—	—	3	7_2	8_4	4	6_3	5	3	70	—	4	—	—	7_3	—	4	9_2	—	—	—	—	9_1	20
— ericetorum	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	—	—	—	3	—	—	—	20
Hypochoeris maculata	—	—	—	—	—	—	—	—	—	—	2	10	—	—	—	—	—	—	—	—	10_5	—	—	—	20
Scorzonera humilis	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	—	—	—	—	**10_7**	—	+	40
Artemisia campestris	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	2	—	—	—	—	—	—	—	—	0
Centaurea jacea	—	4	+	4	10_3	1	—	—	1	1	6_1	**80**	—	6_2	4	—	3	—	—	—	—	—	—	—	0
— scabiosa	—	1	—	—	—	1	6_0	10_1	9_1	—	4	60	—	7_1	—	+	—	—	—	—	—	—	—	—	0
Calamintha acinos	×	—	—	—	—	—	—	—	—	—	—	0	—	1	—	8_3	—	—	—	—	—	—	—	—	0
Pimpinella saxifraga	—	—	—	1	**10_6**	7_2	9_1	6_2	8_1	—	—	60	—	3	1	3	+	10_5	—	4	—	2	—	4	—	40
Hypericum perforatum	—	2	—	—	—	—	—	—	—	—	—	10	+	—	+	—	—	—	—	—	—	1	—	—	20
Genista tinctoria	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	—	—	—	—	—	10_3!	—	20
Trifolium medium	—	—	—	—	—	—	5	—	—	—	4	20	—	—	—	—	1	10_4	3	—	4	1	—	—	5	60
Potentilla verna	—	—	—	—	—	—	—	—	—	+	—	10	—	—	—	—	+	—	—	—	—	—	—	—	—	0
Sanguisorba minor	—	1	+	4	—	—	10_5	10_3	6_1	3	—	70	—	5	8_4	—	—	—	—	—	—	—	—	—	—	0
Arabis hirsuta	—	—	—	+	—	1	—	—	—	—	—	20	—	+	+	—	+	—	—	—	—	—	—	—	—	0
Pulsatilla vulgaris	—	—	—	—	—	3	7_1	1	—	—	1	40	—	3	—	—	9_1	—	—	—	—	—	—	—	—	0
Silene nutans	—	—	—	—	—	—	+	7_2	1	—	—	30	—	—	—	—	—	—	—	—	—	—	—	—	—	0
Arenaria serpyllifolia	×	—	—	—	—	—	—	—	—	—	—	0	—	—	2	3	—	—	—	—	—	—	—	—	—	0
7. Sieglingia decumbens	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	1	—	—	—	—	2	—	2	+	60
Holcus lanatus	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	—	—	—	—	+	—	3	—	40
Carex arenaria	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	—	—	—	—	—	6_2	—	—	20
— pilulifera	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	—	—	—	—	10_5	—	—	—	20
Galium saxatile	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	—	—	—	—	—	—	—	**9_7**	20
Myosotis versicolor	×	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	1	—	—	—	—	—	—	—	0
Armeria vulgaris	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	—	—	—	—	+	1	—	—	40
Calluna vulgaris	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	—	—	—	—	1	—	—	9_1	40
Hypericum pulchrum	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	—	—	—	—	—	—	—	4	20
Lathyrus montanus	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	—	—	—	10_3	**9_6**	—	—	6_1	60
Genista anglica	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	—	—	—	—	—	—	—	7_3	20
Ononis repens*	—	+	—	—	—	+	+	—	2	—	+	50	—	—	2	4	—	—	—	1	—	+	—	—	—	20
Saxifraga granulata*	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	2	+	1	—	—	3	3	—	—	40
Ranunculus bulbosus*	—	—	—	2	5	5	10_3	10_2	5	10_4	10_0	**80**	4	5	**10_9**	5	10_4	9_1	9_1	1	—	—	—	—	1	20

(To be continued)

Table 8 (continued)

