of the heath areas was cut and used as fertilizer for the fields (cf. Behre 1980). This resulted in a far-reaching destruction of the forest and a contemporary formation of heaths, which covered wide areas in the type region and had its maximum in modern times until the introduction of artificial fertilizers in the last century. The heath grounds were thus finally transformed into agricultural areas or afforested, mainly with introduced conifers such as *Pinus* and *Picea*.

TYPE REGION D-s, BERLIN (A. Brande)

The region D-s (Fig. 15.8) belongs to the Weichselian glaciated area of the North German lowlands and is a section of the older part of the young moraine landscape. The Warsaw–Berlin Urstromtal with the Spree River and the Havel lake–river system subdivide the region into four subregions, including a northern, southern and western ground moraine plateau. The region as a whole comprises the former West-Berlin, surrounded by the late GDR.

Altitude: 29–103 m, larger areas 32–60 m, excluding artificial hills made of rubble, etc.

Climate: Mean January –0.7°C, July 18°C, precipitation 580 mm yr^{-1}, 380 mm during vegetative period. Sub-continental within an oceanic-continental transition zone.

Geology: Weichselian fluvioglacial sand (Urstromtal); ice-marginal sand and gravel: marl, loam, and sand (ground moraine); Late Weichselian and Holocene sand, mud, and peat (14% of the region).

Topography: Flat Urstromtal terraces with sand dunes; gently undulating ground moraine plateaux; steep relief of dunes, kames, and end moraines; steep depressions in the lake–river system.

Population: 1.95 million (1988) on 480 km^2, large city area.

Vegetation: Urban and large city vegetation (spontaneous and planted); forests comprise 16% of the region, dominated by *Pinus sylvestris* and *Quercus* spp.; agriculture (arable, grass, and garden land) 7%; lakes, rivers, mires, ponds 7%. Different intensity of actual human influence on vegetation (Böcker & Sukopp 1987).

Soils: Anthopogenic rendzinas on rubble, hortisols, etc; in the outskirts podzolized brown earths (forests); para-brown earth (Lessive) (formerly arable areas); oligo- to eutrophic fens (mires); more or less calcareous gyttja and sapropel (lakes, ponds). Different intensity of actual human influence on soils (Grenzius 1985).

Land use: Large city. Transport (17%, rail-, highways, etc.), forestry, recreation. Anthropogenic effects of extreme lake eutrophication, drying out of mires by groundwater depression, infill or sediment removal in ponds, etc.

Reference site 9 (Tegeler See) and reference site 10 (Pechsee)

Tegeler See

Latitude 52°35′N, Longitude 13°13′E. Elevation 31 m. Age range 11400–0 BP. Lake. 13 local pollen-assemblage zones (paz). Pollen diagram (Fig. 15.9) Subatlantic–Alleröd (Brande 1980, 1988b, and in prep.).

Pechsee

Latitude 52°29′N, Longitude13°13′E. Elevation 31 m. Age range 12500–11400 BP. Lake stage of oligotrophic mire. Three local pollen-assemblage zones (paz). Pollen diagram (Fig. 15.9) Bölling/Older Dryas–Alleröd (Brande 1980, 1988b).

The 15 pollen-assemblage zones, derived from the reference sites as selected in the investigation area (Fig. 15.8), are of regional validity, excluding settlement areas (archaeological and historical sites). In Fig. 15.9 radiocarbon dates and calendar dates are given only for dating the transitions of the pollen-assemblage zones, obtained from peat at various sites in the region (Brande 1978/79, 1980, 1985, 1986a, Brande in Böcker *et al.* 1986, Böse & Brande 1986). The criteria for defining the pollen-assemblage zones (paz) are based on the pollen diagrams (Fig. 15.9) and the regional vegetational events (Fig. 15.10).

