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"Spiderwebs as Natural Pollen Traps:

Analysis of Spiderweb and Dust/Soil Surface Samples from Indoor and Outdoor Locations"

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Abstract

In order to improve the understanding of spiderwebs as natural pollen trapping media, spiderweb and respective dust/soil surface samples were collected from two indoor and three outdoor locations in Vienna and Burgenland. Surrounding vegetation was determined qualitatively.

The following questions were approached: (1) Do pollen spectra received from spiderwebs depict the surrounding vegetation? (2) How similar are the compositions of pollen spectra from spiderweb and dust/soil surface samples of each location?

(1) Comparable levels of vegetation accordance were observed in spiderweb and floor samples for each location. Nevertheless, tendencies were recognized for indoor and outdoor locations, comprising higher rates of surrounding plant taxa in spiderweb than floor samples outdoor, whilst the opposite was detected for indoor samples. Further observations concerned increased amounts of spores in indoor spiderweb samples in contrast to their floor counterparts and the greater abundance of zoophile taxa in spiderweb samples.

(2) Divergence between pollen spectra from spiderweb and dust/surface soil samples was noticed. However, differences were mainly attributed to local accumulations of a single pollen type in spiderweb samples. Minor distinctions may be explained by spiderwebs dominantly filtering airborne particles in contrast to indoor dust samples comprising higher amounts of ruderal pollen carried there i.a. via footwear.

Therefore, it is assumed, that spiderweb and dust/soil surface samples are not interchangeable but should rather be considered two sides of the same coin.

Deutsche Zusammenfassung

Für ein besseres Verständnis über Spinnweben als natürliche Pollenfänger wurden in zwei Häusern und an drei Außenstandorten in Wien und im Burgenland Spinnweben sowie Staub/Bodenproben gesammelt. Die Vegetation in der Umgebung der Standorte wurde qualitativ erhoben.

Folgende Fragen sollten geklärt werden: (1) Spiegeln die Pollenzusammensetzungen der Spinnweben die umliegende Vegetation wider? (2) Wie ähnlich sind die Pollenspektren von Spinnweben und Staub/Bodenproben vom selben Standort?

(1) Die untersuchten Spinnweben spiegeln die umliegende Vegetation wider. Trotzdem können gewisse Tendenzen festgestellt werden: Die Vegetation der Außenstandorte wird durch Spinnweben und jene der Innenstandorte durch Bodenproben besser repräsentiert. Verglichen mit den Bodenproben wurden in den Spinnweben der Innenräume größere Mengen an Pollen insektenbestäubter Taxa sowie deutlich mehr Sporen gefunden.

(2) Zwischen den Pollenspektren der untersuchten Spinnweben und Staub/Bodenproben gibt es Abweichungen. Diese kommen großteils durch örtliche Anhäufung eines bestimmten Pollentyps in Spinnweben zustande. In Staub/Bodenproben wurden dagegen vermehrt Pollen von Ruderalpflanzen gefunden, die unter anderem mit Schuhen eingetragen werden können.

Diese Ergebnisse zeigen, dass Proben aus Spinnweben und Staub/Bodenproben nicht austauschbar sind, sondern eher zwei Seiten derselben Medaille darstellen.

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1 Introduction

1.1 Pollen

Pollen grains are microscopic structures representing the highly reduced male gametophyte of seed plants. They enclose and transport the male gametes which need to be transferred to female reproductive structures for fertilisation to take place. Depending on their pollination mode, different amounts of pollen are produced and released from the anthers (see 1.3 Pollination Modes). However, not all pollen grains arrive at their destination, but are distributed within different ranges from their source. Therefore, pollen is practically omnipresent and hardly noticed by humans due to its size. Various pollen types can be distinguished microscopically by characters like shape or ornamentation of the outer pollen wall. Depending on local vegetation and several other biotic and abiotic parameters, every place holds a unique combination of pollen types at a given time. The total amount of airborne pollen and spores settling on a surface area is defined as pollen rain (Klaus 1987).

1.2 Pollen Catching Structures

Airborne pollen is easily deposited on various natural or artificial media, but retention of certain pollen types or pollen in general varies. Several studies attempted to depict differences between certain kinds of pollen catching structures respectively devices (Cundill 1991; Lisitsyna et al. 2012; Quamar and Bera 2017, Gehrig 2019). Depending on the scientific discipline (i.a. Paleoecology, Aerobiology, Forensic Palynology), trapping devices vary. Concerning natural structures used as pollen traps, amongst others, mosses, lake surface sediments and soil samples are established (Lisitsyna et al. 2012, Quamar and Bera 2017). Spiderwebs were already considered environmental indicators like for instance on behalf of measuring air pollution close to motorways (Hose et al. 2002). Studies on pollen and spore concentrations in spiderwebs have already been performed (Bera et al. 2002, Quamar and Chauhan 2011, Firoze Quamar and Bera 2016), but no comparative approach with dust/surface soil samples is known to the author so far.

1.2.1 Spider Webs

In general, many kinds of airborne particles are restrained by spiderwebs. These structures are composed of proteinaceous threads (Gosline et al. 1999), often decorated with droplets of adhesive glue (Jain et al. 2015) which are produced by web weaving spiders via highly specialized glands (Wehner et al. 1995). Against common believe recent studies depicted that these spiders consume pollen and spores actively and can therefore be categorized as omnivores. This was especially true for juvenile individuals whose diet was 25 % pollen-based (Eggs and Sanders 2013). Web building spiders relevant for this

study were associated to Linyphiidae (sheet weavers), Agelenidae (funnel weavers) and Pholcidae (vibrating spiders) according to respective literature (Bellmann 2016).

1.3 Pollination Modes

Concerning the pollination mode of plant taxa, ornamentation and abundance of pollen grains are crucial factors. Ornamentation refers to polymorphic architecture of the outer pollen wall. While anemophilous pollen tends to be less ornamented (Friedman and Barrett 2009), great diversity of structures on zoophilous and autogamous taxa is known. Zoophilous pollen is usually produced in comparatively small amounts while pollen rain from anemophilous plants is even visible macroscopically. According to Mildenhall et al. 2004 and 2006, the occurrence of zoophile pollen is especially beneficial for attribution to a location as it is produced in small amounts and usually found in proximity of the dispersal source area. In contrast to animal pollinated taxa which are mostly limited in dispersal range, anemophilous pollen is transported over enormously wide distance (Mildenhall et al. 2004).

2 Material and Methods

2.1 Locations

Three outdoor and two indoor locations were selected for this examination. These three main scenes will be referred to as “Department of Botany and Biodiversity Research”, “House Bad Tatzmannsdorf” and “Outdoor Locations Bad Tatzmannsdorf”. The latter two were situated in the southern part of the Austrian province Burgenland, the first in Central Vienna (see Figure 1).

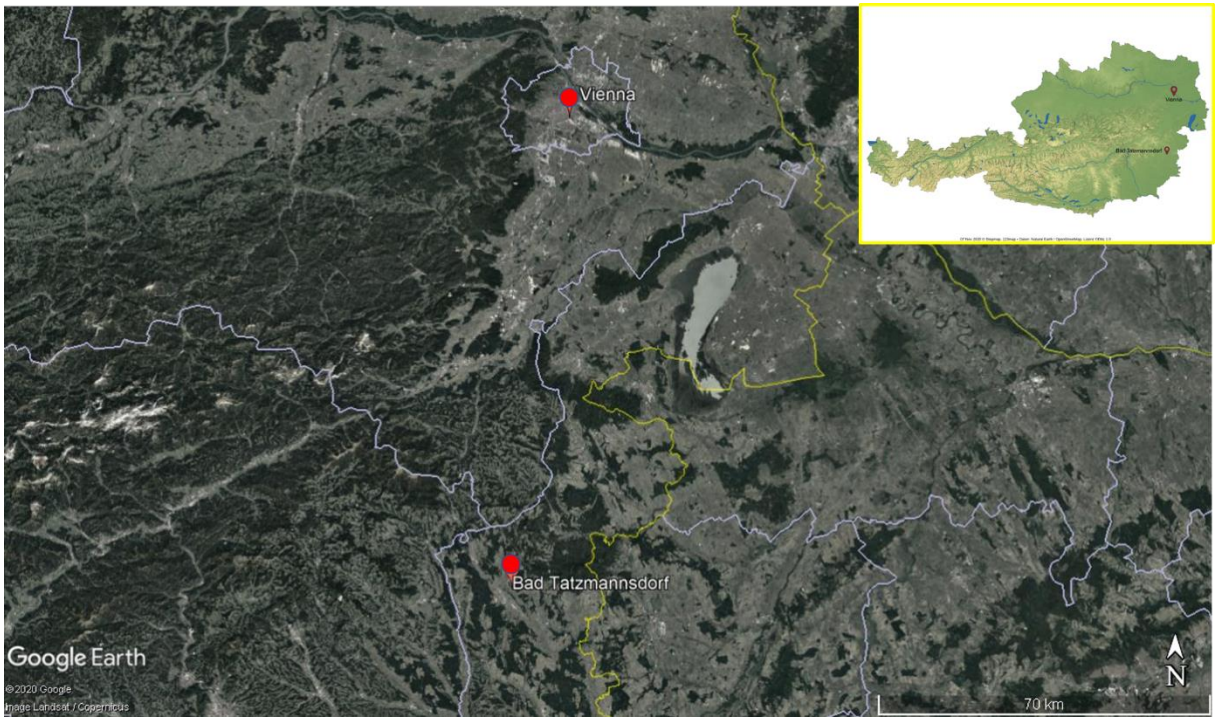


Figure 1: Overview of all sampling areas. Source: Google Earth Pro 2020 (left), StepMap (right).

2.1.1 Sampling Location Vienna

Department of Botany and Biodiversity Research

Location “Department of Botany and Biodiversity Research” is located in the 3rd district in Central Vienna. It is positioned north of the Botanical Garden of Vienna and situated in a municipal environment. Three rooms were sampled in this building.

Figure 2: Map of location “Department of Botany and Biodiversity Research” and surrounding landscape. Source: Google Earth Pro 2020.

Surrounding Vegetation					
Family	**Taxa**	**Family**	**Taxa**	**Family**	**Taxa**
Adoxaceae	*Viburnum* sp.	Cornaceae	*Cornus* sp.	Poaceae	various
	Sambucus sp.	Cupressaceae	*Juniperus* sp.	Rosaceae	*Crataegus* sp.
Amaranthaceae	*Amaranthus* sp.	Dryopteridaceae	*Dryopteris* sp.		*Prunus* sp.
Anacardiaceae	*Rhus* sp.	Euphorbiaceae	*Euphorbia* sp.	Rubiaceae	*Galium* sp.
Apiaceae	various	Fabaceae	*Medicago* sp.	Salicaceae	*Populus* sp.
Araliaceae	*Hedera* sp.		*Trifolium* sp.		*Salix* sp.
Asteraceae	*Ambrosia* sp.	Fagaceae	*Castanea* sp.	Sapindaceae	*Acer* sp.
	Artemisia sp.		*Fagus* sp.		*Aesculus* sp.
	Bellis sp.		*Quercus* sp.	Simaroubaceae	*Ailanthus* sp.
Betulaceae	*Alnus* sp.	Ginkgoaceae	*Ginkgo biloba*	Taxaceae	*Taxus baccata*
	Betula sp.	Juglandaceae	*Carya* sp.	Typhaceae	*Typha* sp.
	Carpinus sp.		*Juglans* sp.	Ulmaceae	*Ulmus* sp.
	Corylus sp.		*Pterocarya* sp.	Urticaceae	*Urtica* sp.
	Ostrya sp.	Malvaceae	*Tilia* sp.	Vitaceae	*Parthenocissus* sp.
Brassicaceae	*Brassica* sp.	Oleaceae	*Fraxinus* sp.		
Cannabaceae	*Celtis* sp.	Platanaceae	*Platanus* sp.		

Table 1: Surrounding vegetation of the study area “Department of Botany and Biodiversity Research”. Pinaceae excluded.

Room E08 (5SDS, 5SDB)

Sampling site “Room E08” was situated at the ground floor of the “Department of Botany and Biodiversity Research”. It was used as an office room and frequented by one person on weekdays. Windows faced south to the Institute’s parking area dominated by trees, shrubs, lawns, some ornamental plants and ruderals. Approximately 150 m further south the Botanical Garden was located (see Figure 2). The following indoor plants were noticed: *Bryophyllum* sp. (Crassulaceae), *Haworthia* sp. (Xanthorrhoeaceae), *Euphorbia* sp. (Euphorbiaceae), *Lilium* sp. (Liliaceae), *Tradescantia* sp. (Commelinaceae).

Room 416 (7SDS, 7SDB)

“Room 416” was located on the 4th floor. It was used as an office room but was under construction at sampling time. Therefore, all furniture had been removed, but cleaning was outstanding. Windows faced north and west. The area to the north comprised comparatively little vegetation, but there was one individuum of *Platanus orientalis* (Platanaceae) approximately 10 m away from the window. 150 m further north a school’s sports ground and parkway were located. To the west, an area dominated by trees, shrubs and herbs with *Ginkgo* sp. (Ginkgoaceae) in 10 m and *Platanus* sp. (Platanaceae) in 30 m distance was situated (see Figure 2). Two exemplars of *Euphorbia* sp. (Euphorbiaceae) were kept as ornamental plants in the room.

Room 414 (9SDS, 9SDB)

Like “Room 416“, this office room was located on the 4th floor and was under construction at sampling time. Windows faced west to an area containing trees, i.a. *Platanus* sp. (Platanaceae), *Ginkgo* sp. (Ginkgoaceae), *Ailanthus* sp. (Simaroubaceae), shrubs and herbs (see Figure 2).

2.1.2 Sampling Sites Bad Tatzmannsdorf

Bad Tatzmannsdorf is a township in the southern part of Burgenland in the urban commune Oberwart. It comprises the districts Bad Tatzmannsdorf, Jormannsdorf and Sulzriegel. The township is known for its moorlands and thermal springs, conditions which resulted in it becoming a spa town. On 1/1/2020 Bad Tatzmannsdorf had a total population of 1 620. Its landscape consisted of 37.8 % woodland, 37.4 % agricultural land, 6.8 % yards, 2.6 % building area, 0.7 % water bodies, 0.1 % vineyards and 14.5% other areas (Statistik Austria 2020). In Bad Tatzmannsdorf, indoor ("House Bad Tatzmannsdorf") and outdoor ("Outdoor Locations Bad Tatzmannsdorf") samples were collected.

House Bad Tatzmannsdorf

Location "House Bad Tatzmannsdorf" was used as a weekend and holiday home and therefore not inhabited permanently. Surrounding vegetation was characterized by yards, meadows, woodland and agricultural land (see Figure 3).

Figure 3: Map of location "House Bad Tatzmannsdorf" and surrounding landscape. Source: Google Earth Pro 2020.

Surrounding Vegetation					
Family	**Taxa**	**Family**	**Taxa**	**Family**	**Taxa**
Adoxaceae	*Sambucus* sp.	Caryophyllaceae	*Dianthus* sp.		*Tilia* sp.
Alliaceae	*Allium* sp.		*Stellaria* sp.	Oleaceae	*Ligustrum* sp.
Apiaceae	*Aegopodium podagraria*	Celastraceae	*Euonymus* sp.		*Syringa vulgaris*
	Daucus carota	Convolvulaceae	*Convolvulus* sp.	Onagraceae	*Oenothera* sp.
	Levisticum officinale		*Ipomoea* sp.	Paeoniaceae	*Paeonia* sp.
	Petroselinum sp.	Cornaceae	*Cornus* sp.	Papaveraceae	*Papaver* sp.
Apocynaceae	*Nerium oleander*	Crassulaceae	*Sedum* sp.	Plantaginaceae	*Plantago* sp.
Araliaceae	*Hedera* sp.		*Sempervivum* sp.	Poaceae	various
Asparagaceae	*Hosta* sp.	Cupressaceae	*Juniperus* sp.	Polygonaceae	*Rumex* sp.
Asteraceae	*Achillea* sp.		*Thuja* sp.	Primulaceae	*Primula* sp.
	Aster sp.	Fabaceae	*Lupinus* sp.	Ranunculaceae	*Aquilegia* sp.
	Bellis sp.		*Trifolium* sp.	Rosaceae	*Amelanchier* sp.
	Calendula sp.	Geraniaceae	*Geranium* sp.		*Fragaria* sp.
	Centaurea sp.	Grossulariaceae	*Ribes* sp.		*Malus* sp.
	Cosmos sp.	Hypericaceae	*Hypericum* sp.		*Potentilla* sp.
	Dahlia sp.	Iridaceae	*Iris* sp.		*Prunus domestica*
	Echinacea sp.	Lamiaceae	*Caryopteris* sp.		*Pyrus* sp.
	Helianthus sp.		*Glechoma hederacea*		*Rosa* sp.
	Leucanthemum sp.		*Lavandula* sp.		*Rubus idaeus*
	Taraxacum sp.		*Melissa* sp.		*Spiraea* sp.
	Tragopogon sp.		*Nepeta* sp.	Salicaceae	*Salix babylonica*
Berberidaceae	*Berberis* sp.		*Ocimum basilicum*	Sapindaceae	*Acer pseudoplatanus*
Betulaceae	*Corylus* sp.		*Origanum* sp.	Saxifragaceae	*Saxifraga* sp.
Boraginaceae	*Borago officinalis*		*Salvia* sp.	Scrophulariaceae	*Buddleja* sp.
	Myosotis sp.		*Thymus vulgaris*		*Verbascum* sp.
Brassicaceae	*Capsella* sp.	Juglandaceae	*Juglans regia*	Simaroubaceae	*Ailanthus* sp.
	Lunaria sp.	Liliaceae	*Lilium* sp.	Solanaceae	*Solanum* sp.
	Thlaspi sp.	Lythraceae	*Lythrum salicaria*	Urticaceae	*Urtica* sp.
Campanulaceae	*Platycodon* sp.	Malvaceae	*Hibiscus* sp.	Violaceae	*Viola* sp.
Caprifoliaceae	*Weigela* sp.		*Malva* sp.	Vitaceae	*Vitis vinifera*

Table 2: Surrounding vegetation of the study area “House Bad Tatzmannsdorf”. Pinaceae excluded.

Kitchen (15SDS, 15SDB)

Sampling site “Kitchen” was located on the ground floor level of “House Bad Tatzmannsdorf”. The two windows faced north and east. To the east, yards, meadows and approximately 150 m further, acres, were situated (see Figure 3). North of this site the landscape was dominated by yards and meadows. No indoor plants were kept in the room. It was freshly painted in 2018. Proximate taxa were: *Hedera* sp. (Araliaceae), *Papaver* sp. (Papaveraceae), *Picea* sp. (Pinaceae), Alliaceae, Apiaceae, Boraginaceae, Convolvulaceae, Fabaceae, Lamiaceae, Poaceae and Solanaceae.

Annex (17SDS, 17SDB)

The “Annex” was a house extension on basement level, mainly used for storage of tools including a lawn mower. Also, shredding was performed and pinewood, pinecones and cherrywood were stored in this room. It was entered about two times a month. The door faced west to yards and meadows, with *Rosa* sp. (Rosaceae), *Euonymus* sp. (Celastraceae), *Ligustrum* sp. (Oleaceae), *Cornus* sp. (Cornaceae) and *Juniperus* sp. (Cupressaceae) in proximity (see Figure 3). No indoor plants were kept in the room.

Corridor (18SDS, 18SDB)

Sampling site “Corridor” refers to a connecting room on the first floor. It was used frequently, and the balcony door was left open regularly. It was painted freshly in May 2019. No indoor plants were kept in the room. It’s main source of fresh air was via the balcony door which faced south towards yards and ruderals (Figure 3). Proximate taxa were: *Sambucus* sp. (Adoxaceae), *Corylus* sp. (Betulaceae), *Picea* sp. (Pinaceae), *Juglans* sp. (Juglandaceae) and *Prunus* sp. (Rosaceae).

Outdoor Locations Bad Tatzmannsdorf

Three outdoor sampling sites (“Forest Edge”, “Forest” and “Park”) were selected, each over 700 m linear distance apart. Vegetation tables were generated separately for each site.

Figure 4: Map of location “Outdoor Locations Bad Tatzmannsdorf” and surrounding landscape. Source: Google Earth Pro 2020.

Forest Edge (10SDS, 10SDB)

The first outdoor sampling site “Forest Edge” was situated uphill from “House Bad Tatzmannsdorf”, surrounded by yards, orchards, acres and woodland (see Figure 4). The spiderweb sample was taken from a pile of wood under *Prunus* sp. (Rosaceae). For detailed characterization of the surrounding vegetation, see Table 3.

Figure 5: “Outdoor Locations Bad Tatzmannsdorf”, sampling site “Forest Edge”.

Surrounding Vegetation					
Family	**Taxa**	**Family**	**Taxa**	**Family**	**Taxa**
Adoxaceae	*Sambucus* sp.		*Glycine max*	Oxalidaceae	*Oxalis* sp.
Amaranthaceae	*Amaranthus* sp.		*Laburnum* sp.	Plantaginaceae	*Plantago* sp.
Apiaceae	*Aegopodium* sp.		*Medicago sativa*	Poaceae	*Avena sativa*
Araliaceae	*Hedera* sp.		*Trifolium* sp.		*Hordeum vulgare*
Asteraceae	*Achillea* sp.		*Vicia* sp.		*Zea mays*
	Helianthus sp.	Fagaceae	*Castanea sativa*	Polygonaceae	*Rumex* sp.
Betulaceae	*Alnus* sp.		*Quercus* sp.	Ranunculaceae	*Ranunculus* sp.
	Betula sp.	Geraniaceae	*Geranium* sp.	Rosaceae	*Agrimonia* sp.
	Carpinus sp.	Hydrangeaceae	*Hydrangea* sp.		*Prunus* sp.
	Corylus sp.	Lamiaceae	*Lamium* sp.		*Rosa* sp.
Boraginaceae	*Symphytum* sp.		*Prunella* sp.		*Rubus* sp.
Brassicaceae	*Capsella* sp.	Malvaceae	*Hibiscus* sp.	Rubiaceae	*Galium* sp.
Caprifoliaceae	*Knautia* sp.		*Tilia* sp.	Salicaceae	*Populus* sp.
Convolvulaceae	*Convolvulus* sp.	Oleaceae	*Fraxinus* sp.	Sapindaceae	*Acer* sp.
Cornaceae	*Cornus* sp.		*Ligustrum vulgare*	Urticaceae	*Urtica* sp.
Fabaceae	*Anthyllis* sp.		*Syringa vulgaris*	Vitaceae	*Vitis vinifera*

Table 3: Surrounding vegetation of the study area “Outdoor Locations Bad Tatzmannsdorf”, site “Forest Edge”. Pinaceae excluded.

Forest (13SDS, 13SDB)

Sampling site “Forest” was situated in a glade in the middle of the woods (see Figure 4). The area was humid and predominantly characterized by herbs and some shrubs and trees (see Table 4 and Figure 6). This area ranged over 40 m in diameter and was further surrounded by mixed forest vegetation. The spiderweb sample was collected from undergrowth of *Rubus* sp. (Rosaceae).

Figure 6: “Outdoor Locations Bad Tatzmannsdorf”, sampling site “Forest”.

Surrounding Vegetation					
Family	**Taxa**	**Family**	**Taxa**	**Family**	**Taxa**
Araliaceae	*Hedera* sp.	Fabaceae	*Trifolium* sp.	Poaceae	various
Asteraceae	*Aster* sp.	Fagaceae	*Fagus* sp.	Polygonaceae	*Rumex* sp.
	Carduus sp.		*Quercus* sp.	Primulaceae	*Lysimachia* sp.
Balsaminaceae	*Impatiens* sp.	Gentianaceae	*Centaurium* sp.	Ranunculaceae	*Ranunculus* sp.
Betulaceae	*Alnus* sp.	Geraniaceae	*Geranium* sp.	Rhamnaceae	*Rhamnus frangula*
	Betula sp.	Hypericaceae	*Hypericum* sp.	Rosaceae	*Agrimonia* sp.
	Carpinus sp.	Lamiaceae	*Lamium* sp.		*Rubus* sp.
	Corylus sp.		*Lycopus* sp.		*Sorbus aucuparia*
Boraginaceae	*Symphytum* sp.	Lythraceae	*Lythrum* sp.	Rubiaceae	*Galium* sp.
Brassicaceae	*Lunaria* sp.	Onagraceae	*Epilobium* sp.	Salicaceae	*Salix* sp.
Campanulaceae	*Campanula* sp.	Oxalidaceae	*Oxalis* sp.	Urticaceae	*Urtica* sp.
Caprifoliaceae	*Knautia* sp.	Plantaginaceae	*Plantago* sp.		

Table 4: Surrounding vegetation of the study area “Outdoor Locations Bad Tatzmannsdorf”, site “Forest”. Pinaceae excluded.

Park (14SDS, 14SDB)

Situated in the spa garden's centre (see Figure 4 and Figure 7), sampling site "Park" was the most anthropogenically disturbed of the outdoor locations. The parkway extended within a radius of 80 m, composed of ornamental trees, shrubs and herbs (see Table 5). Spiderweb sample was taken from a shrub of *Taxus* sp. (Taxaceae) growing beneath *Carpinus* sp. (Betulaceae).

Figure 7: "Outdoor Locations Bad Tatzmannsdorf", sampling site "Park".

Surrounding Vegetation					
Family	**Taxa**	**Family**	**Taxa**	**Family**	**Taxa**
Apiaceae	various	Fabaceae	*Trifolium* sp.	Platanaceae	*Platanus* sp.
Asteraceae	*Aster* sp.	Fagaceae	*Castanea sativa*	Poaceae	various
	Bellis sp.		*Quercus* sp.	Rosaceae	*Prunus* sp.
	Taraxacum sp.	Hydrangeaceae	*Hydrangea* sp.	Sapindaceae	*Acer campestre*
Betulaceae	*Alnus* sp.	Lamiaceae	*Lavandula* sp.		*Acer platanoides*
	Betula sp.		*Prunella* sp.		*Acer pseudoplatanus*
	Carpinus sp.	Malvaceae	*Tilia* sp.	Taxaceae	*Taxus baccata*
	Corylus sp.	Oleaceae	*Fraxinus* sp.	Typhaceae	*Typha* sp.
Campanulaceae	*Campanula* sp.	Paulowniaceae	*Paulownia tomentosa*	Urticaceae/Cannabaceae	*Urtica* sp.
Cupressaceae	*Cryptomeria japonica*	Plantaginaceae	*Plantago* sp.		

Table 5: Surrounding vegetation of the study area "Outdoor Locations Bad Tatzmannsdorf", site "Park". Pinaceae excluded.

2.2 Sampling

Samples were collected on the 15th ("Department for Botany and Biodiversity Research") and 20th ("House Bad Tatzmannsdorf" and "Outdoor Locations Bad Tatzmannsdorf") of July 2019 (see Table 6). At each site, both spiderweb and dust/soil surface samples were taken. The latter were collected using conventional duster sheets. Spiderweb samples were taken wearing latex gloves. Floor samples from outdoor locations consisted of superficial soil material. All samples were stored in sealed plastic bags at room temperature after sampling. Surrounding vegetation was registered in a radius of approximately 100 m of the sampling point.

Sample	Location	GPS	Environment	Sampling Date
5SDS, 5SDB	"Department of Botany and Biodiversity Research" A-1030 Wien, Rennweg 14 Room E08	48.195362,16.383922	Central city	15.07.19
7SDS, 7SDB	"Department of Botany and Biodiversity Research" A-1030 Wien, Rennweg 14 Room 416	48.195362,16.383922	Central city	15.07.19
9SDS, 9SDB	"Department of Botany and Biodiversity Research" A-1030 Wien, Rennweg 14 Room 414	48.195362,16.383922	Central city	15.07.19
15SDS, 15SDB	"House Bad Tatzmannsdorf" Waldegg-Gasse 4, 7431 Bad Tatzmannsdorf Kitchen	47.336501,16.234358	Township	20.07.19
17SDS, 17SDB	"House Bad Tatzmannsdorf" Waldegg-Gasse 4, 7431 Bad Tatzmannsdorf Annex	47.336501,16.234358	Township	20.07.19
18SDS, 18SDB	"House Bad Tatzmannsdorf" Waldegg-Gasse 4, 7431 Bad Tatzmannsdorf Corridor	47.336501,16.234358	Township	20.07.19
10SDS, 10SDB	"Outdoor Locations Bad Tatzmannsdorf" Forest Edge	47.332324,16.239761	Outdoor	20.07.19
13SDS, 13SDB	"Outdoor Locations Bad Tatzmannsdorf" Forest	47.332273,16.250396	Outdoor	20.07.19
14SDS, 14SDB	"Outdoor Locations Bad Tatzmannsdorf" Park	47.335231,16.229629	Outdoor	20.07.19

Table 6: Overview of parameters, all sampling sites.

2.3 Sample Preparation

Before determination and counting took place, samples had to be prepared in order to gain pollen grains from collected material, remove mineral particles and to highlight taxon specific characters for light microscopy. A modified version of acetolysis (Erdtman 1960) was carried out. Samples were treated in random order.

2.3.1 Spiderweb Sample Preparation

Preliminary tests had shown that pollen grains were extracted from spiderwebs more easily by storing the material in acetolysis mixture, (9:1 ratio acetic anhydride and conc. sulfuric acid) over night (> 10 h). Afterwards, the spiderweb had dissolved and larger particles were filtered out via laboratory filter (260 µm mesh size). This additional step for spiderweb samples was followed directly by acetolysis (see 2.3.3 Acetolysis and Glycerine Embedding).

2.3.2 Floor Sample Preparation

Duster sheets were washed in 200 ml distilled water with a drop of detergent Tween 20. The resulting fluid was sieved through a laboratory filter. Further preparation comprised the compaction of pollen in the liquid by multiple steps of centrifuging and decanting of the supernatant (see appendix: “Sample Preparation Specifics”). After a transfer of pollen material into concentrated acetic acid to remove all water, a centrifuging and decanting step, acetolysis took place.

2.3.3 Acetolysis and Glycerine Embedding

Acetolysis is a procedure used to remove all parts of pollen grains apart from sporopollenin, the substance the outer pollen wall is composed of (Hesse and Waha 1989). The original protocol established by Erdtman (1960) was modified after Halbritter et al. (2018) (see appendix: Sample Preparation Specifics). Acetolysis mixture was prepared by merging nine parts acetic anhydride (99 %) and one part sulfuric acid (96 %). It was then added to the anhydrous pollen material which was rinsed with acetic acid before and incubated at 80°C for 10 minutes in an ultrasonic water bath. In several steps, pollen material was rinsed, first in acetic acid, then distilled water to remove acidic components and last in ethanol (99.8 %). Ethanol was decanted and material was air dried and overlaid with glycerine (99.5 %) for light microscopy.

2.3.4 Heavy Liquid Separation

If necessary, particles of mineral origin were removed from the samples after acetolysis by carrying out gravitational separation (see appendix: Sample Preparation Specifics). Therefore, a zinc bromide solution was added to the sample, stirred, overlaid with distilled water and centrifuged. The resulting two phases were organic (pollen grains in water) and

inorganic (mineral components). After steps of washing and decanting, preparation of the organic phase was proceeded (see “Acetolysis and Glycerine Embedding”).

2.4 Microscopy

Acetolyzed samples were stored in closed reaction tubes in glycerine (99.5 %) until final steps of preparation for light microscopy. Therefore, sample fluid was mounted on glass slides and sealed with a cover slip, at least one day prior. This time is required to avoid flowage of pollen grains during microscopic analyses.

An Olympus BX50 light microscope with connected digital camera in combination with imaging software “Olympus cellSens” was used. Counting was performed at 400x, while for micrography, 600x magnification was chosen. To receive statistically significant data, a minimum of 300 pollen grains per sample was counted. For pollen identification, relevant literature (Erdtman 1969, Halbritter et al. 2018) and the pollen database PalDat (2020) were used additionally to the aid of experienced professionals.

2.5 Classification of Pollen Spectra

After pollen determination and preparation of pollen spectra for each sample, the datasets were aligned. Similarity was assigned using the following classification:

Category	Sample match
dissimilar	Almost no common pollen types and/or one sample has a unique marker (rare, exotic) that the other sample lacks.
slightly similar	Similar and dissimilar pollen types. For common pollen types the amount of pollen may vary slightly or significantly. However, neither the dissimilarities nor the similarities allow a distinct assignment to another category.
similar	More similar pollen types than discriminating pollen types in both samples. For many pollen types the amount of pollen varies significantly.
very similar	The majority of the relevant pollen types in both samples are identical. The amount of pollen varies slightly.
almost identical	All pollen types and pollen amounts in both samples are almost identical, including characteristic markers (unusual palynomorphs in significant amounts)
identical	All pollen types and pollen amounts in both samples are nearly identical, including unique markers.

Figure 8: Classification system of pollen spectra.

3 Results

The acetolysed samples were analysed by using light microscopy. The occurring pollen types were counted to generate pollen spectra. Pollen types were assigned to individual plant families or genera, if possible and the discrimination relevant. For instance, *Ambrosia* sp. (Asteraceae) was counted separately from category “Asteraceae” as the taxon showed great abundance in some of the samples.

Pollen from Pinaceae was counted but excluded from the results due to loss during preparation. Possessing pollen grains with air filled sacs (sacci), these taxa tend to float on water surface and thereby get decanted easily. Routinely taken surveys of decanted water showed loss of Pinaceae pollen.

3.1 Combined Results

Total counts and percentages of taxa were established for each sample and combined in Table 7. A colour code was used to illustrate the amount of pollen of a taxon found per sample. The code refers to number ranges shown in Figure 9.

The category “Diverse Spores”, which includes not further determined spores, was integrated into the table as there were noticeable differences between the individual samples. This issue is discussed in chapter “Spore Ratios”. Peculiar differences were depicted between the main locations (“Department of Botany and Biodiversity Research”, “House Bad Tatzmannsdorf” and “Outdoor Locations Bad Tatzmannsdorf”), indoor versus outdoor, individual sites, as well as spiderweb and dust/soil surface samples.

Some taxa showed great accumulations within individual samples. This concerns the striking abundance of *Quercus* sp. (87.11 %) in 14SDS, Rosaceae (52.67 %) in 13SDS, Euphorbiaceae (50.32 %) in 7SDS and Urticaceae/Cannabaceae (44.44 %) in 5SDS. Probed indoor locations generally displayed higher incidences of Urticaceae/ Cannabaceae compared to outdoor. *Platanus* sp. (Platanaceae) and *Ginkgo* sp. (Ginkgoaceae) had their main occurrence at the location of the “Department of Botany and Biodiversity Research”, while *Castanea* sp. (Fagaceae) was found mainly in “Outdoor Locations Bad Tatzmannsdorf”. In most cases, Fabaceae and Apiaceae were more abundant in spiderweb than in dust/soil surface samples. Floor samples mostly contained more *Plantago* sp. (Plantaginaceae) and *Tilia* sp. (Malvaceae) than spiderweb samples.

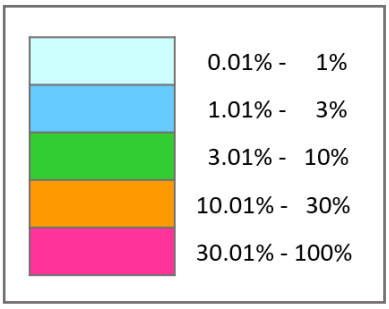


Figure 9: Key to colour codes in Table 7.