Analysis no.		1	2	3	4	5	6	7	8	9	10		11	12	13	14	15	16	17	18	19	20	21	22	23	
Locality no.		13	13	13	18	19	20	20	20	15	15		30	16	16	9	15	29	1	3	15	4	24	22	34	
Exposure		NW	NW	NW	N NE	NE	E NE	E NE	E NE	E NE	NE		W	W SW	S SE	W NW	NE	N NE	NE	W NW	E NE	W NW	N	NE	W NW	
Slope		30–35	40	35	25	40	25–30	25–30	25–30	30	30		25	20	27	25	30	30	30	40–45	45	25	25	20	20	
*p*H (Figures in brackets: at a depth of 4–10 cm.)	Annuals	7.4	7.7	7.2	7.0	8.0	7.3	7.5	7.3	7.4 [7.4]	7.5 [7.3]		7.3	7.7	7.4	7.4	6.9 [7.1]	7.4	6.0	6.7	4.9 [5.5]	4.9	5.3	5.2	4.2	
$CaCO_3$, percentage.. (Without brackets: at top of soil)		74	75	61	53	3–20	59	65	59	36 [45]	56 [70]		76	22	44	6.6	0.3 [3.0]	0.2	0.0	0.5	0.0	0.0	0.0	0.0	0.0	
Density of species ($\frac{1}{10}$ m.²)		13.2	9.6	19.9	22.2	20.9	22.7	21.9	20.2	20.5	21.7		17.4	29.9	23.3	21.7	26.3	25.8	30.3	17.9	18.5	22.1	17.3	19.0	25.2	
Number of species		45	40	59	39	45	46	42	45	40	42		40	63	53	54	51	52	57	40	35	51	35	34	51	
Total covering in per cent.		100	50	80	100	95	90	95	100	100	100	Percentage constancy nos. 1-10	50	95	95	95	95–100	100	100	90	100	100	100	100	100	Percentage constancy nos. 19-23
8. Festuca rubra	—	9_5	6_0	**10_9**	9_3	6_3	1	7_1	2	7_3	10_2	**100**	**10_6**	8_3	**10_9**	10_5	6_3	**10_7**	**10_8**	10_3	10_5	5	**10_7**	**10_{10}**	6_3	**100**
— ovina	—	—	1	—	9_3	**10_9**	1	4	1	10_0	5	**80**	3	**10_9**	—	+	9_4	2	8_3	6_1	—	**10_9**	**10_{10}**	—	10_5	60
Dactylis glomerata	—	1	+	6_1	5	1	1	5	5	5	1	**100**	4	6_1	6_4	9_2	8_1	8_3	2	10_2	5	—	—	—	—	20
Avena elatior	—	—	—	6_0	—	—	—	—	—	—	—	10	—	—	—	—	—	1	—	—	—	—	—	—	—	0
Lolium perenne	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	—	9_2	—	—	—	—	—	—	0
Cynosurus cristatus	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	+	2	8_2	—	—	1	—	—	—	20
Agrostis tenuis	—	—	—	—	—	1	—	+	—	—	—	20	—	—	—	—	—	—	**10_{10}**	—	9_3	5	10_5	**10_9**	3	**100**
— stolonifera	—	—	—	—	—	—	—	—	—	—	—	0	7_3	—	—	—	—	—	—	—	—	—	—	—	—	0
— canina	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	—	—	—	+	—	—	6_2	9_5	60
Deschampsia flexuosa	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	—	—	—	10_5	10_4	—	2	8_3	**80**
Anthoxanthum odoratum	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	2	1	9_2	—	—	7_1	10_5	8_2	9_3	**80**
Poa pratensis	—	—	—	—	—	—	—	—	—	—	+	10	2	—	—	3	1	**10_6**	10_4	10_4	2	3	7_5	6_0	6_1	**100**
Carex hirta	—	—	—	—	—	—	—	—	—	—	—	0	—	—	4	—	—	—	—	—	—	—	—	—	—	0
Luzula campestris	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	4	9_2	**10_6**	—	—	5	5	7_3	**10_8**	**80**
Platanthera bifolia	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	—	—	—	—	—	—	—	4	20
Hieracium pilosella	—	—	—	2	4	6_3	4	—	—	—	2	50	10_3	3	9_5	3	10_4	6_1	5	1	—	3	6_2	4	9_3	**80**
— umbellatum	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	—	—	—	—	4	—	—	6_2	40
Taraxacum sp.	—	—	1	+	2	—	1	—	8_2	—	3	60	5	2	5	6_2	—	2	**10_6**	2	—	—	—	—	—	0
Leontodon autumnalis	—	—	—	—	—	—	—	—	—	—	—	0	—	—	+	—	—	—	**10_7**	—	—	—	—	—	—	0
Tragopogon pratensis	—	—	—	—	+	—	—	—	—	—	—	10	—	—	—	—	—	—	—	1	—	—	—	—	—	0
Solidago virga-aurea	—	—	—	—	—	—	1	5	—	—	—	20	—	—	—	—	—	—	—	—	—	7_1	—	—	—	20
Achillea millefolium	—	6_2	2	—	**10_7**	2	—	2	+	—	3	70	—	—	7_2	4	+	6_1	**10_6**	3	6_3	2	8_4	8_3	4	**100**
Tussilago farfarus	—	—	1	—	—	—	—	—	—	—	—	10	—	—	—	—	—	—	—	—	—	—	—	—	—	0
Campanula rotundifolia	—	4	3	8_2	10_2	4	10_4	4	7_4	10_4	7_1	**100**	6_1	8_2	10_4	10_1	5	**10_8**	—	5	—	9_3	7_1	10_5	6_2	**80**
Knautia arvensis	—	2	1	—	—	—	4	1	3	2	—	60	+	4	+	1	10_1	2	1	—	—	+	—	—	—	20
Galium verum	—	1	—	4	**10_6**	7_1	+	2	+	4	5	**90**	—	5	+	6_0	9_1	5	7_2	4	4	2	9_3	2	—	**80**
— pumilum	—	**10_6**	6_3	6_3	3	—	4	—	—	7_1	1	70	3	3	2	4	4	1	—	1	5	7_5	9_5	**10_8**	—	**80**
Plantago lanceolata	—	—	—	4	8_4	—	—	—	—	1	—	30	—	2	8_3	3	—	+	6_4	9_4	—	—	4	8_2	2	60
— major	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	—	1	—	—	—	—	—	—	0
— maritima	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	7_0	—	—	—	—	—	—	—	—	—	0
Euphrasia stricta	×	—	—	—	3	—	—	—	—	—	—	10	—	—	2	—	—	—	—	—	—	—	—	—	—	0
Veronica chamaedrys	—	—	1	2	—	—	—	—	—	2	—	30	—	3	—	—	+	—	+	—	1	—	3	7_3	3	**80**
— officinalis	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	+	—	—	+	2	—	4	1	**10_7**	2	**80**
— arvensis	×	—	—	—	—	—	—	—	—	—	—	0	—	+	+	—	—	—	—	—	—	—	—	—	—	0
Thymus serpyllum	—	—	—	—	—	3	1	1	—	3	—	40	4	6_3	9_2	1	7_4	1	—	—	—	—	+	—	—	20
Daucus carota	—	1	—	1	2	—	—	—	—	—	—	30	2	1	3	—	—	—	—	—	—	—	—	—	—	0
Lotus corniculatus	—	10_5	2	—	2	6_1	—	1	1	1	9_2	**80**	8_3	5	9_3	+	7_2	2	8_1	1	—	+	3	3	4	**80**
Vicia cracca	—	1	3	7_0	5	—	3	—	4	5	5	**80**	—	1	—	6_2	—	—	—	5	—	—	—	9_2	—	20

