

A GUIDE TO BRYOLOGICALLY INTERESTING REGIONS IN GERMANY

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THE FICHTEL MOUNTAINS

by Klaus von der Dunk

1. General Information

1.1 Location

The Fichtelgebirge is situated in the northeastern part of Bavaria and is enclosed to the north and East by the borders of the German Democratic Republic and the CSSR.

The name "Fichtel"gebirge probably does not link with the spruce trees (*Fichte* = *Picea abies*), which is much abandoned today, but there is a word conjunction with some kind of sprites, called "Wichtel" in German, who are supposed to live in dark woods.

The Fichtelgebirge has the shape of a horseshoe open to the east. The interior part with the city of Wunsiedel is in about 600 m altitude. The surrounding mountains raise up to 1000m (Schnee-berg, Ochsenkopf).

The Fichtelgebirge is part of the main water draining line: three rivers flow to the North Sea (Saale, Eger, Main), while the fourths (Naab) flows (via Danube) to the Black Sea.

1.2. Geology

The Fichtelgebirge lies beyond a famous fault, the so-called Fränkische Linie (Fig.1). This fault divides the mesozoic layers of sedimentary rocks in the Southwest from the granitic igneous rocks in the Northeast. The mountain area itself consists of granite, now and then intruded by magma, especially in the southern part. In several places one can see large basalt quarries. The higher elevations of the granitic massif are often eroded to solitary rocks called "Blockmeere". In this regard the Fichtelgebirge is similar to the Black Forest.

The northern part around Bad Berneck consists of gneiss and Diabase. Around Wunsiedel there are some limestone metamorphosed to marble of limestone silicate. Generally, quartz containing material is dominating and calciphilous bryophytes are rare.

The rocks contain minerals as gold, silver, tin, copper and iron, which were digged out in the last centuries. The marble is used for plates on floors and walls. The quartz serves for glass factories. Granite is cut, polished and exported for floor and table plates and at least basalte and gneiss are crushed and strewed on icy roads in winter.

1.3 Climate

The Fichtelgebirge is situated between the influence of the Atlantic Ocean and the continental climate of eastern Europe. Therefore the western slopes are characterized by a mild climate (which can even be compared with the climate of the Rine valley), but the basins of Bayreuth and Wunsiedel have more extreme temperature values because of the lasting heat in summer and the low of cold air from the surrounding mountains in winter.

The average and the extreme values of the temperature are:

Bayreuth (similar to Wunsiedel) 7,7°C / 37°C / -29°C

Ochsenkopf (second highest peak) 3,9°C / 28°C / -17°C

The mountain climate is characterized by more days with frost and ice (160 and 70 in contrast to 100 and 20 in Bayreuth) and higher precipitation (1200 mm on the Ochsenkopf in contrast to Bayreuth with 600 mm). The mountains have snow layers between 20 and 100 cm for more than 100 days a year.

1.4 Vegetation

As other parts of Central Europe, the Fichtelgebirge was originally covered with woodland with the exception of steep rocky areas, bogs, and fens. Particularly mining activities (glass factories, ore melting) have caused serious changes in the natural woodland vegetation. Thus the original mixed forest of beech (*Fagus sylvatica*), oak (*Quercus robur*, *Q. petraea*), maple (*Acer pseudoplatanus*), spruce (*Picea abies*), fir (*Abies alba*) and pine (*Pinus silvestris*) has been changed to fast growing, artificial spruce forests.

The granite and gneiss areas at high elevations bear a forest with spruces, firs and beeches (*Vaccinio-Abietetum*). The herb layer is dominated by *Vaccinium myrtillus*, *V. vitis-idea* and the grass *Avenella flexuosa*, some ferns as *Blechnum spicant* and typical bryophytes of coniferous forests as *Bazzania trilobata*, *Rhytidiadelphus loreus* and *Plagiothecium undulatum*.

On more nutritious soil as on basalte at high elevations, a fir- beech-forest (*Abieti-Fagetum sudeticum*) is growing with shrubs as *Lonicera nigra* and *Sambucus racemosa* and herbs as *Dentaria bulbifera*, *D. enneaphyllos*, *Polygonatum verticillatum*, *Paris quadrifolia*, *Asarum europaeum*, *Sanicula europaea* etc.

At low elevations, the pine-oak wood (*Vaccinio-vitis-idaeeae- Quercetum*) is characteristic, accompanied by *Populus tremula*, *Sorbus aucuparia*, *Melampyrum pratense*, *Genista germanica* and even *Erica carnea*, which demonstrated the natural occurrence of the pine in these habitats.

On calcium-rich habitats the pine is the dominating tree. Together with birches (*Betula pendula*) and the dwarf shrub *Chamaebuxus alpestris* it forms the Chamaebuxo-Pinetum. Extremely poor stands on siliceous plains are covered by a fragmentary *Piceetum hercynicum* with *Trientalis europaea*, the heraldic plant of the Fichtelgebirge. In peat bogs the *Vaccinio-Mugetum* is developed with mountain pine (*Pinus mugo* or *Pinus rotundata*), *Betula pubescens*, *Vaccinium uliginosum* and several species of *Sphagnum*. Along rivers a fragmentary expression of the *Piceo-Alnetum* is found with alders (*Alnus glutinosa*), *Prunus padus*, *Rubus caesius* and *Humulus lupulus*.

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KRONBERGER, K. (1954): Die Naturschutzgebiete im Regierungsbezirk Oberfranken. - Ber. Naturw. Ges. Bayreuth VIII:26-54.

SCHUBERTH, H. (1935): Botanischer (geologischer) Führer durch das Fichtelgebirge. - Wunsiedel

VOLLRATH, H. (1957): Die Pflanzenwelt des Fichtelgebirges und benachbarter Landschaften in geobotanischer Schau. - Ber. Naturw. Ges. Bayreuth IX:5-250.

2. Bryological exploration of the area.

The first bryologist in the Fichtelgebirge and one of the earliest bryologists in Europe was Heinrich Christian Funck (1771-1839). Funck had studied in Erlangen and Jena and had taken over the pharmacy of his father in Gefrees. In a first compilation of the flora of Bayreuth, Funck (1802) listed 44 mosses and 3 hepatics. By intensive studies, he raised the number of bryophytes up to 300 in the year 1838. From 1800 to 1838 he edited the series "Cryptogamische Gewächse des Fichtelgebirg's" (later "besonders des Fichtelgebirg's"), in total 42 booklets with 20, later 25 glumed specimens of pteridophytes, bryophytes, fungi and algae with short diagnosis and remarks on the locality. Amongst the 245 specimens of mosses and 45 of hepatics there are numerous types, first records or rarities as "Tetraphis" ovata, "Tetraphis" repanda, *Encalypta pilifera* etc.

In 1820 he published "Deutschlands Moose", a pocket-book with glued bryophytes for the use in the field, a transportable herbarium with reference specimens. Most of the specimens (269) were collected in the Fichtelgebirge.

By these both publications the Fichtelgebirge was soon well known as rich area for bryophytes.