	Department of Botany and Biodiversity Research												Outdoor Locations Bad Tatzmannsdorf												House Bad Tatzmannsdorf											
	5SDS_Room E08		5SDB_Room E08		7SDS_Room 416		7SDB_Room 416		9SDS_Room 414		9SDB_Room 414		10SDS_Forest E.		10SDB_Forest E.		13SDS_Forest		13SDB_Forest		14SDS_Park		14SDB_Park		15SDS_Kitchen		15SDB_Kitchen		17SDS_Annex		17SDB_Annex		18SDS_Corridor		18SDB_Corridor	
Taxa	%	value	%	value	%	value	%	value	%	value	%	value	%	value	%	value	%	value	%	value	%	value	%	value	%	value	%	value	%	value	%	value	%	value	%	value
Acer	-	-	0,60	2	-	-	-	-	0,31	1	0,26	1	1,46	11	1,21	8	-	-	0,23	1	-	-	-	-	-	-	-	-	-	-	0,18	1	-	-	-	-
Aesculus	1,32	5	-	-	-	-	0,54	2	-	-	0,26	1	0,13	1	-	-	-	-	-	-	-	-	0,87	3	-	-	-	-	-	-	-	-	-	-	-	-
Ailanthus	0,26	1	1,79	6	11,58	55	0,54	2	0,31	1	0,26	1	0,13	1	-	-	-	-	-	-	-	-	-	-	0,11	1	-	-	-	-	-	-	-	-	-	-
Alnus	1,59	6	-	-	0,84	4	3,22	12	3,45	11	3,63	14	0,93	7	2,27	15	2,94	11	14,29	63	1,29	5	20,70	71	0,45	4	0,77	6	6,18	26	5,96	33	4,40	29	2,78	12
Amaranthaceae	0,26	1	0,30	1	0,42	2	0,80	3	0,31	1	0,52	2	0,40	3	0,91	6	0,27	1	0,91	4	0,26	1	0,87	3	0,67	6	0,38	3	1,19	5	0,72	4	0,91	6	3,02	13
Ambrosia	0,53	2	0,30	1	0,42	2	1,07	4	0,63	2	1,04	4	0,66	5	-	-	1,07	4	7,03	31	-	-	1,75	6	3,01	27	0,26	2	5,94	25	1,44	8	2,28	15	1,39	6
Apiaceae	0,53	2	-	-	-	-	-	-	1,88	6	-	-	0,53	4	0,30	2	-	-	-	-	2,58	10	-	-	0,11	1	-	-	0,95	4	-	-	-	-	0,46	2
Artemisia	0,26	1	-	-	-	-	1,88	7	0,31	1	0,52	2	-	-	-	-	-	-	-	-	-	-	0,29	1	0,33	3	-	-	1,19	5	0,18	1	0,46	3	0,23	1
Asteracee	0,26	1	0,90	3	0,21	1	4,29	16	-	-	-	-	1,19	9	2,57	17	6,15	23	0,68	3	2,58	10	0,29	1	0,89	8	1,41	11	3,56	15	5,23	29	1,67	11	1,16	5
Betula	10,85	41	4,48	15	2,95	14	4,02	15	6,90	22	9,59	37	1,19	9	2,57	17	2,67	10	19,50	86	0,52	2	16,33	56	3,79	34	2,82	22	7,84	33	6,68	37	8,04	53	8,12	35
Boraginaceae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0,80	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1,39	6
Brassicaceae	-	-	1,19	4	0,63	3	0,54	2	1,25	4	-	-	0,66	5	-	-	0,27	1	-	-	-	-	-	-	0,11	1	0,51	4	0,48	2	1,08	6	0,76	5	0,23	1
Campanulaceae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0,77	3	0,58	2	-	-	-	-	-	-	-	-	-	3	-	-
Carpinus	0,26	1	0,30	1	1,05	5	1,88	7	-	-	1,04	4	0,26	2	-	-	1,07	4	5,67	25	0,26	1	4,66	16	0,56	5	-	-	1,90	8	-	-	0,46	-	0,93	4
Carya	-		0,30	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Caryophyllaceae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0,11	1	-	-	-	-	-	-	-	-	-	-
Castanea	0,53	2	0,60	2	-	-	-	-	-	-	0,26	1	3,84	29	3,18	21	3,21	12	2,72	12	0,26	1	2,04	7	0,45	4	0,90	7	0,71	3	1,08	6	-	-	0,23	1
Centaurea	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0,15	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cornus	-	-	-	-	-	-	-	-	-	-	0,78	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Corylus	-	-	-	-	0,42	2	2,95	11	2,82	9	2,85	11	0,53	4	0,61	4	1,07	4	1,81	8	0,26	1	3,50	12	-	-	0,13	1	1,66	7	1,08	6	0,91	6	0,70	3
Cupressaceae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2,71	15	0,46	3	-	-
Dryopteris	-	-	0,60	2	-	-	-	-	-	-	-	-	-	-	0,30	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ericaceae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0,45	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Euphorbiaceae	-	-	0,30	1	50,32	239	0,27	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fabaceae	7,67	29	0,30	1	-	-	-	-	0,31	1	-	-	-	-	-	-	-	-	-	-	-	-	0,29	1	0,56	5	-	-	-	-	-	-	-	-	-	-
Fagus	0,53	2	0,30	1	1,68	8	1,07	4	0,31	1	0,78	3	0,53	4	-	-	0,27	1	3,17	14	-	-	0,29	1	0,78	7	0,90	7	1,43	6	-	-	0,46	3	0,93	4
Fraxinus	1,06	4	0,90	3	0,63	3	-	-	2,51	8	0,78	3	0,66	5	-	-	-	-	1,81	8	0,26	1	-	-	0,67	6	0,26	2	1,19	5	0,72	4	0,91	6	1,16	5
Galium	0,26	1	-	-	-	-	-	-	-	-	0,52	2	0,93	7	0,15	1	0,80	3	0,23	1	-	-	-	-	0,33	3	0,26	2	0,24	1	0,18	1	-	-	0,23	1
Ginkgo	0,26	1	0,30	1	10,74	51	6,43	24	12,23	39	2,07	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0,26	2	-	-	0,18	1	0,30	2	0,70	3
Hedera	-	-	-	-	-	-	-	-	0,31	1	0,26	1	-	-	-	-	-	-	0,68	3	-	-	-	-	-	-	0,26	2	-	-	-	-	-	-	-	-
Impatiens	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0,27	1	-	-	-	-	-	-	-	-	-	-	0,24	1	0,18	1	-	-	-	-
Juglans	1,06	4	1,49	5	4,21	20	15,82	59	3,13	10	1,81	7	-	-	1,06	7	-	-	1,13	5	-	-	0,87	3	0,33	3	0,64	5	1,90	8	2,71	15	3,49	23	4,18	18
Lamiaceae	-	-	-	-	-	-	-	-	-	-	-	-	0,13	1	-	-	-	-	-	-	0,26	1	-	-	0,11	1	-	-	-	-	-	-	-	-	-	-
Lilium	-	-	0,30	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Oleaceae	-	-	-	-	-	-	-	-	0,31	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0,48	2	-	-	-	-	0,23	1
Parthenocissus	-	-	-	-	-	-	0,27	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Plantago	3,17	12	28,36	95	0,84	4	2,95	11	0,63	2	2,59	10	10,71	81	18,76	124	0,80	3	0,68	3	1,29	5	4,66	16	5,46	49	17,29	135	14,49	61	15,16	84	3,19	21	25,52	110
Platanus	3,70	14	13,13	44	1,47	7	16,09	60	26,02	83	29,53	114	-	-	0,30	2	-	-	-	-	-	-	-	-	0,22	2	-	-	-	-	0,18	1	-	-	-	-
Poaceae	1,85	7	11,64	39	0,63	3	5,63	21	3,13	10	3,11	12	28,57	216	8,62	57	9,63	36	0,91	4	1,03	4	1,17	4	3,01	27	5,89	46	15,91	67	15,52	86	6,83	45	13,69	59
Quercus	3,70	14	2,69	9	1,47	7	0,27	1	6,58	21	3,11	12	5,95	45	2,27	15	4,28	16	8,62	38	87,11	338	21,87	75	1,78	16	1,41	11	4,28	18	2,89	16	0,91	6	4,18	18
Ranunculaceae	-	-	-	-	-	-	-	-	-	-	-	-	0,66	5	0,30	2	0,27	1	-	-	-	-	-	-	-	-	0,13	1	-	-	0,18	1	0,30	2	-	-
Reseda	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0,15	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rhus	-	-	-	-	-	-	-	-	-	-	0,26	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rosaceae	-	-	-	-	-	-	-	-	-	-	-	-	0,93	7	-	-	52,67	197	-	-	-	-	-	-	-	-	0,51	4	-	-	-	-	-	-	0,23	1
Rumex	-	-	-	-	-	-	-	-	-	-	0,52	2	0,13	1	-	-	0,27	1	-	-	-	-	0,29	1	0,11	1	0,13	1	0,24	1	0,36	2	-	-	-	-
Salix	0,26	1	0,90	3	0,21	1	-	-	-	-	0,26	1	0,13	1	0,30	2	0,80	3	0,91	4	-	-	-	-	0,89	8	0,77	6	0,48	2	0,72	4	1,67	11	1,39	6
Sambucus	-	-	0,30	1	-	-	0,27	1	0,31	1	-	-	1,06	8	0,15	1	-	-	0,68	3	-	-	-	-	0,11	1	0,26	2	1,19	5	1,62	9	0,30	2	0,46	2
Saxifragaceae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0,15	1	-	-	-	-	-	-	-	-	0,11	1	-	-	-	-	-	-	0,15	1	-	-
Tilia	0,53	2	9,25	31	6,53	31	14,48	54	1,88	6	2,07	8	1,06	8	1,51	10	-	-	-	-	1,03	4	3,21	11	0,11	1	0,13	1	0,24	1	0,36	2	0,76	5	0,46	2
Typha	-	-	0,30	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2,92	10	-	-	-	-	-	-	-	-	-	-	-	-
Ulmus	1,06	4	-	-	-	-	1,34	5	-	-	1,30	5	-	-	-	-	-	-	-	-	-	-	-	-	0,11	1	0,13	1	0,71	3	-	-	0,30	2	0,23	1
Urticaceae/Cannabaceae	44,44	168	16,72	56	2,53	12	12,60	47	19,44	62	27,98	108	2,91	22	0,30	2	1,34	5	0,45	2	0,26	1	0,87	3	8,36	75	16,65	130	4,99	21	6,32	35	9,10	60	20,19	87
diverse Spores	13,76	52	1,19	4	0,21	1	0,80	3	4,70	15	2,07	8	33,73	255	51,44	340	9,09	34	27,89	123	-	-	11,66	40	66,33	595	46,99	367	20,43	86	26,35	146	50,99	336	5,57	24
	100		100		100		100		100		100		100		100		100		100		100		100		100		100		100		100		100		100	
Total count		378		334		475		373		319		386		756		661		374		441		388		343		897		781		421		554		659		431
Pollen count		**326**		**330**		**474**		**370**		**304**		**378**		**501**		**321**		**340**		**318**		**388**		**303**		**302**		**414**		**335**		**408**		**323**		**407**

Table 7: Combined Results of all samples. Pinaceae excluded.

3.2 Individual Samples

The following chapter comprises data from individual samples of the three main locations “Department of Botany and Biodiversity Research”, “House Bad Tatzmannsdorf” and “Outdoor Locations Bad Tatzmannsdorf”. At each location samples were taken from three sites. Every site contains both a spiderweb (“SDS”) and a dust/soil surface sample (“SDB”), giving a total of 18 respective samples. Associated tables and charts were generated to illustrate the resulting pollen spectra. Additionally, plates of pollen micrographs give an overview of the most abundant taxa of each sample.

Taxa that were identified but had a ratio too small to be of quantitative importance (<1 %), were termed “INR” (identified, not relevant). Categories “Pinaceae” and “Diverse Spores” were excluded from the following chapter. Percentages of “Diverse Spores” are subject of chapter “Spore Ratios”.

3.2.1 Location: Department of Botany and Biodiversity Research

Room E08

5SDS Spiderweb

Spiderweb sample 5SDS was retained from an office room at the ground floor of the "Department of Botany and Biodiversity Research". A total of 326 pollen grains was counted (Table 8). Urticaceae/Cannabaceae (51.53 %) had the highest abundance in the sample, followed by *Betula* sp. (Betulaceae) (12.58 %) and Fabaceae (8.90 %) (Figure **10**). Urticaceae/Cannabaceae (51.53 %), Fabaceae (8.90 %) and *Aesculus* sp. (Sapindaceae) (1.53 %) showed the highest percentages in 5SDS among all evaluated samples (Table 8). 53 % of the identified proximate vegetation was represented by the pollen spectra (see Figure 39 and Table 1).

Taxa	Percent	Count
Urticaceae/Cannabaceae	51.53	168
Betula	12.58	41
Fabaceae	8.90	29
Quercus	4.29	14
Platanus	4.29	14
Plantago	3.68	12
Poaceae	2.15	7
Alnus	1.84	6
Aesculus	1.53	5
Juglans	1.23	4
Fraxinus	1.23	4
Ulmus	1.23	4
INR	5.53	18
Total	100	326

INR		
Taxa	**Percent**	**Count**
Fagus	0.61	2
Tilia	0.61	2
Castanea	0.61	2
Apiaceae	0.61	2
Ambrosia	0.61	2
Ginkgo	0.31	1
Salix	0.31	1
Galium	0.31	1
Carpinus	0.31	1
Asteraceae	0.31	1
Artemisia	0.31	1
Amaranthaceae	0.31	1
Ailanthus	0.31	1

Table 8: Pollen percentages and counts of sample 5SDS.

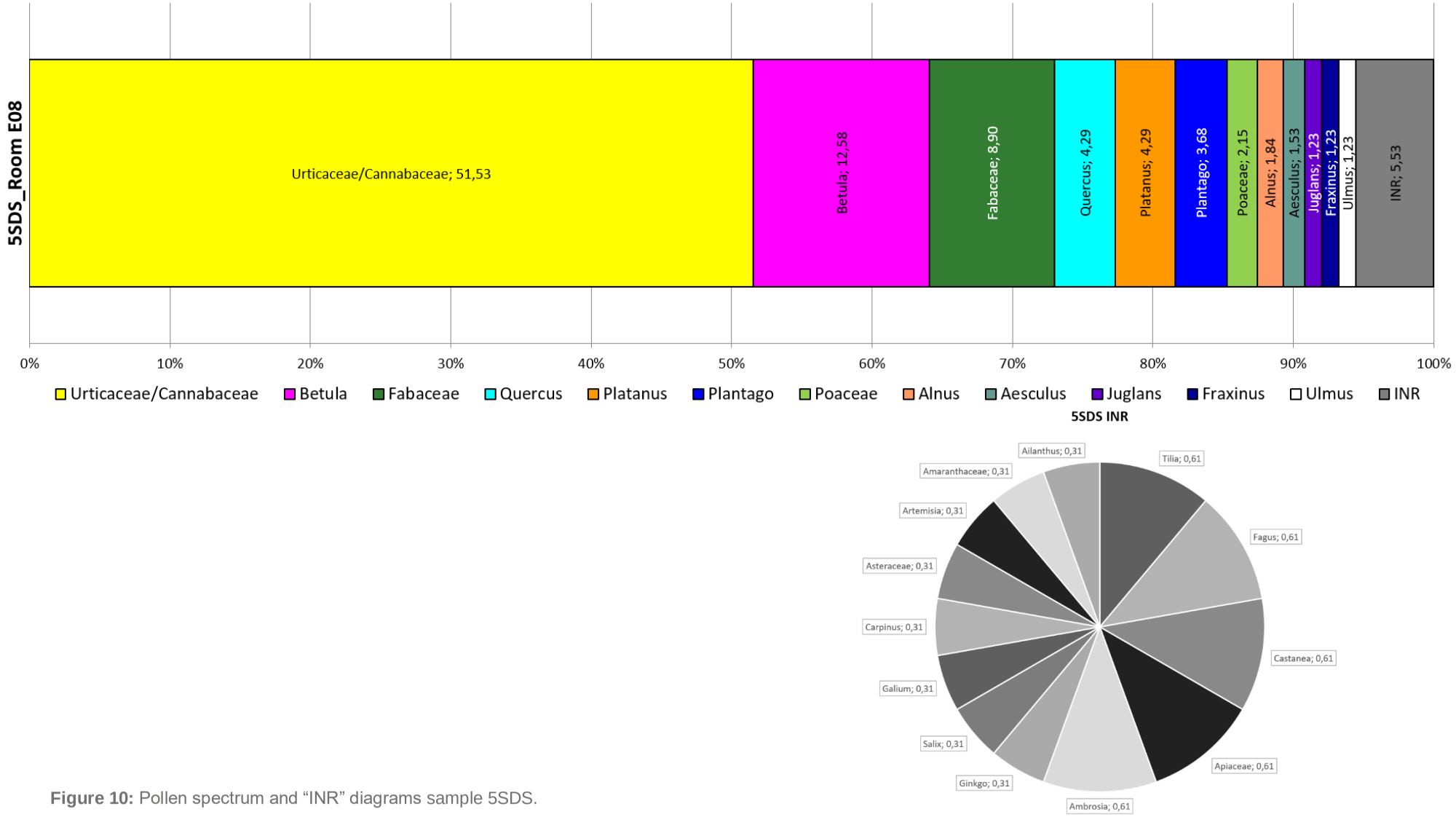


Figure 10: Pollen spectrum and "INR" diagrams sample 5SDS.

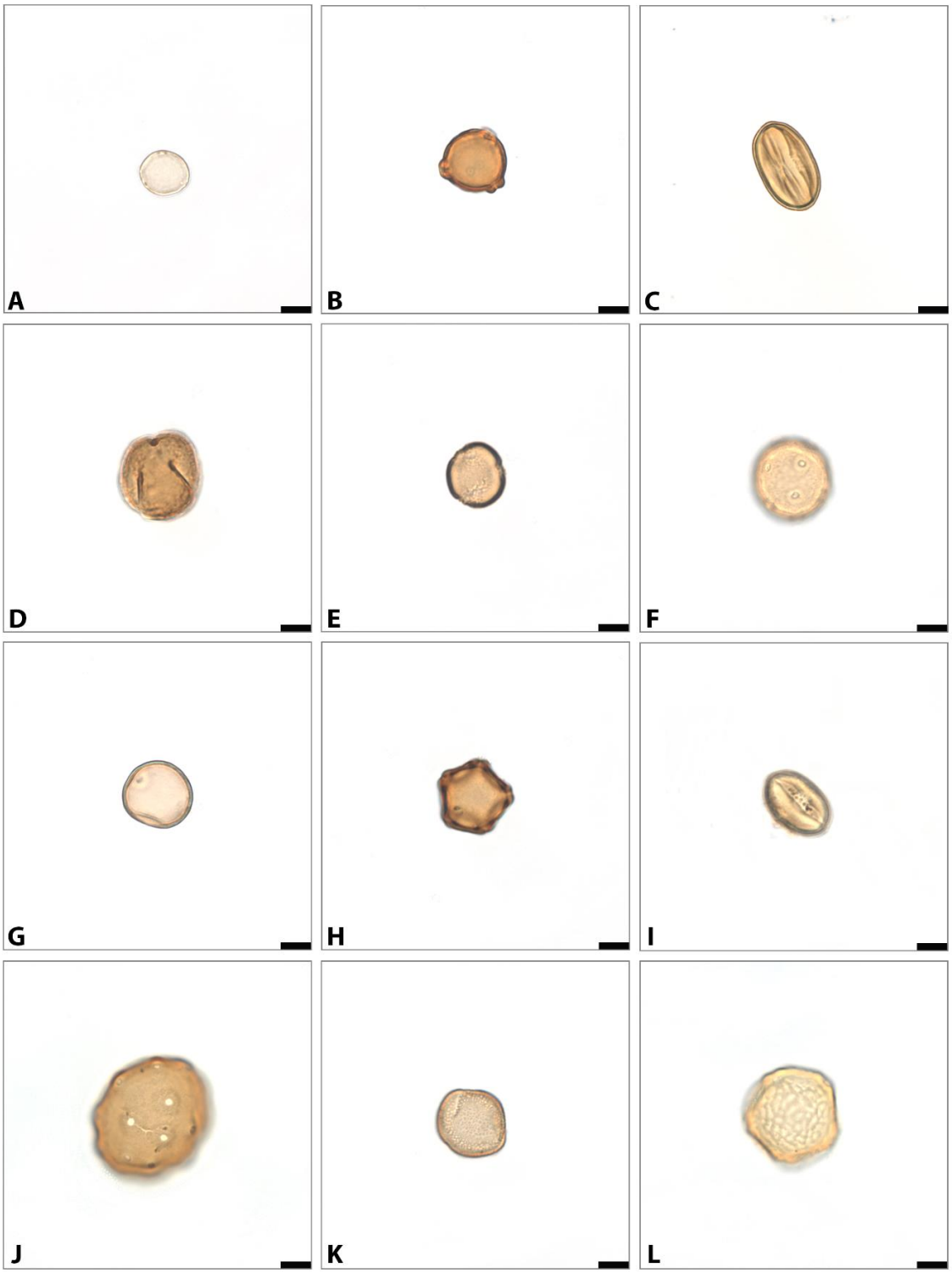


Plate 1: Light micrographs of most abundant taxa in sample 5SDS. Scale bar indicates 10 µm.: **A.** Urticaceae/Cannabaceae. **B.** *Betula*. **C.** Fabaceae. **D.** *Quercus*. **E.** *Platanus*. **F.** *Plantago*. **G.** Poaceae. **H.** *Alnus*.
I. *Aesculus*. **J.** *Juglans*. **K.** *Fraxinus*. **L.** *Ulmus*.

Location: Department of Botany and Biodiversity Research

Room E08

5SDB Floor

For the floor sample 5SDB, a total of 330 pollen grains was counted (Table 9). The highest fractions had *Plantago* sp. (Plantaginaceae) (28.70 %), Urticaceae/Cannabaceae (16.92 %) and *Platanus* sp. (Platanaceae) (13.29 %) (Figure 11). 5SDB held the greatest amount of *Plantago* sp. (Plantaginaceae) (28.70 %) of all samples (Table 7). 55 % of the identified proximate vegetation was represented by the pollen spectra. *Lilium* sp. (Liliaceae) was found only in the pollen sample (Table 1 and Figure 39).

Taxa	Percent	Count
Plantago	28.70	95
Urticaceae/Cannabaceae	16.92	56
Platanus	13.29	44
Poaceae	11.78	39
Tilia	9.37	31
Betula	4.53	15
Quercus	2.72	9
Ailanthus	1.81	6
Juglans	1.51	5
Brassicaceae	1.21	4
INR	5.14	26
Total	100	330

INR		
Taxa	**Percent**	**Count**
Fraxinus	0.91	3
Salix	0.91	3
Asteraceae	0.91	3
Dryopteris	0.60	2
Castanea	0.60	2
Acer	0.60	2
Lilium	0.30	1
Carya (Juglandaceae)	0.30	1
Euphorbiaceae	0.30	1
Typha	0.30	1
Ginkgo	0.30	1
Sambucus	0.30	1
Fagus	0.30	1
Fabaceae	0.30	1
Carpinus	0.30	1
Ambrosia	0.30	1
Amaranthaceae	0.30	1

Table 9: Pollen percentages and counts of sample 5SDB.

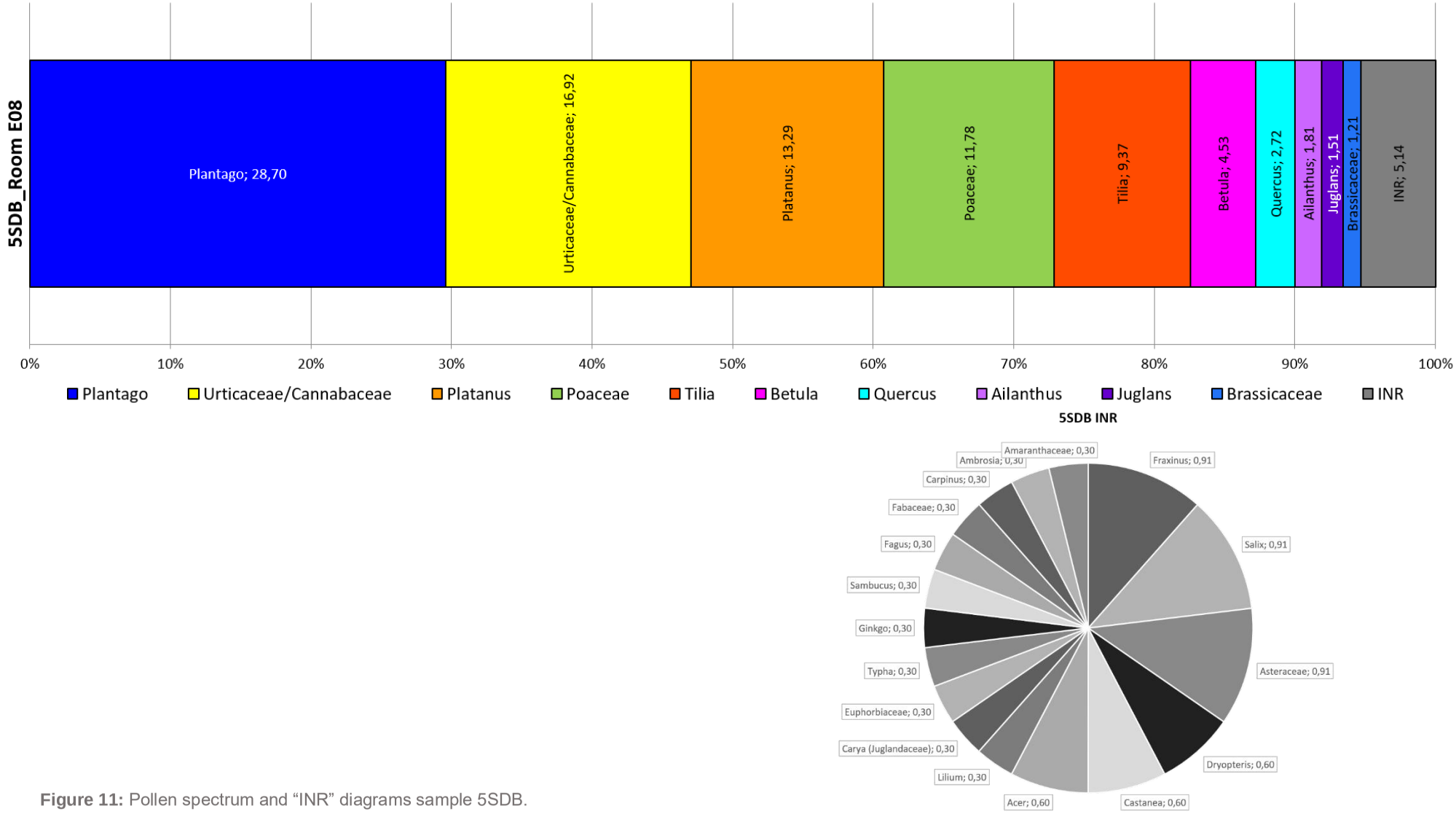


Figure 11: Pollen spectrum and "INR" diagrams sample 5SDB.

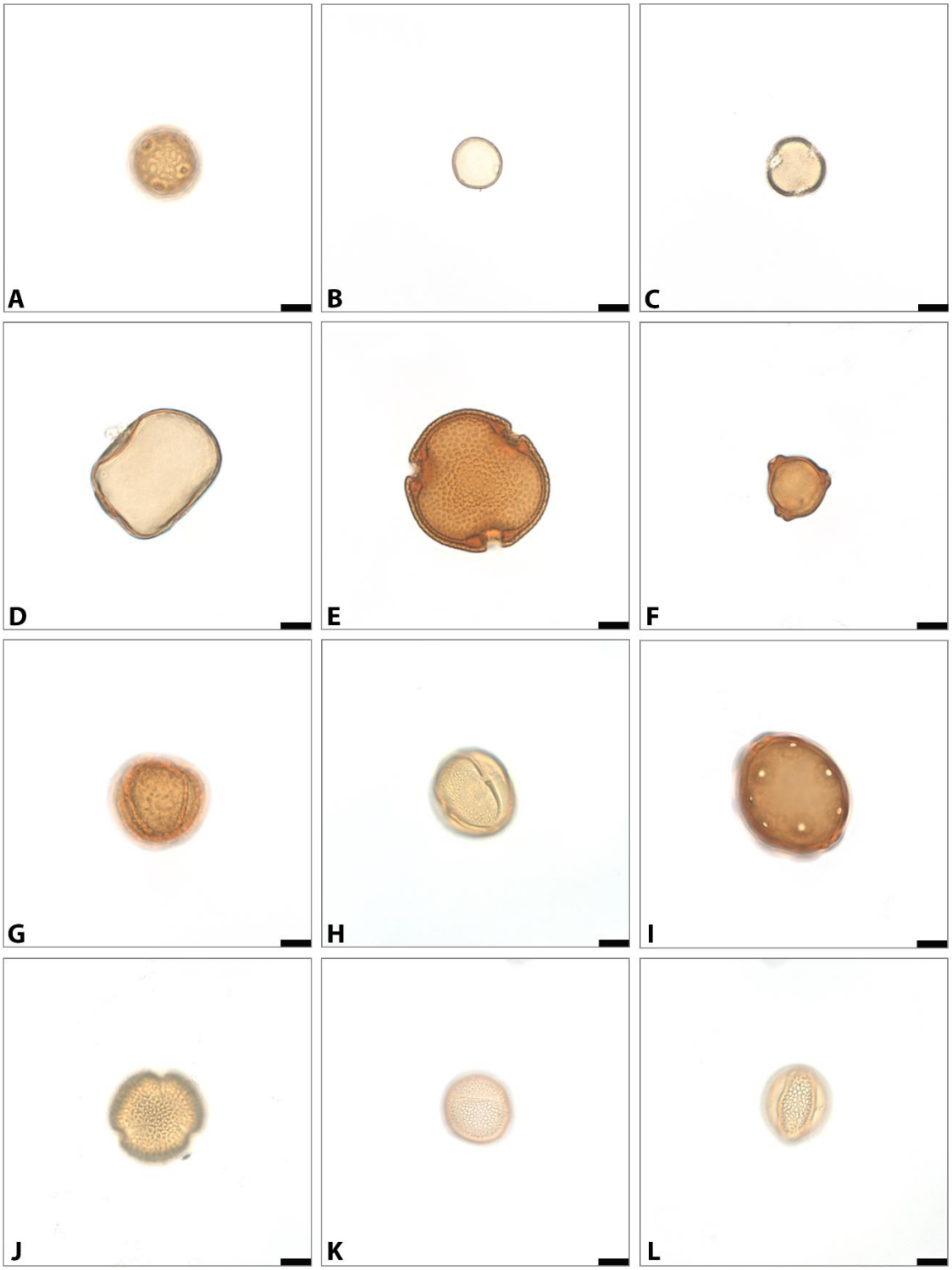


Plate 2: Light micrographs of most abundant taxa in sample 5SDB. Scale bar indicates 10 µm.: **A.** *Plantago*. **B.** Urticaceae/Cannabaceae. **C.** *Platanus*. **D.** Poaceae. **E.** *Tilia*. **F.** *Betula*. **G.** *Quercus*. **H.** *Ailanthus*. **I.** *Juglans*. **J.** Brassicaceae. **K.** *Fraxinus*. **L.** *Salix*.

Location: Department of Botany and Biodiversity Research

Room E08

Combined Results Spiderweb and Floor Sample (5SDS and 5SDB)

Urticaceae/Cannabaceae reached high percentages in both the spiderweb and the floor sample. 5SDS showed larger percentages of *Betula* sp. (Betulaceae) and Fabaceae, while in 5SDB numbers of *Plantago* sp. (Plantaginaceae), *Platanus* sp. (Platanaceae), Poaceae and *Tilia* sp. (Malvaceae) were increased (see Figure 12). In contrast to 5SDB, *Alnus* sp. (Betulaceae), *Aesculus* sp. (Sapindaceae), *Ulmus* sp. (Ulmaceae), *Galium* sp. (Rubiaceae), *Artemisia* sp. (Asteraceae) and Apiaceae were determined only in 5SDS. Whereas 5SDB contained *Acer* sp. (Sapindaceae), *Dryopteris* sp. (Dryopteridaceae), *Lilium* sp. (Liliaceae), *Typha* sp. (Typhaceae), *Sambucus* sp. (Adoxaceae), Caryophyllaceae, Euphorbiaceae and Brassicaceae (see Table 8 and Table 9). With 55 %, 5SDB reflected more of the proximate surrounding vegetation than 5SDS (53 %) (see Figure 39).

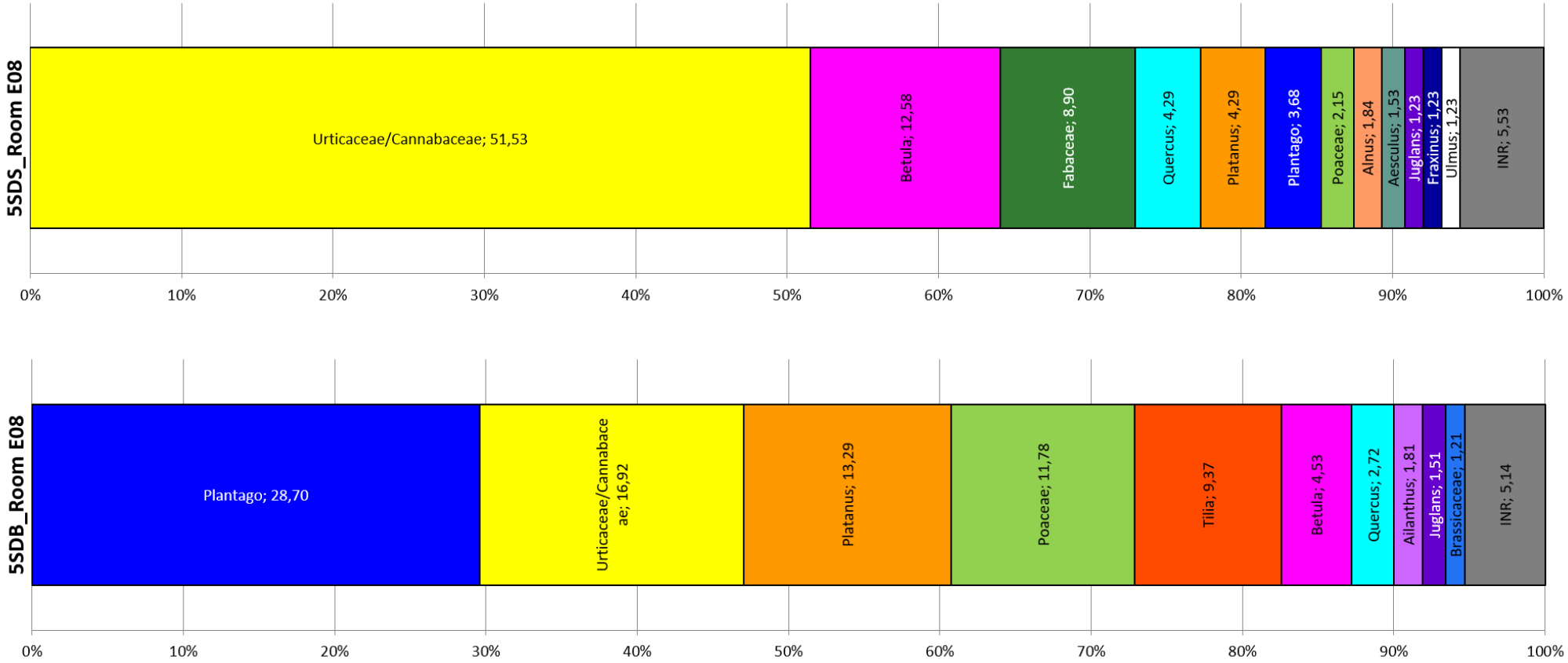


Figure 12: Pollen spectrum diagrams samples 5SDS and 5SDB.

Location: Department of Botany and Biodiversity Research

Room 416

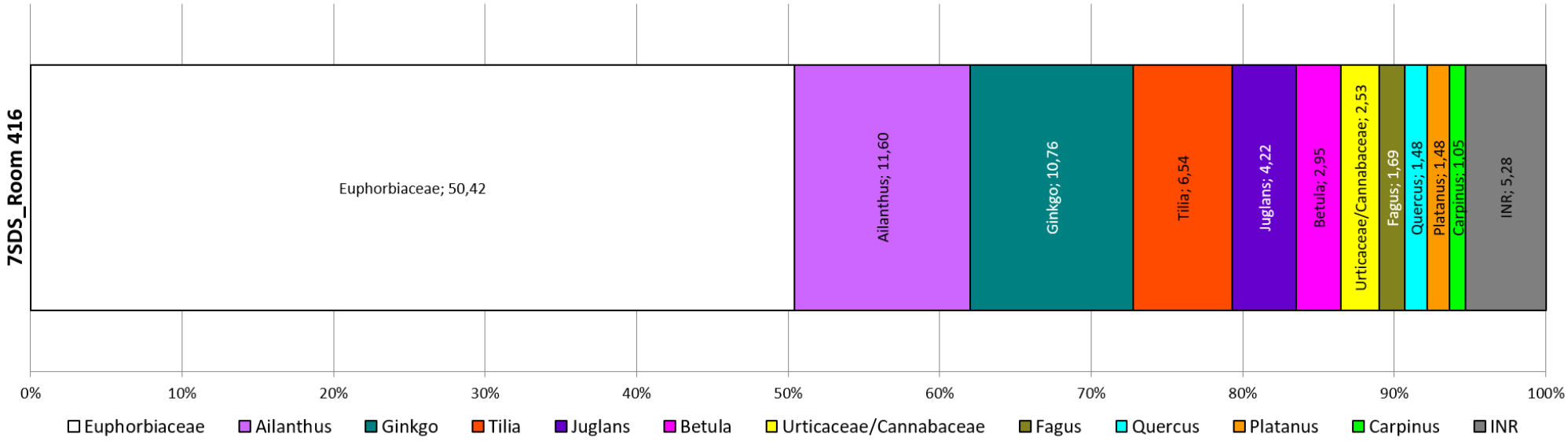
7SDS Spiderweb

Room 416 was located at the 4th floor of the building. Sampling time and constructional alternations in the area were overlapping. A total of 474 pollen grains was counted (Table 10). The most abundant taxa were Euphorbiaceae (50.42 %), *Ailanthus* sp. (Simaroubaceae) (11.60 %) and *Ginkgo* sp. (Ginkgoaceae) (10.76 %) (Figure 13). From all samples, 7SDS holds the highest amount of Euphorbiaceae (50.42 %) and *Ailanthus* sp. (Simaroubaceae) (11.60 %) (Table 7). Taxa found in the floor sample represented 45 % of the proximate surrounding vegetation (see Figure 39).

Taxa	Percent	Count
Euphorbiaceae	50.42	239
Ailanthus	11.60	55
Ginkgo	10.76	51
Tilia	6.54	31
Juglans	4.22	20
Betula	2.95	14
Urticaceae/Cannabaceae	2.53	12
Fagus	1.69	8
Quercus	1.48	7
Platanus	1.48	7
Carpinus	1.05	5
INR	5.28	25
Total	100	474

INR		
Taxa	**Percent**	**Count**
Plantago	0.84	4
Alnus	0.84	4
Fraxinus	0.63	3
Poaceae	0.63	3
Brassicaceae	0.63	3
Corylus	0.42	2
Ambrosia	0.42	2
Amaranthaceae	0.42	2
Salix	0.21	1
Asteraceae	0.21	1

Table 10: Pollen percentages and counts of sample 7SDS.



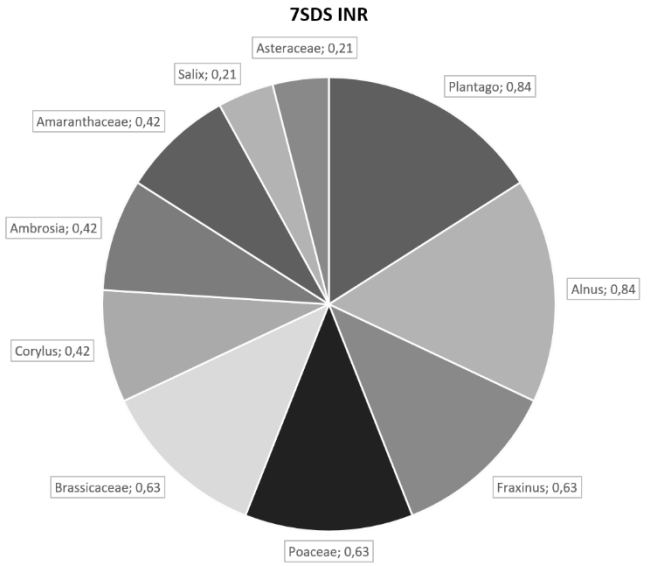


Figure 13: Pollen spectrum and "INR" diagrams sample 7SDS.

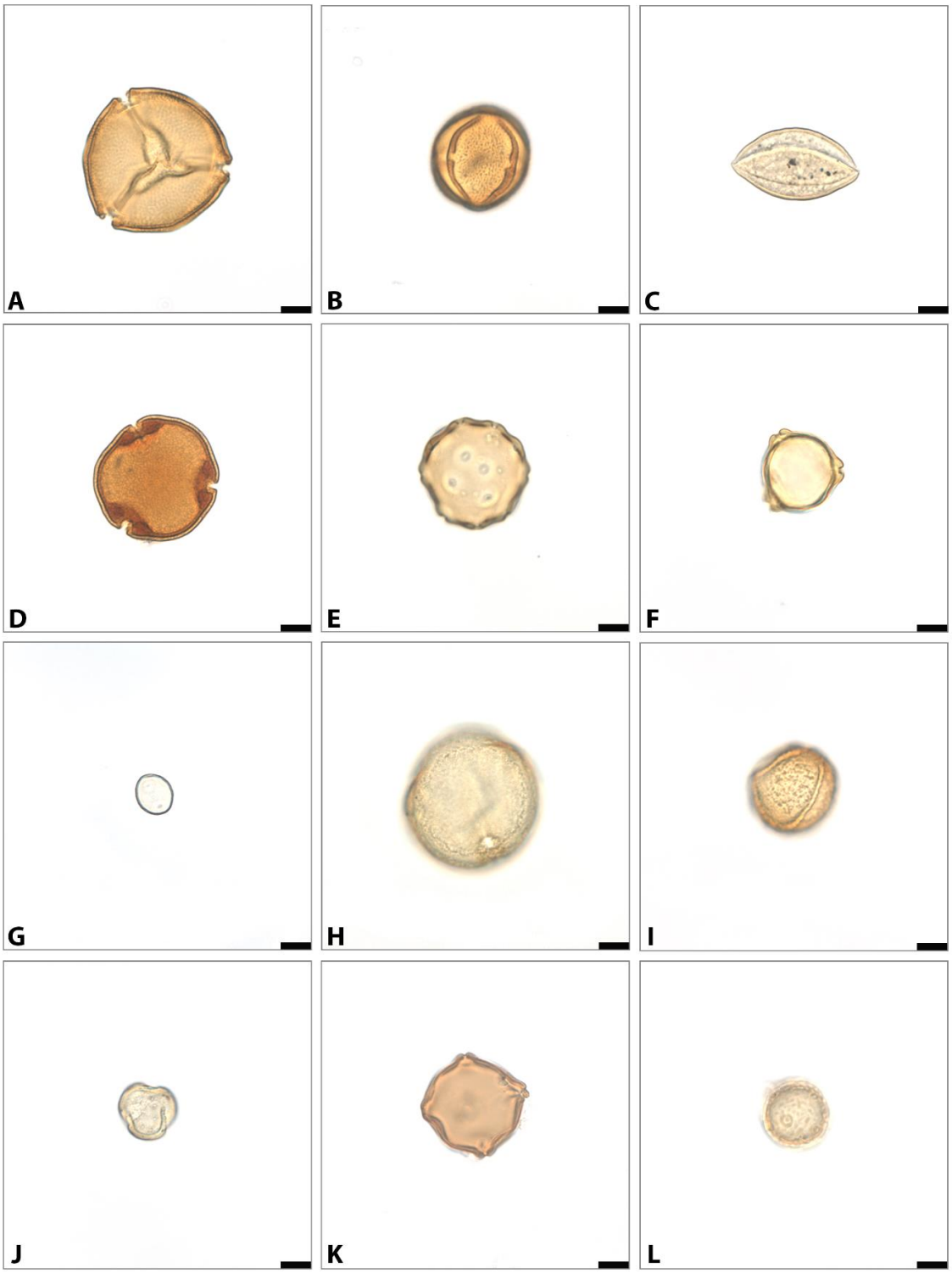


Plate 3: Light micrographs of most abundant taxa in sample 7SDS. Scale bar indicates 10 µm.: **A.** Euphorbiaceae. **B.** *Ailanthus*. **C.** *Ginkgo*. **D.** *Tilia*. **E.** *Juglans*. **F.** *Betula*. **G.** Urticaceae/Cannabaceae. **H.** *Fagus*. **I.** *Quercus*. **J.** *Platanus*. **K.** *Carpinus*. **L.** *Plantago*.