Medicago lupulina	×	—	6_0	4	8_2	1	4	4	2	8_1	10_3	**90**	$\mathbf{9}_6$	$\mathbf{10}_6$	$\mathbf{10}_8$	9_4	7_1	1	—	—	—	—	—	—	—	0
Anthyllis vulneraria	—	1	—	—	—	8_3	7_1	—	3	—	—	40	1	+	—	1	2	+	—	—	—	—	—	—	—	0
Potentilla reptans	—	—	—	—	—	—	—	—	—	—	—	0	—	—	2	—	—	—	—	—	—	—	—	—	—	0
Viola canina	—	1	—	—	—	—	—	—	—	—	—	10	—	4	—	—	—	—	—	10_4	8_1	6_2	3	7_1	2	**100**
Polygala vulgaris	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	—	+	—	—	1	—	—	1	40
Stellaria graminea	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	—	—	—	4	—	2	—	—	40
Cerastium caespitosum	—	—	—	—	—	1	—	—	—	—	—	10	—	—	1	—	4	3	7_4	—	—	—	7_1	+	—	40
— semidecandrum	×	—	—	—	—	—	—	—	—	—	—	0	—	—	—	1	—	—	—	—	—	—	—	—	—	0
Rumex acetosella	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	—	—	—	—	—	4	—	—	20
Salix repens	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	—	—	—	9_1	—	—	—	—	20
Equisetum arvense	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	+	—	—	—	—	—	1	—	20
9. Viburnum opulus	—	1	1	+	—	—	—	—	—	—	—	30	—	—	—	—	—	—	—	—	—	—	—	—	—	0
Rhamnus cathartica	—	1	+	1	—	—	—	—	—	—	—	30	—	—	—	—	—	—	—	—	—	—	—	—	—	0
Rosa tomentosa	—	5	—	—	—	—	—	—	—	—	—	10	—	—	—	—	—	—	—	—	—	—	—	—	—	0
— canina	—	—	—	—	—	—	—	—	2	—	—	10	—	—	—	—	—	—	—	—	—	—	—	—	—	0
Fagus silvatica	—	1	—	+	—	—	—	—	—	—	—	20	—	—	—	—	—	—	—	—	—	—	—	—	—	0
Quercus robur	—	+	—	+	—	—	—	—	—	—	—	20	—	—	—	—	—	—	—	—	—	—	—	—	—	0
Salix aurita	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	—	—	—	—	—	—	—	—	0
Juniperus communis	—	1	—	1	—	—	—	—	—	—	—	20	—	—	—	—	—	—	—	—	1	—	—	—	—	20
Heracleum sphondylium	—	2	3	+	—	—	—	—	—	—	—	30	—	—	—	—	—	—	—	—	—	—	—	—	1	20
Anemone nemorosa	—	—	—	1	—	—	—	—	—	—	—	10	—	—	—	—	3	—	—	—	8_3	10_5	—	—	3	60
Convallaria majalis	—	—	—	—	—	—	—	—	$\mathbf{10}_{10}$	—	—	10	—	—	—	—	—	—	—	—	—	—	—	—	—	0
Luzula pilosa	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	—	—	—	—	—	—	—	1	20
Vicia sepium	—	—	—	+	—	—	—	—	—	—	—	10	—	—	—	—	—	—	—	—	—	—	—	—	—	0
Polypodium vulgare	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	—	—	—	—	—	+	—	—	20
10. Hylocomium schreberi	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	—	—	—	—	3	$\mathbf{10}_9$	2	5	**80**
— splendens	—	—	—	7_4	—	1	—	—	—	5	—	30	—	1	—	—	8_3	—	—	2	2	3	$\mathbf{10}_{10}$	$\mathbf{10}_{10}$	$\mathbf{10}_{10}$	**100**
— squarrosum	—	1	—	6_3	—	—	—	—	—	—	—	20	—	—	—	—	7_2	—	7_3	—	$\mathbf{10}_{10}$	9_3	$\mathbf{9}_7$	1	3	**100**
— triquetrum	—	—	—	$\mathbf{10}_7$	—	2	—	—	—	7_2	1	40	—	3	—	—	$\mathbf{10}_{10}$	4	3	$\mathbf{8}_6$	4	8_2	$\mathbf{10}_9$	$\mathbf{10}_7$	9_4	**100**
Ctenidium molluscum	—	$\mathbf{10}_{10}$	$\mathbf{10}_{10}$	$\mathbf{10}_9$	$\mathbf{10}_{10}$	$\mathbf{10}_9$	$\mathbf{10}_9$	$\mathbf{10}_{10}$	$\mathbf{10}_{10}$	—	—	**80**	$\mathbf{10}_6$	$\mathbf{9}_9$	—	4	—	5	2	2	—	—	—	—	—	0
Hypnum cupressiforme	—	—	—	1	—	8_4	—	—	—	—	—	20	—	3	—	1	5	—	—	1	—	5	—	—	1	40
Campylium chrysophyllum	—	—	—	—	—	—	—	—	—	—	—	0	1	7_2	$\mathbf{10}_6$	$\mathbf{10}_6$	—	—	—	—	—	—	—	—	—	0
Calliergonella cuspidata	—	—	—	—	—	—	—	—	—	—	—	0	+	6_2	—	1	—	1	8_5	—	—	—	—	—	—	0
Eurhynchium swartzii	—	—	—	—	—	—	—	—	—	—	—	0	—	3	3	10_4	—	$\mathbf{10}_6$	2	7_3	—	—	—	—	—	0
Pseudoscleropodium purum	—	1	—	2	—	$\mathbf{6}_6$	—	—	—	2	—	40	—	5	—	1	8_3	$\mathbf{10}_6$	$\mathbf{10}_8$	$\mathbf{10}_8$	7_3	8_3	—	2	8_2	**80**
Brachythecium glareosum	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	3	—	—	9_3	—	—	—	—	—	—	0
— sp.	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	—	6_4	—	—	—	—	—	—	0
Camptothecium lutescens	—	5	7_0	—	$\mathbf{10}_9$	3	9_5	9_4	10_5	$\mathbf{10}_{10}$	$\mathbf{10}_{10}$	**90**	10_5	$\mathbf{10}_{10}$	$\mathbf{10}_8$	10_4	10_4	$\mathbf{10}_8$	—	3	—	1	—	—	—	20
Thuidium abietinum	—	—	—	—	—	2	—	1	1	—	—	30	—	—	—	—	—	—	—	—	—	—	—	—	—	0
— philiberti	—	1	—	—	—	7_4	—	2	—	5	2	50	—	—	—	1	7_1	—	7_2	1	—	—	—	—	—	0
— tamariscinum	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	9_4	—	—	—	—	—	—	—	0
Neckera complanata	—	—	—	+	—	—	—	—	—	—	—	10	—	—	—	—	—	—	—	3?	—	—	—	—	—	0
Fissidens adiantoïdes	—	—	—	1	—	—	1	—	$\mathbf{7}_6$	—	—	30	1	7_2	8_3	—	—	8_4	5	—	—	2	—	—	—	20
— taxifolius	—	—	—	—	—	—	+	9_5	—	—	—	20	—	—	—	—	—	—	—	5	—	—	—	—	—	0
Ceratodon purpureus	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	5	—	7_2	—	—	—	—	—	—	—	0
Dicranum scoparium	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	—	—	—	—	—	—	—	3	20
Barbula unguiculata	—	—	—	—	—	—	—	—	4	—	—	10	—	—	—	—	—	—	5	—	—	—	—	—	—	0
— convoluta	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	1	—	—	—	—	—	—	—	—	—	0
— fallax var. brevifolia	—	—	—	—	—	—	—	—	—	—	—	0	$\mathbf{10}_8$	6_2	5	9_4	—	—	+	—	—	—	—	—	—	0
Weisia microstoma	—	—	—	2	—	—	1(?)	—	—	—	—	20	—	1	—	—	—	—	—	—	—	—	—	—	—	0
Tortula subulata	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	+	—	—	—	—	—	—	—	—	—	0
— ruralis	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	1	—	—	—	—	—	—	—	—	—	0
Encalypta streptocarpa	—	—	—	7_4	—	—	—	—	—	—	—	10	—	—	—	—	—	—	—	—	—	—	—	—	—	0
— vulgaris	—	—	—	—	—	—	—	—	—	—	—	0	—	1	—	1	—	—	—	—	—	—	—	—	—	0

(To be continued)

Table 8 (continued)