Two botanists were taught by Funck: Christian Friedrich Hornschuch (1793-1850) and Johann Friedrich Laurer (1798-1873), both later professors at the university of Greifswald. Hornschuch published since 1823 the "Bryologia germanica" together with the copper-plate engraver Jakob Sturm (1771-1848) from Nürnberg and Christian Gottfried Daniel Nees von Esenbeck (1776-1858). Funck contributed material and also diagnoses for this first comprehensive work on the bryoflora of Germany. He is also mentioned by Nees von Esenbeck in the prologue to the "Naturgeschichte der Europäischen Laubmoose" (1834-38) as one of the most famous collector and investigator.

One generation later, Ludwig Molendo (1833-1902), who had deserved well of the bryological studies on the Alps during his study in München, continued these studies on the Fichtelgebirge together with his brother-in-law, Alexander Walter (1813-1890). They published in 1868 the fundamental description of the bryoflora entitled "Die Laubmoose

Oberfrankens". The authors list, supported by Ferdinand Arnold (1828-1901), P.G. Lorentz and Karl Friedrich Schimper (1803-1867), 384 species mainly (i.e. 300 species) from the Fichtelgebirge and the surroundings of Bayreuth. This work (undertitled "Beiträge zur Pflanzengeographie und Systematik und zur Theorie des Ursprungs der Arten") is remarkable because of its geobotanical aspects and the application of Darwin's theories on the bryology.

In the begin of the 20th. century, publications on the Fichtelgebirge are less frequent and less important due to the fact that no bryologist lived in this region. MÖNKEMEYER (1903) and PAUL (1912) published some floristic contributions, and SCHWAB (1908) a study on the sphagnum-flora, which was not studied in detail by Funck or Molendo. All these floristic studies were comprises in the Bavarian bryofloras by FAMILLER (1911, 1913, 1917).

After a break of 30 years, WALTHER (1940), GAUCKLER (1940) and KOPPE (1955) continued the floristical studies. Ecophysiological studies on hepatics of the surroundings of Bayreuth were published by H FLER (1954).

In the recent decades, several students of Konrad Gauckler and Adalbert Hohenester from the university of Erlangen chose cryptogams as subjects for phytosociological studies also from this region as v.d.DUNK (1972) and HERTEL (1974).

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FAMILLER, I. (1911, 1913): Die Laubmoose Bayerns. Denkschr. Kgl. bayer. bot. Ges. Regensburg 11 (N.F.5):1-233; 12 (N.F.6):1- 174.

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GAUCKLER, K. (1940): Beiträge zur Kenntnis der Laubmoose und Lebermoose Frankens und der Bayerischen Ostmark. - Ber. Bayr. Bot. Ges. 24.

HERTEL, E. (1974): Epilithische Moose und Moosgesellschaften im nordöstlichen Bayern. - Beih. Ber. Naturw. Ges. Bayreuth 1:1-489.

----- (1978) Felsmoose im Bereich von Burgruinen. - Ber. Naturw. Ges. Bayreuth XVI:249-255.

H FLER, K. (1954): Über einige Lebermoose des Bayreuther Raumes und ihre plasmatischen Trockengrenzen. Ber. Naturwiss. Ges. Bayreuth VIII:67-78.

----- & K. KRONENBERG (1942): Die Moosvegetation einiger Höhlen im Bayreuther Stubensandstein. - Hedwigia 81.

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MÖNKEMEYER, W. (1903): Beiträge zur Moosflora des Fichtelgebirges. - Hedwigia 42, Beibl.:67-72.

MOLENDO, L. (1875): Bayerns Laubmoose. Ber. Naturw. Ver. Passau X.
 PAUL, H. (1912): Zur Pflanzenwelt des Fichtelgebirges und des angrenzenden oberpfälzischen Keupers. - Mitt. Bayer. Bot. Ges. 2:402-410.
 SCHWAB, A. (1908): Torfmoosflora des Fichtelgebirges. - Denkschr. Kgl. Bot. Ges. Regensburg 10 (N.F.4):75-92.
 WALTHER, A. & L. MOLENDO (1868): Die Laubmoose Oberfrankens. Leipzig.
 WALTHER, K. (1940): Zur Lebermoosflora des Frankenwaldes. - Mitt. Thür. Bot. Ver. 46:51-61.

3. The bryoflora

The distribution patterns of the bryophytes in NE-Bavaria have been studied by DUNK (1972) and HERTEL (1974) for the epipetric species. HERTEL estimated 57% circumpolar, 10% cosmopolitan species, 6% eurasiatic, 3% boreal, 12% (sub)atlantic, 5% (sub)-mediterranean and 1% continental species. A couple of species can be regarded as relicts from glaciation periods like the alpine and subalpine species *Kiaeria blyttii*, *K. starkei*, *Dicranoweisia crispula*, *Grimmia doniana*, *Racomitrium microcarpum*, *Cephalozia ambigua* and *Gymnomitrium concinatum* on rocks and boulders or *Paludella squarrosa*, *Splachnum ampullaceum* and *S. sphaericum* in bogs, which, however, have been found no more in this century.

For the Fichtelgebirge consists mainly from granite, the bryoflora is usually acidophytic. Basiphytic species are confined to walls of old buildings and ruins, where species as *Amblystegiella subtilis*, *Anomodon longifolius*, *A. viticulosus*, *Bryoerythrophyllum rubellum*, *Bryum elegans*, *Homalothecium lutescens*, *Didymodon rigidulus*, *Distichium capillaceum*, *Encalypta streptocarpa*, *Homomallium incurvatum*, *Leskeella nervosa*, *Mnium stellare*, *Schistidium anodon*, *Taxiphyllum depressum*, *Tortella tortuosa*, *Porella platyphylla*, *Metzgeria pubescens*, *Scapania aequiloba* and others are found.

Since 1945, 220 species of mosses and 80 species of hepatics have been found in this area. If 10% of species are added, which may be overlooked, a decrease of 30% of species can be stated compared with the records published by Familler at the begin of this century. This decrease is due to many well known factors as new methods in forestry, air and water pollution, fertilizing in agriculture and draining of bogs and fens, but also due to some local factors. This concerns the working of basic rocks and the intensive collections of bryologists. MOLENDO (1868), for example, collected *Plagiobryum zierii* "an feuchten Diabasfelsen...bei Berneck...wo ihm die Sprengung der Felsen den Untergang droht" (p.142) (on wet diabas rocks, where it is endangered by blasting the rocks), and in fact, it had no more been collected at this locality. Another factor are the intensive collections of bryologists, especially Funck, considering that his "Kryptogamische Gewächse" were distributed in 300 copies and contained even rare species as *Ptychomitrium polyphyllum*, from which MOLENDO (1868) noted that rich material had been distributed by Funck from a certain locality, in which this species could no more been recovered. Thus of the 500 species recorded altogether for the Fichtelgebirge, 150 species are extinct today and another 150 species are still known only from one or two localities and highly endangered.