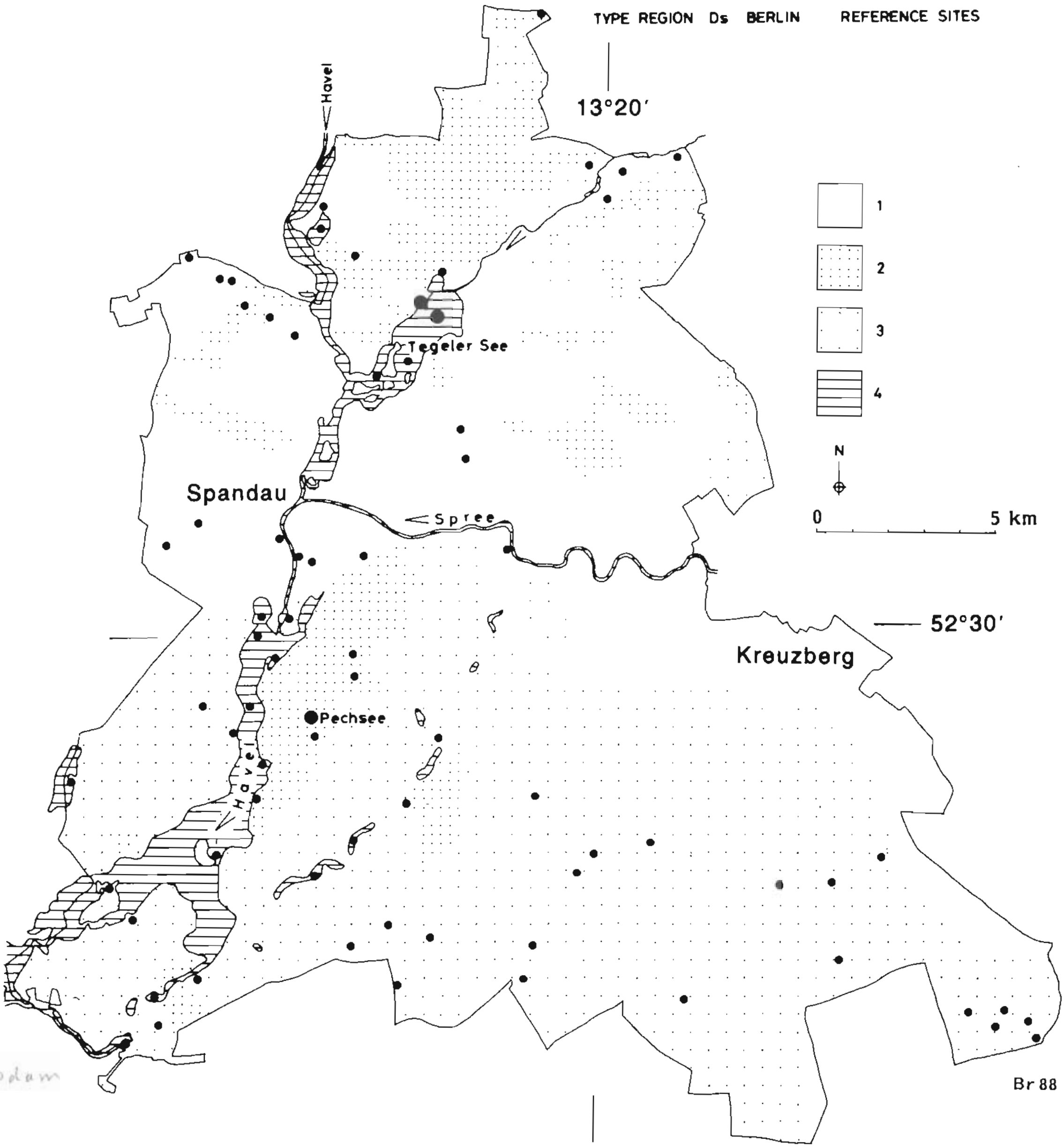


Fig. 15.8 Type region D-s, Berlin. Reference sites Pechsee and Tegeler See and location of other important palynological sites in the area of former Berlin (West), documented by Brande in Böcker *et al.* (1986), Brande (1988a), Brande & Hühn (1988), Brande *et al.* (1990), and unpublished. Landscape units: 1, Urstromtal sand terraces, wet to dry, 30–40 m elevation; 2, sand-dunes and ice-marginal sand and gravel, dry, 35–100 m elevation; 3, ground-moraine marl, loam, and sand, moist to dry, 35–60 m elevation; 4, recent lakes and rivers, 29–31 m elevation

