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Short Communication

The PSRC, a pollen and spore reference collection maintained by the Institute of Biodiversity and Ecosystem Research of the Bulgarian Academy of Sciences

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ABSTRACT: A pollen and spore reference collection can be a valuable instrument in forensic palynology, prehistoric studies, aerobiology, and other areas of research. Referred to hereafter as the PSRC, the collection of pollen and spore samples maintained by the Institute of Biodiversity and Ecosystem Research of the Bulgarian Academy of Sciences (BAS) has been developed over a period of 40 years. Currently, the PSRC includes 7270 slides of pollen/spores from plants distributed in Bulgaria and species common in subtropical and tropical regions. The present article treats the role of samples stored in the PSRC as reference material in palynological research on Palaeogene, Neogene, and Quaternary fossil assemblages.

Keywords: Bulgaria, collection, palynology, pollen, spore

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Investigations of fossil and recent pollen grain and spores give basic data about the composition of vegetation in space and time. The main method of these investigations is the morphological identification of pollen grains and their assignment to the family, genus, and species to which they belong. This identification is achieved using pollen keys and reference collections. Maintained by the Paleobotany and Pollen Analysis Section at the Institute of Biodiversity and Ecosystem Research (IBER), the PSRC is a key factor in the conduct of palynological research on modern and fossil pollen/spores in Bulgaria. It should be noted that the samples stored have been the starting point for a number of palynological research projects carried out by Bulgarian scientists and are a subject of interest to foreign scientists who use the PSRC for comparative research. The collection plays an important role in the training of undergraduate and graduate students and provides an opportunity to demonstrate the morphology of pollen grains of different species.

The PSRC includes 7270 slides of the pollen of 2811 species from 232 recent plant families, thus making this collection one of the largest in the Bulgaria (Fig. 1). A list of all families represented in the collection is presented in Table 1, while a more detailed list of both families and genera is available online (Appendix 1). The collection is basically composed of pollen from plants naturally distributed in Bulgaria, but there are a considerable number of slides of pollen from plants growing in subtropical and tropical areas. Pollen grains are considered to be species-specific, and thus they are used to identify source plants in pollen analysis, e.g., when pollen analysis is applied to reconstruct the history of vegetation throughout the Cenozoic and estimate climatic and anthropogenic influences on the development of floras. The collection is also used as a source of reference information for pollen identification in surface soil samples and pollen traps, in aeropalynology, or in melissopalynology. The PSRC focuses on pollen and spores from native plant taxa and includes samples from plants of all major plant

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Table 1. List of all families represented in the pollen and spore reference collection (PSRC).

Anastrophyllaceae	Oleandraceae	Begoniaceae	Hippocastanaceae	Polygalaceae
Andreaeaceae	Ophioglossaceae	Berberidaceae	Hydrangeaceae	Polygonaceae
Anemiaceae	Osmundaceae	Betulaceae	Hydrocharitaceae	Portulacaceae
Aneuraceae	Pallaviciniaceae	Bignoniaceae	Hydrophyllaceae	Potamogetonaceae
Antheliaceae	Pelliaceae	Boraginaceae	Hypericaceae	Primulaceae
Anthocerotaceae	Plagiochilaceae	Brassicaceae	Hypoxidaceae	Proteaceae
Aspleniaceae	Podocarpaceae	Bromeliaceae	Iridaceae	Punicaceae
Aytoniaceae	Polypodiaceae	Butomaceae	Iteaceae	Pyrolaceae
Blasiaceae	Polytrichaceae	Buxaceae	Juglandaceae	Ranunculaceae
Blechnaceae	Pseudolepicoleaceae	Cactaceae	Juncaginaceae	Resedaceae
Buxbaumiaceae	Pteridaceae	Calycanthaceae	Lamiaceae	Restionaceae
Calypogeiaceae	Ptilidiaceae	Calyceraceae	Lauraceae	Rhamnaceae
Cephaloziaceae	Radulaceae	Campanulaceae	Leitneriaceae	Rosaceae
Cleveaceae	Ricciaceae	Cannabaceae	Lentibulariaceae	Rubiaceae
Conocephalaceae	Riellaceae	Capparaceae	Liliaceae	Rutaceae
Corsiniaceae	Scapaniaceae	Caprifoliaceae	Limnanthaceae	Salicaceae
Cyatheaceae	Schistostegaceae	Caricaceae	Linaceae	Santalaceae
Cystopteridaceae	Schizaeaceae	Caryophyllaceae	Loasaceae	Sapindaceae
Davalliaceae	Selaginellaceae	Celastraceae	Loganiaceae	Saururaceae
Dennstaedtiaceae	Sphaerocarpaceae	Chenopodiaceae	Loranthaceae	Saxifragaceae
Dicksoniaceae	Targioniaceae	Cistaceae	Lythraceae	Scrophulariaceae
Dilaenaceae	Tectariaceae	Combretaceae	Magnoliaceae	Simarubaceae
Diphyseiaceae	Tetraphidaceae	Commelinaceae	Malvaceae	Solanaceae
Ditrichaceae	Thelypteridaceae	Convolvulaceae	Melastomataceae	Sparganiaceae
Dryopteridaceae	Trichocoleaceae	Coriariaceae	Meliaceae	Staphyleaceae
Encalyptaceae	Woodsiaceae	Cornaceae	Menispermaceae	Stiracaceae
Ephedraceae	Cupressaceae	Crassulaceae	Menyanthaceae	Strelitziaceae
Equisetaceae	Pinaceae	Cucurbitaceae	Moraceae	Styracaceae
Fissidentaceae	Taxaceae	Cuscutaceae	Myoporaceae	Symplocaceae
Fossombroniaceae	Taxodiaceae	Cyperaceae	Myricaceae	Tamaricaceae
Geocalycaceae	Acanthaceae	Cyrillaceae	Myrsinaceae	Theaceae
Gleicheniaceae	Actinidiaceae	Dillemaceae	Myrtaceae	Thymelaeaceae
Grimaldiaceae	Adoxaceae	Dioscoreaceae	Nothofagaceae	Tiliaceae
Gymnomitriaceae	Agavaceae	Dipsaceae	Nyctaginaceae	Tremandraceae
Haplomitriaceae	Aizoaceae	Dipterocarpaceae	Nymphaeaceae	Typhaceae
Hymenophyllaceae	Alismataceae	Droseraceae	Nyssaceae	Ulmaceae
Hypodematiaceae	Amaranthaceae	Ebenaceae	Oenotheraceae	Urticaceae
Jubulaceae	Amaryllidaceae	Elaeagnaceae	Oleaceae	Valerianaceae