4. Description of the collecting sites

4.1 Fichtelnaabtal bei Neusorg, 505 m elev.

Bryophytes in and along the stream. Submerged *Fontinalis antipyretica*, *F. squamosa*, *Rhynchostegium riparioides*, *Chiloscyphus polyanthus* var. *rivularis*, *Scapania undulata*. On rocks, periodically inundated *Brachythecium plumosum*, *B. rivulare*, *Dichodontium pellucidum*, *Hypogrohypnum ochraceum*, *Racomitrium aciculare*, *Schistidium alpicola*, *Marsupella emarginata*, *Solenostoma sphaerocarpum*.

THE BLACK FOREST

by Georg Philippi

1. Physical Geography

The Black Forest (Schwarzwald) is the highest and largest mountain massif in Germany except for the Alps. The N-S extension is about 200 km from Karlsruhe in the North to the upper Rhine valley in the south. The highest elevation is the Feldberg (1493m). In the west the Black Forest is confined by the steep slope to the Rhine valley (150-250 m elev.), in the east there is no sharp geomorphological delimitation. The geological substrate consists of granites and gneiss, which is overlaid by mesozoic red sandstone in the north, and thus provides generally acidic habitats (pH about 4). Calcareous habitats occur only locally in small fissures filled with feldspar. The precipitation increases from 800 - 1000 mm at lower altitudes to 2000 mm in the summits. The main annual temperatures decreases from 9,5°C in the Rhine valley to 2,9°C at the Feldberg.

2. Vegetation

The forest vegetation on the western slope consists mainly of beech (*Fagus sylvatica*) and fir (*Abies alba*). The beech forms the forest line (similar to the Vosges mountains in France at the opposite side of the Rhine valley), which is situated at about 1500 m. Spruces (*Picea abies*) occur only above 700-800m, but originally hardly forming own forest types. The forest on the eastern slope consist of *Picea abies*, *Abies alba* and *Pinus sylvestris*. The floristic composition has much been changed by human influence during the past 1000 years: before 1900 the growth of *Abies alba* has been favorized, after 1900 *Picea abies*. In lower altitudes *Pseudotsuga menziesii* has been cultivated in large extension. In contrast, *Fagus sylvatica* and also *Quercus petraea* have been repressed. Since 1980 the "Waldsterben" can be observed in many places, which concerns mostly *Picea abies*.

There are some bryologically interesting habitats, which were never covered by forests as bogs and fens, rocky slopes ("Blockhalden") and the summit region of the Feldberg. Although the natural subalpine forest has been destroyed since 1000 years, there have ever been open habitats as snow beds and windblown ridges.

3. Bryological exploration

The Black Forest is one of the bryologically best known regions in Central Europe. The exploration started in the first half of the last century with C.C. Gmelin and A. Braun. later

with W. Baur, B. Jack and A. Hegelmaier. After 1900 Th. Herzog (1904-06, 1943) and K. Müller (1901, 1941), who lived in Freiburg, gave a first comprehensive overlook over the bryoflora of the Black Forest. In the recent decades, Philippi (1956, 1972, 1972a) gave floristic contributions and especially made bryosociological studies. A compilation of the bryoflora of SW-Germany has been given by Düll (1969-72), which is, however not completed. The bryogeography of this area has been treated by Düll (1969).

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DIERSSEN, B. & K. (1984): Vegetation und Flora der Schwarzwaldmoore. - Beih. Veröff. Landesanst. Naturschutz und Landschaftspflege Bad. Württemberg 39. Karlsruhe.

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PHILIPPI, G. (1956): Einige Moosgesellschaften des Südschwarzwaldes und der angrenzenden Rheinebene. - *Beitr. naturk. Forsch. Südwestdeutschl.* 15(2):91-124.

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----- (1972a): Die Moosvegetation der Wälder in der Rheinauezwischen BaselundMannheim. - *Beitr. naturk. Forschung Südwestdeutschland* 31:5-64.

4. The bryophyte vegetation

4.1 Bryophytes in forests

In forests dominated by beech, the bryophyte vegetation is poorly developed and consists mostly of *Atrichum undulatum* and *Polytrichum formosum*. In spruce and fir forests the bryophyte vegetation is richer and characterized by species as *Pleurozium schreberi*, *Rhytidiadelphus loreus*, *Plagiothecium undulatum* and *Bazzania trilobata*. In higher elevations above 1000 m, species as *Barbilophozia floerkei* and *B. lycopodioides* show the montane character. Along slopes of forest paths the bryophyte vegetation is especially rich and consists of *Dicranella heteromalla*, *Isopterygium elegans*, *Calypogeia arguta* and *C. fissa* (below 600m) and *C. trichomanis* (above 1000 m). In open, sunny places *Nardia scalaris*, *Diplophyllum obtusifolium*, *Ditrichum heteromallum*, *Pogonatum aloides* and *P. urnigerum* occur. The pH of these substrates is between 4.2 and 4.4.

4.2 Epiphytes

The epiphyte vegetation is relatively poor in species on beech, consisting of *Hypnum cupressiforme*, *Isothecium myosuroides* and *I. alopecuroides*. It is richer in host trees with

basic bark (*Acer pseudoplatanus*, *Ulmus scabra*, *Fraxinus excelsior*), where *Neckera complanata*, *N. crispa*, *Antitrichia curtipendula* and more sparsely *Zygodon viridissimus* are found. *Orthotrichum ssp.*, *Ulota ssp.* and *Leucodon sciuroides* are confined to isolated trees. More rarely species such as *Microlejeunea ulicina* (below 800m), *Neckera pumila* (especially on beech), *Frullania tamarisci* (especially on oak) and *Pterigynandrum filiforme* (at higher elevations) are found. In the subalpine belt above 1200 m, species as *Brachythecium reflexum*, *Lescurea mutabilis*, rarely *Homalothecium geheebii* and *Pseudoleskea incurvata* are characteristic. In calcareous districts, *Neckera crispa* and *N. complanata* are more frequent and additionally *Anomodon viticulosus*, *A. attenuatus*, *A. longifolius* and *Metzgeria pubescens* occur.

4.3 Bryophytes on rotten wood

Characteristic species are *Lophocolea heterophylla*, *Nowellia curvifolia* and *Riccardia palmata*, above 700m also *Scapania umbrosa* and *Calypogeia suecica*. The succession is followed on older, decayed wood with *Tetraphis pellucida*, *Dicranodontium denudatum* and *Lophozia ventricosa*.

4.4 Bryophytes on rocks and boulders.

Epipetric species are especially rich on granite and gneiss but poor in species on red sandstone. Common species are *Hedwigia ciliata*, *Racomitrium heterostichum*, *Andreaea rupestris*, *Cynodontium polycarpum*, *Paraleucobryum longifolium* and *Isothecium myosuroides*, in "Blockhalden" *Racomitrium lanuginosum* and *Sphenolobus minutus*. *Andreaea rothii*, *Grimmia funalis* or *Scapania compacta* are found only locally in larger rock massifs. *Dicranum fulvum* is confined to lower altitudes, *Gymnomitrium concinatum*, *Lophozia sudetica*, *Grimmia patens* and *Diplophyllum taxifolium* to higher elevations. Characteristic for shaded habitats are *Heterocladium heteropterum*, *Rhabdoweisia crenulata* and *R. crispata*.