1. 12500–11800 BP *Betula–Hippophaë*
2. 11800–11500 BP *Betula–Juniperus*
3. 11500–11000 BP *Pinus–Betula*
4. 11000–10300 BP *Pinus–Juniperus–Artemisia*
5. 10300–9000 BP *Pinus–Betula–Thelypteris palustris*
6. 9000–8700 BP *Pinus–Corylus–Ulmus*
7. 8700–8000 BP *Pinus –Corylus– Quercus*
8. 8000–7500 BP *Pinus–Corylus–Alnus*
9. 7500–6500 BP *Pinus–Alnus–Tilia*
10. 6500–5000 BP *Pinus–Fraxinus*
11. 5000–3700 BP *Pinus–Plantago lanceolata*–Cerealia
12. 3700–2900 BP *Pinus–Fagus–Corylus–Tilia*
13. 2900–2300 BP *Pinus–Fagus*
14. 2300–900 BP *Pinus–Fagus–Carpinus–Secale*
15. 900–0 BP *Pinus–Secale–Rumex*

The pollen diagram

The pollen-assemblage zones partly coincide with chronozones. Although *Pinus* pollen was dominant from the younger Alleröd before the Laacher See tephra deposition, most woodland successional stages can be defined as being similar to adjacent regions poorer in *Pinus*, e.g. the Atlantic/Subboreal *Ulmus* decline. Accordingly the Subboreal/Subatlantic transition is characterized by the *Corylus* and *Tilia* decline, whereas the repeated *Corylus* expansion during the Atlantic and Subboreal chronozones is very weak or even absent. *Fagus sylvatica* and *Carpinus betulus* are present, confirmed by macroremains in the older Subatlantic chronozone and, in the case of *Fagus*, by high local pollen frequencies.

Pollen-assemblage zone transition 14/15 reveals the last extensive clearance (German period) and is found also in sites on areas still forested. Moreover, it coincides in the Urstromtal subregion with peat-stratigraphic criteria due to an artificial water-level rise by mill barrages, and in the ground-moraine subregion it coincides with historical data for large-scale landnams and deforestation. The radiocarbon age of the 14/15 transition (900 BP) includes a dendrochronologically corrected archaeological/historical date of about AD 1230 (Brande 1985, 1986a). However, a similarly defined pollen-assemblage-zone transition can be found in restricted areas of the region a few centuries older (Slavic period, Brande *et al.* 1987).