Analysis no.		1	2	3	4	5	6	7	8	9	10		11	12	13	14	15	16	17	18	19	20	21	22	23	
Locality no.		13	13	13	18	19	20	20	20	15	15		30	16	16	9	15	29	1	3	15	4	24	22	34	
Exposure		NW	NW	NW	N NE	NE	E NE	E NE	E NE	E NE	NE		W	W SW	SSE	W NW	NE	N NE	NE	W NW	E NE	W NW	N	NE	W NW	
Slope		30–35	40	35	25	40	25–30	25–30	25–30	30	30		25	20	27	25	30	30	30	40–45	45	25	25	20	20	
*p*H (Figures in brackets: at a depth of 4–10 cm.)	Annuals	7.4	7.7	7.2	7.0	8.0	7.3	7.5	7.3	7.4 [7.4]	7.5 [7.3]		7.3	7.7	7.4	7.4	6.9 [7.1]	7.4	6.0	6.7	4.9 [5.5]	4.9	5.3	5.2	4.2	
$CaCO_3$, percentage.. (Without brackets: at top of soil)		74	75	61	53	3–20	59	65	59	36 [45]	56 [70]		76	22	44	6.6	0.3 [3.0]	0.2	0.0	0.5	0.0	0.0	0.0	0.0	0.0	
Density of species ($\frac{1}{10}$ m.²)		13.2	9.6	19.9	22.2	20.9	22.7	21.9	20.2	20.5	21.7		17.4	29.9	23.3	21.7	26.3	25.8	30.3	17.9	18.5	22.1	17.3	19.0	25.2	
Number of species		45	40	59	39	45	46	42	45	40	42		40	63	53	54	51	52	57	40	35	51	35	34	51	
Total covering in per cent		100	50	80	100	95	90	95	100	100	100	Percentage constancy nos. 1-10	50	95	95	95	95–100	100	100	90	100	100	100	100	100	Percentage constancy nos. 19-23
Webera cruda	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	—	—	—	—	—	+	—	—	20
Bryum spp.	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	—	+	—	—	—	+	—	—	20
Rhodobryum roseum	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	—	+	—	—	—	—	—	—	0
Mnium undulatum	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	7_2	9_4	1	—	2	—	—	—	20
— stellare	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	1	—	—	—	—	+	—	—	20
Polytrichum commune	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	—	—	—	—	—	—	—	5	20
Lophocolea bidentata	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	+	8_4	—	—	—	—	—	—	0
— bicuspidata	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	—	—	4	—	—	—	—	—	0
— cuspidata	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	—	—	—	—	—	—	—	3	20
Plagiochila asplenioïdes	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	2	—	—	—	—	—	—	—	0
Jungermannia badensis	—	—	—	—	—	—	—	—	—	—	—	0	2	—	—	—	—	—	—	—	—	—	—	—	—	0
11. Verrucaria acrotella	—	—	—	—	—	—	—	—	—	—	—	+	8_2	—	—	—	—	—	—	—	—	—	—	—	—	0
— muralis	—	—	—	—	—	—	—	—	—	—	—	0	+	—	—	—	—	—	—	—	—	—	—	—	—	0
Polyblastia intermedia	—	—	1	—	—	—	—	—	—	—	—	10	—	—	—	—	—	—	—	—	—	—	—	—	—	0
Collema cfr. pulposum	—	—	+	3	—	—	—	—	—	—	—	20	4	1	—	2	—	—	—	—	—	—	—	—	—	0
Leptogium scotinum	—	—	+	—	—	—	—	—	—	—	—	10	—	—	+	—	—	—	—	—	—	—	—	—	—	0
Peltigera canina	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	—	—	—	—	—	1	—	—	20
Cladonia furcata	—	—	—	—	—	—	—	—	—	—	—	0	—	1	—	—	—	—	—	—	—	—	—	—	2	20
— subrangiformis	—	—	—	—	—	8_5	—	—	—	—	—	10	—	—	—	—	—	—	—	—	—	—	—	—	—	0
— rangiformis	—	—	—	—	—	1	—	—	—	—	—	10	—	—	—	—	—	—	—	—	—	—	—	—	—	0
— pyxidata	—	2	3	4	—	—	—	—	—	—	—	30	—	—	—	—	—	—	—	—	—	—	—	—	—	0
Protoblastenia rupestris	—	—	+	—	—	—	—	—	—	—	—	10	4	—	—	—	—	—	—	—	—	—	—	—	—	0
12. Trentepohlia aurea	—	—	—	—	—	—	—	—	—	—	—	0	2	—	—	—	—	—	—	—	—	—	—	—	—	0
— iolithus var. bovina	—	—	3	1	—	—	—	—	—	—	—	20	2	—	—	—	—	—	—	—	—	—	—	—	—	0
Endolithic Cyanophycea	—	—	5	—	—	—	—	—	—	—	—	10	—	—	—	—	—	—	—	—	—	—	—	—	—	0

Groups of species: (1) Montane or boreal continental (subcontinental) meadow plants. — (2) Montane-boreal species (*Arnica*: montane suboceanic). — (3) Widely ranging meadow plants, with the exception of *Succisa* preferring neutral or basic soils. — (4) The same, but preferring acid soils. — (5) Continental-subcontinental species connected with wood steppe or similar communities. — (6) Other continental-subcontinental species. — (7) Oceanic-suboceanic species and species with a tendency of distribution towards the west (marked with an asterisk). — (8) Widely ranging indifferent species not particularly connected with meadows. — (9) Widely ranging trees and fairly tall bushes and woodland plants (among the bushes *Rhamnus cathartica* has a subcontinental distribution). — (10) Bryophytes. — (11) Lichens. — (12) Algae.

In Table 8, the vegetations nos. 1—15 belong to the *Cineraria-Polygala-Ctenidium* type. The most typical analyses have been placed first (nos. 1—10). The figures of constancy show that there is a fairly great uniformity here. There are, however, at least four subtypes: (1) A type without *Koeleria*, *Avena pratensis*, and *Carex caryophyllea*, but with some woody plants (nos. 1—3, all from the locality near the spring Blaakilde), (2) another type without *Ctenidium*, but with *Crepis praemorsa* (nos. 9—10 from the same locality), (3) a type in which both *Koeleria*, *Avena pratensis*, and *Ctenidium* show a pronounced dominance (nos. 4—7 from three different localities), (4) finally there is the peculiar vegetation no. 8, where also *Convallaria* and *Polygonatum officinale* dominate, a vegetation which has already been touched on under the mention of the communities of the wood-steppe group p. 33.

The vegetations nos. 11—13 deviate in being developed on somewhat drier, sunnier slopes (cp. the description of the Loc. 16 and 30). No. 14, which faces WNW., is situated on a loose sandy soil mixed with lime and dug through by animals, and differs both by including such therophytes as *Calamintha acinos* and *Arenaria serpyllifolia* and by an unusual abundance of mosses with such species as *Campylium chrysophyllum*, *Barbula fallax* var. *brevifolia* and *Eurhynchium swartzii* as dominants. In the west-facing analysis no. 15 *Koeleria* is absent, while *Barbula fallax* is abundant. Many of the differences separating the subtypes are difficult to account for ecologically, and there is hardly any doubt that chances during the immigration may play a rather considerable part as causes.