Neuro- and basiphilous species are confined to seeping rock fissures, especially in gneiss, rarely in granite: *Amphidium mougeotii*, *Blindia acuta*, *Tortella tortuosa*, *Ctenidium molluscum* and rarely *Gymnostomum aeruginosum* and *Frullania jackii*.

4.5 Bryophyte vegetation along creeks

Beside common species as *Scapania undulata*, *Racomitrium aciculare* and *Brachythecium rivulare*, some species are rare as *Hyocomium armoricum* at the eastern border of its range or only locally frequent as *Fontinalis squamosa* and *Hygrohypnum ochraceum* in the northern part of the Black Forest or *Jungermannia exsertifolia* only in the Feldberg-area.

4.6 Bryophytes in springs

Widespread are *Philonotis fontana* and *Dicranella palustris*, especially in Gneiss or granite areas. *Philonotis fontana* is replaced above 1000m by *P. seriata*. Species of the summit regions are of special interest, as *Jungermannia obovata*, *Marsupella sphacelata*, *Scapania paludicola*, rarely also *S. subalpina*, *S. uliginosa* and *S. paludosa*. The type locality of the latter species is situated on the Feldberg.

4.7 Bryophyte vegetation along the Rhine

Between Rastatt and Karlsruhe, the Rhine is only moderately polluted in this part and thus characterized by a rich bryophyte flora on boulders as by *Cinclidotus nigricans*, *C. fontinaloides*, *Leptodictyum riparium*, *Hygroamblystegium fluviatile*, *Octodiceras julianum*

(on always submerged habitats) and *Fissidens crassipes*, scattered *Cinclidotus danubicus* and very rarely by *Hyophila involuta*, which has here its northernmost locality in Europe. In flooded forests at the base of *Salix alba*, *Leskea polycarpa* and *Tortula latifolia* form a typical bryophyte community. Here is rarely also found *Dialytrichia mucronata*.

South of Rastatt the aquatic bryophyte vegetation has been damaged by the canalisation of the river (with stagnant water and a constant water level), in other areas also by water-pollution. By this way *Pachyfissidens grandifrons* (last records in Central Europe) and *Fissidens rufulus* have become extremely rare. Even common species as *Fontinalis antipyretica* have got rare.

4.8 Bryophyte Vegetation of the Wutachschlucht

The Wutachschlucht is situated east of the Black Forest but no part of it. The upper part of this deep valley consists of granite and quartzporphyre, the median and lower parts consists of sedimentic layers of shell-lime, Keuper, Lias and Dogger. The epiphytic vegetation is much developed due to the moisture and the basic soil and rocks. On open limestone rocks *Ctenidium molluscum*, *Tortella tortuosa* and *Plagiopus oederi* occur, on moist and shaded habitats *Pedinophyllum interruptum*, *Cololejeunea calcarea*, *Orthothecium intricatum* and *Gymnostomum calcareum*. For northern exposed rocks *Neckera crispa* is typical, for southern exposed rocks *Anomodon attenuatus*, *A. longifolius*, *Neckera complanata* and *Apometzgeria pubescens*. Dripping rocks are covered by *Cratoneurum commutatum* and rarely also by *Philonotis calcarea*, *Eucladium verticillatum* (S-exposed) and *Gymnostomum recurvirostre* (N-exposed), on marl *Lophozia badensis*. The upper part of the valley shows an interesting change of acidophytic and calciphytic vegetation.

5. Description of the collection sites.

5.1 Northern Black Forest near Schönmünzsch

Topographical map 7316, 7315 (7416), ca. 490 m elev.

Walk through the Schönmünzschachtal from Schönmünzsch (490 m elev.) to the Schurmsee (795 m elev.). Distance 4 km (one way). The valley is formed by granite topped by red sandstone. Remarkable hepatics: *Nardia scalaris*, *N. compressa*, *Jungermannia exsertifolia*, *J. gracillima*, *Marsupella emarginata*, *Diplophyllum obtusifolium*, *Scapania umbrosa*, *Kurzia sylvatica*.

Remarkable mosses: *Ditrichum heteromallum*, *Fontinalis squamosa*, *Antitrichia curtipendula*, *Hyocomium armoricum*, *Hygrohypnum ochraceum*, *Oligotrichum incurvum*, *Sphagnum riparium*.

The bog around the Schurmsee is nature preserve and access is not allowed.

5.2 Rhine near Plittersdorf W of Rastatt

topographical map 7114, 110 m elev.

On rocks along the Rhine *Cinclidotus nigricans*, *Leptodictyum riparium*, *Fontinalis antipyretica*, *Fissidens crassipes*, rarely *Cinclidotus fontinaloides*, *C. danubicus* and perhaps *Octodiceras julianum*. At the bases of *Salix alba*: *Leskea polycarpa* and *Tortula latifolia*.

5.3 Feldberg

Topographical map 8114, elevation 1275 - 1448 m.

Walk from Feldbergerhof (1275 m) along the "Felsenweg" on the E- side of the Seebuck and back across the Seebuck (1448m). Distance 7 km. The whole area is nature preserve, please collect no phanerogams and bryophytes only in moderate quantities.

Hepatics: *Nardia scalaris*, *Barbilophozia floerkei*, *Anastrepta orcadensis*, *Lophozia sudetica*, *L. wenzelii*, *Gymnomitrium concinatum*, *Jungermannia exsertifolia*, *Marsupella emarginata*, *M. funckii*, *Scapania paludosa* (locus classicus).

Mosses: *Dicranella palustris*, *Blindia acuta*, *Amphidium mougeotii*, *Philonotis seriata*, *Racomitrium fasciculare*, *Grimmia patens*, *Brachythecium reflexum*, *Lescurea mutabilis*, *Pseudoleskea incurvata*.

5.4 Lotenbachklamm, Wutachschlucht

Topographical maps 8115, 8116. 640 - 725 m alt.

Walk along the Lotenbachklamm (725 m) to the Schattenmühle (640m). Granitporphyr with an acidophilous vegetation in the fissures and crevices. Walk along the Wutach (ca. 10 km distance) through a deep limestone valley, and up to Bachheim (736 m). This walk may be in some parts difficult, especially after rainfalls. Good boots required. - Nature preserve, please do not collect phanerogams and bryophytes only moderately.

Characteristic species to be found here are *Apometzgeria pubescens*, *Cololejeunea calcarea*, *Pedinophyllum interruptum*, *Jungermannia tristis*, *Nowellia curvifolia*, *Riccardia palmata*, *Leiocolea badensis*, *Plagiopus oederi*, *Anomodon attenuatus*, *A. longifolius*, *A. viticulosus*, *Neckera crispa*, *Cratoneuron commutatum*, *Eucladium verticillatum*, *Gymnostomum recurvirostre*, *Orthothecium intricatum*.