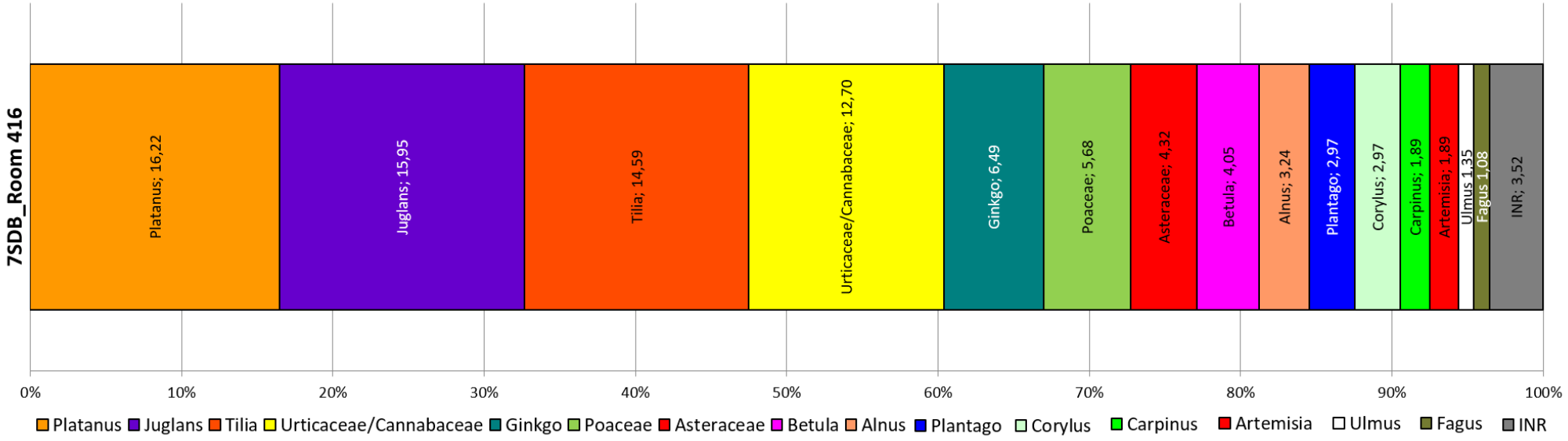
Location: Department of Botany and Biodiversity Research
Room 416
7SDB Floor

For the floor sample of Room 416, a total of 370 pollen grains was counted (Table 11). The most abundant taxa were *Platanus* sp. (Platanaceae) (16.22 %), *Juglans* sp. (Juglandaceae) (15.95 %) and *Tilia* sp. (Malvaceae) (14.59 %) (Figure 14). Across all samples, *Juglans* sp. (Juglandaceae) (15.95 %), *Tilia* sp. (Malvaceae) (14.59 %) and *Artemisia* sp. (Asteraceae) (1.89 %) showed highest percentages in 7SDB (Table 7). 51 % of the determined plant taxa proximate to the sampling location (see Table 1) were recognized in the pollen spectra as well (see Figure 39).

Taxa	Percent	Count
Platanus	16.22	60
Juglans	15.95	59
Tilia	14.59	54
Urticaceae/Cannabaceae	12.70	47
Ginkgo	6.49	24
Poaceae	5.68	21
Asteraceae	4.32	16
Betula	4.05	15
Alnus	3.24	12
Plantago	2.97	11
Corylus	2.97	11
Carpinus	1.89	7
Artemisia	1.89	7
Ulmus	1.35	5
Fagus	1.08	4
Ambrosia	1.08	4
INR	3.52	13
Total	100	370

INR		
Taxa	**Percent**	**Count**
Amaranthaceae	0.81	3
Brassicaceae	0.54	2
Ailanthus	0.54	2
Aesculus	0.54	2
Euphorbiaceae	0.27	1
Parthenocissus	0.27	1
Sambucus	0.27	1
Quercus	0.27	1

Table 11: Pollen percentages and counts of sample 7SDB.



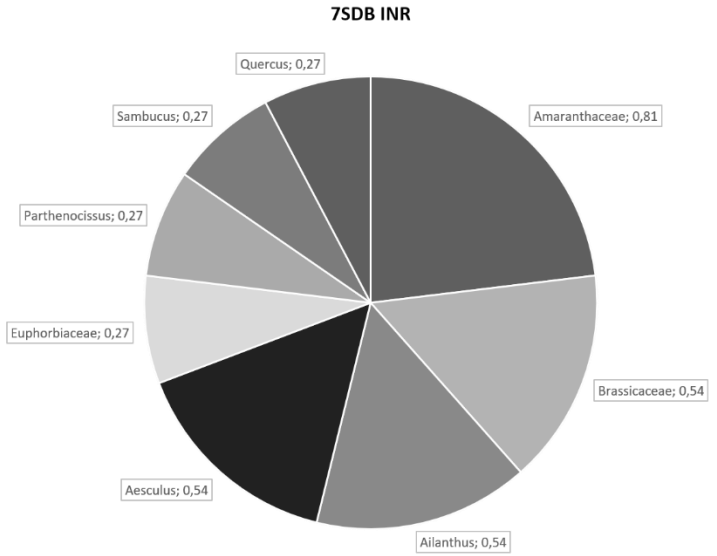


Figure 14: Pollen spectrum and "INR" diagrams sample 7SDB.

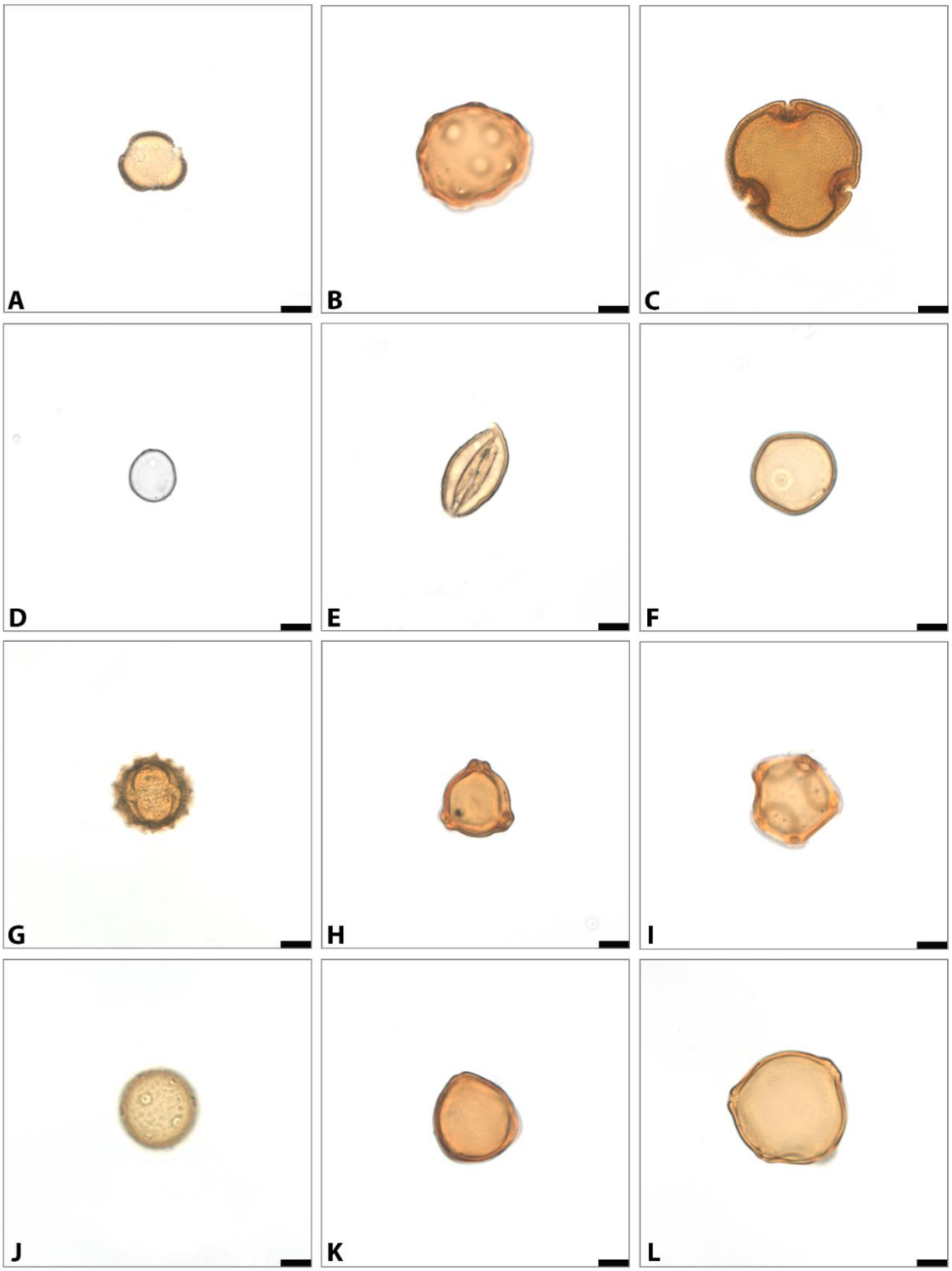


Plate 4: Light micrographs of most abundant taxa in sample 7SDB. Scale bar indicates 10 µm.: **A**. *Platanus*. **B**. *Juglans*. **C**. *Tilia*. **D**. Urticaceae/Cannabaceae. **E**. *Ginkgo*. **F**. Poaceae. **G**. Asteraceae. **H**. *Betula*. **I**. *Alnus*. **J**. *Plantago*. **K**. *Corylus*. **L**. *Carpinus*.

Location: Department of Botany and Biodiversity Research

Room 416

Combined Results Spiderweb and Floor Sample (7SDS and 7SDB)

Being negligible in 7SDB, Euphorbiaceae composed over half of the pollen amount in 7SDS. Also, *Ailanthus* sp. (Simaroubaceae) was more dominant in this sample. In 7SDB *Platanus* sp. (Platanaceae) and Poaceae percentages are increased (Figure 15). 7SDS is lacking *Sambucus* sp. (Adoxaceae), *Parthenocissus* sp. (Vitaceae), *Aesculus* sp. (Sapindaceae), *Artemisia* sp. (Asteraceae) and *Ulmus* sp. (Ulmaceae) compared to 7SDB, in which *Fraxinus* sp. (Oleaceae) and *Salix* sp. (Salicaceae) were not determined (see Table 10 and Table 11). 7SDB reflected 51 % of the proximate surrounding vegetation, while for 7SDS only 45 % were reached (see Figure 39).

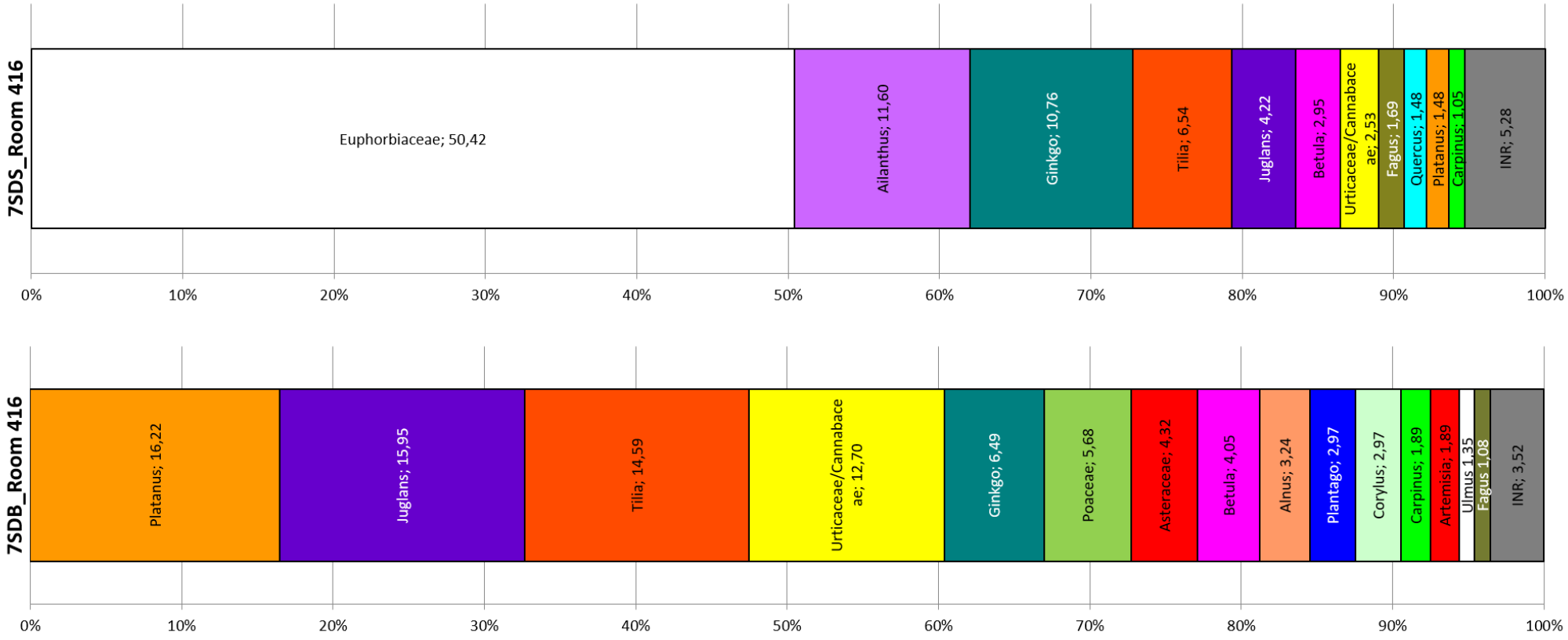


Figure 15: Pollen spectra diagrams samples 7SDS and 7SDB.

Location: Department of Botany and Biodiversity Research

Room 414

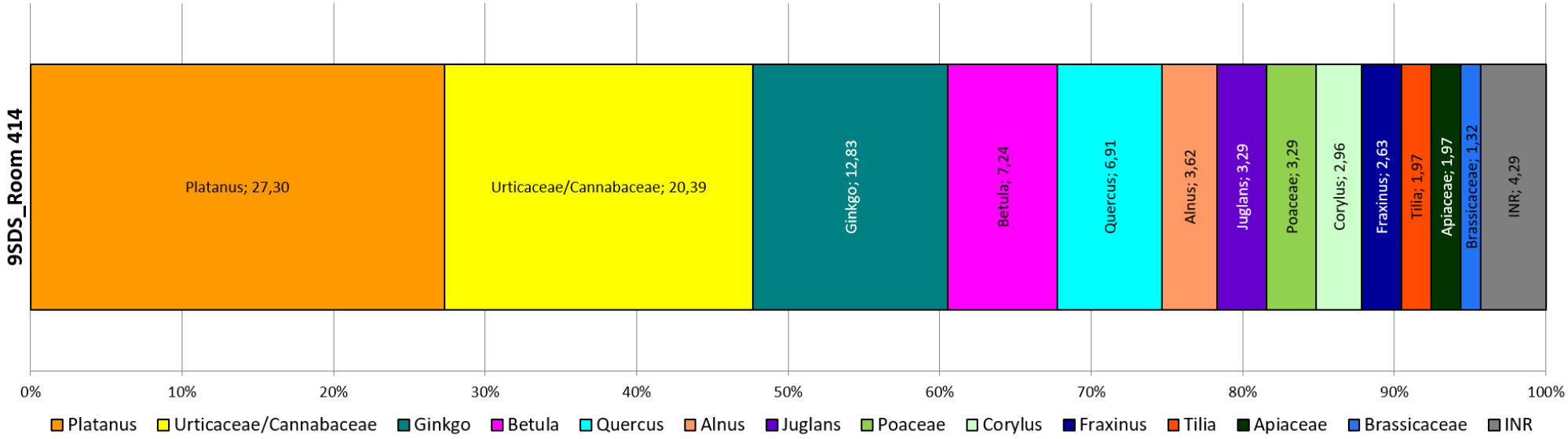
9SDS Spiderweb

Also, Room 414 was located at the 4th floor of the building and was under construction at sampling time. Here, a total of 304 pollen grains was counted (Table 12). The three highest abundant taxa were *Platanus* sp. (Platanaceae) (27.30 %), followed by Urticaceae /Cannabaceae (20.39 %) and *Ginkgo* sp. (Ginkgoaceae) (12.83 %) (Figure 16). The latter shows its largest amount in 9SDS among all samples (Table 7). Determined pollen grains represented 51 % of the close surrounding vegetation (see Figure 39).

Taxa	Percent	Count
Platanus	27.30	83
Urticaceae/Cannabaceae	20.39	62
Ginkgo	12.83	39
Betula	7.24	22
Quercus	6.91	21
Alnus	3.62	11
Juglans	3.29	10
Poaceae	3.29	10
Corylus	2.96	9
Fraxinus	2.63	8
Tilia	1.97	6
Apiaceae	1.97	6
Brassicaceae	1.32	4
INR	4.29	13
Total	100	304

INR		
Taxa	**Percent**	**Count**
Plantago	0.66	2
Ambrosia	0.66	2
Oleaceae	0.33	1
Hedera	0.33	1
Sambucus	0.33	1
Fagus	0.33	1
Fabaceae	0.33	1
Artemisia	0.33	1
Amaranthaceae	0.33	1
Ailanthus	0.33	1
Acer	0.33	1

Table 12: Pollen percentages and counts of sample 9SDS.



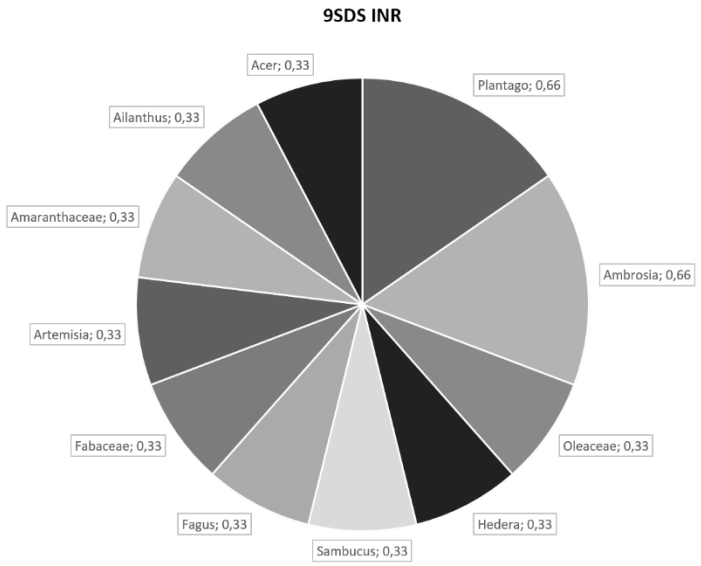


Figure 16: Pollen spectrum and "INR" diagrams sample 9SDS.

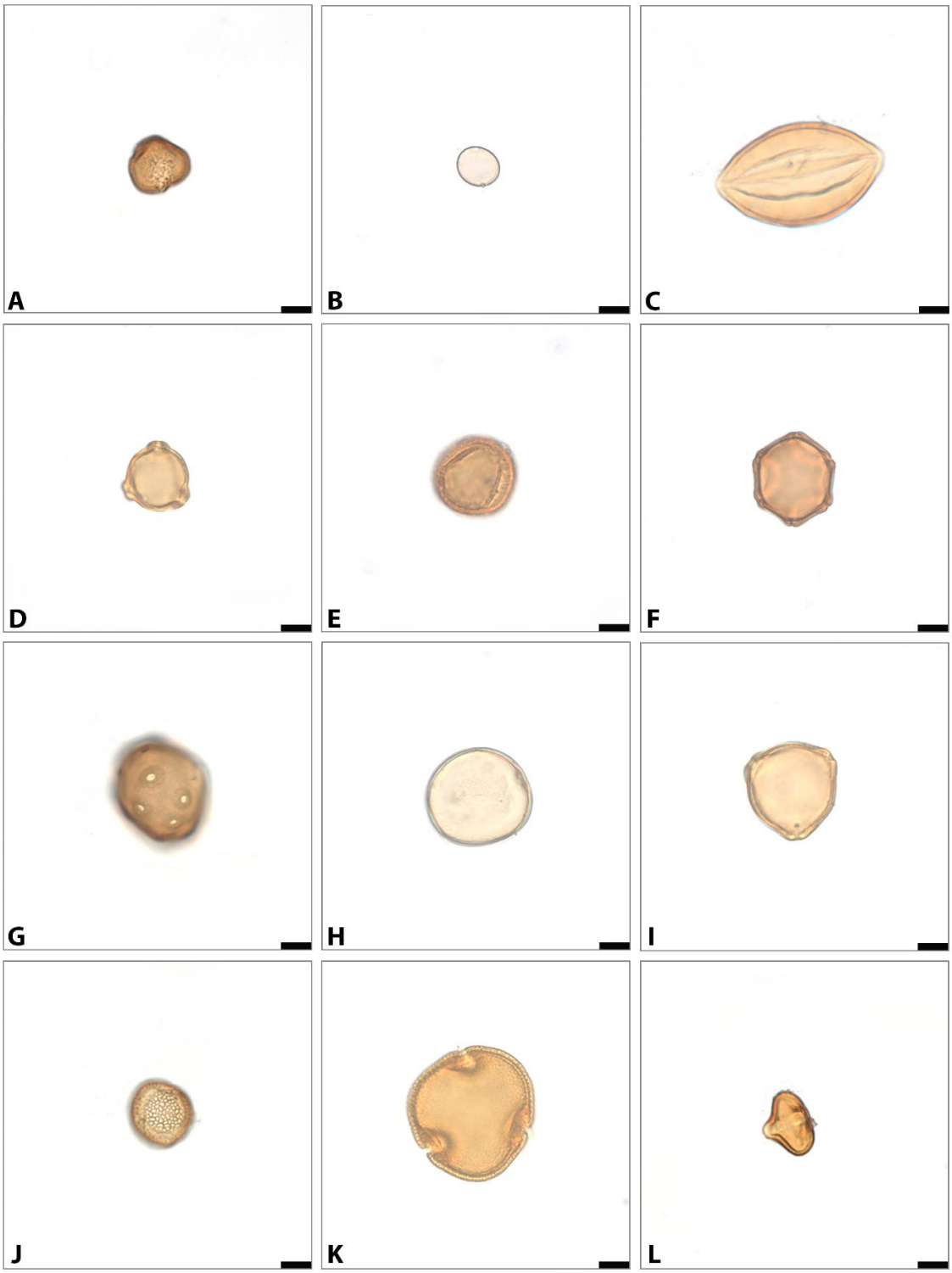


Plate 5: Light micrographs of most abundant taxa in sample 9SDS. Scale bar indicates 10 µm.: **A**. *Plantago*. **B**. Urticaceae/Cannabaceae. **C**. *Ginkgo*. **D**. *Betula*. **E**. *Quercus*. **F**. *Alnus*. **G**. *Juglans*. **H**. Poaceae. **I**. *Corylus*. **J**. *Fraxinus*. **K**. *Tilia*. **L**. Apiaceae.

Location: Department of Botany and Biodiversity Research

Room 414

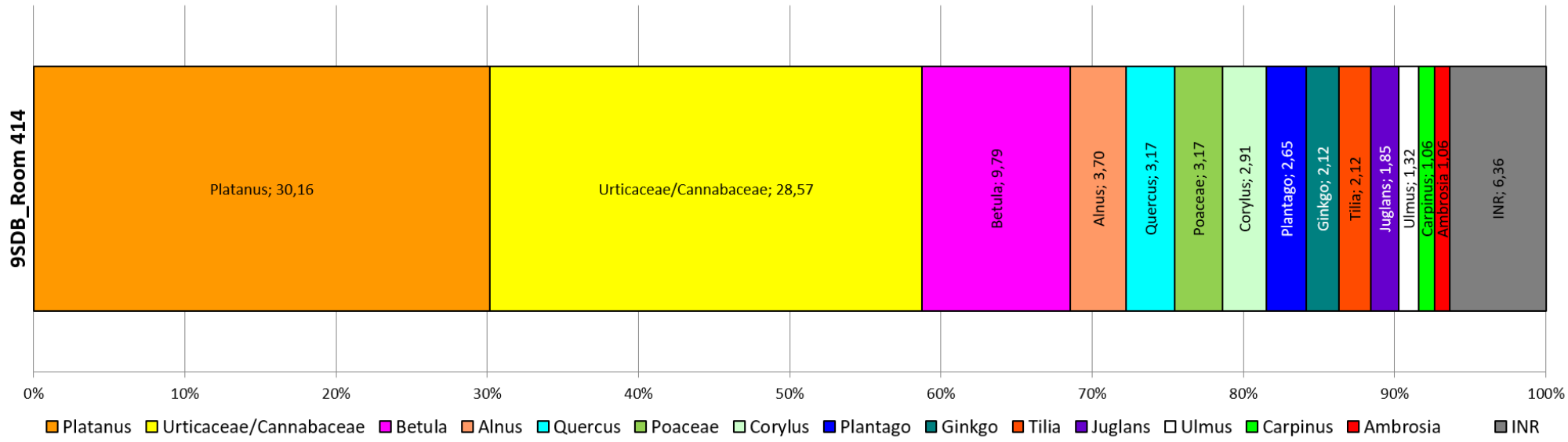
9SDB Floor

For 9SDB, a total of 409 pollen grains was identified (Table 13). The sample showed a pollen spectrum with *Platanus* sp. (Platanaceae) (30.16 %) as the dominating taxon, followed by Urticaceae/Cannabaceae (28.57 %) and *Betula* sp. (Betulaceae) (9.79 %) (Figure 17). *Platanus* sp. (Platanaceae) had the highest abundance in 9SDB of all samples (Table 7). 60 % of the identified proximate vegetation (Table 1) was represented by the pollen spectra (see Figure 39).

Taxa	Percent	Count
Platanus	30.16	144
Urticaceae/Cannabaceae	28.57	108
Betula	9.79	37
Alnus	3.70	14
Quercus	3.17	12
Poaceae	3.17	12
Corylus	2.91	11
Plantago	2.65	10
Ginkgo	2.12	8
Tilia	2.12	8
Juglans	1.85	7
Ulmus	1.32	5
Carpinus	1.06	4
Ambrosia	1.06	4
INR	6.36	25
Total	100	409

INR		
Taxa	**Percent**	**Count**
Fraxinus	0.79	3
Cornus	0.79	3
Fagus	0.79	3
Rumex	0.53	2
Galium	0.53	2
Artemisia	0.53	2
Amaranthaceae	0.53	2
Rhus	0.26	1
Hedera	0.26	1
Salix	0.26	1
Castanea	0.26	1
Ailanthus	0.26	1
Aesculus	0.26	1
Acer	0.26	1

Table 13: Pollen percentages and counts of sample 9SDB.



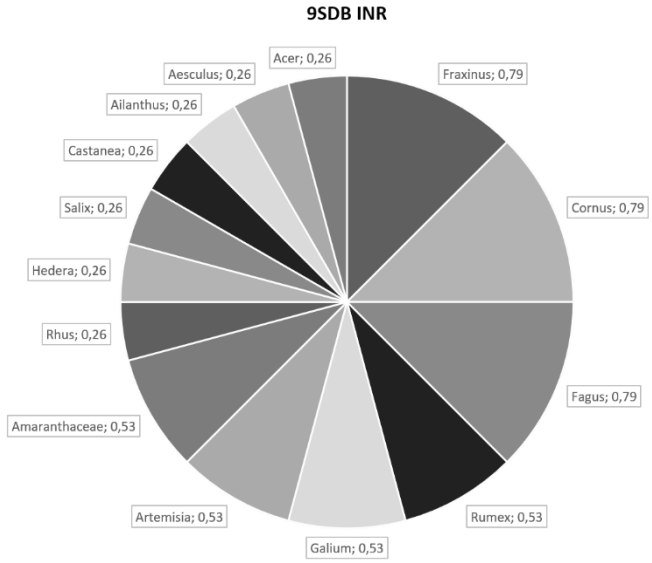


Figure 17: Pollen spectrum and "INR" diagrams sample 9SDB.

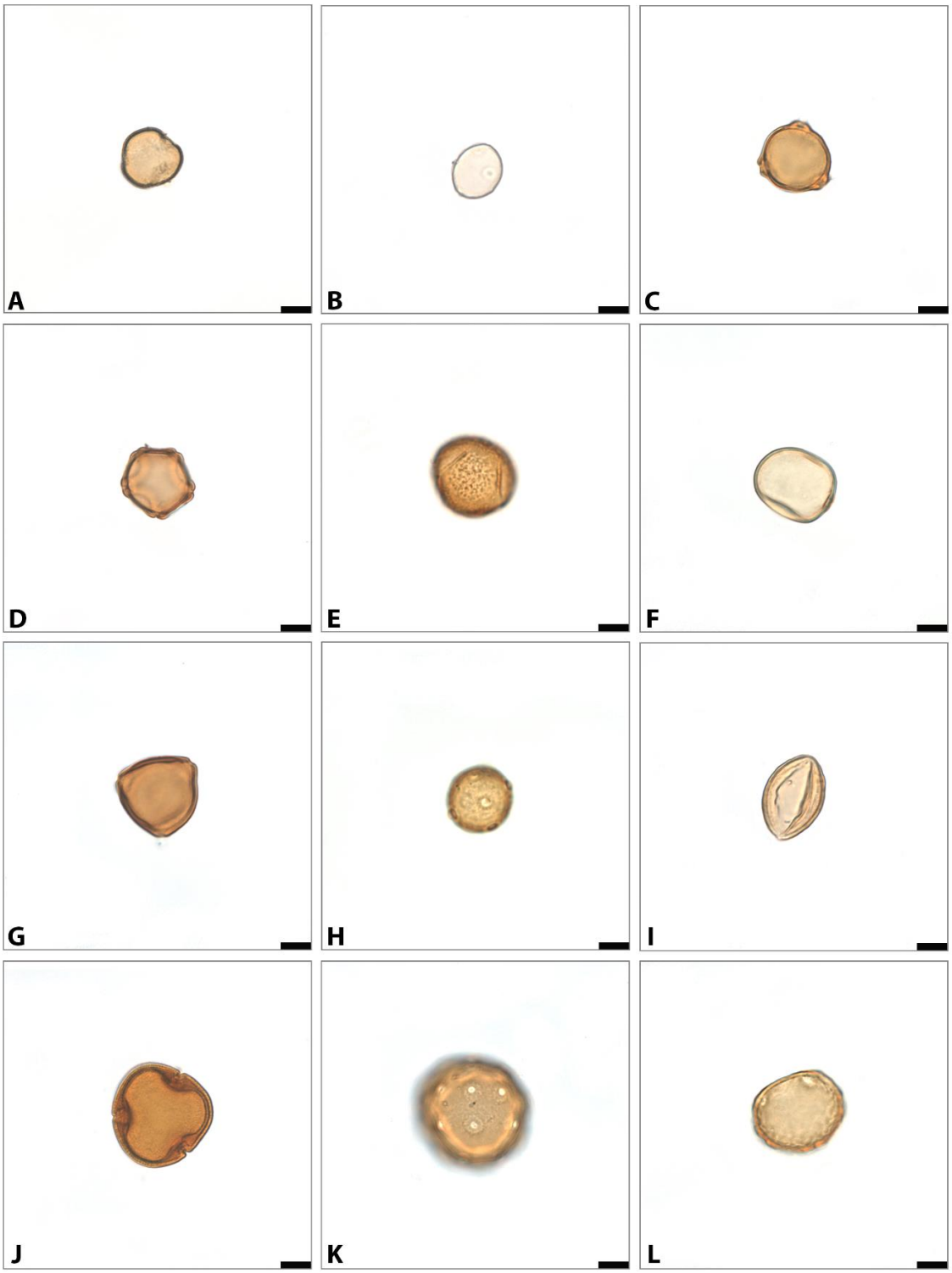


Plate 6: Light micrographs of most abundant taxa in sample 9SDB. Scale bar indicates 10 µm.: **A**. *Platanus*. **B**. Urticaceae/Cannabaceae. **C**. *Betula*. **D**. *Alnus*. **E**. *Quercus*. **F**. Poaceae. **G**. *Corylus*. **H**. *Plantago*. **I**. *Ginkgo*. **J**. *Tilia*. **K**. *Juglans*. **L**. *Ulmus*.

Location: Department of Botany and Biodiversity Research

Room 414

Combined Results Spiderweb and Floor Sample (9SDS and 9SDB)

Both samples showed high percentages of *Platanus* sp. (Platanaceae) and Urticaceae/Cannabaceae. In 9SDS the amount of *Ginkgo* sp. (Ginkgoaceae) was increased (Figure 18). Compared to the floor sample, 9SDS was lacking *Ulmus* sp. (Ulmaceae), *Carpinus* sp. (Betulaceae), *Cornus* sp. (Cornaceae), *Rumex* sp. (Polygonaceae), *Galium* sp. (Rubiaceae), *Rhus* sp. (Anacardiaceae), *Salix* sp. (Salicaceae), *Castanea* sp. (Fagaceae) and *Aesculus* sp. (Sapindaceae). In 9SDB *Sambucus* sp. (Adoxaceae), Apiaceae, Brassicaceae, Oleaceae and Fabaceae were not determined. Also, for this sampling site the surrounding vegetation was reflected better by the floor sample (9SDB, 60 %) than by the spiderweb sample (9SDS, 51 %) (see Figure **39**).

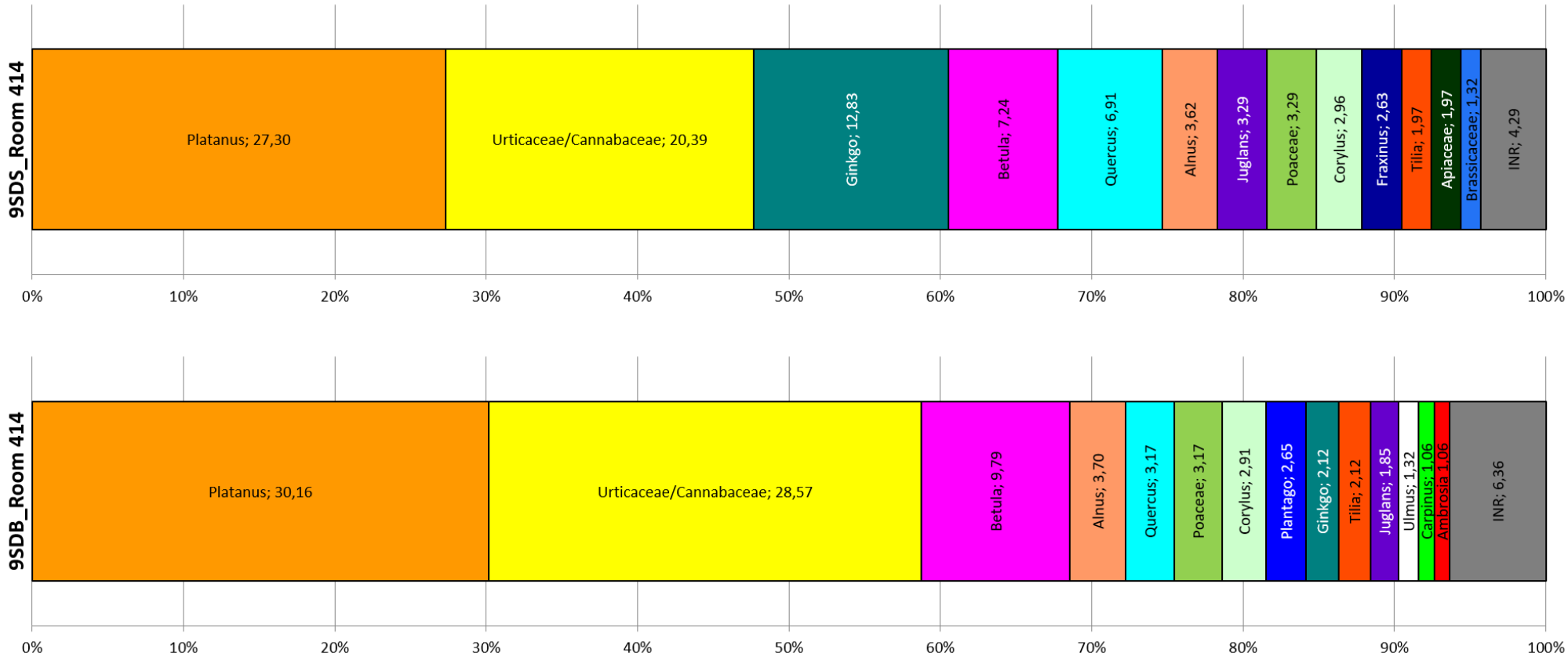


Figure 18: Pollen spectrum diagrams samples 9SDS and 9SDB.

Location: Department of Botany and Biodiversity Research

All Rooms Combined

Combined Results Spiderweb and Floor Samples (5SDS, 5SDB; 7SDS, 7SDB; 9SDS, 9SDB)

Noticeable differences between the samples of this location were the high amount of *Plantago* sp. (Plantaginaceae) pollen in 5SDB as well as of Euphorbiaceae and *Ailanthus* sp. (Simaroubaceae) in 7SDS. Also, the majority of *Ginkgo* sp. (Ginkgoaceae) pollen occurred in samples 7 and 9. The only noteworthy appearance of Fabaceae was in 5SDS (Figure 19). In all cases floor samples reflected higher portions of the surrounding vegetation than spiderweb samples (see Figure 39).