Among the communities described above the *Brachypodium pinnatum-Inula salicina* type is rather closely related to the one just mentioned. The transition between them is particularly mediated by the vegetation rich in *Crepis praemorsa* rendered in Tables 3 and 8. It is possible that the *Crepis praemorsa* vegetations should be considered a special type. According to Sterner (1922, p. 399) *Crepis praemorsa* belongs to the meadow steppe, while Meusel further considers it a typical element of the Sarmatian wood-steppe. Therefore there might be reason to operate with a *Crepis* type as a transitional stage between woodsteppe-like and meadowlike communities. Such a species as *Campanula glomerata* like *Crepis praemorsa* has its optimum in the *Brachypodium-Inula* and the *Cineraria-Polygala-Ctenidium* types and the same holds good of *Primula veris*.

Besides, the exclusive species mentioned, particularly *Cineraria integrifolia*, *Polygala amarella*, and *Ctenidium* suggest relationship with the "dealpine Grasfluren" of Central Europe (cf. Meusel), among which are especially reckoned the communities of the calcareous Alps, the Lower Alps, and the *Sesleria* communities of the Central German mountains. Among the cryptogams characteristic of the dealpine vegetations which are found in the Jutlandish community, we may, besides *Ctenidium molluscum*, mention *Campylum chrysophyllum*, *Encalypta streptocarpa*, and *Trentepohlia aurea*. While the similarity between the subcontinental grass-slopes of Sealand and Møn and the dealpine grassland community is not very pronounced, we can hardly deny the existence of a fairly great similarity between this montane Central

European community and that of Himmerland. This can hardly be due to a particular edaphic correspondence, as communities rich in *Ctenidium* are found on the chalk of Stevns and Høje Møn and on clay on Sjællands Odde. The cause is rather to be sought in historical circumstances (see p. 74) or perhaps in the somewhat colder and more humid climate of Northern Jutland, which may remind more of the montane climate of Central Europe.

The two analyses nos. 16 and 17 in Table 8 show examples of Himmerlandish vegetation corresponding completely to the subcontinental grass slope of Sealand. In both analyses *Koeleria pyramidata* is absent, and among the species in Group 1 only *Plantago media* is present in no. 17. This analysis is peculiar by its unusually high density of species (on an average 30 species per $\frac{1}{10}$ m.^{2}). Besides by the absence of certain species the vegetations differ by dominance of *Pseudoscleropodium purum*. Both no. 17 and the somewhat different vegetation no. 18 from Marbjerg to some degree approach the oligotrophic communities on northern exposures, though they cannot be characterized as intermediate forms. Such were not seen in Himmerland, but in our material from Thy, Mors, and the Hanherreder we have several instances of floristic and ecological transitional forms between the calcareous-alkaline communities of north-facing slopes and the acid-poor ones. Intermediate forms from Sealand have been described by numerous examples, particularly from Gilleleje.

The *Vaccinium myrtillus-Arnica montana-Hylocomium schreberi* Type.

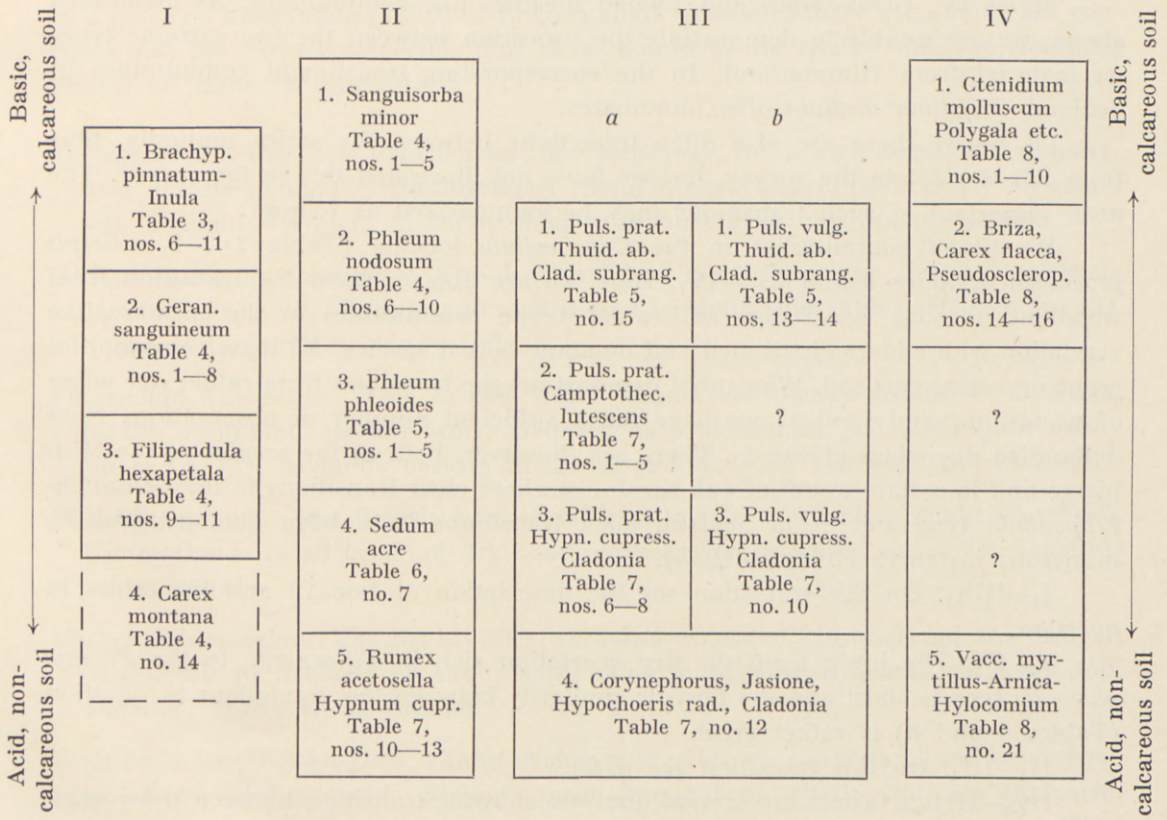
There are several places in Himmerland in which oligotrophic, acidic, and more or less north-facing slopes have not grown into heaths. Instead there is a grassland vegetation (Table 8, nos. 19—23) of the same type as the suboceanic grass-slope described from Nakkehoved and other places in Sealand. There is here a boreal and montane element and certain rather northern or submontane and also oceanic species (*Arnica montana, Galium saxatile*). The mosses are practically the same as those of the corresponding heath communities, still e. g. *Hylocomium loreum* is absent, which may occur in the most typical north-sloping heaths with *Cornus suecica, Blechnum spicant,* and others (Böcher 1943).