THE ALPS OF THE ALLGÄU by Renate Lübenau-Nestle

1. Physical Geography

1.1 Delimitation

Allgäu is a name for the western part of the German Alps and its foothills. It extends from the town of Memmingen in the north to the border with Austria in the south and from the lake Bodensee in the west to the river Lech in the east, which has its sources in the Alps and flows into the Danube. Politically the main part of the Allgäu belongs to Bavaria, a smaller part in the west to Baden-Württemberg. The original population, however, is not Bavarian but belongs to the Alemans and Swabes.

1.2. Climate

According to the situation at the northern margin of the Alps, the climate is relatively wet and cool. With increasing elevation from N to S, the precipitation is increasing and the temperatures decreasing:

main annual temperature in the foothills	6,5°C
in the pre-Alps	3,5°C
in the high-Alps	0,5°C
main annual precipitation in the foothills	1100 mm

in the Oberstdorf basin 1700 mm
maximum in highest elevations up to 2500 mm

The season with highest precipitation (mostly as thunderstorms) is the summer. Snow is in northern expositions from November until May.

1.3. Geology

The Allgäu consists (from S to N) of three different geological regions, which are all result of the alpine folding (fig. 1,2): the calcareous Alps, the Flysch region and the Molasse region.

The calcareous Alps form a chain of rugged, steep summits 2300 - 2600 m high, which consist from solid triassic limestone and dolomites. They overlap softer, younger jurassic layers. These jurassic coral chalk and marls are weathered and provide nutrients for a rich vegetation. They also form, however, deep ravines in steep slopes. One harder jurassic layer is formed by pebble stone and allows the occurrence of acidiphytic plants, which can usually be found only in the central Alps.

Flysch is a mixture of limestone, flinty chalk, schistous marls and sandstone rich in mica. It is also easily weathered and provides good soil for pastures. It forms deep ravines (so called tobel) covered with canyon forests. Loamy layers prevent seepage of water and cause in combination with the high precipitation bogs and fens. The Flysch region is interrupted in the western part by the cretaceous formation Helvet, which forms rugged, karsted mountains and steep northern slopes by northwards slided, alpine folded layers. The river Breitach crosses these Helvet layers and has formed a 80 m deep canyon (so called Klamm) with nearly vertical walls, which will be visited during the fieldtrip because of its interesting bryophyte vegetation.

North of the Flysch region there is the Molasse region, tertiary deposits consisting of sand and stones (baked together like concrete), forming low rounded mountains.

The whole areas has been glaciated during glaciation periods, which has formed kars in the Alps, has rounded the valleys to U- shape and has produces moraines in the pre-Alps. Most lakes of the pre-Alps have been originated during this time by glaciers.

1.4 Vegetation

The Flysch and Molasse region is predominantly used for agriculture. Wet areas as fens and transition mires have been mowed once a year in autumn. The hay has been used as litter for the barns. This regular crop has caused interesting plant communities with *Primula farinosa*, *Gentiana clusii*, *Trichophorum caespitosum*, rarely also *Trollius europaeus*, *Orchis latifolia*, *Tofieldia calyculata*, *Parnassia palustris* and others. Fens and mires are also present around lakes, were the lakes have been silted up. They show the characteristic suczessions and sometimes even transitions to raised bogs (see description of Attle-See and Seeger-See in part 3).

Characteristic for the Flysch and Molasse region are canyon forests with ash (*Fraxinus exelsior*), maple (*Acer pseudoplatanus*), spruce (*Picea abies*) and fir (*Abies alba*), rarely also elm with a herb layer of *Aruncus dioicus*, *Actaea spicata*, *Veronica urticifolia*, *Bellidiastrum michellii*, *Viola biflora* and others. The vegetation along rivers is formed by alder (*Alnus incana*) with *Petasites officinalis*, *Anemone nemorosa*, *Primula elatior* and others.

The slopes of the Alps have been originally covered with spruce forests. At lower elevations, firs were intermingled, at higher elevations beech (*Fagus sylvatica*) and maple. These forest are very mossy with acidophytic higher plants as *Blechnum spicant* (Pterid.), species of *Luzula* (Gramin.), *Moneses uniflora* (Eric.), *Calluna*, *Lycopodium* ssp.

The subalpine belt is formed by scrubs (*Pinus mugho*, *Rhododendron hirsutum* or *R. ferrugineum*, *Sorbus chamaemespilus*, in wet places *Alnus viridis*) and species like *Daphne striata*, *Erica carnea*, *Pulsatilla alpina* ssp. *sulphurea*, *Lloydia serotina*, *Vaccinium* ssp., *Arnica montana* and *Lycopodium* ssp. This vegetation has frequently changed to alpine pastures with *Phleum alpinum*, *Ligusticum mutellinum*, *Crepis aurea*, *Trifolium badium*, *Leontodon hispidus* and around huts nitrophile plant associations with *Rumex alpinus* and *Aconitum napellus*.

The alpine vegetation consists of plants in rock fissures as *Androsace helvetica*, *Saxifraga aizoon*, *Primula auricula*, *Kernera saxatilis*, *Drabe aizoides* etc.) and plants in rock debris as *Pinus mugho*, *Dryas octopetala* and *Rhododendron hirsutum*, and *Geum reptans*, *Sesleria coerulea* or *Oxyria digyna* on less calcareous substrate.

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2. Bryological exploration

The first comprehensive studies on the bryoflora of the Allgäu have been performed by Sendtner, Molendo and Holler in the second part of the last century. This is remarkable in so far as this region was not easily accesible (the first railroad was constructed in 1888) and fieldtrips have been troublesome and difficult. Further investigations have been made by famous bryologists as LOESKE (1907), HOOCK (1926-1927), PAUL (1943), PAUL & POELT (1950), and KOPPE (1964,1967). A survey of the bryological exploration of the Allgäu is given by SCHRÖPEL (1967).

An impression of the rich bryophyte flora of this area is given by the report of the fieldtrip of the Bryological and Lichenological working group of Central Europe in 1973 (LÜBENAU 1973), were 393 species (103 hepatics, 24 sphagna, 266 mosses) have been listed, amongst them rarities as *Distichophyllum carinatum*.

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3. Touristical Information

The Allgäu was originally settled by illyric and later by celtic people. Already the greek historian Strabo mentioned the place Cambodunum (later Kempten), which was subdued by the Romans. In the 5th century, Alemans and Suebs settled here. From the midage, several ruins of castles are preserved. The churches in the villages are mostly in barock style (17.th century).

90% of the area used for agriculture are meadows and pastures, mainly for milk and cheese production.

Due to a favourite climate in a hollow at 800m elevation, Oberstdorf (the "uppermost village") is the center for tourism during the whole year, in summertimes for hiking, in wintertime for skiing.

3. Description of the collection spots

3.1 Breitachklamm

(Topographical map 8527/3, 8627/1, 800m elev.)

On the way from the sources in the Kleines Walsertal to the Oberstdorf-basin the small river Breitach has formed a deep ravine in a limestonebarrier (so called Schrattekalk), which is

1 km long but up to 80m deep and only 1,5m wide in some places. Here no vegetation is developed. In the anterior part of the ravine, a wet canyon forest is developed, due to the high humidity rich in mosses.