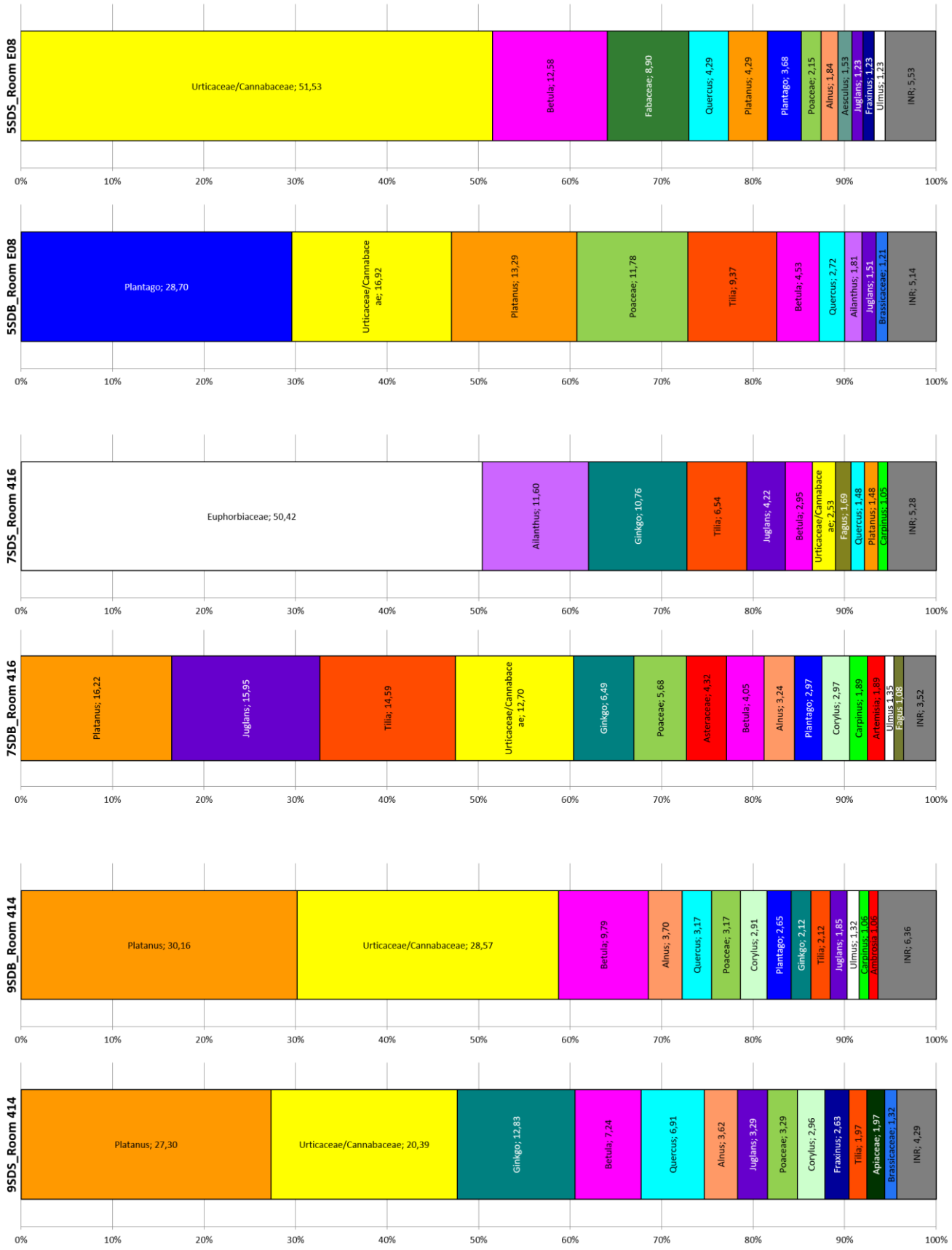


Figure 19: Pollen spectra diagrams of all samples of location “Department of Botany and Biodiversity Research”.

3.2.2 Location: House Bad Tatzmannsdorf

Kitchen

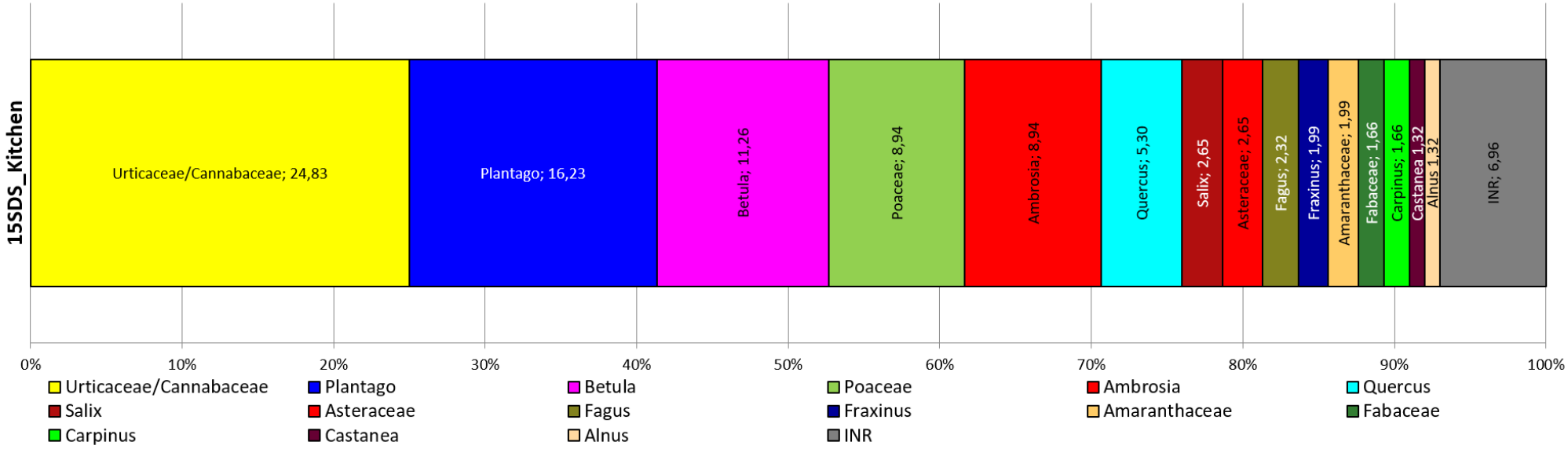
15SDS Spiderweb

Sample 15SDS was collected from the kitchen at the ground floor level of the building. From 302 identified pollen grains, the dominant taxon was Urticaceae/Cannabaceae (24.83 %), followed by *Plantago* sp. (Plantaginaceae) (16.23 %) and *Betula* sp. (Betulaceae) (11.26 %) (Table 14). This was the only sample Caryophyllaceae pollen was determined (see Table 7). Concerning location "House Bad Tatzmannsdorf" Lamiaceae, and Caryophyllaceae were found exclusively in this samples. 17 % of the identified taxa proximate to the sampling location (Table 2) were recognized in the pollen spectrum (see Figure 39). The following taxa were determined in the pollen sample only: *Carpinus* sp. (Betulaceae), *Artemisia* sp. (Asteraceae), *Platanus* sp. (Platanaceae), *Ailanthus* sp. (Simaroubaceae) (Table 14).

Taxa	Percent	Count
Urticaceae/Cannabaceae	24.83	75
Plantago	16.23	49
Betula	11.26	34
Poaceae	8.94	27
Ambrosia	8.94	27
Quercus	5.30	16
Salix	2.65	8
Asteraceae	2.65	8
Fagus	2.32	7
Fraxinus	1.99	6
Amaranthaceae	1.99	6
Fabaceae	1.66	5
Carpinus	1.66	5
Castanea	1.32	4
Alnus	1.32	4
INR	6.96	21
Total	100	302

INR		
Taxa	**Percent**	**Count**
Juglans	0.99	3
Galium	0.99	3
Artemisia	0.99	3
Platanus	0.66	2
Saxifragaceae	0.33	1
Lamiaceae	0.33	1
Ulmus	0.33	1
Tilia	0.33	1
Sambucus	0.33	1
Rumex	0.33	1
Caryophyllaceae	0.33	1
Brassicaceae	0.33	1
Apiaceae	0.33	1
Ailanthus	0.33	1

Table 14: Pollen percentages and counts of sample 15SDS.



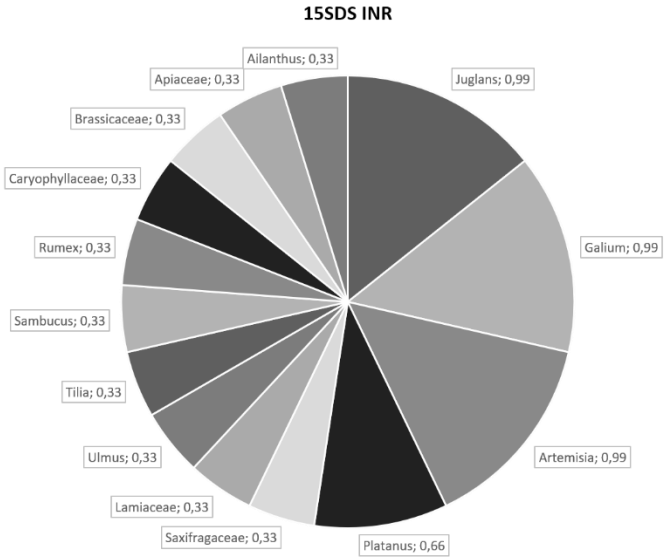


Figure 20: Pollen spectrum and "INR" diagrams sample 15SDS.

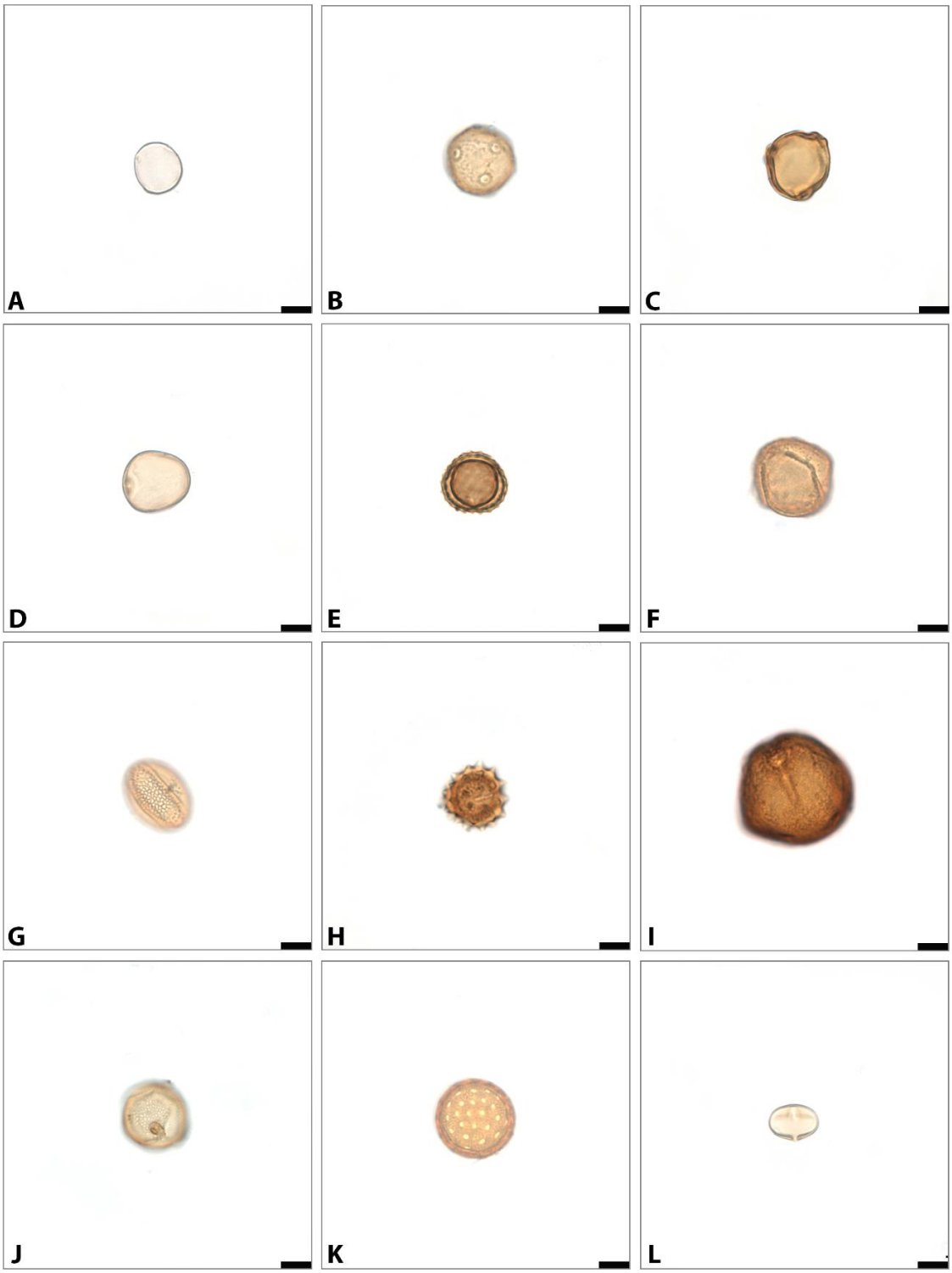


Plate 7: Light micrographs of most abundant taxa in sample 15SDS. Scale bar indicates 10 µm.: **A**. Urticaceae/Cannabaceae. **B**. *Plantago*. **C**. *Betula*. **D**. Poaceae. **E**. *Ambrosia*. **F**. *Quercus*. **G**. *Salix*. **H**. Asteraceae. **I**. *Fagus*. **J**. *Fraxinus*. **K**. Amaranthaceae. **L**. Fabaceae.

Location: House Bad Tatzmannsdorf

Kitchen

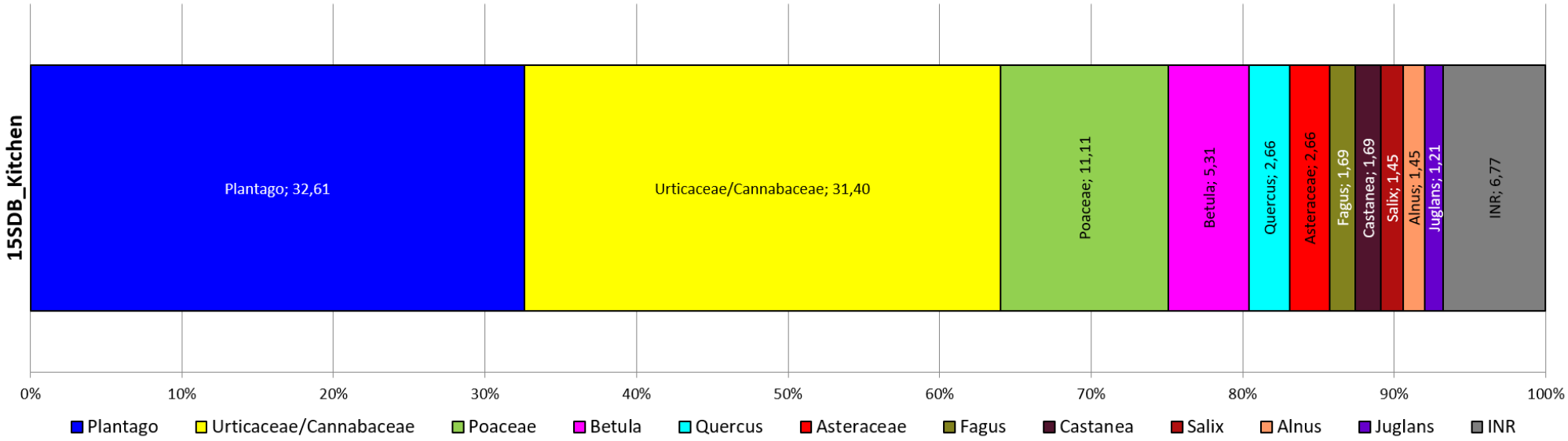
15SDB Floor

The dominating taxa from a total count of 414 pollen grains (Table 15) in floor sample 15SDB were *Plantago* sp. (Plantaginaceae) (32.61 %), Urticaceae/Cannabaceae (31.40 %) and Poaceae (11.11 %) (Figure 21). Determined pollen grains represented 16 % of the close surrounding vegetation (Table 2, Figure 39). *Ginkgo* sp. (Ginkgoaceae) was found only in the pollen sample. *Hedera* sp. (Araliaceae) was detected exclusively in 15SDB regarding this location.

Taxa	Percent	Count
Plantago	32.61	135
Urticaceae/Cannabaceae	31.40	130
Poaceae	11.11	46
Betula	5.31	22
Quercus	2.66	11
Asteraceae	2.66	11
Fagus	1.69	7
Castanea	1.69	7
Salix	1.45	6
Alnus	1.45	6
Juglans	1.21	5
INR	6.77	28
Total	100	414

INR		
Taxa	**Percent**	**Count**
Rosaceae	0.97	4
Brassicaceae	0.97	4
Amaranthaceae	0.72	3
Hedera	0.48	2
Ginkgo	0.48	2
Fraxinus	0.48	2
Sambucus	0.48	2
Galium	0.48	2
Ambrosia	0.48	2
Ulmus	0.24	1
Tilia	0.24	1
Rumex	0.24	1
Ranunculaceae	0.24	1
Corylus	0.24	1

Table 15: Pollen percentages and counts of sample 15SDB.



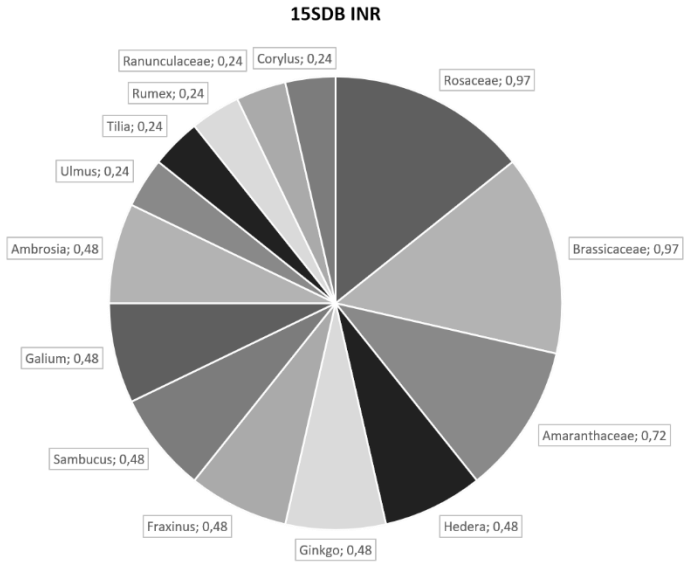


Figure 21: Pollen spectrum and "INR" diagrams sample 15SDB.

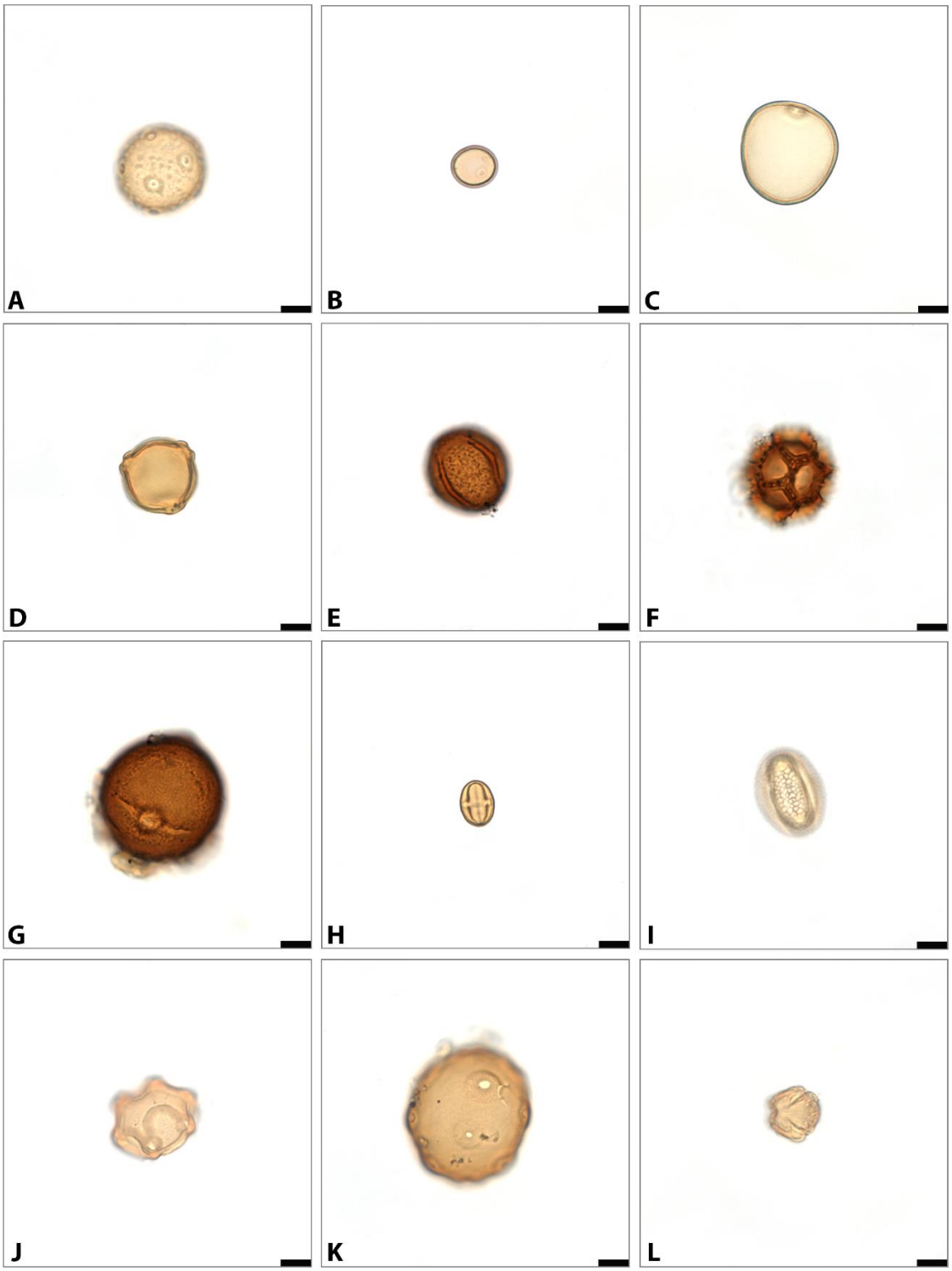


Plate 8: Light micrographs of most abundant taxa in sample 15SDB. Scale bar indicates 10 µm.: **A**. *Plantago*. **B**. Urticaceae/Cannabaceae. **C**. Poaceae. **D**. *Betula*. **E**. *Quercus*. **F**. Asteraceae. **G**. *Fagus*. **H**. *Castanea*. **I**. *Salix*. **J**. *Alnus*. **K**. *Juglans*. **L**. Rosaceae.

Location: House Bad Tatzmannsdorf

Kitchen

Combined Results Spiderweb and Floor sample (15SDS and 15SDB)

Spiderweb and floor samples showed similar pollen spectra except for *Ambrosia* sp. (Asteraceae) appearing in significant numbers in 15SDS and the inverted order of amounts of Urticaceae/Cannabaceae and *Plantago* sp. (Plantaginaceae) for these two samples (Figure 22). In contrast to the floor sample the following taxa were only determined in 15SDS: *Carpinus* sp. (Betulaceae), *Saxifraga* sp. (Saxifragaceae), *Platanus* sp. (Platanaceae), Lamiaceae, Caryophyllaceae and Apiaceae. However, 15SDB contained *Hedera* sp. (Araliaceae), *Ginkgo* sp. (Ginkgoaceae) and Ranunculaceae. Spiderweb sample 15SDS (17 %) reflected slightly higher ratios of the surrounding vegetation than 15SDB (16 %) (see Figure 39).

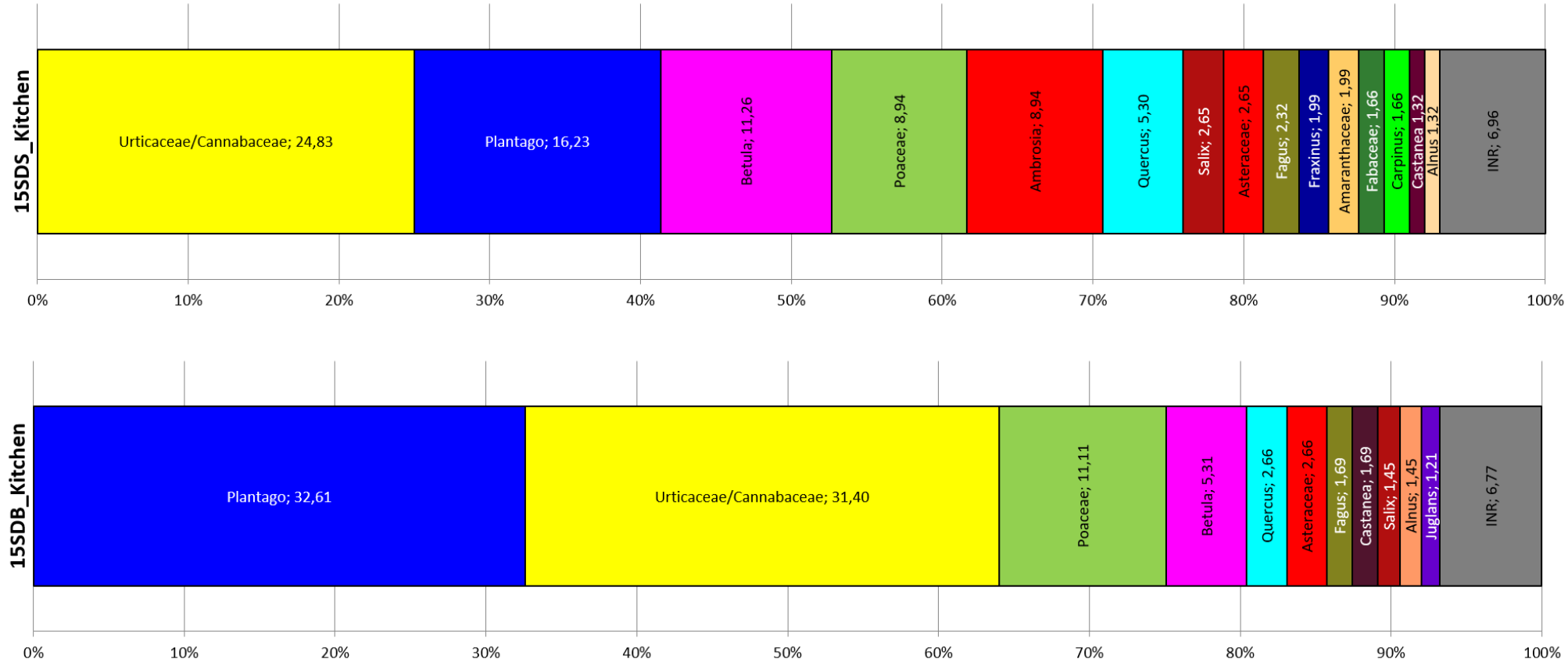


Figure 22: Pollen spectra diagrams samples 15SDS and 15SDB.

Location: House Bad Tatzmannsdorf

Annex

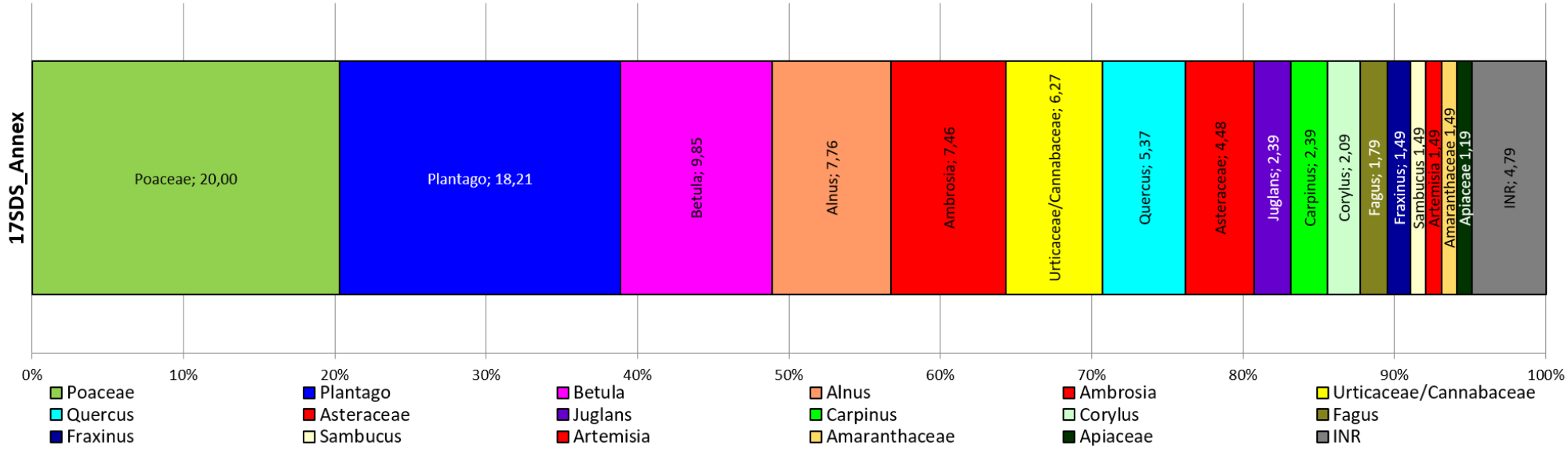
17SDS Spiderweb

The annex is a compartment separated from the other locations in “House Bad Tatzmannsdorf”. In spiderweb sample 17SDS a total of 335 pollen grains were identified (Table 16). The dominating taxon was Poaceae (20.00 %) followed by *Plantago* sp. (Plantaginaceae) (18.21 %) and *Betula* sp. (Betulaceae) (9.85 %) (Figure 23). 15 % of the identified proximate vegetation was represented by the pollen spectra (see Figure 39). *Carpinus* sp. (Betulaceae), *Artemisia* sp. (Asteraceae) and *Impatiens* sp. (Balsaminaceae) were not found in proximate surrounding vegetation.

Taxa	Percent	Count
Poaceae	20.00	67
Plantago	18.21	61
Betula	9.85	33
Alnus	7.76	26
Ambrosia	7.46	25
Urticaceae/Cannabaceae	6.27	21
Quercus	5.37	18
Asteraceae	4.48	15
Juglans	2.39	8
Carpinus	2.39	8
Corylus	2.09	7
Fagus	1.79	6
Fraxinus	1.49	5
Sambucus	1.49	5
Artemisia	1.49	5
Amaranthaceae	1.49	5
Apiaceae	1.19	4
INR	4.79	16
Total	100	335

INR		
Taxa	**Percent**	**Count**
Ulmus	0.90	3
Castanea	0.90	3
Oleaceae	0.60	2
Salix	0.60	2
Brassicaceae	0.60	2
Impatiens	0.30	1
Tilia	0.30	1
Rumex	0.30	1
Galium	0.30	1

Table 16: Pollen percentages and counts of sample 17SDS.



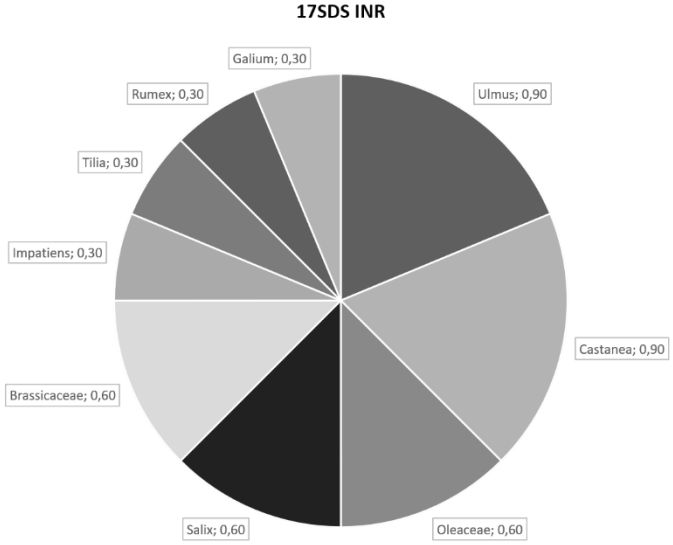


Figure 23: Pollen spectrum and "INR" diagrams sample 17SDS.

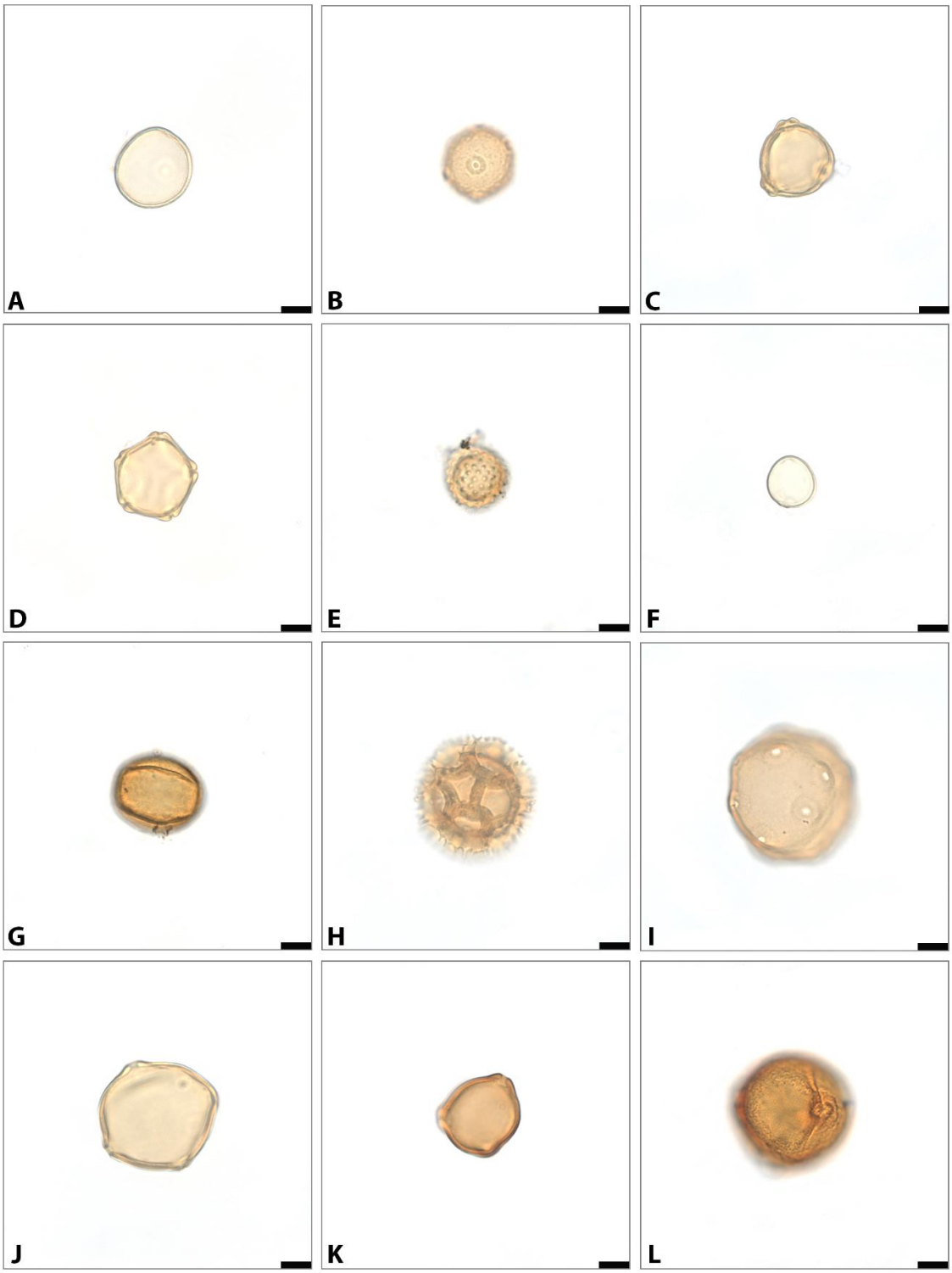


Plate 9: Light micrographs of most abundant taxa in sample 17SDS. Scale bar indicates 10 µm.: **A**. Poaceae. **B**. *Plantago*. **C**. *Betula*. **D**. *Alnus*. **E**. *Ambrosia*. **F**. Urticaceae/Cannabaceae. **G**. *Quercus*. **H**. Asteraceae. **I**. *Juglans*. **J**. *Carpinus*. **K**. *Corylus*. **L**. *Fagus*.

Location: House Bad Tatzmannsdorf

Annex

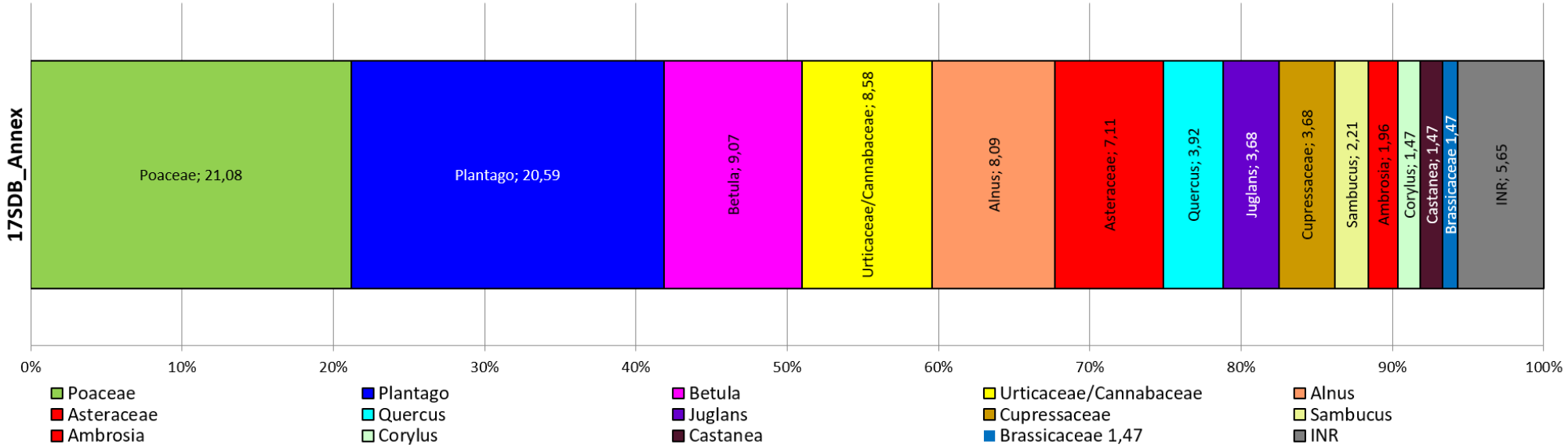
17SDB Floor

For the floor sample of the annex, a total of 408 pollen grains was identified (Table 17), with Poaceae (21.08 %) as the dominating taxon. Second most abundant was *Plantago* sp. (Plantaginaceae) (20.59 %) followed by *Betula* sp. (Betulaceae) (9.07 %) (Figure 24). Compared to all other samples, 17SDB had the highest numbers of Cupressaceae (3.68 %) (Table 7). Taxa found in the floor sample represented 16 % of the proximate surrounding vegetation (see Figure 39). *Impatiens* sp. (Balsaminaceae), *Ginkgo* sp. (Ginkgoaceae), *Platanus* sp. (Platanaceae) and *Artemisia* sp. (Asteraceae) were not determined in the close environment. From all samples from location „House Bad Tatzmannsdorf" exclusively 17SDB contained *Acer* sp. (Sapindaceae).

Taxa	Percent	Count
Poaceae	21.08	86
Plantago	20.59	84
Betula	9.07	37
Urticaceae/Cannabaceae	8.58	35
Alnus	8.09	33
Asteraceae	7.11	29
Quercus	3.92	16
Juglans	3.68	15
Cupressaceae	3.68	15
Sambucus	2.21	9
Ambrosia	1.96	8
Corylus	1.47	6
Castanea	1.47	6
Brassicaceae	1.47	6
INR	5.65	26
Total	100	408

INR		
Taxa	**Percent**	**Count**
Fraxinus	0.98	4
Salix	0.98	4
Amaranthaceae	0.98	4
Tilia	0.49	2
Rumex	0.49	2
Impatiens	0.25	1
Ginkgo	0.25	1
Galium	0.25	1
Ranunculaceae	0.25	1
Platanus	0.25	1
Artemisia	0.25	1
Acer	0.25	1

Table 17: Pollen percentages and counts of sample 17SDB.