A number of acidophilous plants separate the *Vaccinium-Arnica-Hylocomium* type clearly from the preceding type (thus *Deschampsia flexuosa, Agrostis canina, Viola canina,* and *Hylocomium schreberi*), but besides it is interesting to note how several species seem to prefer the acidic north-facing slopes and the less calcareous vegetations (nos. 14—18) mentioned in connexion with the *Cineraria-Polygala-Ctenidium* type. This, e. g., holds good of *Agrostis tenuis, Anthoxanthum odoratum, Poa pratensis, Luzula campestris, Veronica officinalis,* and *Anemone nemorosa*. On the other hand some species are absent in the *Vaccinium-Arnica-Hylocomium* type (thus *Ranunculus bulbosus, Taraxacum officinale,* and *Medicago lupulina*).

V. Summarizing Remarks on the Vegetation and the Flora.

In the preceding description the points of mutual contact of the various communities have been mentioned several times. In what follows they will be sketched out again, and as this is done to all communities, an attempt will be made at making clear the structure of all the great complex of vegetations rich in herbs and grasses found in Himmerland. In the below survey we have considered phytogeographical and ecological conditions, especially as regards the soil. The various types have been distributed to four series and within these they have been arranged between two extreme types, *viz.* communities on acid-sandy and on alkaline-calcareous soil. By such an arrangement they are at the same time often distributed in relation to the degree of humidity of the soil, sandy soils, as mentioned, probably always being drier than calcareous soils, all other conditions being equal.

Series I includes woodsteppe-like communities. The transition between no. 1 and no. 2 is clear, particularly at Klithuse, where *Geranium sanguineum* enters in *Brachypodium-Inula* communities (Table 3). The transition between 2 and 3 has



been mentioned on p. 37. The scarcity of the *Carex montana* vegetation (Table 4, no. 14) causes this to be placed in the way stated with a certain reserve only.

Series II includes communities of dry slopes. The transition from 1 to 2 is mentioned on p. 49. Instances of transitions between 2 and 3 are found in such cases in which *Phleum phleoides* grows on sand mixed with chalk (see Table 6). Also the further transition to the *Sedum acre* type on slightly acid soil and to *Corynephorus* communities (Series III) through what was called dry acidic grassland types, is mentioned above (p. 60). In the survey these dry acidic communities for the sake of uniformity have been named after some rather characteristic species (*Rumex acetosella, Hypnum cupressiforme*).

Series III includes sand-alvar and *Corynephoretum*. We have here set up two related parallel series: (a) with *Pulsatilla pratensis* and (b) with *Pulsatilla vulgaris*. In none of these there is any subtype on very calcareous soil. The above-mentioned dense community rich in species and with sporadic *Draba incana* (Table 5, no. 12) in many respects resembles the sand-alvar vegetation and may perhaps be considered a kind of beginning of the series on very calcareous soil. Curiously enough we have not found intermediate types between 1 and 3 within the vegetations containing *Pulsatilla vulgaris*. No doubt such vegetations may be found.

Series IV. Grass-slopes and related meadow-like communities. As mentioned above, we are unable to demonstrate the transition between the two extreme types on material from Himmerland. In the corresponding transitional communities in Sealand *Trifolium medium* often dominates.

Of course there are also often transitions between the series mutually, thus from left to right in the survey, but we have not illustrated this in the survey. The most important of such transitions may be summarized as follows:

Woodland communities in the *Cypripedium* locality (Table 2) — I_1 — *Crepis praemorsa* (Tables 3 and 8) — IV_1. Here we are able to show the transition from woodland through wood-edge and wood-steppe communities to the meadow-like vegetation with widely distributed and montane-boreal species. All these communities occur on calcareous soil. We cannot demonstrate the transition from rather dry edges of woods on sandy soil as we have not a sufficient number of observations from Jutlandish dry edges of woods. There are, however, both in the scrubs on the Mulbjerge and in certain woods of oak-scrub elsewhere clear transitions to the *Geranium-Filipendula* type and from Sealand such transitions have been demonstrated by numerous instances (Böcher 1945).

I_2—$IIIa_2$. On this transition see the description of Loc. 10 and the tables in question.

I_3—II_3. The jump from the dry vegetation rich in *Filipendula* to the *Phleum phleoides* type is short and the floristic similarity between the vegetations in question (Tables 4 and 6) is rather great.

II_5—III_4. On this transition see p. 60.

II_{2-3}—$IIIb_{1-3}$. There are several analyses showing transition between drier vege-

tations of slopes and the sand-alvar rich in *Pulsatilla vulgaris*, see e. g. Table 6, no. 14, which shows an abundance of *Pulsatilla vulgaris*, but otherwise, if anything, belongs to the dry-slopes on slightly acid soil.

The transition from the complex of vegetations of the heath to the types just mentioned on the whole is clear. There is a transition to the *Carex montana* type I_4 (cf. Böcher 1943, Table 16), to II_5, to $IIIb_3$ and to IV_5 (cf. Böcher 1943, Tables 2—3).

A study of the tables and the topographical section will give a number of clues also respecting the ecology of the various species. The material, however, is too scarce to give summaries for each single species so far. Autecology should, if possible, be based on observations of the vegetation of an extensive area. Sealand, Møn, and Himmerland have now been investigated in respect to the grass-herb vegetation. When the material from Thy and the Hanherreder has been published, the time may have come for an autecological summarizing. It should, however, on such an occasion be attempted to the greatest possible extent to work in data from the vegetations of other countries, just to extend the area under investigation. In this connexion we shall call attention to some interesting facts which already now appear from a comparison between Sealand, Himmerland and the chalky areas of the British Isles. In Tansley's description (1939) of English chalk grassland there are among the constants and the exclusive species, thus those bound to the chalky soil, the following species of particular interest:

Anthyllis vulneraria. The British Isles: low constancy, but a high degree of exclusiveness, locally abundant. Himmerland: frequent everywhere, particularly on sandy soil. Sealand: frequent in sandy fields and on clayey north-facing slopes.

Helianthemum nummularium. The British Isles: low constancy, almost completely exclusive to chalk. Himmerland: not bound to chalk, but rather selective (p. 42). Sealand: frequent on sandy soil.

Filipendula hexapetala. The British Isles: almost completely exclusive to chalk, locally abundant. Himmerland: frequent as a dominant on rather poor sandy slopes (p. 37). Sealand: besides in the slope vegetation also scattered in heaths.

Pulsatilla vulgaris. The British Isles: local and nearly confined to chalk grassland. Himmerland: in all kinds of dry communities, also in heath, see p. 55. Sealand: on poor soil.

Hypochoeris maculata. The British Isles: rare and exclusive. Himmerland and Jutland in general: particularly on sandy soils, often in Jutlandish heaths on richer soil. Sealand: nearly as in Jutland.

Viola hirta. The British Isles: almost exclusive to calcareous grassland and calcareous woodland. Himmerland: perhaps most frequent on chalk, but not exclusive.