Species of the forest are *Polytrichum formosum*, *Plagiomnium undulatum*, *Rhytidiadelphus triquetrus*, *R. loreus*, *Thuidium tamariscinum*, *Hylocomium splendens*, *Sanionia uncinata*, *Ptilium crista-castrensis*, *Marchantia polymorpha*, *Conocephalum conicum*, *Plagiochila asplenioides* and others, in wet habitats *Plagiothecium undulatum*, *Sphagnum quinquefarium*, *Cratoneurum commutatum*, *Bryum pseudotriquetrum*, *Trichocolea tomentella* and *Chiloscyphus pallescens*.

On rocks and soil covered rocks: *Fissidens cristatus*, *Encalypta streptocarpa*, *Tortella tortuosa*, *Bartramia halleriana*, *Plagiopus oederi*, *Distichium capillaceum*, *Gymnostomum aeruginosum*, *Trichostomum mutabile*, *Ctenidium molluscum*, *Neckera crispa*, *Orthothecium rufescens*, *Campylium halleri*, *Lejeunea cavifolia*, *Cololejeunea calcarea*, *Blepharostoma trichophyllum* and (in smaller quantities) *Plagiobryum zierii* and *Seligeria trifaria*.

On trees: *Amblystegiella subtilis*, *Leucodon sciuroides*, *Isothecium alopecuroides*, *Ulota crispa*, *Orthotrichum pallens*, *Metzgeria conjugata*, *M. furcata* and *Radula complanata*.

3.2 Mires below Höllritze Alpe (Topographical map 8525, 8526/2, 1400 m elev.)

These mires in the Flysch region are caused by landslips of the loamy marl, which cause wet, swampy places along the slopes of the mountains as swampy forests, wet scrubs of *Pinus mugho* with an underlayer of species of *Vaccinium*, ponds with flowing and stagnant water (with *Carex limosa*, *Carex pauciflora*, *Scheuchzeria palustris*). A bryosociological characteristic has been given by v.d.DUNK (in LüBENAU 1973). The wet forests are characterized by *Mylia taylori*, *Dicranodontium denudatum*, *Kurzia pauciflora*, *Sphenobolus minutus*, *Calypogeia neesiana*, *Bazzania trilobata*, *Ptilium crista-castrensis*, *Sphagnum nemoreum*, *Hylocomium splendens*, *Anastrepta orcadensis*, *Bazzania tricrenata*, *Barbilophozia lycopodioides*, *B. floerkei*, *Plagiochila asplenioides*, *Dicranum scoparium*, *Rhytidiadelphus loreus*, *Hylocomium splendens*, *Riccardia palmata*, *Tetraphis pellucida* and *Lepidozia reptans*, rarely also *Hookeria lucens*. On rocks *Blindia acuta* and *Andreaea rupestris* are found, in swamps *Sphagnum papillosum*, *S. rufescens* and remarkably also *Splachnum ovatum*.

3.3 Strausbergmoor near Hindelang (Topographical map 8528/1, 1200 m elev.)

The Strausbergmoor is a raised bog surrounded by fens. It is situated between the calcareous Alps and the Flysch region in a depression formed by a glacier in an area with 5 °C main annual temperature and 1700 mm main annual precipitation.

The raised bog is covered with dwarf-pines (*Pinus mugho* ssp. *pumilio*) and spruces in dry parts and in wetter parts *Sphagnum magellanicum*, *S. nemoreum*, *S. fuscum* and *Polytrichum strictum* in tussocks and *Sphagnum cuspidatum*, *S. fallax* s.lat. and *Cladopodiella fluitans* in depressions.

In the northern transition zone the bryophyte vegetation is dominated by *Calliergon stramineum* and *Scorpidium scorpioides*, rarely also *Meesia triquetra* and *Cinclidium stygium* as glacial relicts. In the eastern transition zone *Drepanocladus fluitans*, *Calliergon giganteum*, *Scorpidium scorpioides*, *Gymnocolea inflata*, *Sphagnum subsecundum*, *Sphagnum inundatum*, *Sphagnum centrale* and *Campylium stellatum*.

In the southwestern part a locality of *Paludella squarrosa* is located in a fen, which is annually mowed.

3.4 Hinanger Wasserfall near Sonthofen (Topographical map 8527/2, 820-850 m elev.)

This waterfall is formed by a barrier of Molasse with large calcareous tuffs covered with *Eucladium verticillatum*. On open rocks *Seligeria trifaria*, *Conocephalum conicum*, *Neckera crispa*, *Fissidens cristatus*, *Orthothecium rufescens* and *Pohlia wahlenbergii* are found and also some de-alpine phanerogams as *Pinguicula alpina*, *Potentilla caulescens* and *Rhododendron hirsutum*. A short ravine is below the waterfall, in which remarkable species as *Brotherella lorentziana* and *Hookeria lucens* occur.

3.5 Attlesee and Spittalmoos near Nesselwang (Topographical map 8329/3, 880 m elev.)

This locality consists of a complex of various, eu- to oligotrophic bog communities with a central raised bog and marginal fens. It is known floristically for alpine relicts as *Gentiana asclepiadea*, *Veratrum album*, *Carex davalliana*, *Trichophorum alpinum*, *Bellidiastrum michelii* and *Gentiana clusii*. A phytosociological study has been published by BRAUN (1968). BRAUN described 18 plant communities, amongst them the Scorpidio-Utricularietum with *Scorpidium scorpioides* and *Calliergon trifarium*, the Sphagnetum cuspidato-obesi, the Splachnetum ampullacei, the Caricetum vesicariae with *Calliergon giganteum*, the Caricetum chordorrhizae with *Meesia triquetra*, *Bryum neodamense* and *Cinclidium stygium*, the Rhynchosporietum fuscae with *Sphagnum subsecundum*, *S. platyphyllum* and *Drepanocladus fluitans*, the Sphagnetum medii with *Sphagnum magellanicum*, *S. rubellum*, *Polytrichum strictum* and *Dicranum bergeri*, the Trichophoretum alpini with *Drepanocladus intermedius* and *Campylium stellatum* and others.

3.6 Calcareous fen near Seeg (Topographical map 8329/2, 820 m elev.)

West of Seeg are situated two lakes in a depression, which show calcareous fens at their shores. These fens are mowed annually and consist in part of a rare and interesting plant community, the Primulo-Schoenetum ferruginei, with rare phanerogams as *Primula farinosa* and *Gentiana clusii* (flower in spring) and *Tofieldia calyculata*, *Parnassia palustris*, species of *Drosera*, *Carex* and *Eriophorum* and Bryophytes as *Scorpidium*

scorpioides, *Campylium stellatum*, *Drepanocladus intermedius*, *Tomenthypnum nitens*, *Calliergonella cuspidata* and *Climacium dendroides*.

THE WETTERSTEINGEBIRGE (BAVARIAN ALPS)

by Reinhard Lotto

1. Physical Geography

1.1 Location

The Wettersteingebirge is part of the northern calcareous Alps. It is situated at the border between Austria and Germany and stretches from the German village Mittenwald in the east to the Austrian village Ehrwald in the west.