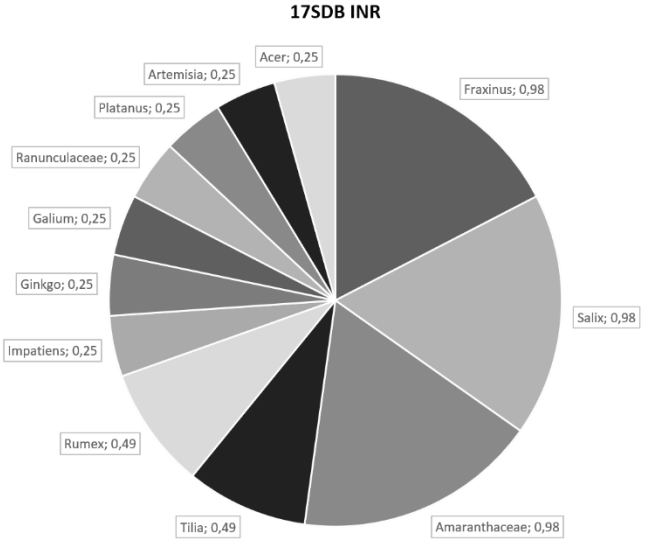


Figure 24: Pollen spectrum and “INR” diagrams sample 17SDB.

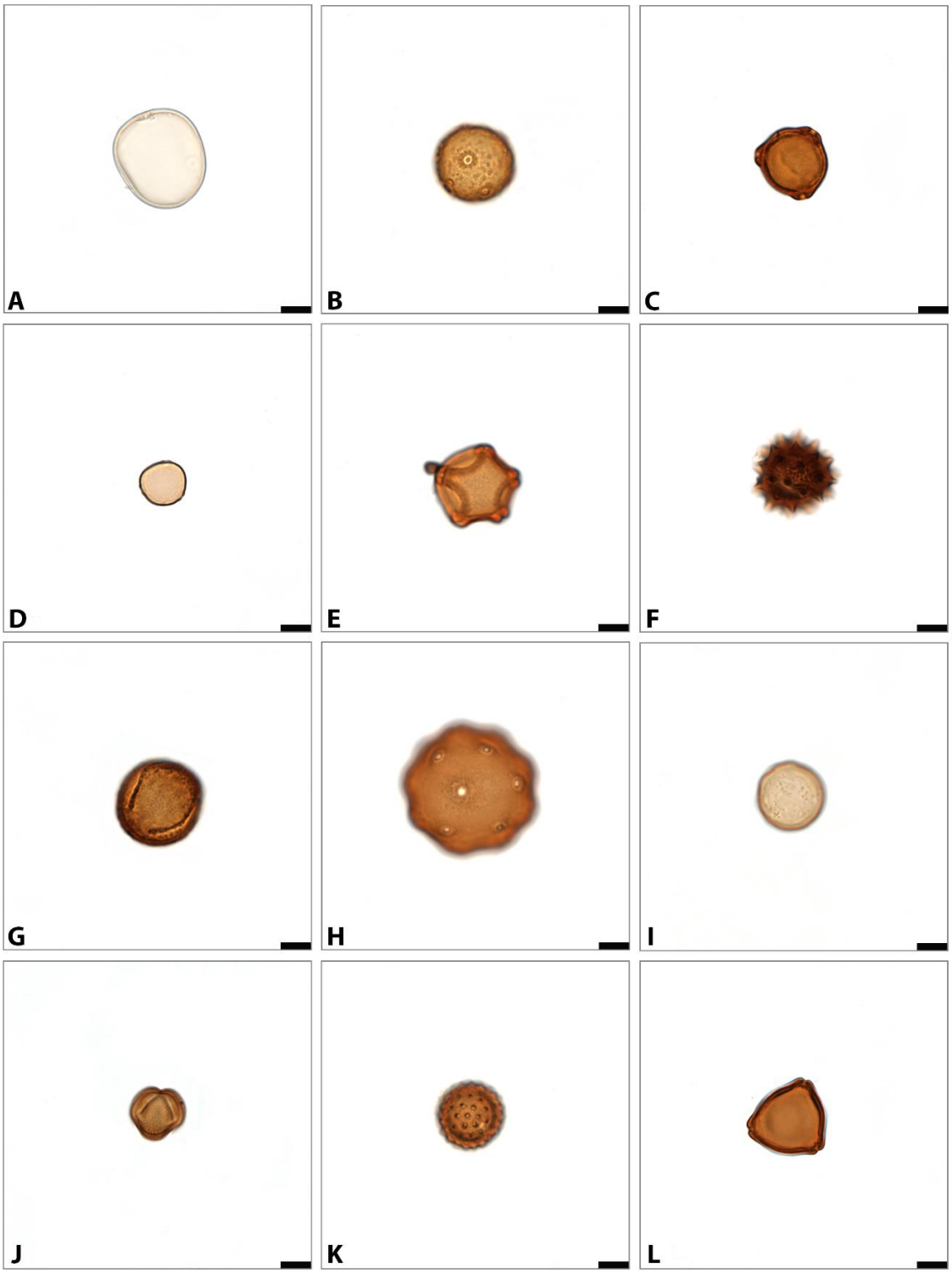


Plate 10: Light micrographs of most abundant taxa in sample 17SDB. Scale bar indicates 10 µm.: **A**. Poaceae. **B**. *Plantago*. **C**. *Betula*. **D**. Urticaceae/Cannabaceae. **E.** *Alnus*. **F**. Asteraceae. **G**. *Quercus*. **H**. *Juglans*. **I**. Cupressaceae. **J**. *Sambucus*. **K**. *Ambrosia*. **L**. *Corylus*.

Location: House Bad Tatzmannsdorf

Annex

Combined Results Spiderweb and Floor sample (17SDS and 17SDB)

Apart from higher rates of *Ambrosia* sp. (Asteraceae) in 17SDS, both samples showed similar pollen spectra (Figure 25). Comparing spiderweb and floor sample, only 17SDS contained *Fagus* sp. (Fagaceae), *Carpinus* sp. (Betulaceae), *Ulmus* sp. (Ulmaceae), Apiaceae and Oleaceae. Respectively, *Ambrosia* sp. (Asteraceae), *Ginkgo* sp. (Ginkgoaceae), *Platanus* sp. (Platanaceae), Ranunculaceae and Cupressaceae were determined in 17SDB exclusively. With 16 % 17SDB represented a slightly higher proportion of the surrounding vegetation than 17SDS (15 %) (see Figure 39).

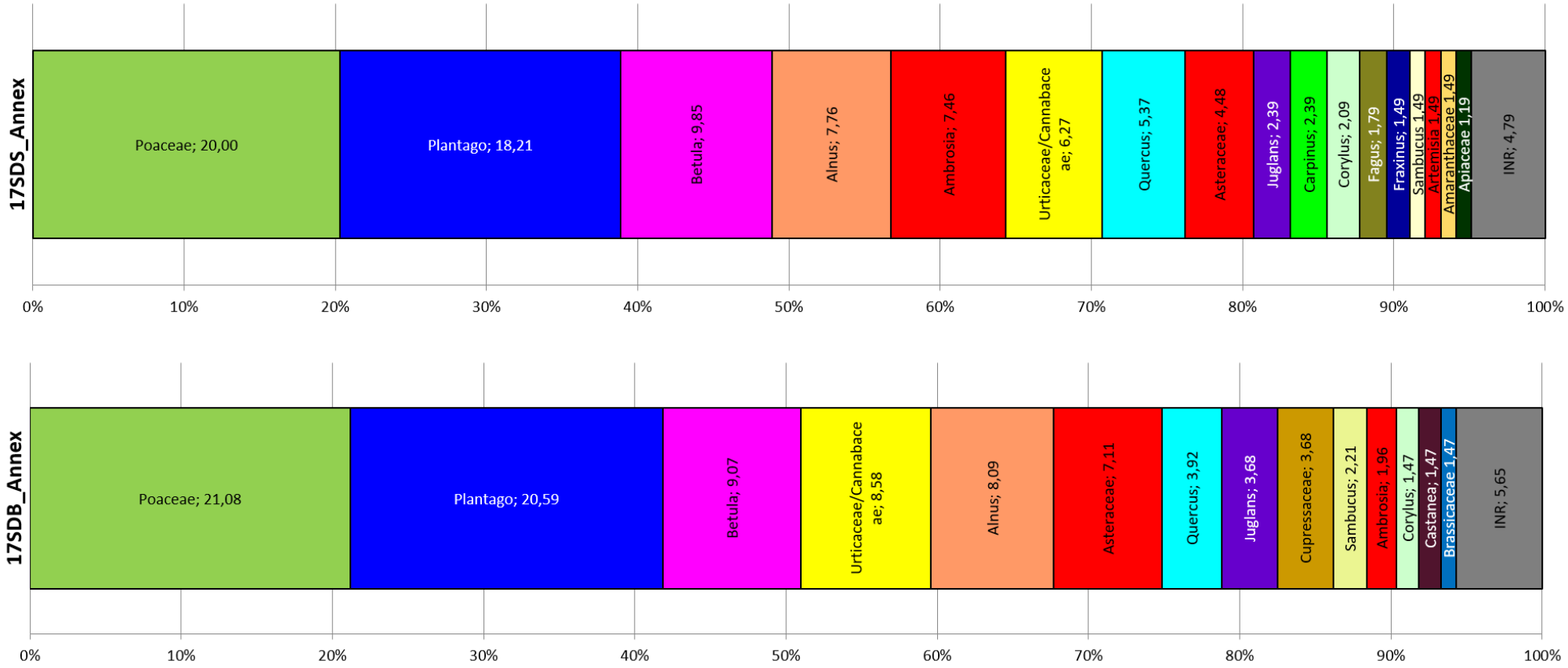


Figure 25: Pollen spectrum diagrams samples 17SDS and 17SDB.

Location: House Bad Tatzmannsdorf

Corridor

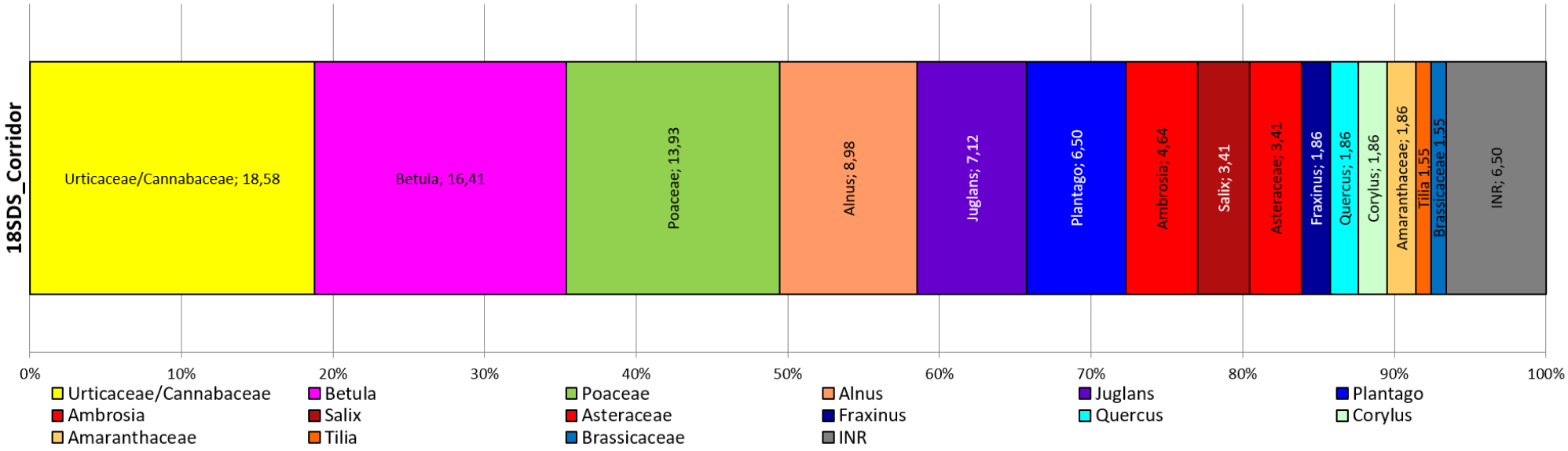
18SDS Spiderweb

In spiderweb sample 18SDS from the corridor at the 1st floor, a total of 323 pollen grains was counted (Table 18). The most abundant taxa were Urticaceae/Cannabaceae (18.58 %), *Betula* sp. (Betulaceae) (16.41 %) and Poaceae (13.93 %) (Figure 26). 15 % of the determined taxa proximate to the sampling location (Table 2) were recognized in the pollen spectra as well (see Figure 39). The following taxa were determined in the pollen sample only: *Carpinus* sp. (Betulaceae), *Artemisia* sp. (Asteraceae), *Ginkgo* sp. (Ginkgoaceae).

Taxa	Percent	Count
Urticaceae/Cannabaceae	18.58	60
Betula	16.41	53
Poaceae	13.93	45
Alnus	8.98	29
Juglans	7.12	23
Plantago	6.50	21
Ambrosia	4.64	15
Salix	3.41	11
Asteraceae	3.41	11
Fraxinus	1.86	6
Quercus	1.86	6
Corylus	1.86	6
Amaranthaceae	1.86	6
Tilia	1.55	5
Brassicaceae	1.55	5
INR	6.50	21
Total	100	323

INR		
Taxa	**Percent**	**Count**
Fagus	0.93	3
Carpinus	0.93	3
Artemisia	0.93	3
Cupressaceae	0.93	3
Ginkgo	0.62	2
Ulmus	0.62	2
Sambucus	0.62	2
Ranunculaceae	0.62	2
Saxifragaceae	0.31	1

Table 18: Pollen percentages and counts of sample 18SDS.



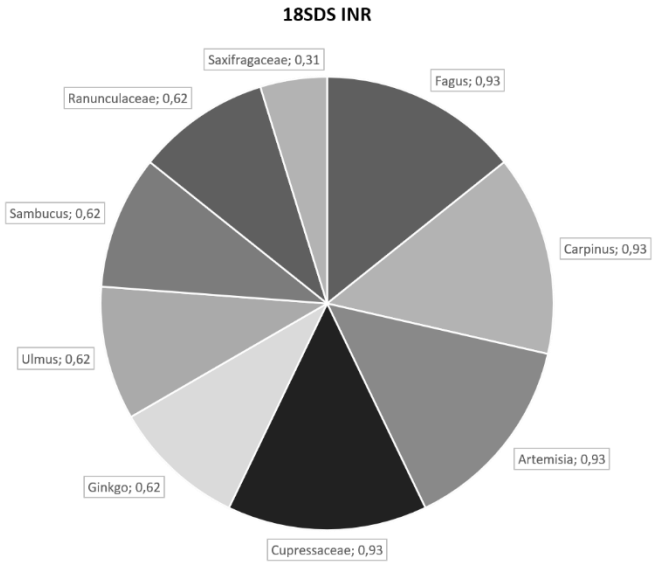


Figure 26: Pollen spectrum and "INR" diagrams sample 18SDS.

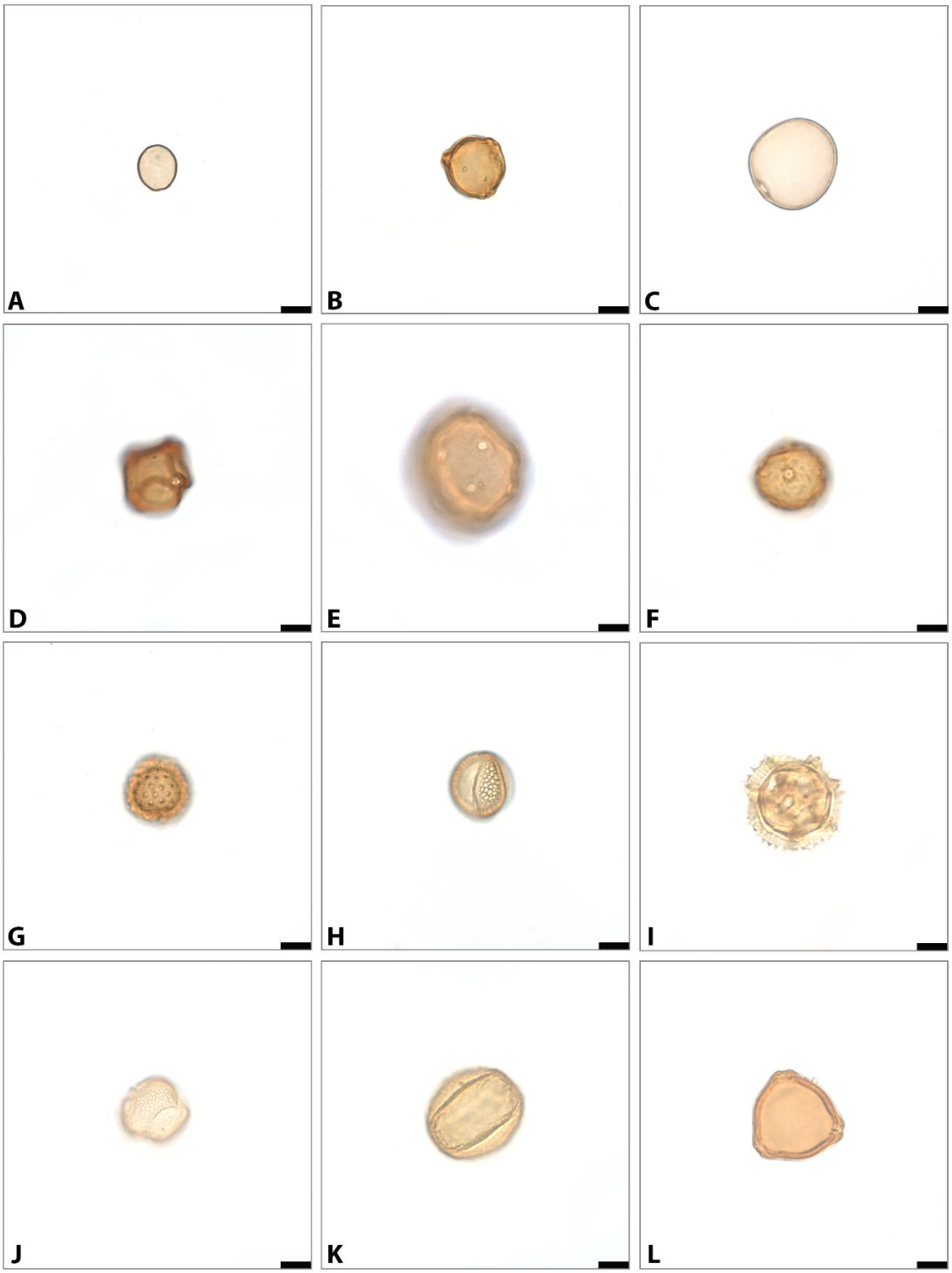


Plate 11: Light micrographs of most abundant taxa in sample 18SDS. Scale bar indicates 10 µm.: **A**. Urticaceae/Cannabaceae. **B**. *Betula*. **C**. Poaceae. **D**. *Alnus*. **E**. *Juglans*. **F**. *Plantago*. **G**. *Ambrosia*. **H**. *Salix*. **I**. Asteraceae. **J**. *Fraxinus*. **K**. *Quercus*. **L**. *Corylus*.

Location: House Bad Tatzmannsdorf

Corridor

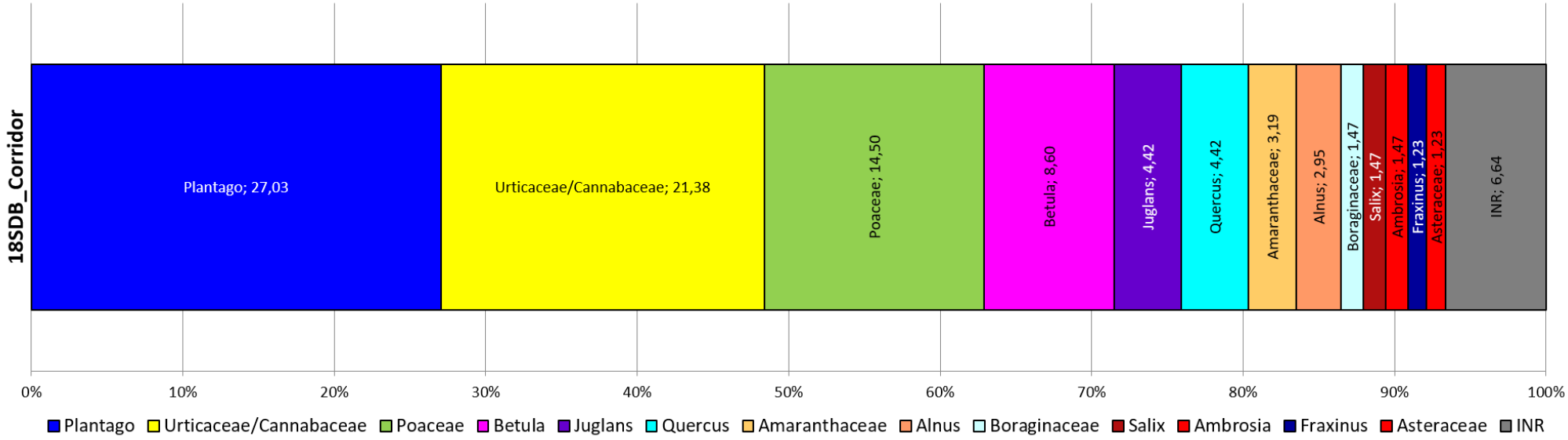
18SDB Floor

Concerning the floor sample 18SDB, a total of 407 pollen grains was counted (Table 19). Most abundant were the taxa *Plantago* sp. (Plantaginaceae) (27.03 %), followed by Urticaceae/Cannabaceae (21.38 %) and Poaceae (14.50 %) (Figure 27). Across all samples, Amaranthaceae and Boraginaceae showed highest rates in this sample (Table **7**). Identified pollen grains represented 16 % of the close surrounding vegetation (Table 2, Figure 39). *Ginkgo* sp. (Ginkgoaceae), *Carpinus* sp. (Betulaceae) and *Artemisia* sp. (Asteraceae) were found in the pollen sample only. Boraginaceae were detected exclusively in 18SDB regarding this location.

Taxa	Percent	Count
Plantago	27.03	110
Urticaceae/Cannabaceae	21.38	87
Poaceae	14.50	59
Betula	8.60	35
Juglans	4.42	18
Quercus	4.42	18
Amaranthaceae	3.19	13
Alnus	2.95	12
Boraginaceae	1.47	6
Salix	1.47	6
Ambrosia	1.47	6
Fraxinus	1.23	5
Asteraceae	1.23	5
INR	6.64	27
Total	100	407

INR		
Taxa	**Percent**	**Count**
Fagus	0.98	4
Carpinus	0.98	4
Ginkgo	0.74	3
Corylus	0.74	3
Tilia	0.49	2
Sambucus	0.49	2
Apiaceae	0.49	2
Oleaceae	0.25	1
Ulmus	0.25	1
Galium	0.25	1
Rosaceae	0.25	1
Castanea	0.25	1
Brassicaceae	0.25	1
Artemisia	0.25	1

Table 19: Pollen percentages and counts of sample 18SDB.



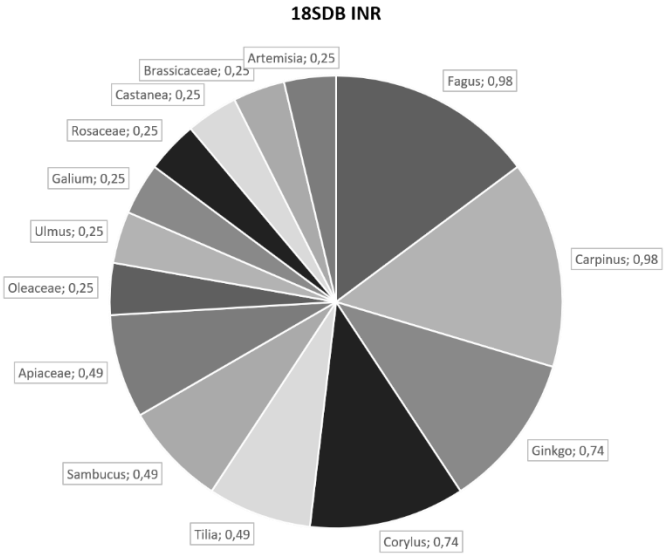


Figure 27: Pollen spectrum and "INR" diagrams sample 18SDB.

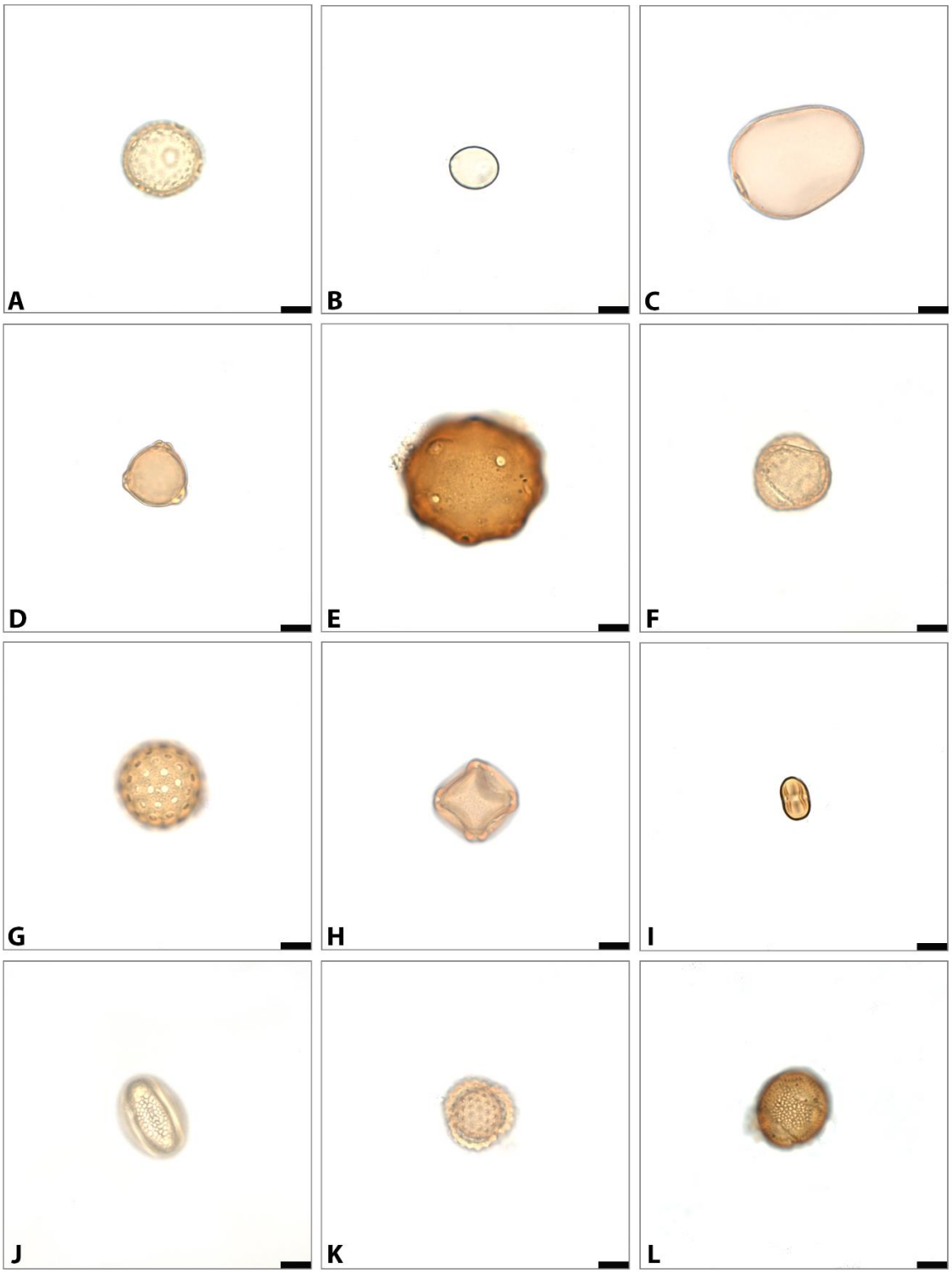


Plate 12: Light micrographs of most abundant taxa in sample 18SDB. Scale bar indicates 10 µm.: **A**. *Plantago*. **B**. Urticaceae/Cannabaceae. **C**. *Poaceae*. **D**. *Betula*. **E**. *Juglans*. **F**. *Quercus*. **G**. Amaranthaceae. **H**. *Alnus*. **I**. Boraginaceae. **J**. *Salix*. **K**. *Ambrosia*. **L**. *Fraxinus*.

Location: House Bad Tatzmannsdorf

Corridor

Combined Results Spiderweb and Floor sample (18SDS and 18SDB)

In 18SDB *Plantago* sp. (Plantaginaceae) was increased compared to the spiderweb sample (Figure 28). Also, it contained *Castanea* sp. (Fagaceae), *Galium* sp. (Rubiaceae) and Rosaceae. In contrast only in 18SDS Ranunculaceae was determined. Surrounding vegetation was represented by 18SDB (16 %) slightly better than by 18SDS (15 %) (see Figure 39).

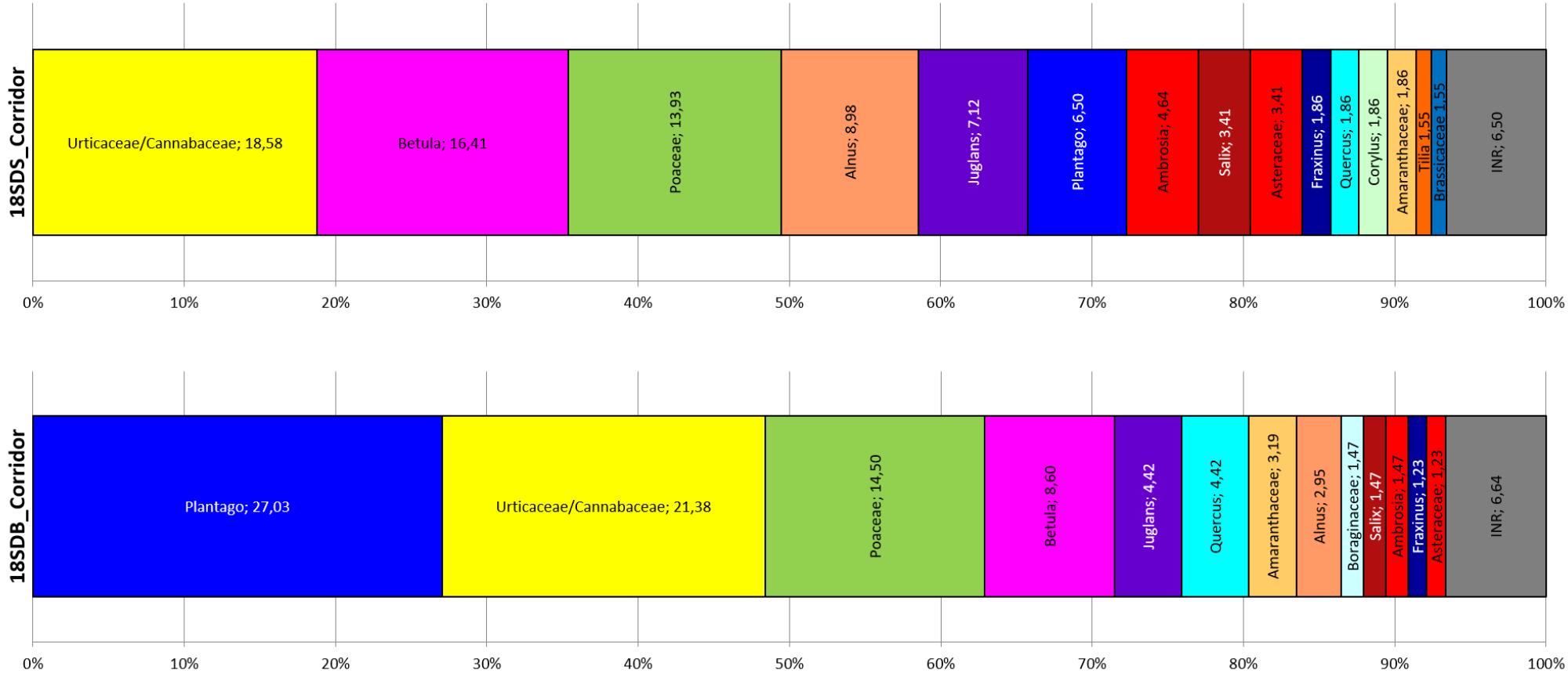


Figure 28: Pollen spectra diagrams samples 18SDS and 18SDB.

Location: House Bad Tatzmannsdorf

All Rooms Combined

Combined Results Spiderweb and Floor Samples (15SDS, 15SDB; 17SDS, 17SDB; 18SDS, 18SDB)

Common characters of the samples from this location were the high abundance of *Plantago* sp. (Plantaginaceae), especially in the floor samples. Generally, there was a higher analogy between samples from the Kitchen (15SDS and 15SDB) and from the Corridor (18SDS and 18SDB). In “House Bad Tatzmannsdorf” *Impatiens* sp. (Balsaminaceae) were found exclusively in 17SDB and 17SDS. Divergence between reflection of the surrounding vegetation of spiderweb versus floor samples was minor (1 %) for all sampling sites (see Figure 39).

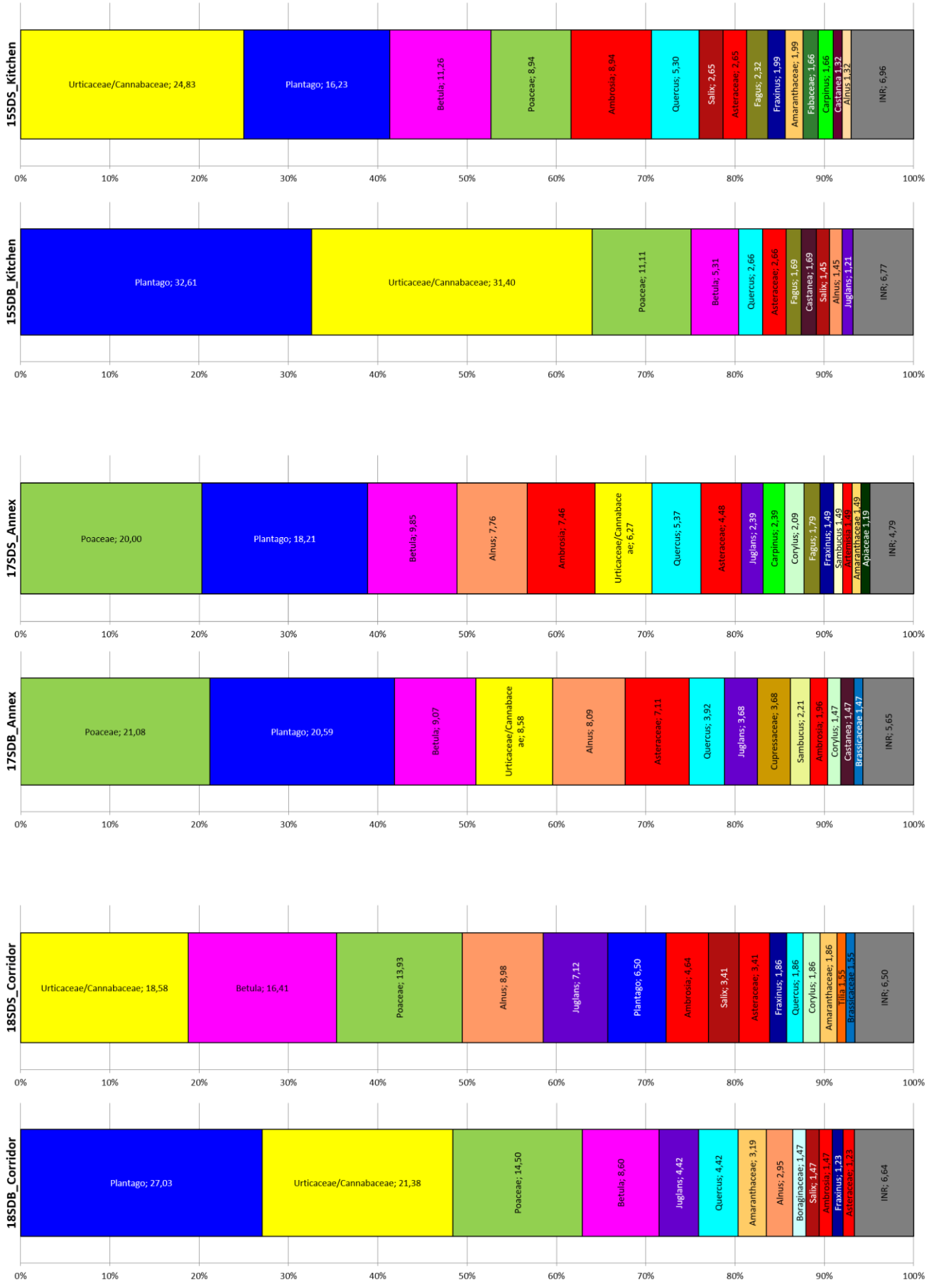


Figure 29: Pollen spectra diagrams of all samples of location “House Bad Tatzmannsdorf”.

3.2.3 Location: Outdoor Locations Bad Tatzmannsdorf

Forest Edge

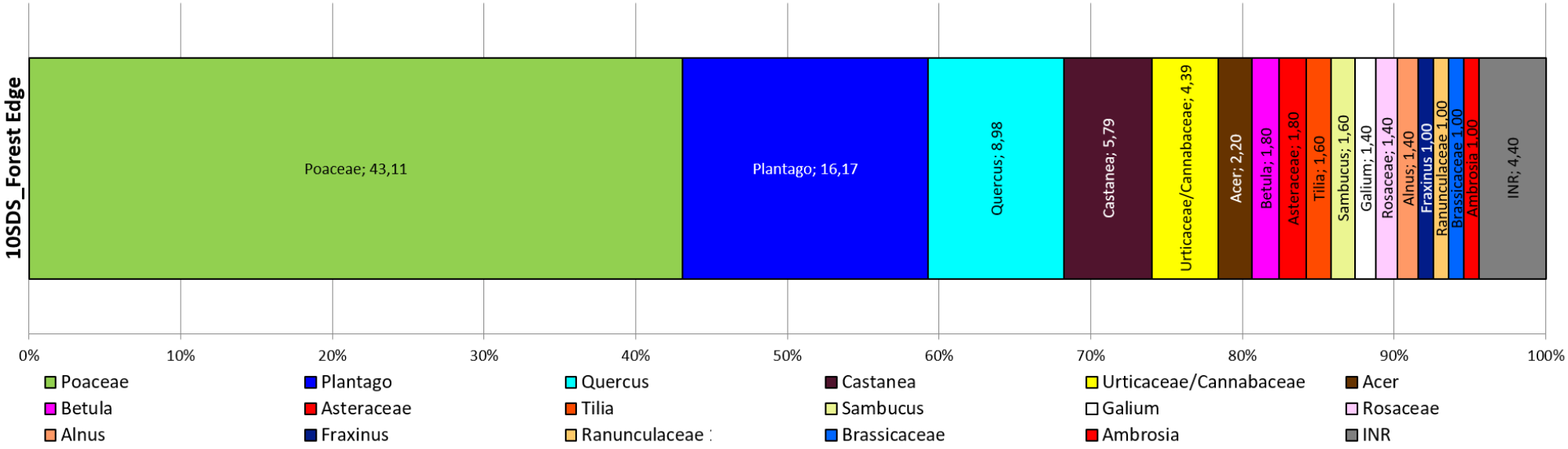
10SDS Spiderweb

Sample 10SDS was retained from a spiderweb adherent to a pile of wood close to the forest. A total of 501 pollen grains was counted (Table 20). The most abundant taxon was Poaceae (43.11 %), followed by *Plantago* sp. (Plantaginaceae) (16.17 %) and *Quercus* sp. (Fagaceae) (8.98 %) (Figure 30). An overall comparison of all samples indicated the highest numbers of Poaceae (43.11 %), *Castanea* sp. (Fagaceae) (5.79 %) and *Acer* sp. (Sapindaceae) (2.20 %) in 10SDS (Table 7). Determined pollen grains represented 44 % of the close surrounding vegetation (Figure 39). *Fraxinus* sp. (Oleaceae), *Ambrosia* sp. (Asteraceae), *Fagus* sp. (Fagaceae), *Salix* sp. (Salicaceae), *Ailanthus* sp. (Simaroubaceae) and *Aesculus* sp. (Sapindaceae) were found only in the pollen sample.