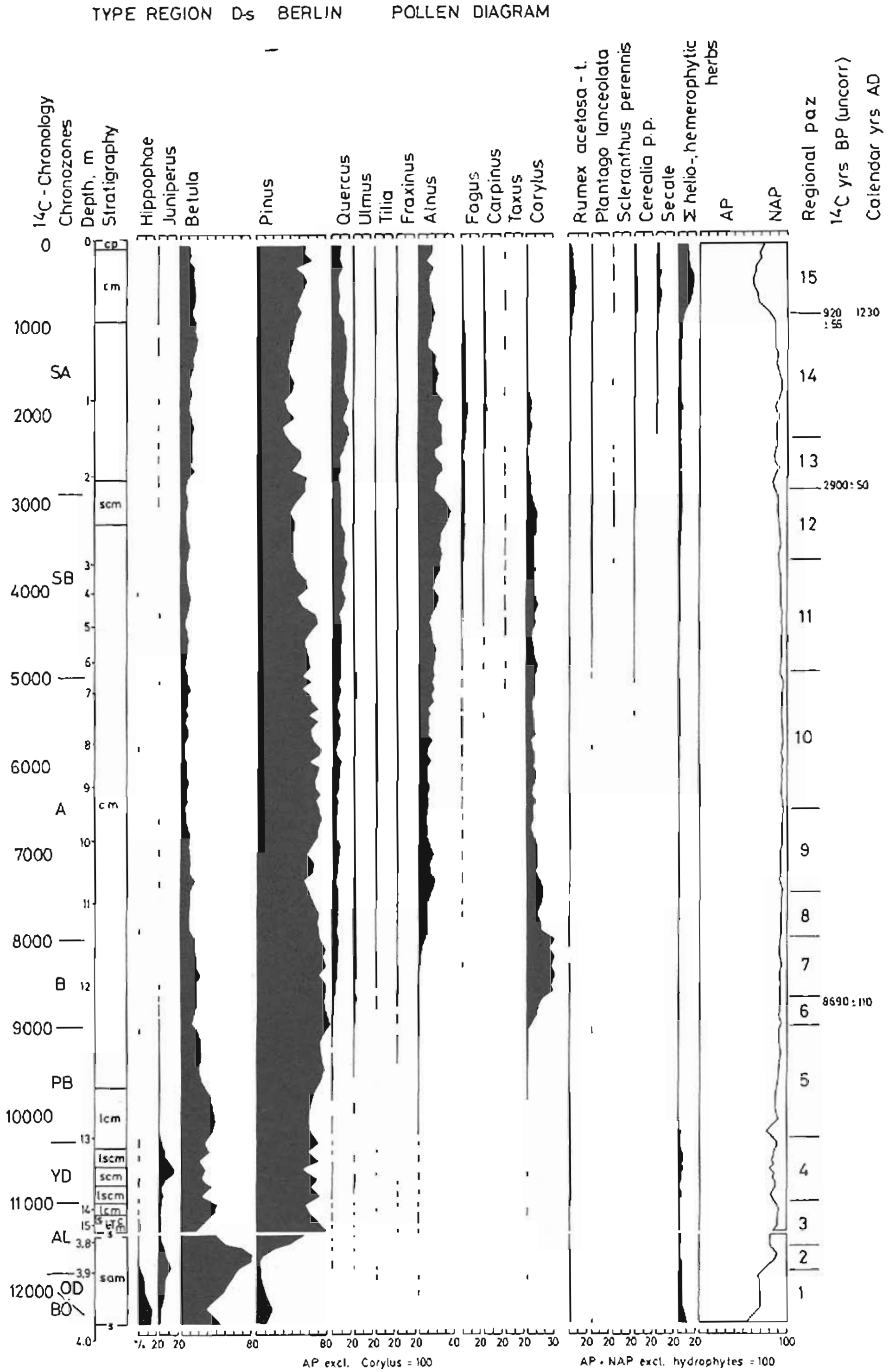
Palaeohydrological and palaeoecological events

The events shown in Fig. 15.10 are derived from many sites in the region (Fig. 15.8), including mires and ponds but excluding archaeological sites and locally confined events. Only a few events are reflected in the pollen diagram (Fig. 15.9). On the other hand, the reference site Tegeler See has been intensively studied by palaeolimnology, palynology, and ecological history (Brande 1980, 1988a,b, and in prep., Sukopp & Brande 1984/85, Böcker & Sukopp 1985, Bertzen 1987, Pachur & Röper 1987, Wolter 1992).

The water-level rise of the Havel–Spree lake–river system during the Atlantic chronozone is probably a distant effect of the Holocene North Sea transgression via the Elbe catchment area, which includes the region. The water level does not yet reach the level of flat mires, which during that period show severe reduction of growth or hiatus (Brande 1986b). This event in the non-ombrotrophic mire development accords with surrounding regions (Succow 1987).

At least since AD 1230 the lake level and corresponding groundwater table influenced the mire development in the sandy Urstromtal subregion, as documented by the Havel mill barrage, which caused increasing peat formation in hollows some distance from the lake–river system even in still forested areas. But already since the Subboreal chronozone peat formation increased, with some marginal paludification after the hiatus period. This is also true for the groundwater-independent kettle-holes

Fig. 15.9 Type region D-s Berlin. Reference site pollen diagram (percentage/time) Pechsee 3.8-3.95 m and Tegeler See 0–15.1 m, selected pollen types (from Brande 1980, 1988b, and in prep.). Analyst: A. Brande, G. Hinz



Stratigraphy: p sapropel, m mud, a algae, c calcareous, s sandy, l laminated, LT Laach tephra layer