1.2 Geology

The northern part of the Alps consist of heavily folded mesozoic sediments, especially calcareous marine deposits of the Tethys ocean. The Wetterstein mountains are formed by 1 km wide strata of triassic rocks, rarely Jurassic and Cretaceous. Most part of the mountains are calcareous and determine the floristic character of this area. During Tertiary in Oligocene and Miocene, these sediments were folded and raised that coral reefs now form the peak of the Zugspitze in nearly 3000m elevation.

During glaciation periods the Wetterstein massif was glaciated by local and also central-alpine glaciers. The glaciers reached a height of max. 2600m.

In post glaciation time, huge landslides came down from the N-side of the Zugspitz massif, which fall upon a glacier snowfield and formed a wall, in which the Eibsee is situated today. During these milleniums, the rivers cut deep ravines into the limestone, as for instance the Höllentalklamm, which will be visited during the fieldtrip, which is up to 120 m deep.

1.3 Climate

The northern calcareous Alps have a relatively cool and humid, oceanic climate. Western and northwestern wind bring relatively high precipitation in all seasons to the northern Alps (in contrast to the dry inner alpine valleys). Because of the high elevations there are large climatic differences between the valleys and the mountain slopes and -tops and also between northern and southern expositions. Characteristic for the northern Alps is the "Föhn", a warm and dry wind blowing from southern Europe and falling down the northern slopes of the Alps. The bryophyte vegetation is favoured by high precipitation, frequent cloud and mist in elevations between 1200 und 1600m and a cool microclimate especially in northern expositions.

Main annual values for temperature and precipitation

	Temperature	Precipitation
Garmisch-Partenkirchen 700 m elev.	+ 6,3°C	1359 mm
Zugspitze 2962 m elev.	- 4,7°C	1946 mm

Monthly precipitation

in millimeter for A Garmisch-Partenkirchen, B Zugspitze

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
A	94	84	80	85	130	171	193	166	123	87	78	68
B	175	160	146	169	169	191	209	179	142	134	134	138

Main temperature

in °C for A Garmisch-Partenkirchen and B Zugspitze

A	-4,3	-2,9	1,9	6,4	10,9	14,2	16,0	15,2	12,4	6,6	1,7	-2,7
B	-11,6	-11,6	-9,5	-6,9	-2,5	0,5	2,5	2,4	0,6	-3,2	-7,0	-10,0

1.4 Vegetation

The higher vegetation consists of a fir (*Abies alba*)-beech (*Fagus sylvatica*) forest in elevations between 700 and 1300m and a spruce forest (*Picea abies*) from 1300 to 1600m. In southern slopes are pine forest (*Pinus silvestris*) with snow-heather (*Erica carnea*). The forest line is in about 1600m followed by a subalpine scrub of dwarf-pines (*Pinus mugo*), rarely also of green alder (*Alnus viridis*). Above, alpine vegetation is present dominated by *Carex firma*, *C. sempervirens* and *Sesleria coerulea* in alpine grassland and *Thlaspi rotundifolium* in rubble of calcareous rocks. Rarely snow beds with *Polytrichum norvegicum* are found.

2. Bryological exploration of the area

The bryological exploration of the bavarian Alps and also the Wettersteingebirge started with Otto Sendtner (1813-1859). Sendtner was professor for botany in Munich and one of the founder of the plant geography. He was able to interest his students also for bryophytes, who continued his work intensively, as P.G. Lorentz (1835-1881), L. Molendo (1833-1902), A. Holler (1835-1904), F. Arnold (1828-1901) and A. Progel (1829-1889).

Some mosses were named after these men as *Brotherella lorentziana* after Lorentz, *Molendoa* after Molendo and *Fissidens arnoldii* after Arnold. Holler and Progel were physicians, Holler was lawyer and Lorentz was professor of botany. Lorentz went to Cordoba in Argentina in 1870 and was one of the first bryological explorer of Argentina. His collections were studied by C. Müller and published in the "Prodromus Bryologiae Argentinae".

Later, at the begin of this century, J.Röll, F. Stolz (who perished on a mountain hike in Tyrolia), G. Schellenberg, G. Hegi, I. Familler and T. Herzog collected in this area. Hegi was the editor of the famous phanerogam flora of Central Europe and Ignaz Familler the author of the bavarian bryophyte-flora (1911,1917).

During this century, H. Paul (author of the Sphagnaceae in Engler-Prantl's "Natürliche Pflanzenfamilien" and in Pascher's fresh-water-flora of Central Europe) published contributions on this region. Further contributions were made by M. Schinnerl (1935), a teacher, J. Poelt (when he was lecturer in Munich), A. Schmidt, H. & R. Lotto and K. v.d. Dunk.

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3. Bryoflora and -vegetation.

The northern Alps are known for many rare species. *Barbula bicolor*, *B. enderesii* and *Tayloria rudolphiana* are endemic to this area. *Brotherella lorentziana* is confined only to the northern Alps and the Black Forest. The occurrence of many species is confined in Germany to the Alps as *Asterella lindenbergiana*, *Peltolepis quadrata*, *Sauteria alpina*, *Anthelia juratzkana*, *Barbilophozia quadriloba*, *Scapania apiculata*, *S. glaucocephala*, *Polytrichum norvegicum*, *Dicranum elongatum*, *Paraleucobryum enerve*, *Encalypta alpina*, *E. longicolla*, *Geheebia gigantea*, *Molendoa hornschuchiana*, *Tortula norvegica*, *Tayloria froelichiana*, *T. splachnoides*, *Plagiobryum demissum*, *Brachythecium glaciale*, *Ctenidium procerrimum*, *Hypnum ravaudii*, *H. revolutum*, *Orthothecium binervulum*, *O. chryseon* and others. Other species as *Anastrophyllum michauxii*, *Haplomitrium hookeri*, *Saccobasis polita*, *Trematodon longicollis*, *Catoscopium nigritum*, *Anomobryum filiforme*, *Rhodobryum ontariense*, *Zygodon dentatus*, *Isopterygium muellerianum* or *Buxbaumia indusiata* are very rare elsewhere. The Splachnaceae are represented here by several species such as *Splachnum ampullaceum*, *S. sphaericum*, *Tayloria froelichiana*, *T. serrata*, *T. rudolphiana* and *Tetraplodon mnioides*. Typical for the calcareous Alps are (amongst others) *Leiocolea ssp.*, *Jungermannia tristis*, *Scapania aequiloba*, *S. aspera*, *Cololejeunea calcarea*, *Seligeria donniana*, *S. trifaria*, *Encalypta ssp.*, *Barbula crocea*, *B. rigidula*, *B. spadicea*, *Hymenostylium recurvirostre*, *Meesia uliginosa*, *Plagiopus oederi*, *Timmia norvegica*, *Cyrtomnium hymenophylloides*, *Mnium marginatum*, *M. stellare*, *M. thomsonii*, *Pseudoleskea incurvata*, *Pseudoleskeella catenulata*, *Campylium chrysophyllum*, *Entodon schleicheri*, *Hypnum bambergeri*, and *Orthothecium ssp.*

3. Touristical Information

All villages in the surroundings of the Wettersteingebirge are touristical places for hiking, climbing and skiing. Numerous lifts facilitate an easy access to the mountains. The highest peak of the Wettersteingebirge is also the highest elevation in Germany (2962m). The peak is accessible by a cog railway (from Garmisch-Partenkirchen) or cabin lifts (from Eibsee and from Ehrwald in Austria).