Taxa	Percent	Count
Poaceae	43.11	216
Plantago	16.17	81
Quercus	8.98	45
Castanea	5.79	29
Urticaceae/Cannabaceae	4.39	22
Acer	2.20	11
Betula	1.80	9
Asteraceae	1.80	9
Tilia	1.60	8
Sambucus	1.60	8
Galium	1.40	7
Rosaceae	1.40	7
Alnus	1.40	7
Fraxinus	1.00	5
Ranunculaceae	1.00	5
Brassicaceae	1.00	5
Ambrosia	1.00	5
INR	4.40	22
Total	100	501

INR		
Taxa	**Percent**	**Count**
Fagus	0.80	4
Corylus	0.80	4
Apiaceae	0.80	4
Amaranthaceae	0.60	3
Carpinus	0.40	2
Lamiaceae	0.20	1
Salix	0.20	1
Rumex	0.20	1
Ailanthus	0.20	1
Aesculus	0.20	1

Table 20: Pollen percentages and counts of sample 10SDS.



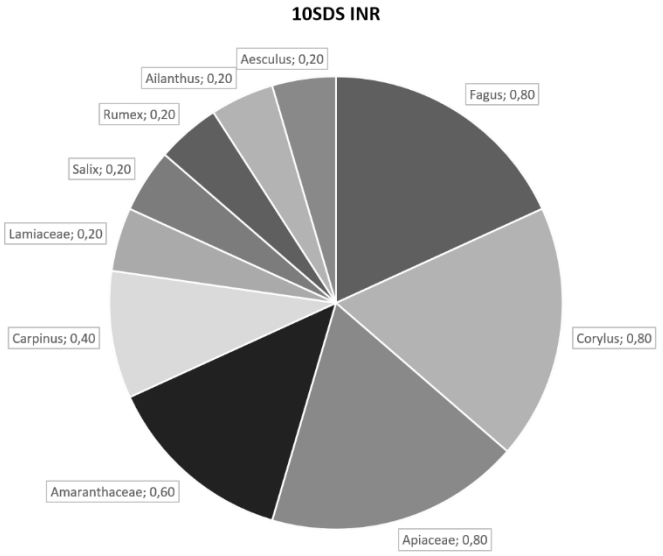


Figure 30: Pollen spectrum and "INR" diagrams sample 10SDS.

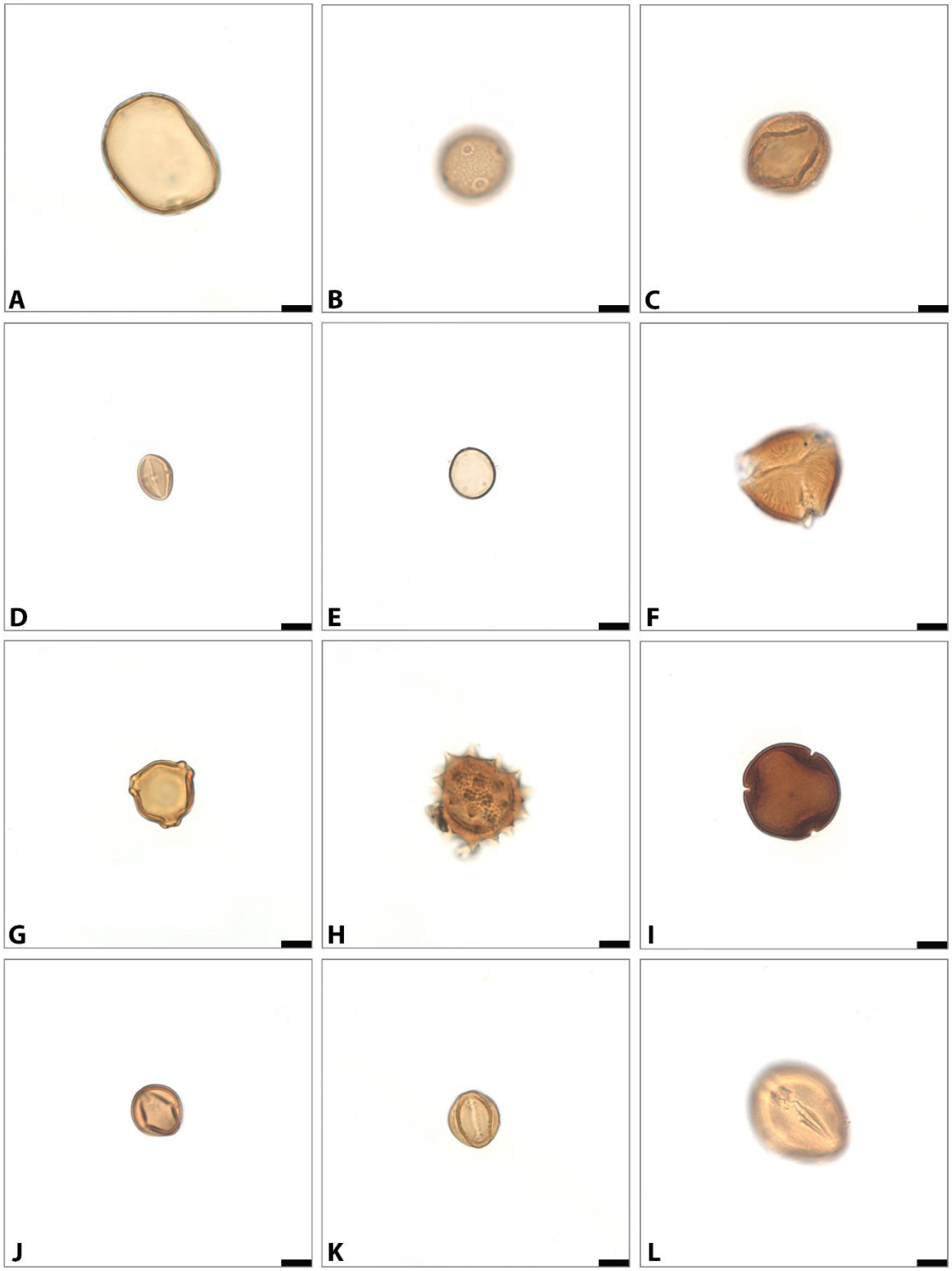


Plate 13: Light micrographs of most abundant taxa in sample 10SDS. Scale bar indicates 10 µm.: **A**. Poaceae. **B**. *Plantago*. **C**. *Quercus*. **D**. *Castanea*. **E**. Urticaceae/Cannabaceae. **F**. *Acer*. **G**. *Betula*. **H**. Asteraceae. **I**. *Tilia*. **J**. *Sambucus*. **K**. *Galium*. **L**. Rosaceae.

Location: Outdoor Locations Bad Tatzmannsdorf

Forest Edge

10SDB Floor

In floor sample 10SDB a total of 321 pollen grains was counted (Table 21) at which *Plantago* sp. (Plantaginaceae) (38 %) was the dominant taxon. Second most abundant was Poaceae (17.76 %) followed by *Castanea* sp. (Fagaceae) (6.54 %). Ericaceae pollen was found exclusively in 10SDB (Table 7). Taxa found in the floor sample represented 33 % of the proximate surrounding vegetation (Table 3, Figure 39). *Juglans* sp. (Juglandaceae), *Dryopteris* sp. (Dryopteridaceae), *Salix* sp. (Salicaceae), *Platanus* sp. (Platanaceae), *Reseda* sp. (Resedaceae), *Centaurea* sp. (Asteraceae), Saxifragaceae and Ericaceae, were not determined in the close environment.

Taxa	Percent	Count
Plantago	38.63	124
Poaceae	17.76	57
Castanea	6.54	21
Betula	5.30	17
Asteraceae	5.30	17
Quercus	4.67	15
Alnus	4.67	15
Tilia	3.12	10
Acer	2.49	8
Juglans	2.18	7
Amaranthaceae	1.87	6
Corylus	1.25	4
INR	6.24	20
Total	100	321

INR		
Taxa	**Percent**	**Count**
Ericaceae	0.93	3
Dryopteris	0.62	2
Urticaceae/Cannabaceae	0.62	2
Salix	0.62	2
Ranunculaceae	0.62	2
Platanus	0.62	2
Apiaceae	0.62	2
Reseda (lutea ev.)	0.31	1
Saxifragaceae	0.31	1
Centaurea	0.31	1
Sambucus	0.31	1
Galium	0.31	1

Table 21: Pollen percentages and counts of sample 10SDB.

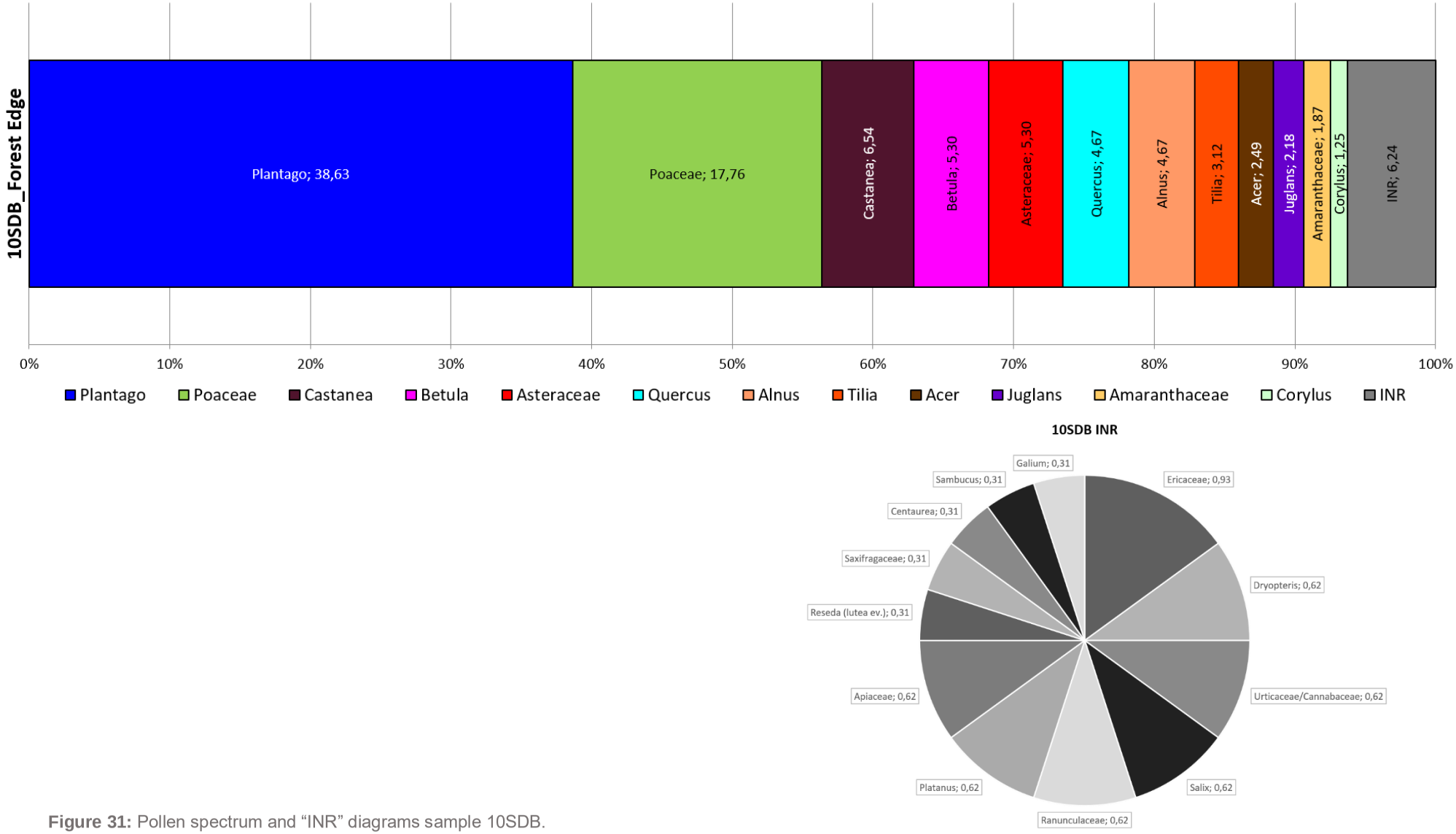


Figure 31: Pollen spectrum and "INR" diagrams sample 10SDB.

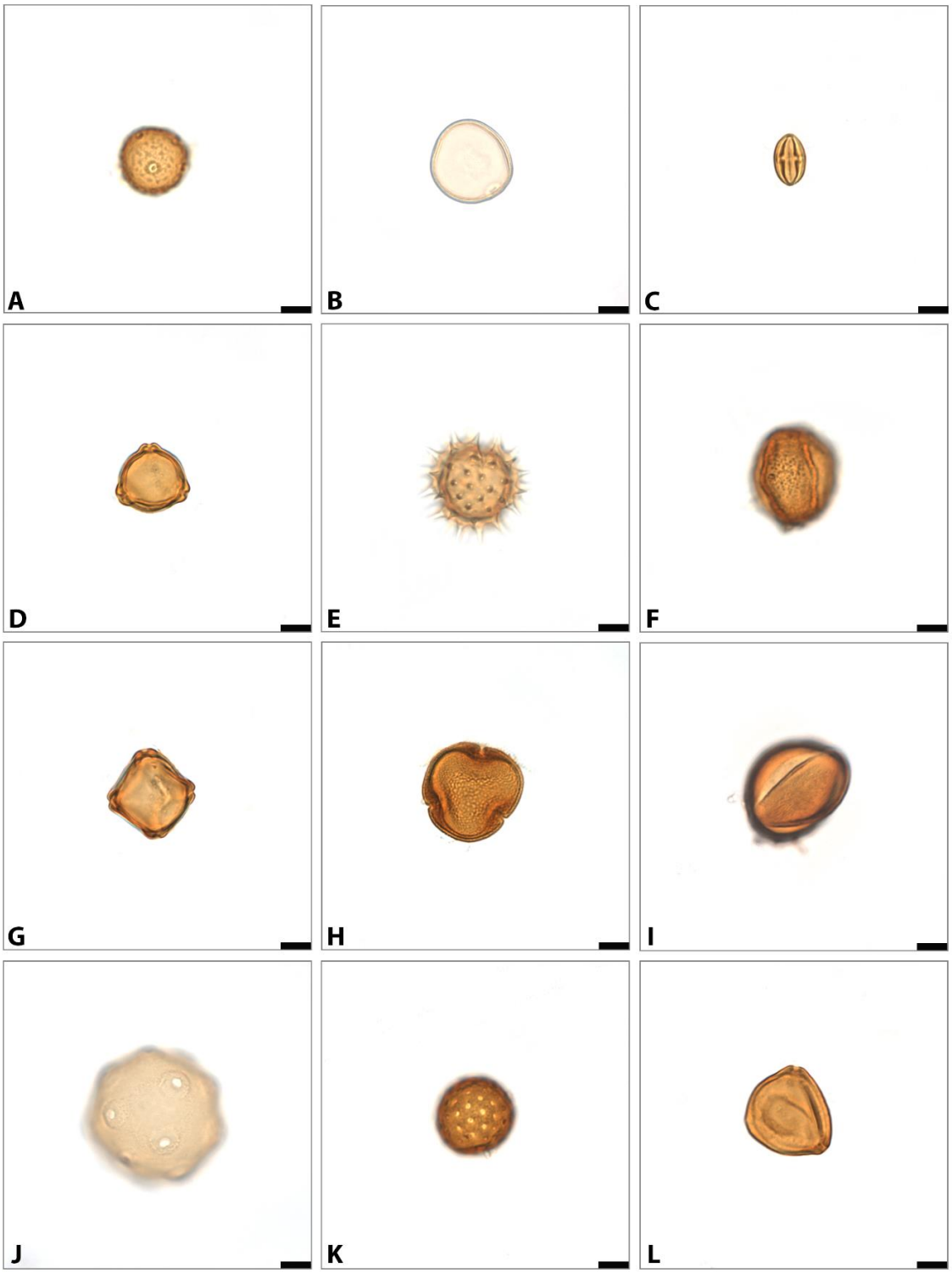


Plate 14: Light micrographs of most abundant taxa in sample 10SDB. Scale bar indicates 10 µm.: **A**. *Plantago*. **B**. Poaceae. **C**. *Castanea*. **D**. *Betula*. **E**. Asteraceae. **F**. *Quercus*. **G**. *Alnus*. **H**. *Tilia*. **I**. *Acer*. **J**. *Juglans*. **K**. Amaranthaceae **L**. *Corylus*.

Location: Outdoor Locations Bad Tatzmannsdorf

Forest Edge

Combined Results Spiderweb and Floor sample (10 SDS and 10 SDB)

Both samples had high percentages of Poaceae and *Plantago* sp. (Plantaginaceae) in common, only the sequence of these taxa was inverted. Floor sample 10SDB contained increased numbers of *Betula* sp. (Betulaceae) (Figure 32). In contrast to the floor sample, 10 SDS contained *Fraxinus* sp. (Oleaceae), *Ambrosia* sp. (Asteraceae), *Fagus* sp. (Fagaceae), *Carpinus* sp. (Betulaceae), *Rumex* sp. (Polygonaceae), Rosaceae, Brassicaceae, Lamiaceae. On the contrary, *Juglans* sp. (Juglandaceae), *Platanus* sp. (Platanaceae) and Ericaceae were found in 10SDB only. 44 % of the surrounding vegetation was reflected by the spiderweb and only 33 % by the floor sample (Figure 39).

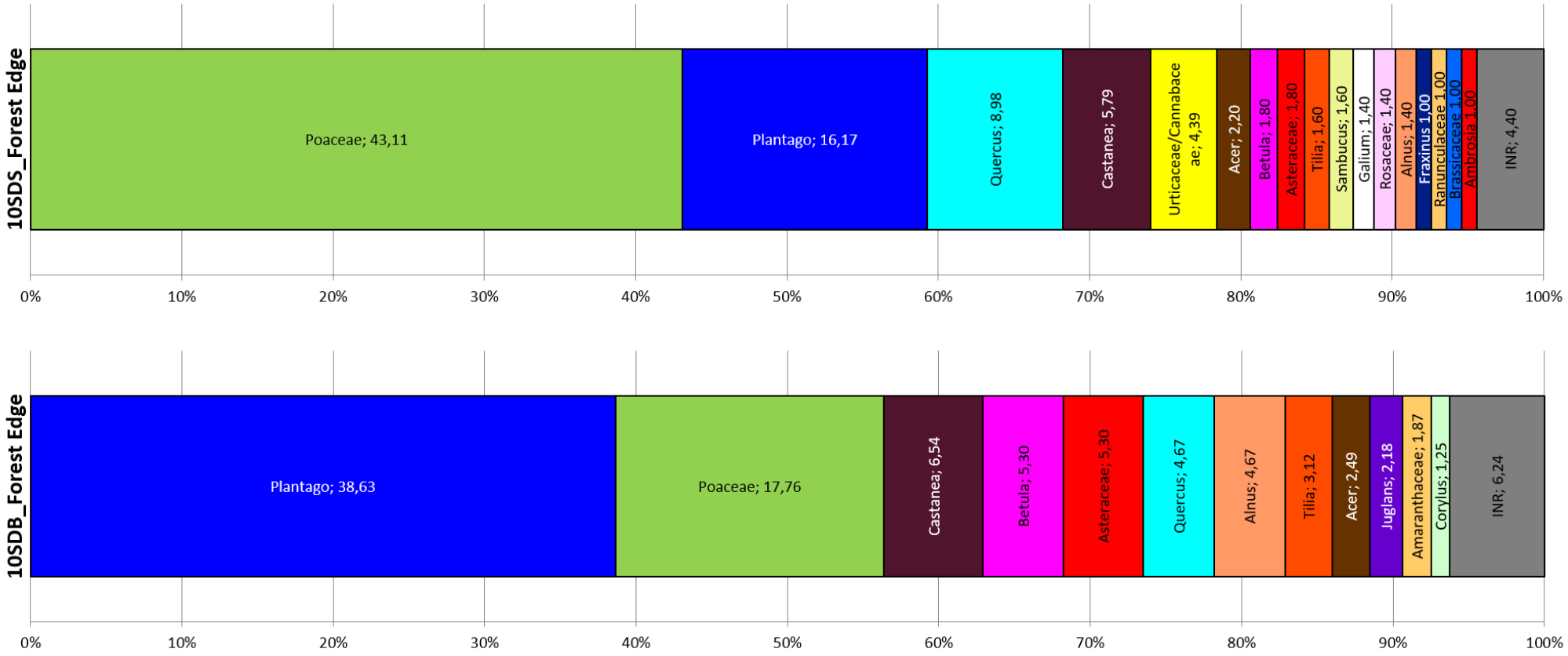


Figure 32: Pollen spectra diagrams samples 13SDS and 13SDB.

Location: Outdoor Locations Bad Tatzmannsdorf

Forest

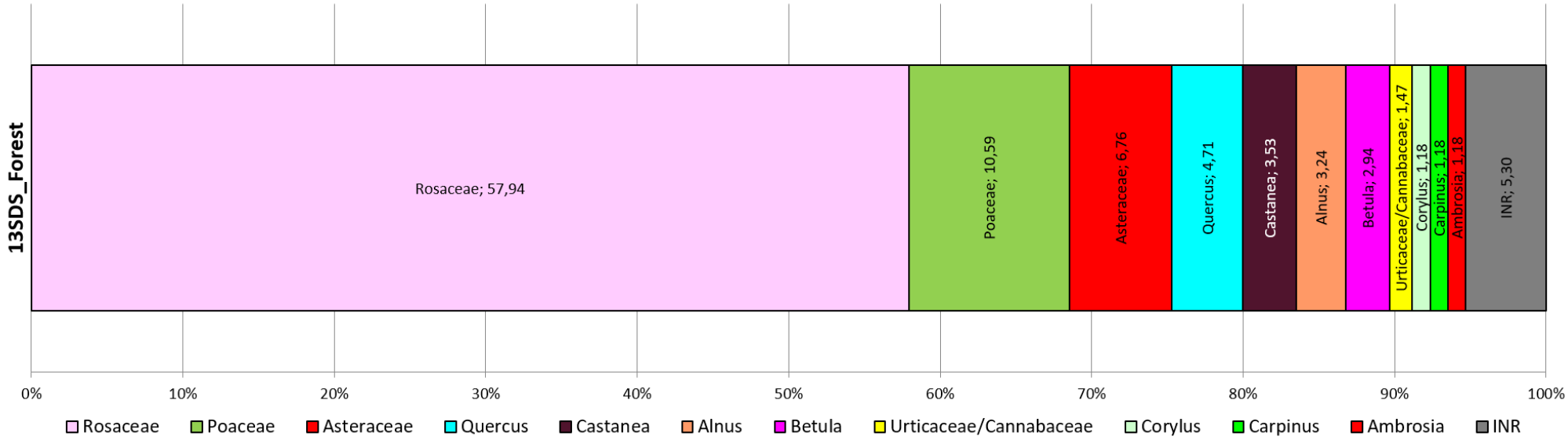
13SDS Spiderweb

Sampling site “Forest” was a humid, relatively open area in the middle of the forest. 340 pollen grains were counted (Table 22), over half of them identified Rosaceae pollen (57.94 %). The second and third highest percentages were Poaceae (10.59 %) and Asteraceae (6.76 %) (Figure 33). The latter as well as Rosaceae exhibited the greatest abundance of all samples in 13SDS (Table 7). 51 % of the determined taxa proximate to the sampling location (Table 4) were recognized in the pollen spectra as well (see Figure **39**). The following taxa were found in the pollen sample only: *Castanea* sp. (Fagaceae), *Ambrosia* sp. (Asteraceae), Amaranthaceae.

Taxa	Percent	Count
Rosaceae	57.94	197
Poaceae	10.59	36
Asteraceae	6.76	23
Quercus	4.71	16
Castanea	3.53	12
Alnus	3.24	11
Betula	2.94	10
Urticaceae/Cannabaceae	1.47	5
Corylus	1.18	4
Carpinus	1.18	4
Ambrosia	1.18	4
INR	5.30	18
Total	100	340

INR		
Taxa	**Percent**	**Count**
Boraginaceae	0.88	3
Salix	0.88	3
Galium	0.88	3
Plantago	0.88	3
Impatiens	0.29	1
Rumex	0.29	1
Ranunculaceae	0.29	1
Fagus	0.29	1
Brassicaceae	0.29	1
Amaranthaceae	0.29	1

Table 22: Pollen percentages and counts of sample 13SDS.



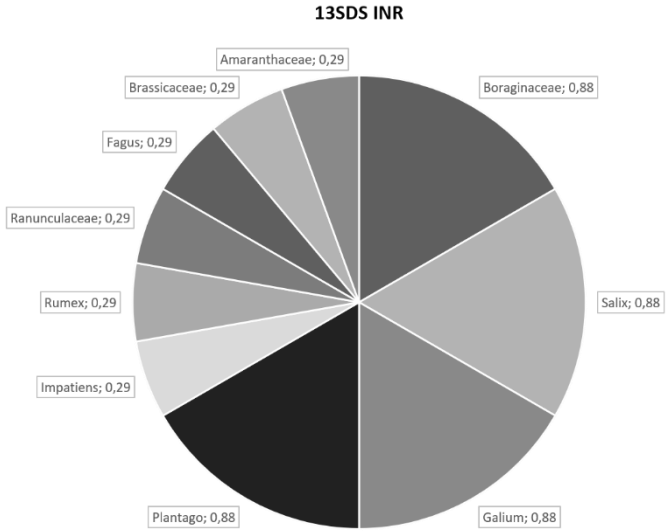


Figure 33: Pollen spectrum and "INR" diagrams sample 13SDS.

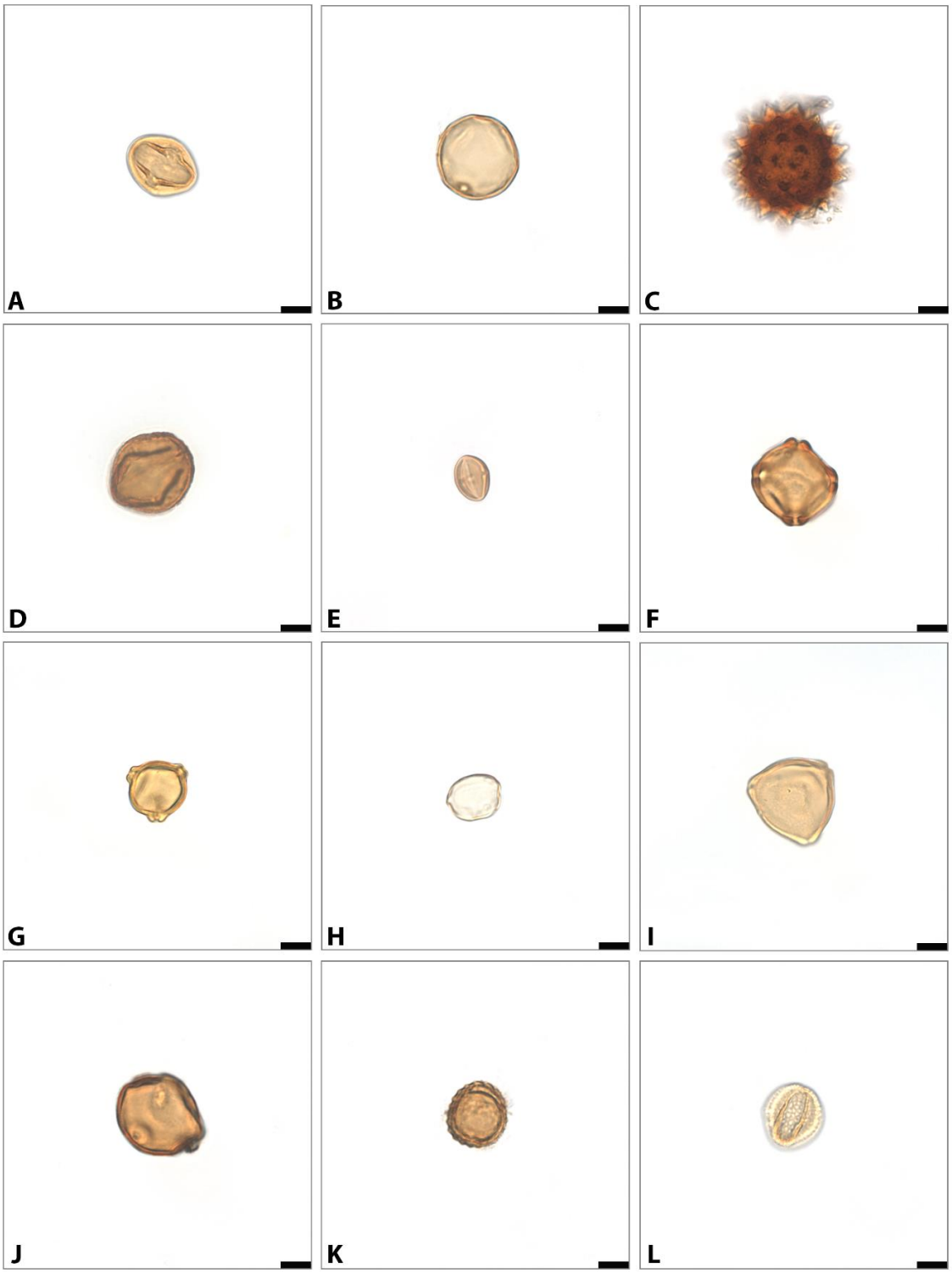


Plate 15: Light micrographs of most abundant taxa in sample 13SDS. Scale bar indicates 10 µm.: **A**. Rosaceae. **B**. Poaceae. **C**. Asteraceae. **D**. *Quercus*. **E**. *Castanea*. **F**. *Alnus*. **G**. *Betula*. **H**. Urticaceae/Cannabaceae. **I**. Corylus. **J**. *Carpinus*. **K**. *Ambrosia*. **L**. *Salix*.

Location: Outdoor Locations Bad Tatzmannsdorf

Forest

13SDB Floor

A total of 318 pollen grains was counted in floor sample 13SDB (Table 23). This sample was collected at a humid area in the forest. The most abundant taxa were *Betula* sp. (Betulaceae) (27.04 %), *Alnus* sp. (Betulaceae) (19.81 %) and *Quercus* sp. (Fagaceae) (11.95 %) (Figure 34). Compared to all other samples, the highest percentages of *Betula* sp. (Betulaceae) (27.04 %), *Ambrosia* sp. (Asteraceae) (9.75 %), *Carpinus* sp. (Betulaceae) (7.86 %) and *Fagus* sp. (Fagaceae) (4.40 %) were found in this sample (Table 7). 37 % of the surrounding vegetation was reflected by the pollen spectra (see Figure 39). *Ambrosia* sp. (Asteraceae), *Castanea* sp. (Fagaceae), *Fraxinus* sp. (Oleaceae), *Juglans* sp. (Juglandaceae), *Acer* sp. (Sapindaceae), *Sambucus* sp. (Adoxaceae) and Amaranthaceae were not determined in proximate vegetation, but in the pollen sample.

Taxa	Percent	Count
Betula	27.04	86
Alnus	19.81	63
Quercus	11.95	38
Ambrosia	9.75	31
Carpinus	7.86	25
Fagus	4.40	14
Castanea	3.77	12
Fraxinus	2.52	8
Corylus	2.52	8
Juglans	1.57	5
Salix	1.26	4
Poaceae	1.26	4
Amaranthaceae	1.26	4
INR	5.04	16
Total	100	318

INR		
Taxa	**Percent**	**Count**
Hedera	0.94	3
Sambucus	0.94	3
Plantago	0.94	3
Asteraceae	0.94	3
Urticaceae/Cannabaceae	0.63	2
Galium	0.31	1
Acer	0.31	1

Table 23: Pollen percentages and counts of sample 13SDB.

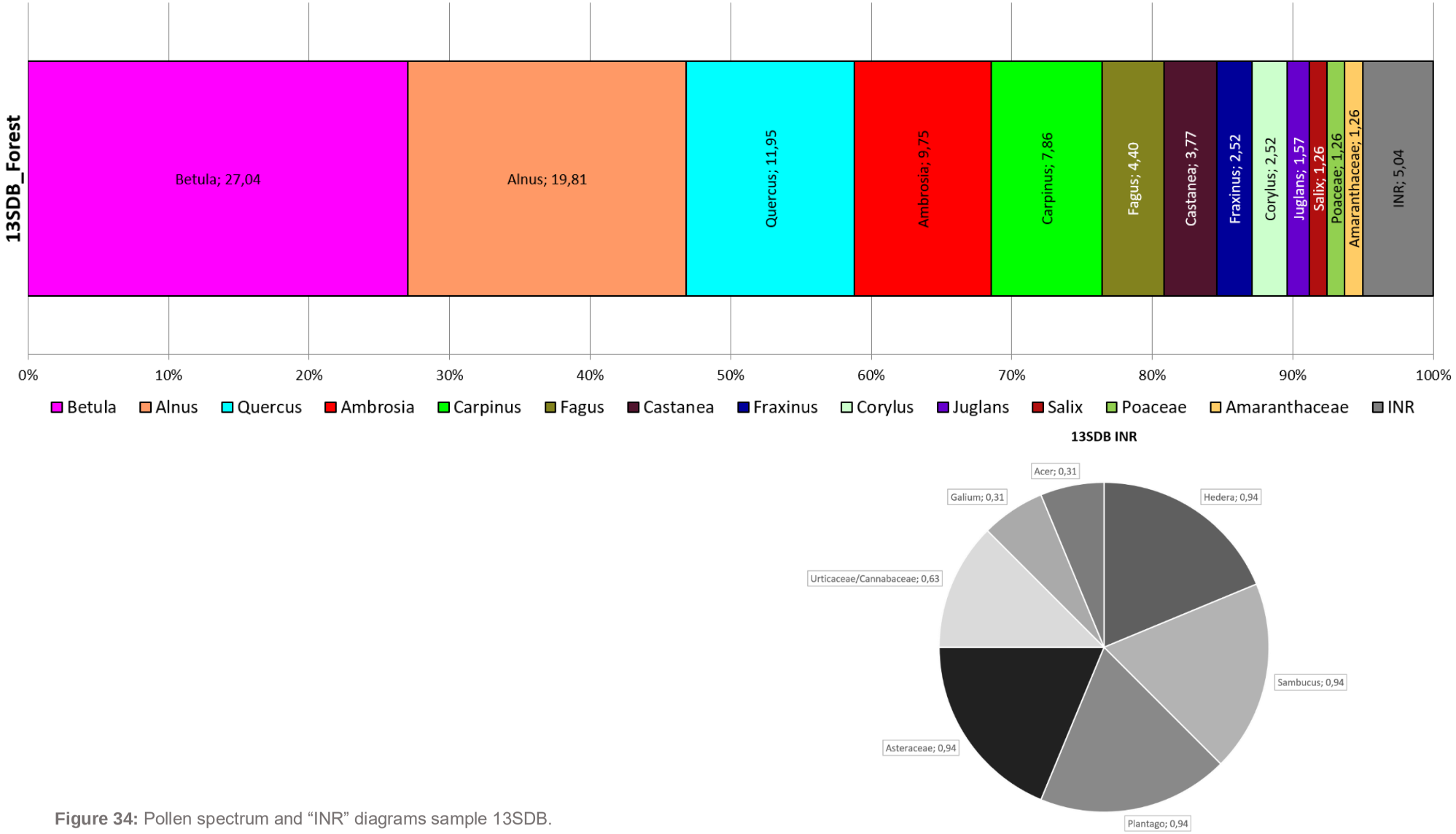


Figure 34: Pollen spectrum and "INR" diagrams sample 13SDB.

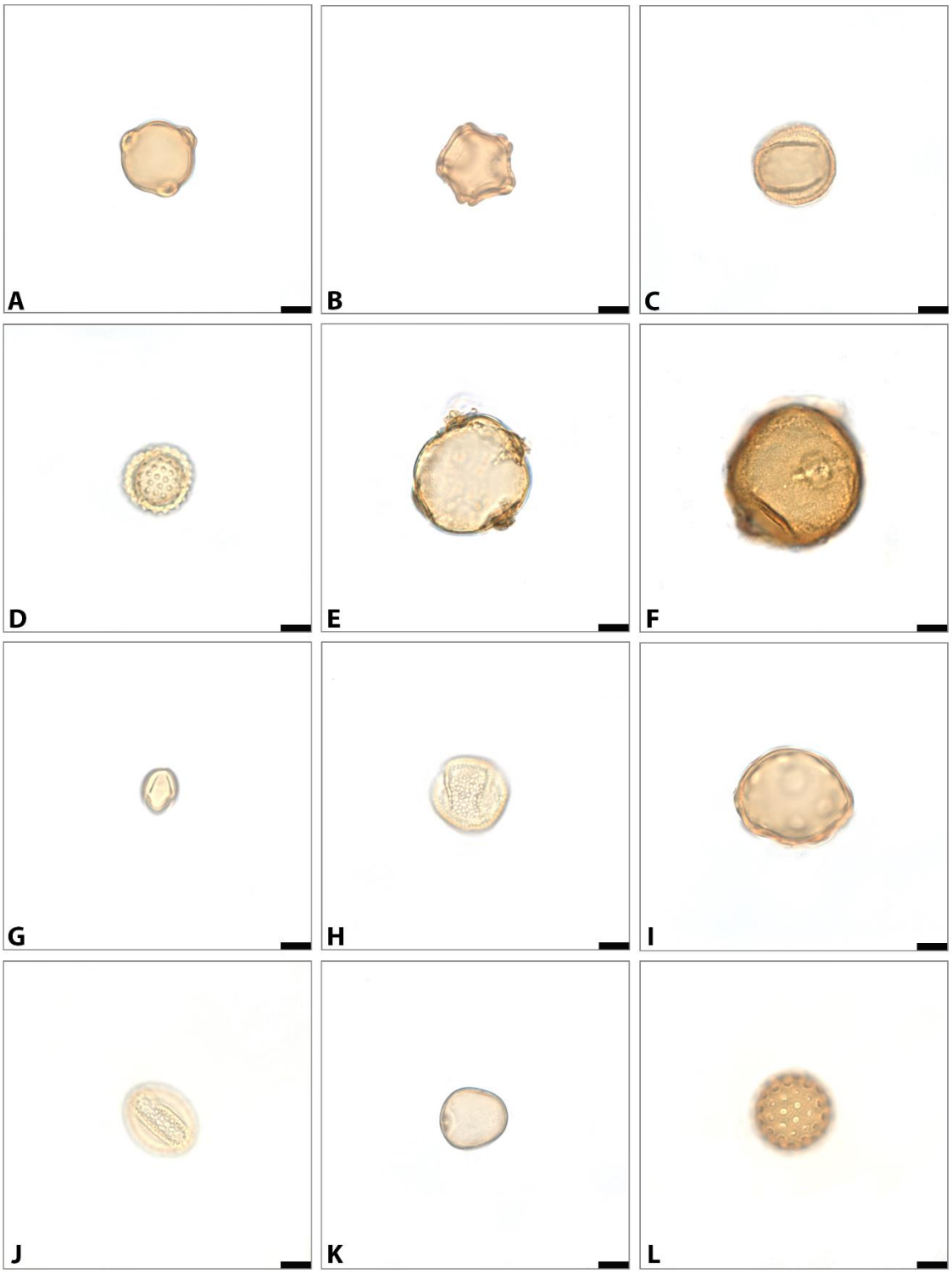


Plate 16: Light micrographs of most abundant taxa in sample 13SDB. Scale bar indicates 10 µm.: **A**. *Betula*. **B**. *Alnus*. **C**. *Quercus*. **D**. *Ambrosia*. **E**. *Carpinus*. **F**. *Fagus*. **G**. *Castanea*. **H**. *Fraxinus*. **I**. *Juglans*. **J**. *Salix*. **K**. Poaceae. **L**. Amaranthaceae.