Sealand: wood-edges, woodsteppe-like communities and grass-slopes on sandy as well as clayey soil.

Camptothecium lutescens. The British Isles: calcicole (HOPE-SIMPSON 1941). Denmark: on chalk but also on sandy and not markedly acid soils.

All these examples show great exclusiveness to chalk in the British Isles and less or none in Himmerland and Sealand. In one case (*Pulsatilla vulgaris*) there is at last perhaps even an exclusiveness to the opposite, i. e. acid, poor soil. All species with the exception of *Anthyllis vulneraria* and *Camptothecium lutescens* have a continental distribution and thus become calciphilous species, or exclusively represented by calciphilous races near their western boundaries. As regards Denmark something of that kind has already been mentioned respecting *Pulsatilla pratensis* (p. 55). However, there are also many species which both in the British Isles and Himmerland appear as typical calcicoles, thus *Brachypodium pinnatum, Campanula glomerata, Sanguisorba minor,* and *Cineraria integrifolia.* This last species, however, still farther east is not bound to chalk (see p. 74). A peculiar feature is also the high degree of exclusiveness to chalk of *Scabiosa columbaria* in the British Isles. This species appears as dominant on loose sand in Sealand (BÖCHER 1945, p. 62). It was not found at all in the localities in Himmerland. Similarly *Seseli libanotis,* which is a rare chalk plant in the British Isles and in Sealand is found on sand and shingles. Besides, the English chalk communities are fairly rich in species and include several species totally absent in Denmark, thus *Asperula cynanchica, Hippocrepis comosa, Ophrys apifera, Phyteuma orbiculare,* and others. Among Danish species from chalk soil growing completely wild *Polygala amarella, Inula salicina,* and *Crepis praemorsa* are not mentioned in TANSLEY's lists from the British Isles.

VI. Questions Concerning the History of the Vegetation.

As regards the glades in the wood of Allindelille near Ringsted (Sealand) CARSTEN OLSEN (1943) has advanced the view that these are natural, the trees of the wood because of want of nutrition being unable to thrive on soil which at a depth of 15 cm. contains about 80 per cent. $CaCO_3$ or more. Our soil samples from Himmerland are mostly taken from the surface of the soil. There are several with more than 60 per cent. and one with more than 70 per cent. $CaCO_3$. At a depth of 20 cm. the percentage will not infrequently reach the values critical to tree-growth.[1] In such places the woodless state therefore may be due to the special conditions of the soil. Unfortunately civilization in Himmerland has caused a very considerable reduction of the wood-grown area. Therefore there are few places suitable for a test of OLSEN's

[1] On the contents of nutrition in a couple of chalky soils from Himmerland see CARSTEN OLSEN 1921.

theory. Only two localities are worth special mention in this connexion, both on the valley-slopes along Lindenborg Aa (cf. p. 15).

In Loc. 13, the slope at Lille Blaakilde, the situation greatly reminds of the glades in the wood of Allindelille. On the open spots there are low individuals of trees and shrubs which apparently are stunted and in certain cases chlorotic. The glades are surrounded by *Rhamnus cathartica* scrub, which also is the case of a single somewhat more humid place in the wood of Allindelille, where, however, *Cornus sanguinea* generally forms the edge vegetation. At the bottom of the slope at Blaakilde the *Rhamnus* scrub stands on practically pure chalk soil. This might seem to go against OLSEN's view. There are, however, at the foot of the slope everywhere signs of the presence of oozing-out water or even springs, a fact which completely changes the edaphic situation as the water may supply the missing substances to the chalk soil.

In Loc. 14, the growing-place of *Cypripedium calceolus* near Buderupholm, conditions are not so clear. The content of chalk in the surface of the soil is between 12 and 52 per cent. and by digging no pure chalk soil was observed at a depth of 20 cm., even though the content of chalk obviously increased with increasing depth. There is no *Cornus* or *Rhamnus* scrub towards the glades. The place does not remind of the wood of Allindelille, but of the wood on the cliff of Møn. As regards this, LINDQUIST (1938) has advanced a theory to the effect, *i. a.*, that spots may of themselves now and then become illuminated, the beeches dying and only immigrating again after some time, often after a stage with juniper (cf. the Juniper-sanicle-sere of England mentioned by WATT and TANSLEY). As on Timmesøbjerg on Møn there are near Buderupholm dying or dead beeches (Plate I, Fig. 1). Juniper is abundant in the glades, in a few places junipers are seen which are shaded to death by beeches, and there may here be approaches to LINDQUIST's "Filtförna" formation. A somewhat mor-like soil is found under the junipers and as on Møn this particular form of mor shows a basic reaction (*p*H 7.5). Everything seems to indicate that lady's slipper orchid and *Cephalanthera rubra* will not bear strong shading (cf. for the latter BÖCHER 1946). The fact that these species are found quite isolated near Buderupholm suggests that the natural woodland vegetation here is rather bright or always has bright spots, which probably change places according as now one, now the other of the beeches die. A state of woodland of this type is no doubt extremely rare in Jutland, and this is no doubt the cause of the rare occurrence of the species mentioned.

Not only a large amount of chalk in the soil, but also slides may be natural causes of slopes being devoid of tree-growth. As for the west-facing slopes the wind probably also will play a part as a factor hostile to woods. Therefore it is rather probable that Himmerland contains a number of localities in which the original wood was not close and where, therefore, the grass-herb vegetation in places is very old, representing an edaphically conditioned subclimax. This view for that matter is also supported by certain circumstances connected with the distribution of some species, particularly *Cineraria integrifolia* and *Polygala amarella*.

The distribution of *Cineraria integrifolia* has recently been the object of a study by HULTÉN (1937, p. 111), who is of opinion that the species should have been swept out from the greater part of Scandinavia under the Würm glaciation and that it is now engaged on healing its area. A map (see BÖCHER 1944) based particularly on CUFODONTIS (1933), and the map made by ANDERSSON (1944), however, shows that the area of the species is greatly split up and that it is found as a relic in several isolated areas ice-covered during the Würm glaciation. It is very questionable whether these localities harbour the first pioneers of a re-immigration. Very much may be said in favour of the opposite view. *Cineraria integrifolia* has been called a subarctic steppe plant and its distribution shows that it belongs to a boreal-montane and also continental type. Such a species has hardly had equally good conditions of dispersal during all late- or postglacial climatic periods, but must be supposed to have had optimal conditions in the Late Glacial and the Preboreal Periods. When the Yoldia Sea separated Southern Sweden from the rest of Scandinavia it must—topographically and ecologically—have had particularly good possibilities of reaching its present localities in Northern Jutland and Southern Sweden. It may at that time easily have had a closed area in the ice-free regions from Varanger south along the White Sea and the Baltic (cf. map in SAURAMO (1929) of the extension of the Yoldia Sea). Just as in our day on the Kola peninsula and in Northern Norway it is found in humid meadows, bogs and dwarf-shrub heath poor in chalk, it may in the climate of the Yoldia Period have occurred in similar communities beyond Denmark. It seems that the species is calciphilous only at its western boundaries in relatively oceanic climates. Thus there is something in favour of the view that *Cineraria integrifolia* in Northern Jutland may be considered a relic from the Late Glacial Period. It has presumably held out on the calcareous slopes because these offered favourable edaphic conditions and in several places were not wooded in the later periods. This is not to say that it is a relic in all North Jutlandish finding-places. In some of these it may have immigrated in modern times. It has a great power of spreading, and hence many botanists will doubt its being a relic. Therefore it must be pointed out that it has not immigrated to the calcareous hillsides of Møn, which have not been wooded for a rather long period, and that it is absent in the large Central Swedish area with Archaean limestone rocks or calcareous soils, which just in the Yoldia Period for the most part were inundated by the sea or were very close to the inland ice.