Garmisch-Partenkirchen is known as the place for the winter olympiade in 1936 and has all facilities for wintersports. Until 1918 ores have been exploited near Garmisch, which were crushed in mills driven by the water of the Hammersbach, which is flowing through the Hölltalklamm.

Oberammergau north of Garmisch-Partenkirchen is worldwide known for its passion-performances, which are made since 1639.

In Linderhof there is a castle built 1869-1878 for the bavarian king Ludwig II in a rococo style.

Mittenwald is known for its violin-makers, and in Ettal is a famous monastery founded in 1330 and rebuilt in rococo style in the 18. century.

4. Description of the collecting sites

4.1. Alpsee near Burg Neuschwanstein (900m elev.)

The rocky slopes at the W-side of the Alpsee are covered with acidic spruce forest over calcareous substrate. Thus both acidophile and basiphile bryophytes are growing together.

Typical bryophytes on calcareous substrate are *Tortella tortuosa*, *Fissidens cristatus*, *Ctenidium molluscum*, *Homalothecium lutescens*, *Campylium stellatum*, *Cirriphyllum cirrhosum*, *Neckera crispa*, *Bartramia halleriana*, *Encalypta contorta*, *Orthothecium rufescens* and *Anomodon viticulosus*. On nutrient-rich forest floor: *Plagiochila asplenioides*, *Mnium affine*, *Polytrichum formosum*, *Mnium undulatum*, *Scleropodium purum*, *Thuidium tamariscinum*, *Bartramia pomiformis*, *Rhytidiadelphus triquetrus* and others. On acidic litter: *Leucobryum juniperoideum*, *Bazzania trilobata*, *B. tricrenata*, *Dicranodontium denudatum*, *Campylopus fragilis*, *Scapania nemorosa*, *Dicranum scoparium*, *Sphagnum quinquefarium*, *Barbilophozia hatcheri*, *Hylocomium splendens* and *Trichocolea tomentella*. On logs: *Myliia taylorii*, *Crossocalyx* and *Tetraphis pellucida*. As epiphytes occur *Frullania dilatata*, *F. tamarisci*, *Leucodon sciuroides*, *Pterigynandrum filiforme*, *Orthotrichum lyellii*, *Zygodon dentatus*, *Hypnum cupressiforme* and *Porella platyphylla*.

4.2. Schwefelfilz near Wieskirche

The Schwefelfilz is a raised bog covered with *Pinus silvestris* with typical ombrotrophic species such as *Sphagnum papillosum*, *Dicranum bergeri* and *Polytrichum strictum* on tussocks and *S. cuspidatum* in wet places. In marginal, mesotrophic sites *Sphagnum subsecundum* and *S. fallax* are found. Please pay attention to vipers.

4.3 Kreuzeck above Garmisch-Partenkirchen (Topographical map 8532, 760-1750m elev.)

On the way from the Kreuzeck to the H. Ilentalklamm, montane spruce forests and subalpine dwarf-pine scrubs will be passed. Species of basic substrates are: *Hypnum bambergeri*, *H. revolutum*, *Hylocomium pyrenaicum*, *Ctenidium molluscum*, *Philonotis calcarea*, *Campylium chrysophyllum*, *Campylophyllum halleri*, *Encalypta contorta*, *Barbula crocea*, *Orthothecium rufescens*, *Tortella tortuosa*, *T. inclinata*, *Tortula alpina*, *Meesia uliginosa*, *Scapania aequiloba*, *Schistidium trichodon*, *Plagiopus oederi*, *Plagiobryum zierii*, *Timmia norvegica*, *Mnium marginatum* and others, on humus and logs *Myliia taylorii*, *Bazzania tricrenata*, *Ptychodium plicatum*, *Sanionia uncinata*, *Dicranodontium denudatum*, *Barbilophozia lycopodioides*, *Lophozia incisa* etc.

4.4 Slopes along the southern shore of the Eibsee (Topographical map 8531/2, 980-990m elev.)

The Eibsee is situated north of the Zugspitz massif. Due to an enormous landslide, the slopes along the southern shore consists of large calcareous boulders, which are covered in dry sites by *Pinus silvestris*, *Erica carnea*, *Sorbus aria*, *S. aucuparia* and in mesic sites by beech-fir-forests with an understore of *Vaccinium myrtillus* and *Lycopodium*-species. Bryophytes typical for calcareous substrates are *Distichium capillaceum*, *Campylophyllum halleri*, *Ctenidium molluscum*, *Bryoerythrophyllum recurvirostre*, *Fissidens cristatus*, *Ditrichum flexicaule*, *Scapania aequiloba*, *Neckera crispa*, *Rhynchostegium murale*, *Orthothecium rufescens*, *O. intricatum*, *Anomodon attenuatus*, *A. viticulosus*, *Plagiochila porelloides*, *Plagiopus oederi*, *Pellia fabbroniana*, *Gymnostomum aeruginosum*, *Cololejeunea calcarea*, *Plagiobryum zierii*, *Cirriphyllum cirrhosum*, *Brachythecium glareosum*, *Pseudoleskeella catenulata*, *Eurhynchium angustirete*, *Preissia quadrata*,

Conocephalum conicum, *Homalothecium lutescens*, *Cratoneurum commutatum*, *Bryum pseudotriquetrum*, *Tortula ruralis* and others. On acidic forest floor and logs: *Mylia taylorii*, *Dicranum scoparium*, *D. undulatum*, *D. spurium*, *Mnium affine*, *M. undulatum*, *M. punctatum*, *Hylocomium splendens*, *H. umbratum*, *Rhytidiadelphus triquetrus*, *H. loreus*, *Bazzania trilobata*, *Polytrichum commune*, *Plagiothecium curvifolium*, *Rhytidiadelphus subpinnatus*, *Sphagnum quinquefarium*, *Ptilium crista-castrensis*, *Anastrepta orcadensis*, *Lophozia incisa*, *Nowellia curvifolia*, *Leucobryum juniperoideum*, *Mnium spinosum*, *Tayloria serrata*, *Cirriphyllum piliferum*, *Calliergonella cuspidata*, *Plagiothecium undulatum*, *Sanionia uncinata*, *Paraleucobryum longifolium*, , *Ptilium ciliare* etc. etc. As epiphytes occur: *Frullania tamarisci*, *F. dilatata*, *Ulota crispa*, *U. coarctata*, *Zygodon dentatus*, *Orthotrichum lyellii*, *O. stramineum*, *Lejeunea cavifolia*, *Neckera complanata*, *Isothecium myurum*, *Orthodicranum montanum*, *Dicranum viride*, *Leucodon sciuroides*, *Antitrichia curtipendula*, *Radula complanata*.