Location: Outdoor Locations Bad Tatzmannsdorf

Forest

Combined Results Spiderweb and Floor sample (13SDS and 13 SDB)

The most striking difference between spiderweb and floor sample was the amount of Rosaceae pollen with more than 50 % in 13SDS, compared to not a single pollen grain of this taxon found in 13SDB. While *Betula* sp. (Betulaceae), *Alnus* sp. (Betulaceae) and *Ambrosia* sp. (Asteraceae) percentages were increased in 13SDB, 13SDS contained comparatively higher numbers of Poaceae and Asteraceae (Figure 35). In contrast to 13SDB, in 13SDS *Impatiens* sp. (Balsaminaceae), *Rumex* sp. (Polygonaceae), Rosaceae, Boraginaceae, Ranunculaceae and Brassicaceae were found. Surrounding vegetation was reflected by 13SDS with 51 % and by 13SDB with 37 % (see Figure 39).

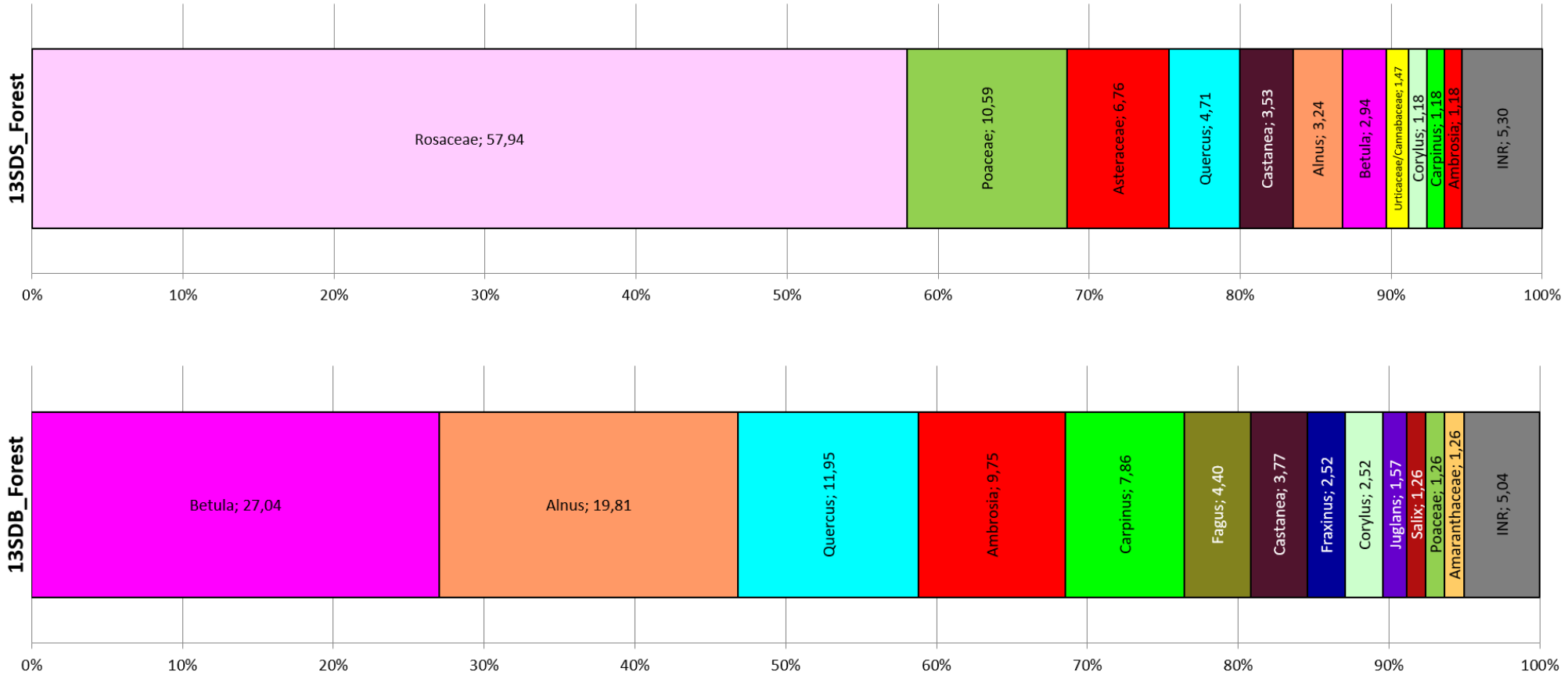


Figure 35: Pollen spectrum diagrams samples 13SDS and 13SDB.

Location: Outdoor Locations Bad Tatzmannsdorf

Park

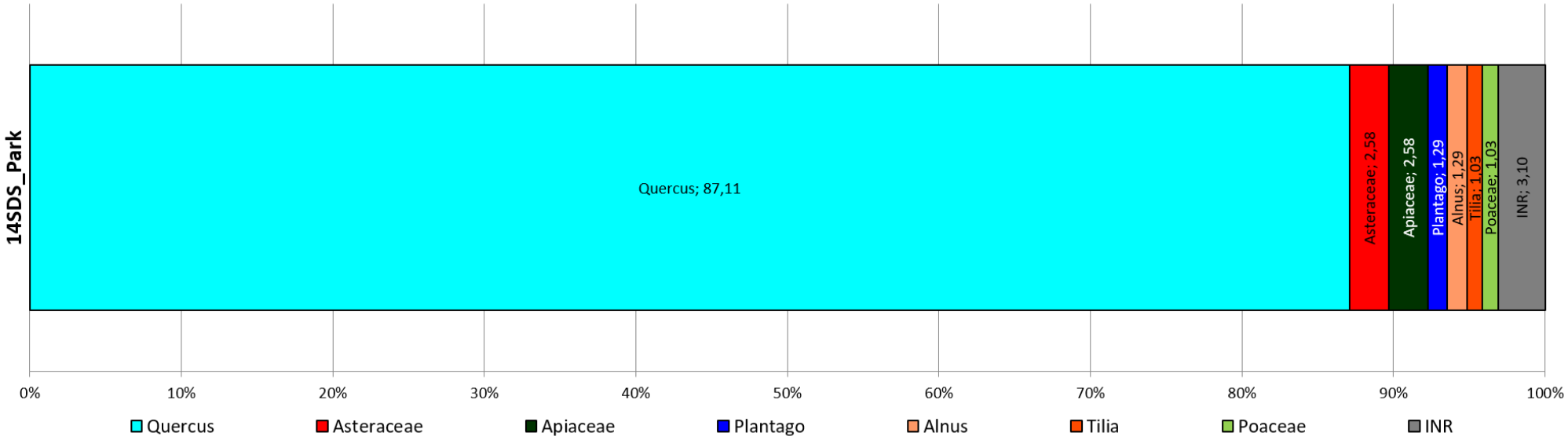
14SDS Spiderweb

Sample 14SDS was collected from a central hedge in the villages Spa Gardens. For sample 14SDS a total of 388 pollen grains was counted (Table 24), over 2/3 of it were identified as *Quercus* sp. (Fagaceae) (87.11 %) which makes this the highest ratio of *Quercus* sp. (Fagaceae) pollen of all samples. The second most abundant taxa were Asteraceae and Apiaceae (both 2.58 %) (Figure 36), making 14SDS the sample with highest numbers of Apiaceae of all processed samples (Table 7). Taxa found in the floor sample represented 48 % of the proximate surrounding vegetation (Figure 39). *Fraxinus* sp. (Oleaceae) and Amaranthaceae were not determined in the close environment.

Taxa	Percent	Count
Quercus	87.11	338
Asteraceae	2.58	10
Apiaceae	2.58	10
Plantago	1.29	5
Alnus	1.29	5
Tilia	1.03	4
Poaceae	1.03	4
INR	3.10	12
Total	100	388

INR		
Taxa	**Percent**	**Count**
Campanula	0.77	3
Betula	0.52	2
Lamiaceae	0.26	1
Fraxinus	0.26	1
Urticaceae/Cannabaceae	0.26	1
Corylus	0.26	1
Castanea	0.26	1
Carpinus	0.26	1
Amaranthaceae	0.26	1

Table 24: Pollen percentages and counts of sample 14SDS.



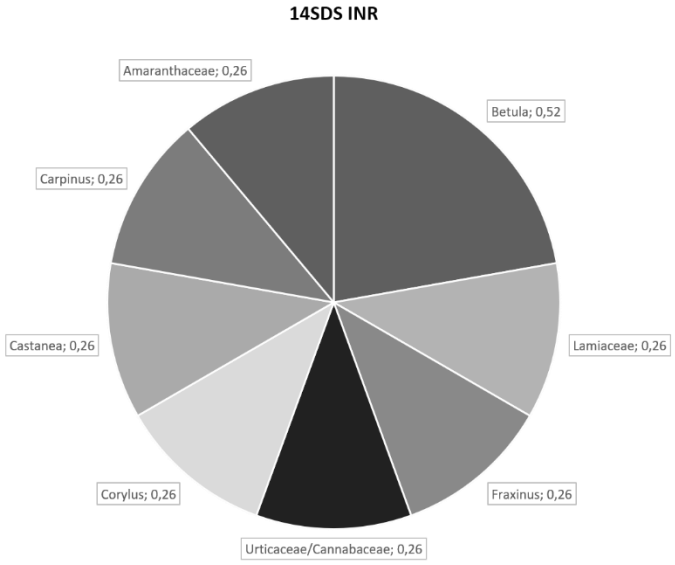


Figure 36: Pollen spectrum and "INR" diagrams sample 14SDS.

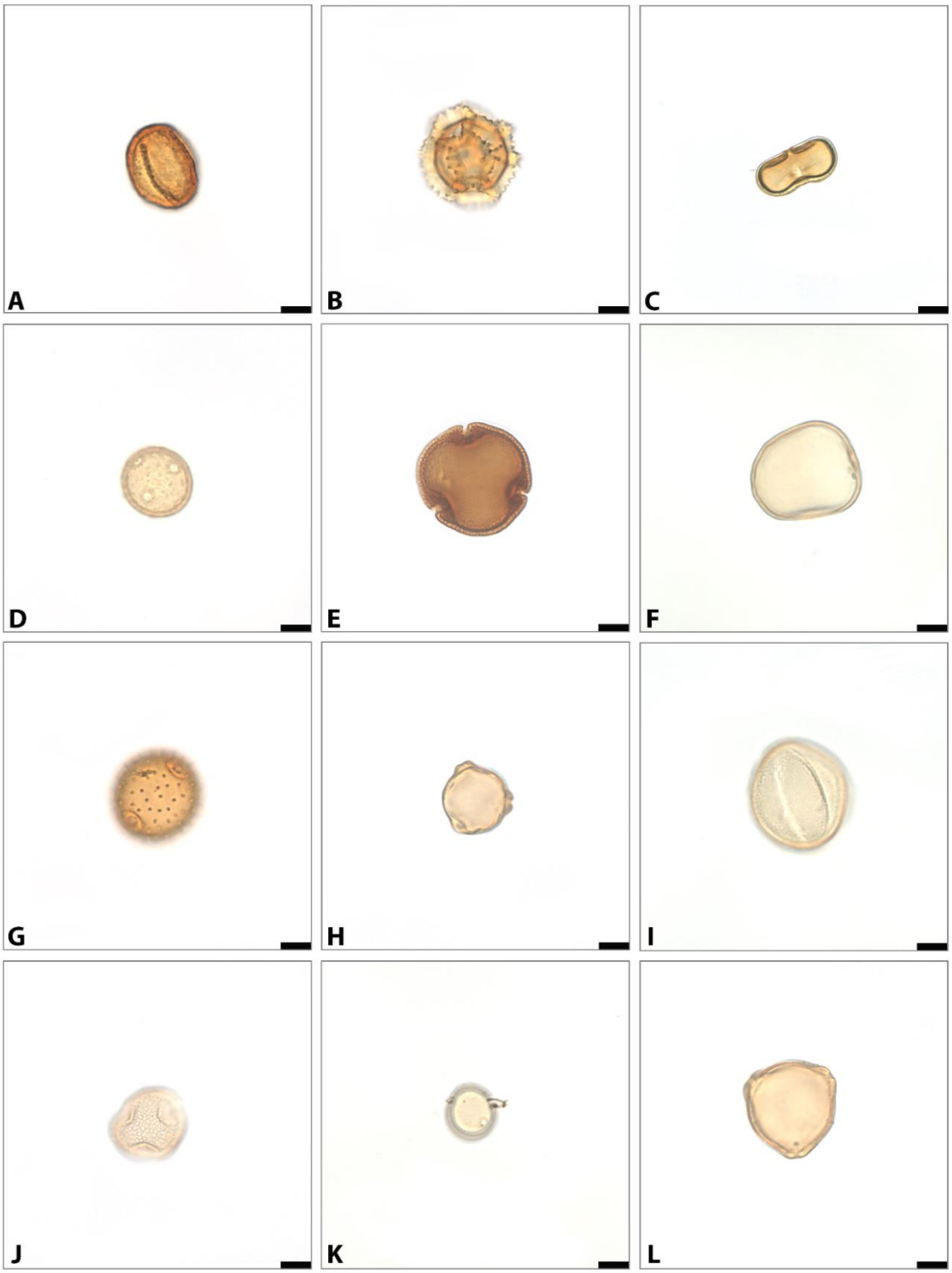


Plate 17: Light micrographs of most abundant taxa in sample 14SDS. Scale bar indicates 10 µm.: **A**. *Quercus*. **B**. Asteraceae. **C**. Apiaceae. **D**. *Plantago*. **E**. *Tilia*. **F**. Poaceae. **G**. *Campanula*. **H**. *Betula*. **I**. Lamiaceae. **J**. *Fraxinus*. **K**. Urticaceae/Cannabaceae. **L**. *Corylus*.

Location: Outdoor Locations Bad Tatzmannsdorf

Park

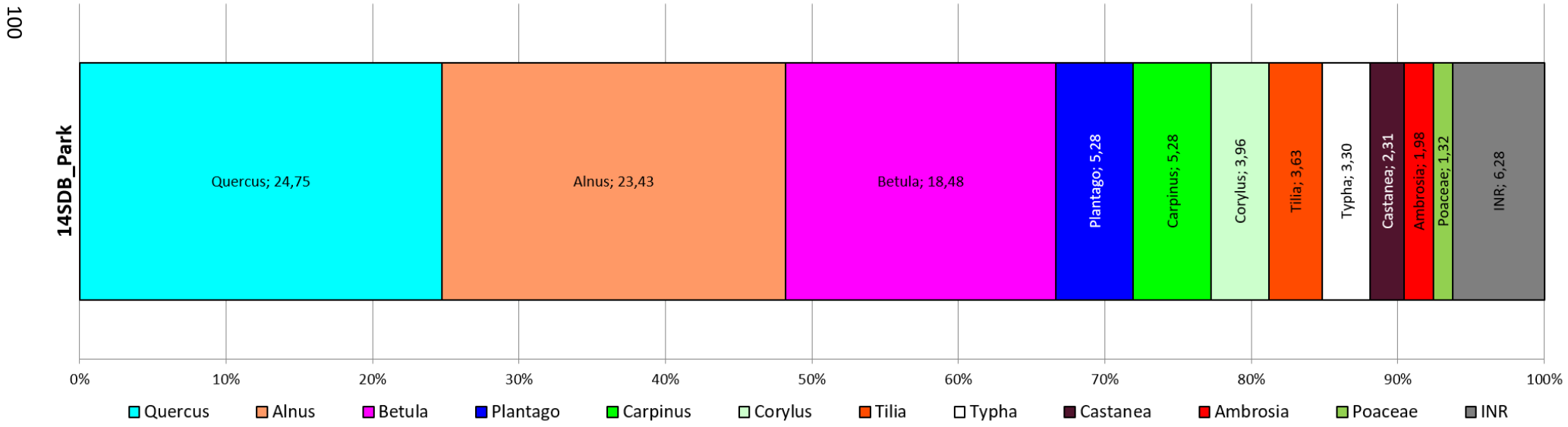
14SDB Floor

In floor sample 14SDB, a total of 303 pollen grains was counted (Table 25). The most abundant taxon was again *Quercus* sp. (Fagaceae) (24.75 %) followed by *Alnus* sp. (Betulaceae) (23.43 %) and *Betula* sp. (Betulaceae) (18.48 %) (Figure 37). 14SDB was the sample with highest percentages of *Alnus* sp. (Betulaceae), *Corylus* sp. (Betulaceae) and *Typha* sp. (Typhaceae) amongst all (Table 7). 48 % of the identified proximate vegetation was represented by the pollen spectra (see Figure 39). *Ambrosia* sp. (Asteraceae), *Juglans* sp. (Juglandaceae), *Aesculus* sp. (Sapindaceae), *Rumex* sp. (Polygonaceae), *Fagus* sp. (Fagaceae), *Artemisia* sp. (Asteraceae) and Amaranthaceae were only found in the pollen sample.

Taxa	Percent	Count
Quercus	24.75	75
Alnus	23.43	71
Betula	18.48	56
Plantago	5.28	16
Carpinus	5.28	16
Corylus	3.96	12
Tilia	3.63	11
Typha	3.30	10
Castanea	2.31	7
Ambrosia	1.98	6
Poaceae	1.32	4
INR	6.28	19
Total	100	303

INR		
Taxa	**Percent**	**Count**
Juglans	0.99	3
Urticaceae/Cannabaceae	0.99	3
Amaranthaceae	0.99	3
Aesculus	0.99	3
Campanula	0.66	2
Rumex	0.33	1
Fagus	0.33	1
Fabaceae	0.33	1
Asteraceae	0.33	1
Artemisia	0.33	1

Table 25: Pollen percentages and counts of sample 14SDB.



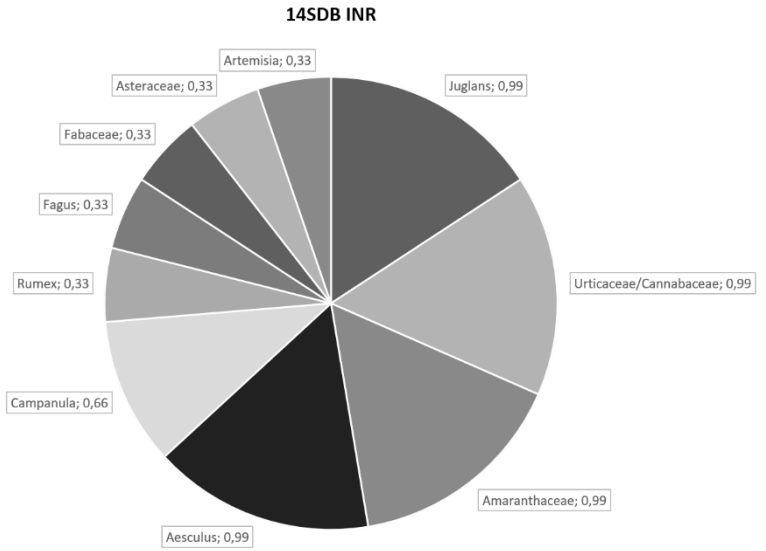


Figure 37: Pollen spectrum and "INR" diagrams sample 14SDB.

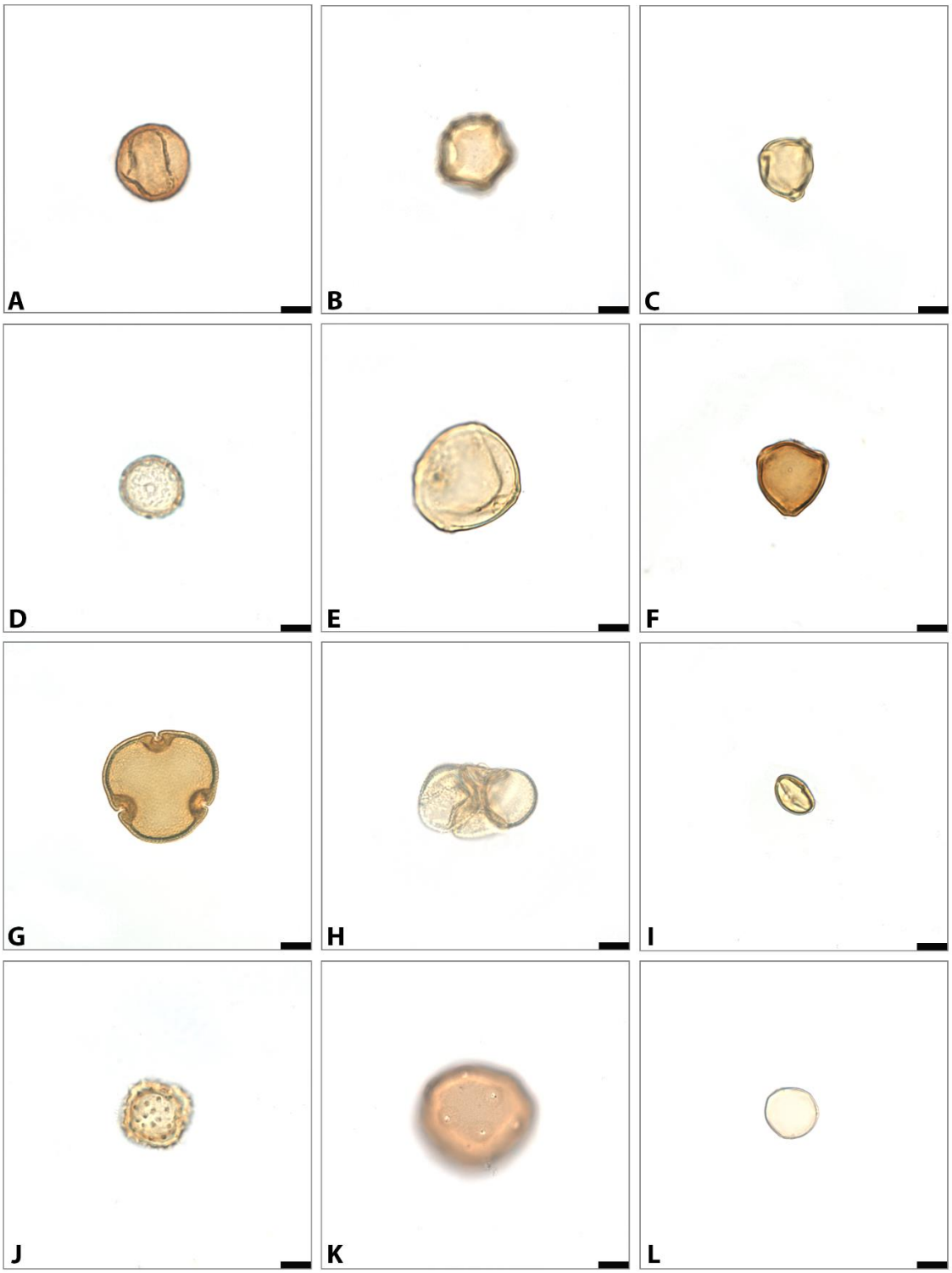


Plate 18: Light micrographs of most abundant taxa in sample 14SDB. Scale bar indicates 10 µm.: **A**. *Quercus*. **B**. *Alnus*. **C**. *Betula*. **D**. *Plantago*. **E**. *Carpinus*. **F**. *Corylus*. **G**. *Tilia*. **H**. *Typha*. **I**. *Castanea*. **J**. *Ambrosia*. **K**. *Juglans*.
L. Urticaceae/Cannabaceae.

Location: Outdoor Locations Bad Tatzmannsdorf

Park

Combined Results Spiderweb and Floor Sample (14SDS and 14SDB)

While both samples depicted *Quercus* sp. (Fagaceae) as dominating taxon, in 14SDS it makes up over 87 % of the identified pollen grains. In 14SDB it is limited to 24.75 %. *Alnus* sp. (Betulaceae) and *Betula* sp. (Betulaceae) showed high abundance in 14SDB (Figure 38). Samples 14SDS and 14SDB were the only ones containing Campanulaceae pollen (Table 7). While in 14SDS *Fraxinus* sp. (Oleaceae), Apiaceae and Lamiaceae were found in contrast to 14SDB, only the latter contained *Juglans* sp. (Juglandaceae), *Aesculus* sp. (Sapindaceae), *Fagus* sp. (Fagaceae) *Artemisia* sp. (Asteraceae) and Fabaceae. Both spiderweb and floor sample represented the surrounding vegetation with 48 % (see Figure 39).

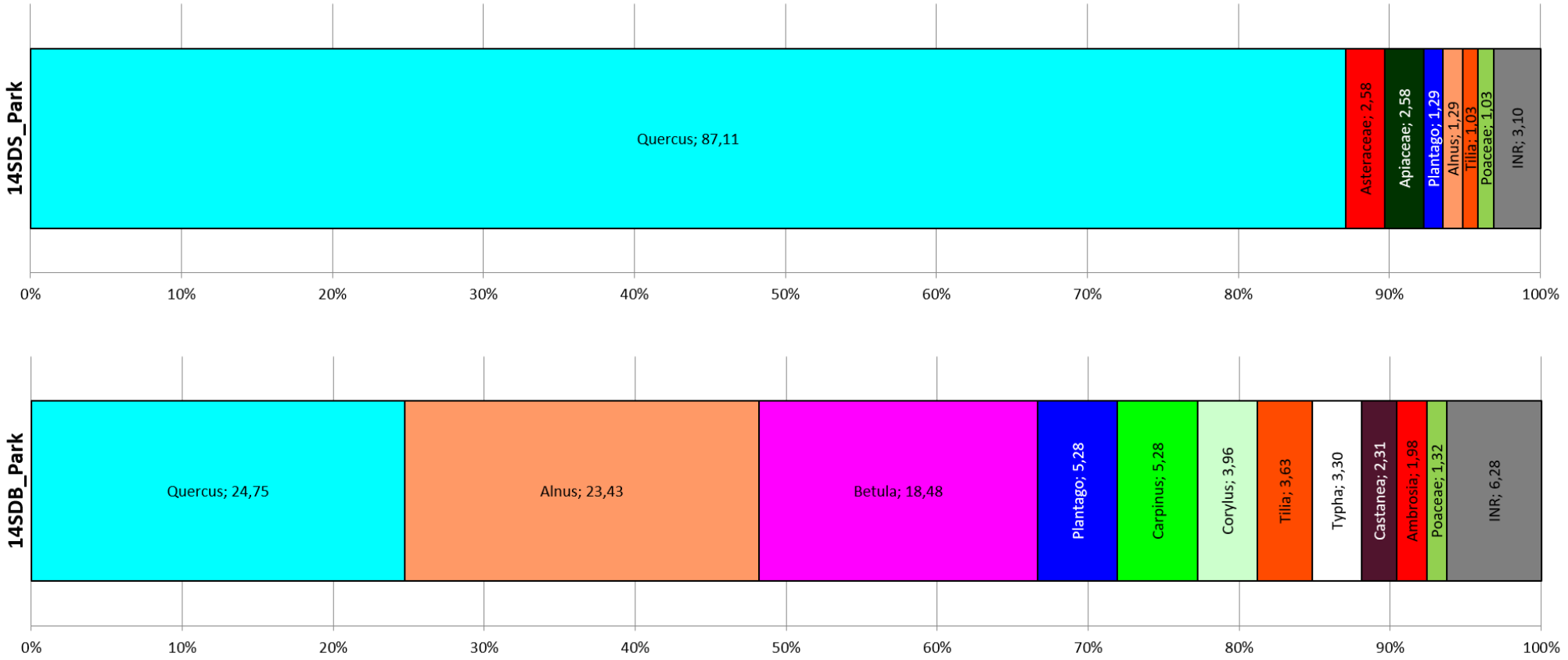


Figure 38: Pollen spectrum diagrams samples 14SDS and 14SDB.

3.3 Vegetation Accordance

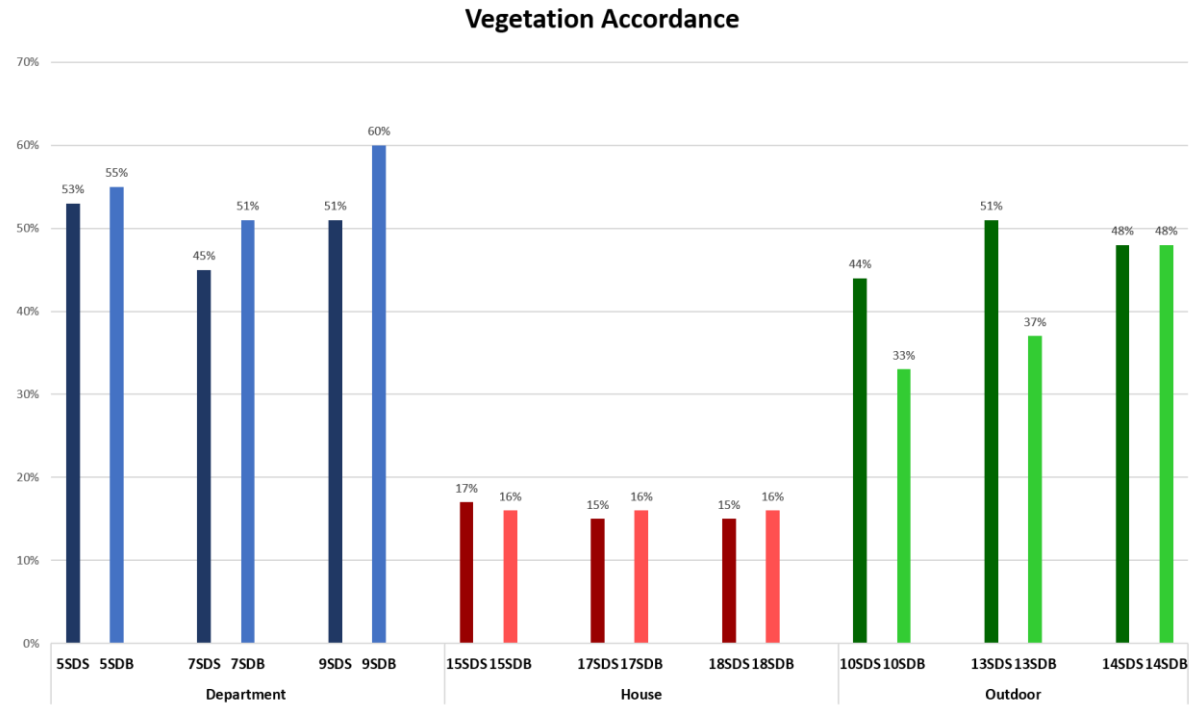


Figure 39: General survey of vegetation accordance (all samples compared). Values indicate the fraction of taxa determined both in the surrounding vegetation and the respective pollen sample.

3.4 Pollination Modes

The identified taxa were categorized by means of their dominating pollination mode. “Anemophily” refers to taxa performing wind pollination, “Zoophily” to those being pollinated via an animal vector. The category “Ambophily” was used to correspond to taxa which use both pollination modes to some extent. This division also includes plant families in which some representatives are wind pollinated and others animal pollinated and was accounted in cases no further determination than the family level was feasible. Categories were assigned on basis of respective literature (Abrahamczyk et al. 2020). Table 26 depicts the underlying classification of taxa.

Taxon	Pollination Mode
Acer	Ambophily
Aesculus	Zoophily
Ailanthus	Zoophily
Alnus	Anemophily
Amaranthaceae	Ambophily
Ambrosia	Anemophily
Apiaceae	Zoophily
Artemisia	Anemophily
Asteraceae	Zoophily
Betula	Anemophily
Boraginaceae	Zoophily
Brassicaceae	Zoophily
Campanulaceae	Zoophily
Carpinus	Anemophily
Carya	Anemophily
Caryophyllaceae	Zoophily
Castanea	Ambophily
Centaurea	Zoophily
Cornus	Zoophily
Corylus	Anemophily
Cupressaceae	Anemophily
Ericaceae	Zoophily
Euphorbiaceae	Ambophily
Fabaceae	Zoophily
Fagus	Anemophily
Fraxinus	Anemophily

Taxon	Pollination Mode
Galium	Zoophily
Ginkgo	Anemophily
Hedera	Zoophily
Impatiens	Zoophily
Juglans	Anemophily
Lamiaceae	Zoophily
Lilium	Zoophily
Oleaceae	Ambophily
Parthenocissus	Zoophily
Plantago	Ambophily
Platanus	Anemophily
Poaceae	Anemophily
Quercus	Anemophily
Ranunculaceae	Zoophily
Reseda	Zoophily
Rhus	Zoophily
Rosaceae	Zoophily
Rumex	Anemophily
Salix	Zoophily
Sambucus	Zoophily
Saxifragaceae	Zoophily
Tilia	Ambophily
Typha	Anemophily
Ulmus	Anemophily
Urticaceae/Cannabaceae	Anemophily

Table 26: Pollination modes of identified taxa from all samples.

While the amount of ambophile taxa show no consistency, zoophile taxa hold higher percentages in spiderweb samples of this location. Upon these, 7SDS depicts the highest amount of ambophile taxa (see Figure 19).

House Bad Tatzmannsdorf

Ambophile taxa showed higher percentages in dust samples, while with the exception of sample 17SDS, again the highest concentration of zoophile taxa was found in spiderweb samples (see Figure 41).

Outdoor Locations Bad Tatzmannsdorf

Like observed in the other two locations, the outdoor sites showed higher percentages of zoophile taxa in the spiderweb samples as well. Ambophile taxa were distributed conversely (see Figure 42).

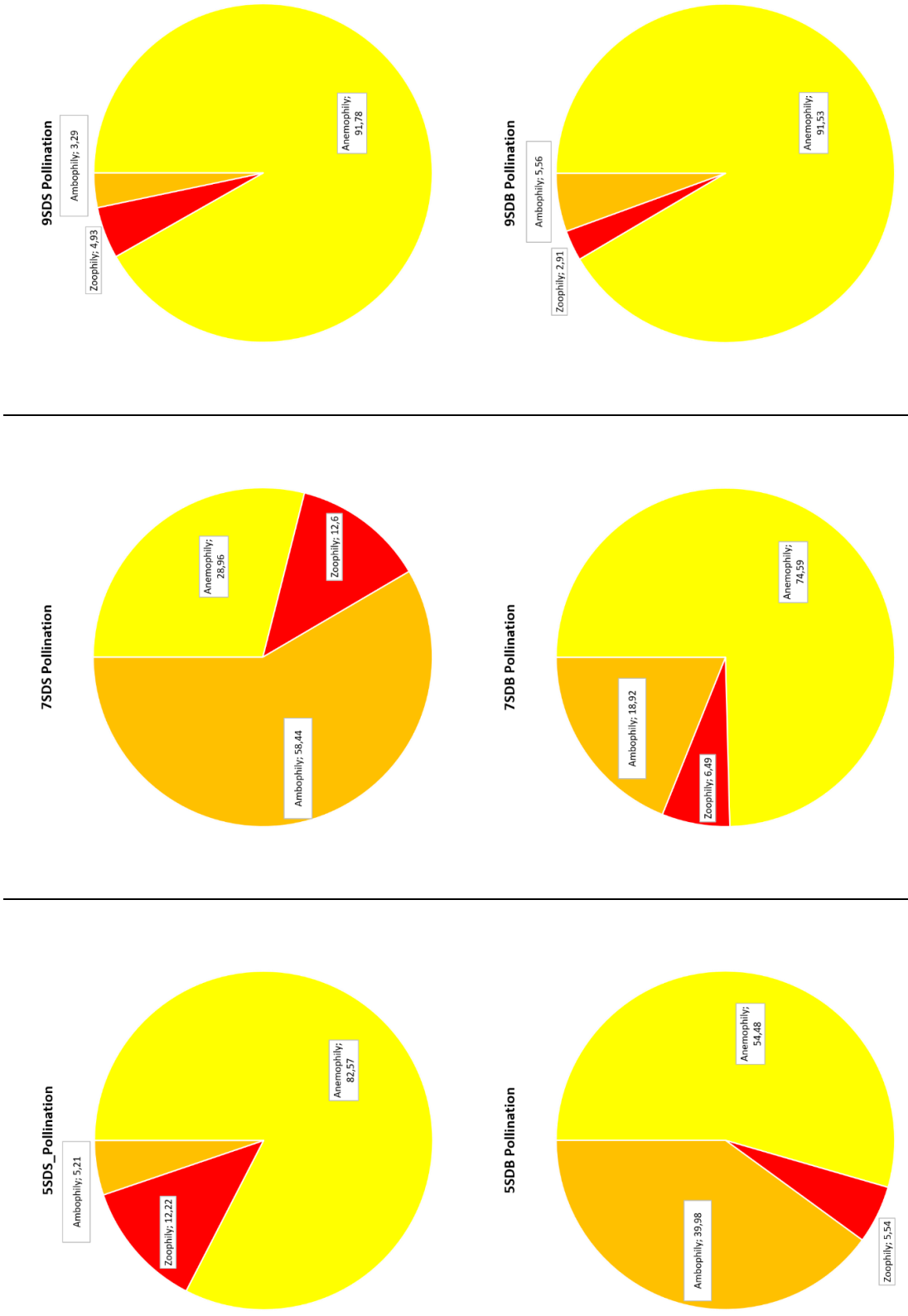


Figure 40: Pollination mode diagrams of location “Department of Botany and Biodiversity Research”

Figure 41: Pollination mode diagrams of location “House Bad Tatzmannsdorf”.