Also the areas in Northern Jutland of *Polygala amarella* and *Draba incana* are remarkably isolated. The latter has its southern limit in the localities investigated by us. Farther south it is not found till the Alps. It is a circumpolar, subarctic-boreal species. Its present localities in Norway and Sweden are separated from its Danish ones by more than 50 miles of sea. *Polygala amarella* is similarly separated from Norwegian and Swedish localities and the distance to the nearest German ones is very great. ASCHERSSON & GRÄBNER (1898—99) state a northern limit of it in the NE. German lowlands. It belongs to a boreal-montane subcontinental type of distribution. Like *Cineraria integrifolia* it may have belonged to a subarctic-boreal meadow-flora with a more general distribution in the Late Glacial Period. Its isolated Northern Jutlandish area appears from Fig. 14. Its seeds have elaiosomes, hence spreading by ants is very probable.

Furthermore it is not excluded that the species *Prunella grandiflora*, which in the south is montane and further is continental, has reached its Danish and Swedish habitats in the Yoldia Period. It is astonishing that this species, which in the Alps rises to the alpine-subalpine zones, in Sweden is found only as far north as Lake Vänern (see map in STERNER 1922, Plate 6). Like *Cineraria integrifolia* it only grows in the part of Sweden which in the Yoldia Period was connected with Denmark and Germany. Its small number of localities in the Swedish mainland like its two Danish ones are in strangely isolated places and suggest that it is a relic rather than an advancing species.

In this connexion the area of *Galium pumilum* is very interesting. According to STERNER (1944) this species in northern Europe has a very disrupted range, and almost every isolate of it constitutes a separate taxonomic unit. In Sweden there are three isolates and the northernmost is at the Lake Vänern in the same area where *Prunella grandiflora* has an isolated occurrence. The Danish ssp. *septentrionale* (Sterner) is restricted to Jutland, Funen and the Oslo-

Fig. 14. The distribution within Denmark of *Polygala amarella*.

region. It is assumed to be a relic of a population that during the latest glaciation existed in some icefree refugia in Southern Jutland or Central Europe.

In *Galium pumilum* we have another example of a boreal, in the south montane species which in Denmark has an isolated area and a local southern limit. Owing to its wide ecological amplitude (cf. the tables) it is not restricted to the chalk grassland areas. It has probably immigrated to northern Jutland during the Late Glacial Period; it may have held out on the calcareous slopes here and, later, when the woods disappeared have enlarged the area, but it has not reached the numerous grassy slopes of Sealand.

Supposing the theory of the immigration of these species is correct, the illuminated Northern Jutlandish vegetation of calcareous slopes may date back to the Late Glacial Period. But of course the communities have not always been the same during

the long period. The species mentioned no doubt originally belonged to communities essentially different from those in which they are found now, communities including species now dead because the climate was no longer suitable to them. And even though the Northern Jutlandish chalkhill vegetation like the corresponding communities on the islands represent something of the most original and natural of Danish grass-herb vegetation, it should not be forgotten that civilization almost everywhere asserts itself strongly and also characterizes the chalk flora. This particularly applies to the flora on the open dry slopes, where so many species of weeds (*Echium vulgare*, see Plate IV, Fig. 1) may find suitable localities (cf. also the locality Høvblege on Møn, BÖCHER 1946).

Translation of some Danish common names used as elements of place-names:

Aa 'river'
Bakke 'hillside'
Bjerg (or **Bjærg**) 'mountain, hill'
Bredning 'broad' (widening of a fiord),
Bæk 'brook'
Dal 'valley'
Høj 'hill'
Kilde 'spring, source'.
Krat 'scrub, copse'
Lund 'grove'
Skov 'wood, forest'
Sund 'sound, straits'

-r in e. g. **Bakker** is a Danish plural ending.

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Fig. 1. The lady's slipper orchid locality in Bjergeskov near Buderupholm. On the left an old dead beech. On the right a specimen of *Viburnum opulus* between young beeches. Near this spot there are some vigorous specimens of *Cypripedium calceolus*, which cannot be seen in the picture. In the foreground *Calamagrostis arundinacea* in the illuminated vegetation. T. W. B. phot. 1943.

Fig. 2. The east-facing slope of Mulbjergene. Behind the meadows on the right the Kattegat is seen. Besides scrub the *Geranium sanguineum* vegetation on completely illuminated soil is seen in the foreground. T. W. B. phot. 1943.

Fig. 1. Næsby Dale near Løgstør. South-facing slope with *Chrysanthemum leucanthemum* sociation and *Hippophaes rhamnoides* scrub. T. W. B. phot. 1943.

Fig. 2. St. Nicolajs Bjerg near Sebbersund. West-facing slope. In the foreground *Geranium sanguineum* sociation with *Heracleum sphondylium*. The person in the middle of the picture is standing at the transition between the *Geranium* vegetation (downwards) and the drier vegetation rich in therophytes with *Potentilla verna*, *Viscaria vulgaris* and others (upwards). T. W. B. phot. 1943.

Fig. 1. Klithuse north of Nibe. Vigorous vegetation of *Crepis praemorsa* on north-facing slope. The fruits most of them have been blown away; the bright receptacle and the outstanding bracts (phyllaries) are seen. T. W. B. phot. 1943.

Fig. 2. Klithuse north of Nibe. Flowering *Geranium sanguineum* in the sand-alvar above the low Litorina slope. Also the fruits of *Pulsatilla pratensis* are visible. T. W. B. phot. 1943.

Fig. 1. South-facing calcareous slope near Voxlev. *Echium vulgare* sociation. In intervening spaces *Ranunculus repens* is seen. T. W. B. phot. 1943.

Fig. 2. *Anthemis tinctoria-Echium vulgare* sociation on a formerly ploughed calcareous hill near Sdr. Kongerslev. T. W. B. phot. 1943.