Br 88

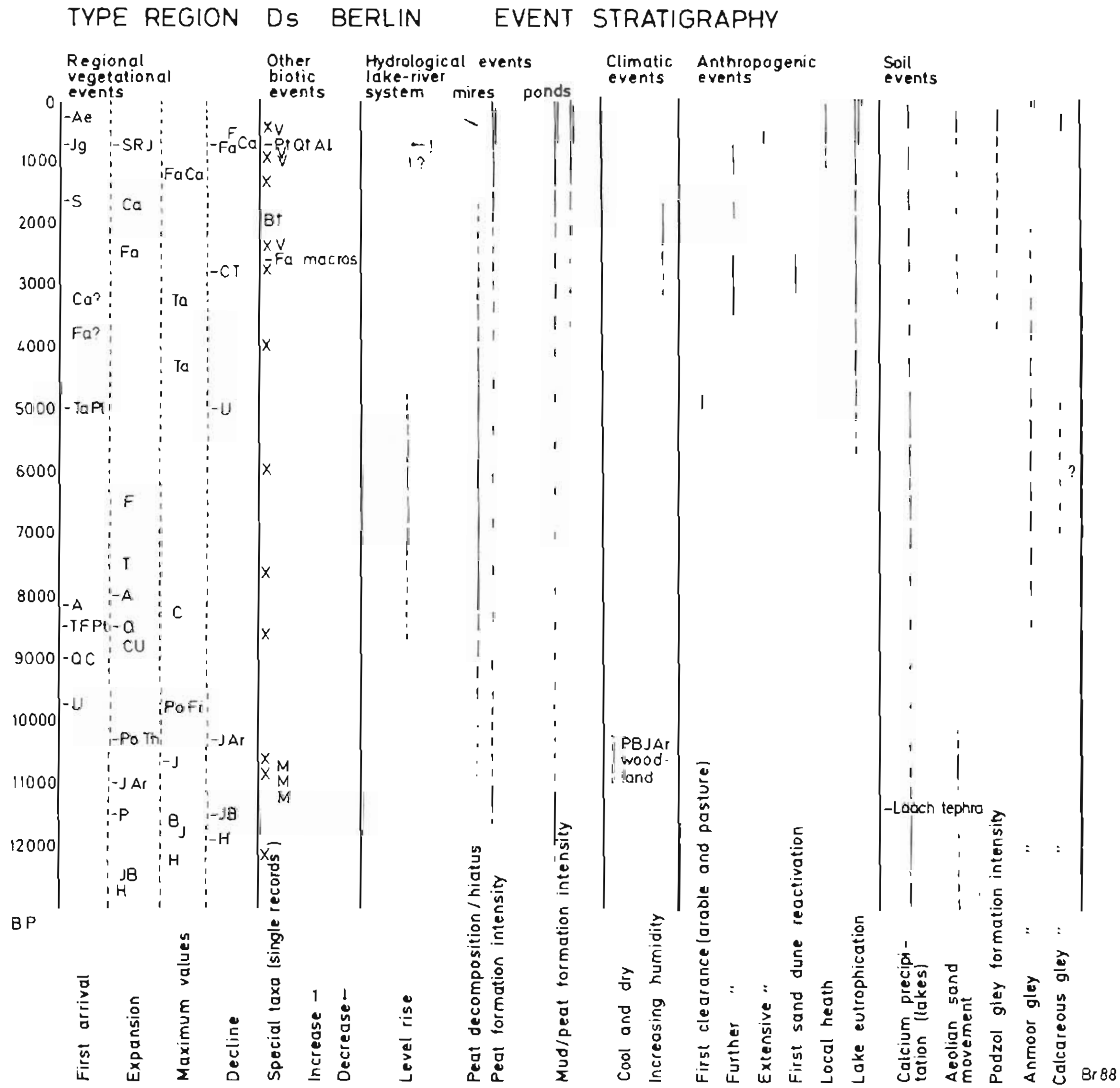


Fig. 15.10 Type region D-s Berlin. Event stratigraphy. A *Alnus*, Ae *Aesculus*, Ar *Artemisia*, B *Betula*, C *Corylus*, Ca *Carpinus*, F *Fraxinus*, Fa *Fagus*, Fi *Filipendula*, H *Hippophaë*, J *Juniperus*, Jg *Juglans*, M *Myriophyllum alterniflorum*, P *Pinus*, Pl *Plantago lanceolata*, Po *Populus*, Pt *Pteridium*, Q *Quercus*, R *Rumex acetosa* type, S *Secale*, T *Tilia*, Ta *Taxus*, Th *Thelypteris palustris*, V *Vitis*, X *Xanthium*

(ponds) on the ground-moraine plateaux, and therefore the increasing humidity of climate probably is one responsible factor. In this subregion organic sedimentation in the ponds also intensified since the 13th century AD because of more runoff water after large-scale clearances (Brande *et al.* 1990). Within the last 100 years in the Urstromtal subregion the mires dried out again, this time as a consequence of groundwater lowering caused by urban water-works.