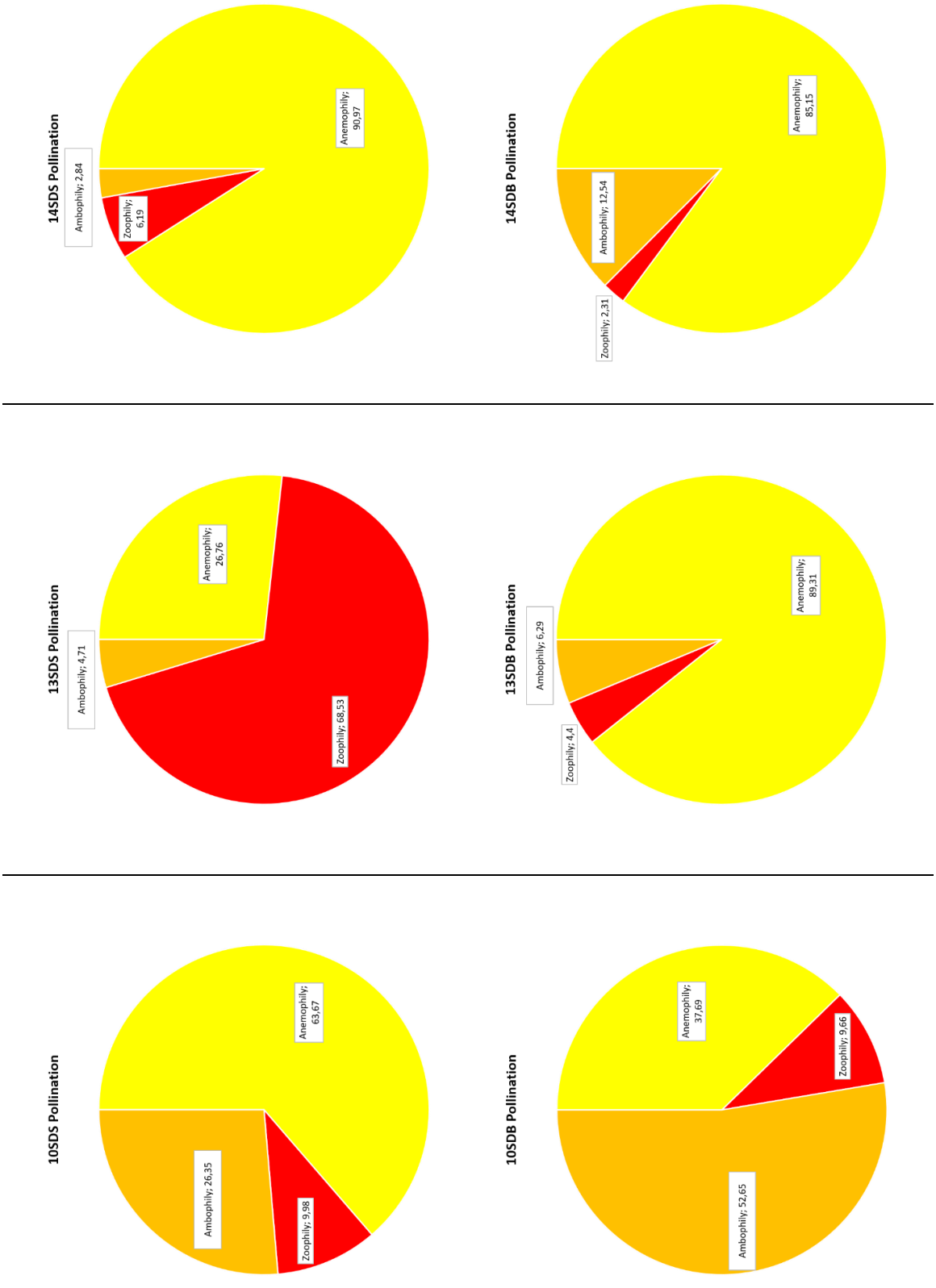


Figure 42: Pollination mode diagrams of location “Outdoor Locations Bad Tatzmannsdorf”.

3.5 Spore Ratios

The numbers of counted pollen grains and spores per individual sample were compared and displayed in circular charts. The category “Spores” comprises indefinite spores, not considering hyphae. Charts were combined for the three main locations separately.

3.5.1 Department of Botany and Biodiversity Research

In two of the three sampled rooms (5SDS and 5SDB, 9SDS and 9SDB), spiderweb samples contained higher percentages of spores than the respective floor samples. In the 3rd case (7SDS and 7SDB), both samples showed similarly low numbers of spores. The highest concentration was found in spiderweb sample 5SDS (see Figure 43).

3.5.2 House Bad Tatzmannsdorf

Analog to the circumstances at the location “Institute of Botany and Biodiversity Research”, two out of three sites from “House Bad Tatzmannsdorf” depicted greater amounts of spores in the spiderweb than in the floor sample. The highest abundance of spores in this location was found in sample 15SDS (see Figure 44)

3.5.3 Outdoor Locations Bad Tatzmannsdorf

All floor samples of the Outdoor Locations showed higher percentages of spores than the respective spiderweb samples. The highest spore ratio was found in sample 10SDB (see Figure 45).

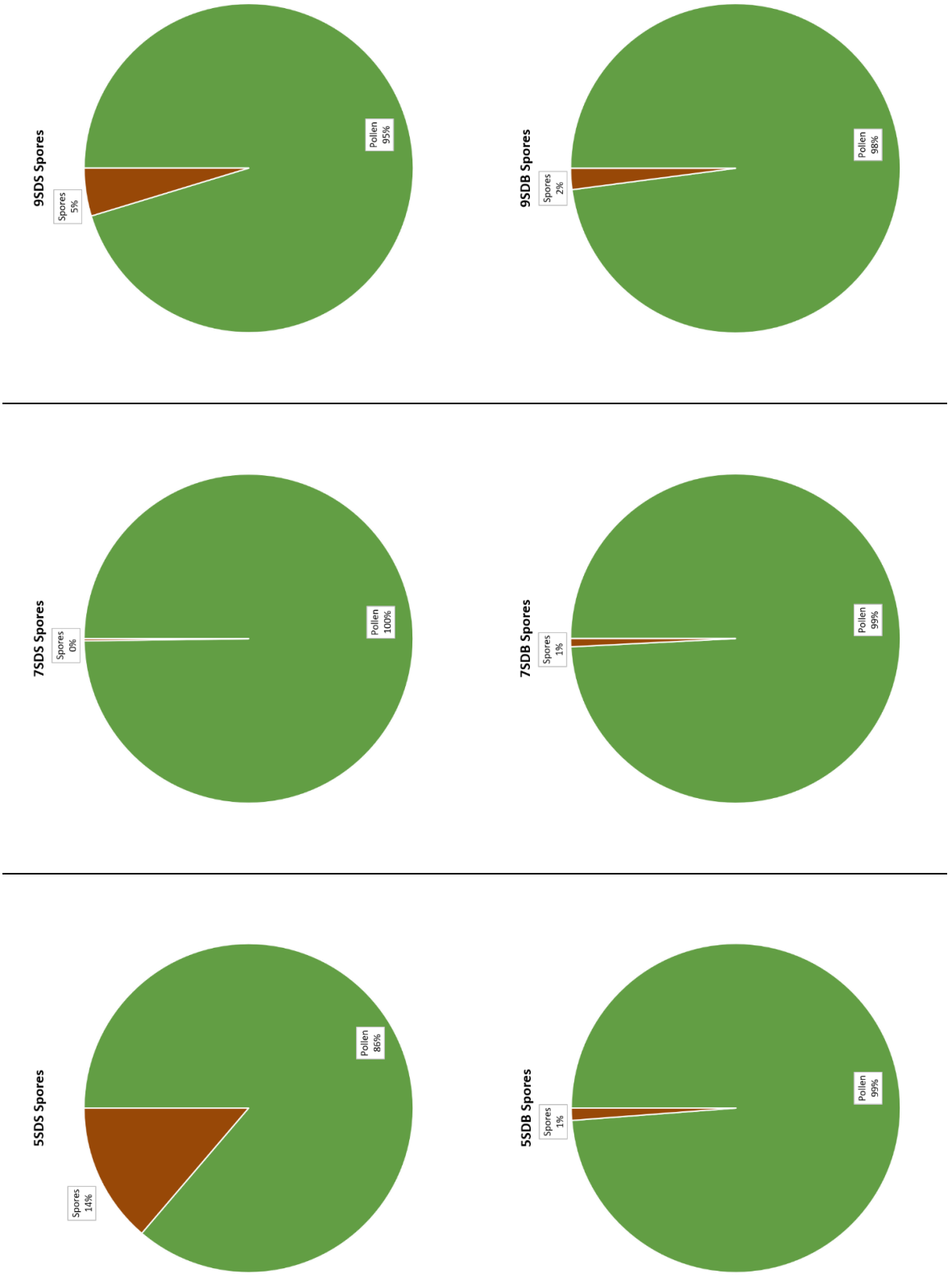


Figure 43: Spore ratio diagrams of location “Institute of Botany and Biodiversity Research”.

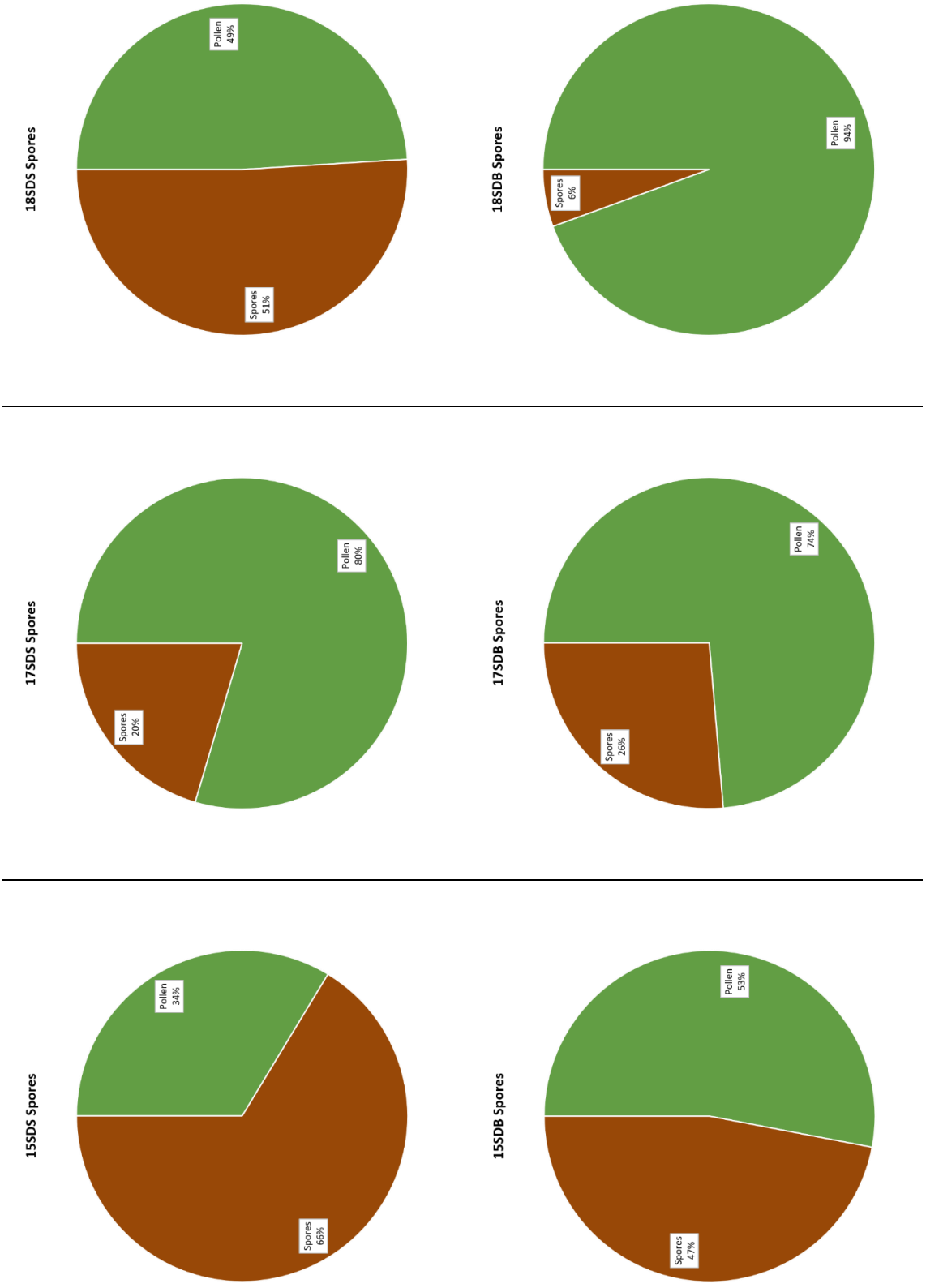


Figure 44: Spore ratio diagrams of location “House Bad Tatzmannsdorf”.

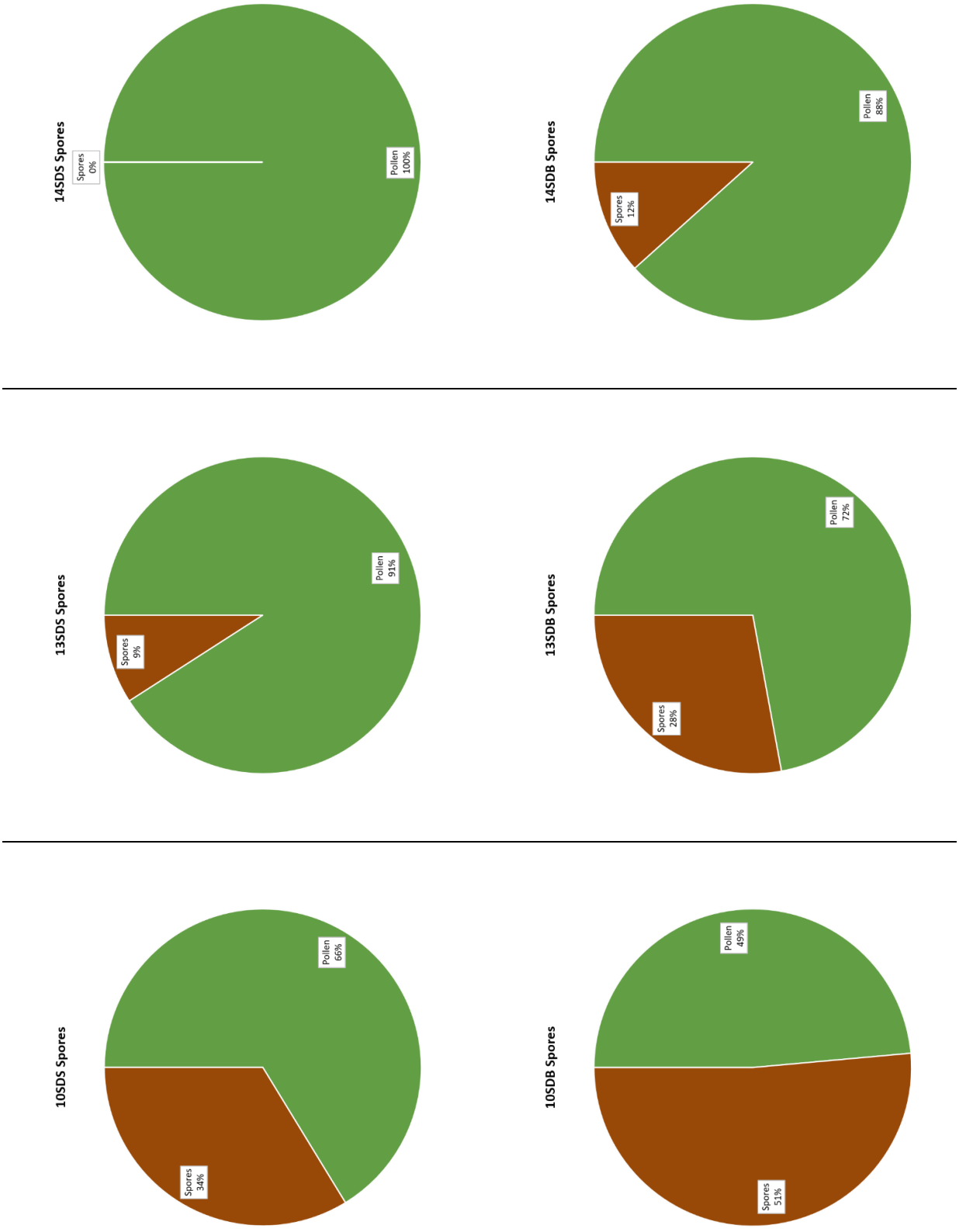


Figure 45: Spore ratio diagrams of location “Outdoor Locations Bad Tatzmannsdorf”.

4 Discussion

4.1 Palynological taphonomy

“Palynological taphonomy” comprises all factors that influence if a palynomorph is found at a particular time in a certain place (Wiltshire 2006). These aspects may be of abiotic or biotic nature and can vary greatly between i.a. indoor and outdoor locations and sample type. Considering the amount of possible impacts, every site is unique from a palynological point of view.

The dispersal range of pollen grains may be influenced by various factors. With increasing wind velocity, pollen grains are dispersed more distantly (Niklas 1985), and already deposited pollen may be carried away again. Dispersal range of a pollen type is also confined by its size, aerodynamic shape and overall mass (Mildenhall et al. 2004).

Another important influencing factor is pollen preservation. Although pollen protoplasts decompose quickly, the outer wall can be preserved under anoxic conditions for millions of years (Mildenhall et al. 2004). However, pollen from soil surface samples might suffer from degradation by i.a. microbes, mechanical forces or oxidation (Dimbleby 1957). Susceptibility to damage is linked to the relative amounts of sporopollenin (Wiltshire 2006). Sporopollenin is an extremely stable organic polymer which comprises the outer wall of pollen grains (Steemans et al. 2010).

4.2 Vegetation Accordance

In the current investigation surrounding vegetation was registered within a radius of approximately 100 m of the two indoor locations and all three sites of the outdoor locations individually. Registration was performed qualitatively not quantitatively as obtained via cover-abundance measurement methods. All samples contained taxa connecting them to their sampling location (see Figure 39).

In general, the highest accordance was noticed for samples taken from location “Department of Botany and Biodiversity Research”. Although the Botanical Garden Vienna with numerous different taxa is located close to this location, vegetation within 100 m was noticed less diverse in species than location “House Bad Tatzmannsdorf” which was encircled by a species rich cottage garden. This fact and the influence of distant anemophilous vegetation explains the different ranges of vegetation accordance between the two indoor locations.

From all sampled locations *Platanus* sp. (Platanaceae) and *Ginkgo* sp. (Ginkgoaceae) were found most frequent in “Department of Botany and Biodiversity Research” (see Table **7**). Both taxa were located in the immediate surroundings of the building (see Table **1**). Their highest amounts were detected in “Room 414” and “Room 416” on the 4th floor of the building. The reason why “Room E08” on the ground floor contained less pollen from these taxa might be connected to its window not facing directly towards the trees. The

buildings edge could have acted as an obstacle to the pollen dispersal as described by Wiltshire (2006).

At “Department of Botany and Biodiversity Research” in every case floor samples reflected higher ratios of the nearby vegetation than spiderweb samples. However, “House Bad Tatzmannsdorf” exhibited spiderweb and floor samples being more similar concerning their accordance of the vegetation. For two of the three sampled rooms, spiderwebs had greater resemblance of the surroundings, but a discrepancy of only 1 % between all three pairs must be declared. Interestingly, only room “Kitchen” contained Lamiaceae, Caryophyllaceae and Saxifragaceae (see Table 7). This fact could be explained by one of the windows facing east right towards the flower bed comprising named taxa (see Figure 3).

Spiderweb samples from “Forest Edge” and “Forest” both were more representative for these site’s vegetation than the respective floor samples. For location “Park” equivalent percentages for vegetation accordance of spiderweb and floor samples were observed. Outdoor samples are impacted by some features which play no or only a minor role concerning indoor samples. Factors like local weather events (Wiltshire 2006), higher abundance of pollinators and degradation of pollen grains on the soil (Webster et al. 2008) have to be taken into account.

4.3 Dominant Pollen Types in Spiderweb Samples

In three spiderweb samples a single taxon was significantly dominating the pollen spectrum.

87.11 % of 14SDS, the spiderweb sample taken at the outdoor location “Park”, were made up by *Quercus* sp. (Fagaceae). *Quercus* is an anemophilous tree with anthesis from April to May (Fischer et al. 2008) in the respective region. Samples were taken in the mid of July. Generally, wind pollinated taxa tend to produce higher amounts of pollen grains, than zoophilous plants by far (Wiltshire 2006). This pollen type possibly accumulated in the spiderweb over time, whilst it might have been blown away from the ground. Also, degradation of pollen on soil material should be considered (Wiltshire 2006, Webster et al. 2008).

In sample 13SDS from location “Forest” the Rosaceae pollen amount was increased to 52.67 % compared to no determination at all in the associated floor sample (see Figure 32). 13SDS was sampled from spiderwebs in undergrowth of *Rubus* sp. (Rosaceae), close to a tree of *Sorbus* sp. (Rosaceae). Webs were of the canopy type (see 1.2.1 Spider Webs) which enables a large horizontal contact surface. Anthesis of both nearby zoophilous Rosaceae species dominantly starts in May and lasts until June (Fischer et al. 2008), so high amounts of pollen might have accumulated in the web until sampling took place. This possibly happened through various local events including rain (McDonald 1962), animal interaction and gravity. Rosaceae pollen in the floor sample could be missing due to degradation or limitation of dispersal range (Mildenhall et al. 2004).

Euphorbiaceae amounted 50.32 % of the pollen grains in spiderweb sample 7SDS. The respective floor sample contained 0.27 % (see Figure 15). Two individuals of *Euphorbia* sp. (Euphorbiaceae) were kept as indoor plants in the room. Lack of this pollen type in the floor sample could be explained by the higher cleaning activity performed there in contrast to the spiderwebs which were located behind furniture and by a narrow dispersal range around the plant (Mildenhall et al. 2004). Also, Nguyen and Weber (2015) had detected amounts of < 5 % of *Euphorbia* (Euphorbiaceae) pollen in floor samples taken from rooms containing a *Euphorbia* species and therefore categorized them as “rare pollen types” in their study.

In all mentioned cases, the pollen type was considerably less abundant or completely missing in the associated floor sample. This kind of accumulation was detected exclusively in spiderweb samples, which could characterize spiderwebs as a meaningful pollen archive.

4.4 Accordance of Spiderweb and Floor Samples

Pollen spectra of each site were aligned and categorized on basis of the introduced classification system (see Figure 8). Resemblance between spiderweb and floor samples ranged from dissimilar to very similar.

Location “House Bad Tatzmannsdorf” featured the highest amount of similar and very similar samples. Two sample pairs were classified as “similar” (“Kitchen” and “Corridor”) and one as “very similar” (“Annex”). The high resemblance between spiderweb and floor pollen spectra of the latter could be attributed to the fact that diverse gardening tools e.g. a lawn mower and a scythe were stored in this room. Assumed, that these objects have had close contact to the lawn and wildflower areas in the garden, they might have carried pollen to the floor. Also, all kinds of plant material were shredded in the room, which could have added to similarity by dispersing pollen in the annex (zit).

Sampled outdoor locations exhibited the greatest differences between spiderweb and floor samples, ranging from one instance of “similar” (“Forest Edge”) to two cases of “dissimilar” (“Forest” and “Park”). The latter two can be explained by the accumulations of one pollen type in both spiderweb samples of these sites.

Spiderweb and floor pollen spectra of location “Department of Botany and Biodiversity research” were categorized “similar” (“Room 414”), “slightly similar” (“Room E08”) and “dissimilar” (“Room 416”). Variation in “Room E08” could be due to frequent entering of it after having contact with the ruderal vegetation in the surrounding area. For “Room 416” again high percentage of one taxon (*Euphorbia* sp.) was the reason for the dissimilarity.

The three cases of great discrepancy between spiderweb and floor samples were due to massive accumulation of one pollen type in the spiderweb sample. These were Euphorbiaceae for “Room 416”, Rosaceae for sampling site “Forest” and *Quercus* sp. (Fagaceae) for sampling site “Park”. All three incidences might be related to a local accumulation of pollen that was archived in the spider web (see 4.3 Dominant Pollen Types in Spiderweb Samples).

4.5 Trends in Spiderweb and Floor Samples

4.5.1 Certain Taxa

For some taxa, a tendency of appearing in a distinct sample type was noticed.

Lamiaceae were only detected in small amounts but if so, exclusively in spiderweb samples. This might be the case because pollen was transported to the spiderweb by pollinators which were trapped or restrained by the structure. The same could be true for Apiaceae and Fabaceae which were mostly determined in spiderweb samples. Zoophilous pollen is hardly transported by wind and produced in small amounts (see 1.3 Pollination Modes).

In contrast, *Plantago* sp. (Plantaginaceae) held significantly higher amounts in floor than in spiderweb samples apart from sampling site “Forest” where numbers were similar (see Figure 35). Genus *Plantago* comprises both zoophile and anemophile species (Abrahamczyk et al. 2020) which often grow in ruderal environments (Fischer et al. 2008). Studies displayed that pollen from previously visited sites often is adhered to a person’s footwear (Riding et al. 2007; Nguyen and Weber 2015) and it is assumed, that it could have been carried indoors this way. Three sampling sites (“Room E08”, “Kitchen” and “Corridor”) depicted similar pollen spectra concerning *Plantago* sp. (Plantaginaceae). All these sites were characterized by the frequent entering with outdoor shoes. Jantunen and Saarinen (2011) stated that clothing which has had direct contact to plants contained the highest amount of pollen carried indoors. Riding et al. (2007) detected that the pollen sample of shoes worn at different sites predominantly reflected those found at the last location. As *Plantago* sp. was determined growing in proximity of named sites, this effect may also be displayed here.

4.5.2 Pollination Mode

Determined taxa in the pollen spectra were divided into three pollination modes: “Zoophily”, “Anemophily” and “Ambophily” (see Table 26). Eight out of nine sample pairs depicted higher amounts of zoophilous pollen in spiderweb samples. In contrast to the floor, pollinators are more likely to get into a close contact with spiderwebs or even being trapped by these structures. Whilst attempting to escape the net, multiple contacts with the sticky silk are made. Another possible way of transfer of zoophilous pollen into spiderwebs might be by directly falling from the source structure (inflorescence or pollen carrying media) into it. The massive amount of Rosaceae pollen in sample 13SDS, which was collected from canopy type webs in *Rubus* sp. (Rosaceae) right next to *Sorbus* sp. (Rosaceae) could at least partly be accounted to this mechanism.

Zoophilous pollen in floor samples is likely to originate from pollen containing material like shoes and fabrics. Distinct ornamentation (Mildenhall et al. 2006) and high levels of pollenkitt (Pacini and Hesse 2005), make it more likely to adhere to material after direct contact than anemophilous pollen.

The only case of a floor sample containing higher amounts of zoophilous pollen than its counterpart in this study was for site “Annex” at location “House Bad Tatzmannsdorf”. A supposable reason for this effect might be the storage of gardening tools and usage of a shredder in this room.
Increased amounts of ambophile pollen can be traced back to the accumulation of Euphorbiaceae in 7SDS and high amounts of *Plantago* sp. (Plantaginaceae) or *Tilia* sp. (Malvaceae) in floor samples.

4.6 Spore Ratios

Not further determined spores were counted along with the pollen grains performing light microscopy. Pollen and spore ratios of each sample were opposed in Figure 43, Figure 44 and Figure 45 and a clear discrimination between indoor and outdoor samples was observable. All but one of the spiderweb samples from indoor locations contained higher portions of spores than their counterpart from the floor. Indoors, floor covering does not give fungi a beneficial environment to grow and build spores, due to minimal amounts of organic matter there. However, sticky spiderwebs comprising of spider silk and adhesive glue droplets composed mainly of glycoproteins (Jain et al. 2015) provide a more suitable medium. Wiltshire et al. (2014) stated that the distribution of fungal spores is variable depending on appropriate supply of food for the fungus. Opposite results were gained from outdoor samples (see Figure 45). Outdoors, soil bears high potential for fungal activity and therefore higher spore ratios in floor samples are expectable. Highest overall spore concentrations were found in sampling site “Kitchen” (see Figure 44), a particularly warm and humid room due to cooking activity and heating. This conforms with a study by Firoze Quamar and Bera (2016) that indicates that fungal spores found in spiderwebs hint to moist, warm conditions. As it is known for spores to cause diverse allergenic reactions in humans, having them restrained in spiderwebs can give an insight to the spore concentration and composition of a locality.

4.7 Limitations

Although, carried out with great caution and intent, some limitations of this study shall be mentioned. Samples of each location were taken only once on a day in July 2019 and are therefore not suitable for representing the whole pollen season. Also, surrounding vegetation was determined only qualitatively and not quantitatively. Indoor samples might have been influenced by cleaning activities and the time of construction of the individual spiderwebs is unknown. Hence, it is unclear to some extent, what timespan the samples are representing. Conclusions should therefore be viewed under consideration of named factors.

5 Conclusion

The present study aimed to throw light on following questions: (1) Do pollen spectra received from spiderwebs depict the surrounding vegetation? (2) How similar is the composition of pollen spectra from spiderweb and dust/soil surface samples?

(1) In general, comparable levels of vegetation accordance were observed in spiderweb and floor samples for each location. However, some discrepancies were noticeable: For the majority of outdoor samples, spiderwebs contained more of the surrounding plant taxa than soil surface samples, whilst the opposite was true for indoor samples. A comparison of pollination modes showed the greater abundance of insect pollinated taxa in the spiderweb samples. Another issue worth mentioning is the higher ratio of spores found in spiderwebs indoors compared to the floor. As some spores are relevant allergens, determining their abundance in indoor locations can be crucial. A comparative analysis of data from modern pollen samplers and spiderwebs could be instructive.

(2) Resemblance between both sample types appeared instable, ranging from dissimilar to very similar, depending on the location. However, high dissimilarity was mainly caused by the accumulation of one pollen type in some spiderweb samples like for instance Rosaceae at sampling site “Forest”. Other effects are the higher abundance of ruderals and less noticed zoophile taxa in indoor floor samples. Therefore, spiderweb and dust/soil surface samples are not interchangeable as a palynological resource. Anyhow, due to specific characters, spiderwebs may act as a pollen archive, capturing significant aerobiological events, although diverse environmental factors must be taken into account. It is assumed, that spiderweb samples provide relevant data unique to a location and could serve as supplements to state-of-the-art palynological techniques.

References

Abrahamczyk S, Dannenberg LS, Weigend M (2020) Pollination modes and divergent flower traits in three species of Plantago subgenus Plantago (Plantaginaceae). Flora 267:151601. doi: 10.1016/j.flora.2020.151601

Bellmann H (2016) Der Kosmos Spinnenführer, [2. Auflage]. Kosmos-Naturführer. Kosmos, Stuttgart

Bera S, Trivedi A, Sharma C (2002) Trapped pollen and spores from spider webs of Lucknow environs. Current Science 83:1580–1585

Cundill PR (1991) Comparisons of moss polster and pollen trap data: a pilot study. Grana 30(2):301–308. doi: 10.1080/00173139109431984

Dimbleby GW (1957) Pollen Analysis of Terrestrial Soils. The New Phytologist 56:28. doi: 10.1111/j.1469-8137.1957.tb07446.x

Eggs B, Sanders D (2013) Herbivory in spiders: the importance of pollen for orb-weavers. PloS one 8(11):e82637. doi: 10.1371/journal.pone.0082637

Erdtman G (1960) The acetolysis method-a revised description. Sven Bot Tidskr 54:516–564

Erdtman G (1969) Erdtman's handbook of palynology. Handbook of palynology. Munksgaard, Copenhagen

Firoze Quamar M, Bera SK (2016) Pollen analysis of spider web samples from Korba District, Chhattisgarh (central India): an aerobiological aspect. Aerobiologia 32(4):645–655. doi: 10.1007/s10453-016-9438-2

Fischer MA, Oswald K, Adler W, Gottschlich G, Kästner A (2008) Exkursionsflora für Österreich, Liechtenstein und Südtirol. Bestimmungsbuch für alle in der Republik Österreich, im Fürstentum Liechtenstein und der Autonomen Provinz Bozen, 3., verbesserte Auflage. Land Oberösterreich, Biologiezentrum der Oberösterr. Landesmuseen, Linz

Friedman J, Barrett SCH (2009) Wind of change: new insights on the ecology and evolution of pollination and mating in wind-pollinated plants. Annals of botany 103(9):1515–1527. doi: 10.1093/aob/mcp035

Gehrig R (2019) Representativeness of pollen traps: a review of the national pollen network of Switzerland. Aerobiologia 35(3):577–581. doi: 10.1007/s10453-019-09593-z

Gosline J, Guerette P, Ortlepp C, Savage K (1999) The mechanical design of spider silks: from fibroin sequence to mechanical function. The journal of experimental biology 202

Halbritter H, Ulrich S, Grímsson F, Weber M, Zetter R, Hesse M, Buchner R, Svojtka M, Frosch-Radivo A (2018) Illustrated Pollen Terminology, 2nd ed. 2018. Springer International Publishing; Imprint, Springer, Cham

Hesse M, Waha M (1989) A new look at the acetolysis method. Plant Systematics and Evolution 163(3/4):147–152

Hose G, James J, Gray M (2002) Spider webs as environmental indicators. Environmental Pollution 120(3):725–733. doi: 10.1016/S0269-7491(02)00171-9

Jain D, Zhang C, Cool LR, Blackledge TA, Wesdemiotis C, Miyoshi T, Dhinojwala A (2015) Composition and Function of Spider Glues Maintained During the Evolution of Cobwebs. Biomacromolecules 16(10):3373–3380. doi: 10.1021/acs.biomac.5b01040

Jantunen J, Saarinen K (2011) Pollen transport by clothes. Aerobiologia 27(4):339–343. doi: 10.1007/s10453-011-9200-8

Klaus W (1987) Einführung in die Paläobotanik. Fossile Pflanzenwelt und Rohstoffbildung, vol 1. Deuticke, Wien

Lisitsyna OV, Hicks S, Huusko A (2012) Do moss samples, pollen traps and modern lake sediments all collect pollen in the same way? A comparison from the forest limit area of northernmost Europe. Veget Hist Archaeobot 21(3):187–199. doi: 10.1007/s00334-011-0335-x
McDonald JE (1962) Collection and Washout of Airborne Pollens and Spores by Raindrops. Science (New York, N.Y.) 135(3502):435–437. doi: 10.1126/science.135.3502.435
Mildenhall D, Bryant V, Milne L (2004) Forensic Palynology. In: Coyle HM (ed) Forensic botany. Principles and applications to criminal casework. CRC, Boca Raton, Fla., London
Mildenhall DC, Wiltshire PEJ, Bryant VM (2006) Forensic palynology: why do it and how it works. Forensic science international 163(3):163–172. doi: 10.1016/j.forsciint.2006.07.012
Nguyen P, Weber M (2015) Forensic value of pollen from ornamental indoor plants. Grana 54(3):236–246. doi: 10.1080/00173134.2015.1045024
Niklas KJ (1985) The aerodynamics of wind pollination. Bot. Rev 51(3):328–386. doi: 10.1007/BF02861079
Pacini E, Hesse M (2005) Pollenkitt – its composition, forms and functions. Flora 200(5):399–415. doi: 10.1016/j.flora.2005.02.006
(2020) PalDat – a palynological database. (2000 onwards, www.paldat.org). https://www.paldat.org/. Accessed 15 Nov 2020
Quamar M, Chauhan M (2011) Pollen analysis of spider webs from Khedla village, Betul District, Madhya Pradesh. Current Science 101:25–2011
Quamar MF, Bera SK (2017) Do the common natural pollen trapping media behave similarly? A comparative study of modern palynoassemblages from Chhattisgarh, central India. Quaternary International 444:217–226. doi: 10.1016/j.quaint.2016.04.041
Riding JB, Rawlins BG, Coley KH (2007) Changes in Soil Pollen Assemblages on Footwear Worn at Different Sites. Palynology 31:135–151
Statistik Austria (2020) Fläche und Flächennutzung bzw. Bevölkerungsdichte Bad Tatzmannsdorf
Steemans P, Lepot K, Marshall CP, Le Hérissé A, Javaux EJ (2010) FTIR characterisation of the chemical composition of Silurian miospores (cryptospores and trilete spores) from Gotland, Sweden. Review of Palaeobotany and Palynology 162(4):577–590. doi: 10.1016/j.revpalbo.2010.07.006
Webster EA, Tilston EL, Chudek JA, Hopkins DW (2008) Decomposition in soil and chemical characteristics of pollen. Eur J Soil Science 59(3):551–558. doi: 10.1111/j.1365-2389.2008.01022.x
Wehner R, Gehring W, Kühn A (1995) Zoologie. Glossar mit 730 Stichworten ; 29 Tabellen, 23., neu bearb. Aufl. Flexibles Taschenbuch. Thieme, Stuttgart
Wiltshire PEJ (2006) Consideration of some taphonomic variables of relevance to forensic palynological investigation in the United Kingdom. Forensic science international 163(3):173–182. doi: 10.1016/j.forsciint.2006.07.011
Wiltshire PEJ, Hawksworth DL, Webb JA, Edwards KJ (2014) Palynology and mycology provide separate classes of probative evidence from the same forensic samples: a rape case from southern England. Forensic science international 244:186–195. doi: 10.1016/j.forsciint.2014.08.017

Appendix

Sample preparation specifics modified after Halbritter et al. (2018)

Spiderweb sample preparation

1. Dissolve spiderwebs in acetolysis mixture (nine parts acetic anhydride (99 %) and one part sulfuric acid (96 %) over night (> 10 h)

2. Filter via laboratory filter (260 µm mesh size)

3. Acetolysis

   a) Overlay pollen material carefully with acetolysis mixture
   b) Boil sample in ultrasonic water bath (10 min, 80°C)
   c) Centrifuge for 5 min, 3000 rpm
   d) Decant supernatant

4. Rinse with concentrated acetic acid

   a) Overlay pollen material with acetic acid
   b) Centrifuge for 2 min, 3000 rpm
   c) Decant supernatant

5. Rinse with distilled water three times

   a) Overlay pollen material with distilled water
   b) Centrifuge for 2 min, 3000 rpm
   c) Decant supernatant

6. Heavy Liquid Separation

   a) Overlay pollen material with 2 cm zinc bromide solution in test tube (250 g zinc bromide in 25 ml HCl (10 %) added to 100 ml distilled water)
   b) Stir sample
   c) Carefully overlay with 2 cm distilled water
   d) Centrifuge for 10 min, 3000 rpm
   e) Pipette organic and dispose inorganic phase
   f) Rinse with distilled water three times (see 7.)

7. Rinse with ethanol (99.8 %)

   a) Overlay pollen material with ethanol
   b) Centrifuge for 5 min, 3000 rpm
   c) Decant supernatant but leave test tube turned for 15 min to let dry

8. Store in glycerine (99.5 %)

   a) Overlay pollen material with glycerine
   b) Fill sample into airtight cryotubes

Floor sample preparation

1. Wash duster sheets thoroughly in 200 ml distilled water with a drop of detergent Tween 20

2. Filter via laboratory filter (260 µm mesh size)

3. Compacting of pollen material: Perform following steps until all fluid is depleted

a) Centrifuge aliquot in test tube (2 min, 3000 rpm)
b) Decant supernatant
c) Overlay pollen material with another aliquot

4. Rinse with concentrated acetic acid

a) Overlay pollen material with acetic acid
b) Centrifuge for 2 min, 3000 rpm
c) Decant supernatant

5. Acetolysis

e) Overlay pollen material carefully with acetolysis mixture
f) Boil sample in ultrasonic water bath (10 min, 80°C)
g) Centrifuge for 5 min, 3000 rpm
h) Decant supernatant

6. Rinse with concentrated acetic acid

d) Overlay pollen material with acetic acid
e) Centrifuge for 2 min, 3000 rpm
f) Decant supernatant

7. Rinse with distilled water three times

d) Overlay pollen material with distilled water
e) Centrifuge for 2 min, 3000 rpm
f) Decant supernatant

8. Heavy Liquid Separation

g) Overlay pollen material with 2 cm zinc bromide solution in test tube (250 g zinc bromide in 25 ml HCl (10 %) added to 100 ml distilled water)
h) Stir sample
i) Carefully overlay with 2 cm distilled water
j) Centrifuge for 10 min, 3000 rpm
k) Pipette organic and dispose inorganic phase.
l) Rinse with distilled water three times (see 7.)

9. Rinse with ethanol (99.8 %)

d) Overlay pollen material with ethanol
e) Centrifuge for 5 min, 3000 rpm
f) Decant supernatant but leave test tube turned for 15 min to let dry

10. Store in glycerine (99.5 %)

    a) Overlay pollen material with glycerine
    b) Fill liquid into airtight cryotubes