The climatic history (Brande 1990), derived from palynological data, is partly confirmed by oxygen-isotope analysis of the Tegeler See sediments (Pachur 1987, Wolter 1992) and is compared in some detail with northwest German regions.

In correspondence with the regional archaeological record the palynological traces of Neolithic land use go back in general only to the Atlantic/Subboreal chronozone transition or slightly earlier, linked with the first steps of anthropogenic lake eutrophication in the reference site.

Intensified land use is found in the Urstromtal subregion during the Late Bronze age (Subboreal chronozone, 11/12 transition) with the spread of *Scleranthus perennis* and the first indications of anthropogenic sand-dune reactivation since consolidation during the Younger Dryas/Preboreal transition. Large sand-dune movements took place between the 13th and 18th centuries AD until afforestation. Anthropogenic *Calluna* heathland also developed but not before Medieval times, thus dating back to the Slavic period. Typical natural *Calluna* stands are on the anmoor and podzol gley soils of dry mires, and mainly date from the Atlantic up to the older Subatlantic chronozones.

The progress of lake eutrophication is closely correlated to anthropogenic influence, increasing rapidly in the late 19th century AD during industrialization and drainage from waste-water disposal into the lake–river system, thus forming sapropel on calcareous mud (Fig. 15.9).

Changes in the composition of the remaining woodland on less fertile sandy soils (podzolized brown earth) depend on various types of land use since the 14/15 transition, favouring *Pinus sylvestris* and *Quercus* spp. at the expense of *Fagus*, *Carpinus*, *Fraxinus*, and *Alnus*.

Among the palaeofloristic results, the native status of *Xanthium* (Brande 1980, Opravil 1983) and *Vitis* has been confirmed as well as of *Trapa* and *Salvinia* by listing all single pollen finds in the region (Fig. 15.10).

During the stages of soil development calcium leaching of sandy soils came to an end already in the Late Weichselian at many sites, mostly in the Alleröd chronozone. Secondary calcium accumulation, forming calcareous gley soils, is probably a consequence of the mid-Holocene lake-level rise, at least of the artificial rise of lake and groundwater table in the upper Subatlantic chronozone. Late Weichselian soil leaching is indicated even in the ground-moraine subregion by the only occurrence of *Myriophyllum alterniflorum* at that time. Other processes of hydromorphic soil formation (podzol gley and anmoor gley) are also closely connected with the changes of groundwater table, runoff-water access, and their natural and anthropogenic nutrient content during the Holocene.

Patterns of events between regions

In terms of the woodland history, the region is part of the landscape farther south of the Baltic and west of the Elbe, where *Pinus* dominates in the tree pollen rain on prevailing anhydromorphic sandy soils, i.e. in the eastern parts of the German type regions with subcontinental climate. Slight climatic changes, based on very local mire and pollen stratigraphy (e.g. Müller 1971), are still contradictory (Brande 1985). The general trends in regional palaeohydrology, reflected by non-ombrotrophic peat growth and presented independently for the type region D-s, strongly confirm the results obtained from the surrounding regions of the Northeast German lowland, as discussed by Lange *et al.* (1978, 1986), Succow & Lange (1984), and Succow (1987). The precondition, however, is to take into account the local features of every site, e.g. groundwater table in relation to site elevation, runoff-water catchment area, intensity of earlier organic sedimentation in flat and small hollows, and compactibility and water content of sediments during dry periods.

The anthropogenic events discussed here are on a regional scale only, whereas results from archaeological sites reveal additional effects.

TYPE REGIONS D-n, D-l AND D-r, SOUTHWEST GERMANY (M. Rösch)

The region discussed here (see Fig. 15.11) corresponds to the present-day German county of Baden-Württemberg. It covers an area of 35750 km² and