Jungermanniaceae	Anacardiaceae	Empetraceae	Onagraceae	Verbenaceae
Lepidoziaceae	Annonaceae	Ericaceae	Orchidaceae	Violaceae
Lindsaeaceae	Apiaceae	Euphorbiaceae	Orobanchaceae	Vitaceae
Lophocoleaceae	Apocynaceae	Fabaceae	Oxalidaceae	Zingiberaceae
Lophoziaceae	Aquifoliaceae	Fagaceae	Paeoniaceae	Zygophyllaceae
Lycopodiaceae	Araceae	Frankeniaceae	Papaveraceae	
Lygodiaceae	Araliaceae	Gentianaceae	Passifloraceae	
Marattiaceae	Arecaceae	Geraniaceae	Pittosporaceae	
Marchantiaceae	Aristolochiaceae	Gesneriaceae	Plantaginaceae	
Marsupellaceae	Asclepiadaceae	Globulariaceae	Platanaceae	
Metzgeriaceae	Asparagaceae	Grossulariaceae	Plumbaginaceae	
Myliaceae	Asteraceae	Haloragaceae	Poaceae	
Nephrolepidaceae	Balsaminaceae	Hamamelidaceae	Polemoniaceae	

Fig. 1. The pollen and spore reference collection (PSRC).

groups (ferns, gymnosperms, and angiosperms). Pollen and spores are processed by standard pollen treatment techniques, outlined in the literature (Erdtman 1966; Faegri & Iversen 1975; Moore *et al.* 1991). All samples are mounted on microscope slides so that they do not deteriorate in long-term storage. In the collection, families and the species among the genera are arranged alphabetically, following the International Code of Botanical Nomenclature (ICBN).

The PSRC was started at the end of 1960's together with establishment of the Department of Palaeobotany and Pollen Analysis at the Institute of Botany of the Bulgarian Academy of Sciences under the direction of Dr. S. Petrov. During different periods, Prof. Dr. E. Palamarev, Dr. L. Filipovich, Prof. Dr. D. Ivanov, Dr. M. Lazarova, E. Slavomirova, M. Petrova, and others (Palamarev & Petrova 1997) played an important role in development of the PSRC. At present, the collection is housed in the Department of Palaeobotany and Palynology at the Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences.

A number of publications on biostratigraphy (Petrov & Drazheva-Stamatova 1971, 1972, 1973), palaeoecology (Bozukov & Ivanov 1995; Ivanov 1995, 1996, 1997a; Ivanov & Koleva-Rekalova 1999; Palamarev & Ivanov 2003), and plant systematics (Ivanov 1994a, b, 1997b, 2000, 2001a, b, c, 2004), and more recently on palaeoclimate changes from the regional and global points of view (Palamarev & Ivanov 2001; Ivanov *et al.* 2002, 2007, 2010, 2012; Ivanov 2004, 2010; Hristova & Ivanov 2009, 2013, 2014; Utescher *et al.* 2009; Hristova *et al.* 2015), are based on this collection. The main achievements include significant findings obtained in research on changes in plant ecosystems and dynamics of biodiversity in the Neogene age based on palynological and palaeobotanical investigation of the structure of these ecosystems. In connection with this aspect of research on the Bulgarian and European flora, the PSRC supports a wide array of projects that reflect the research interests of its staff:

- Ecosystem and climate evolution in the Neogene of Bulgaria (2007);
- Conservation of biodiversity in the hot-spots of glacial relict plants in Bulgaria (2009-2011);
- Vegetation and climate dynamics in the Eastern and Central Paratethys (Southeastern and Central Europe) during the middle and late Miocene

(2011-2013);
- Neogene palynomorphs from Bulgaria and Poland as a palaeoenvironmental proxy (2011-2014);
- Neogene climate evolution in Eurasia (NECLIME) (2010-2020); and
- Composition and structure of the Cenozoic flora in Bulgaria: palaeoecological analysis and main stages in diversity. Phase III (2017-2019).

The pollen and spores preserved in the PSRC can be used to answer questions about the evolution of plants, biodiversity, and anthropogenic influence on the climate. The main work in future development of the collection will be devoted to the following priority activities:

1) Digitisation of all objects in the PSRC;
2) Establishment of a palynological database;
3) Creation of a catalogue with morphological and image data on pollen grains and spores from different plant families and species in the collection;
4) Development of a website that can be used in the general methodological sense, in dealing with individual business areas of research related to plant evolution, and in testing environmental and climatic hypotheses;
5) Facilitation of access to information and sharing of knowledge and skills with national and international teams in the worldwide research process; and
6) Acceleration of of taxonomic research in the fields of palynology and palaeobotany.

The extensive material of the PSRC includes thousands of pollen/spore samples of many species and genera from all over the world and has been a basis for different types of pollen-focused research (in the fields of palaeoecology, vegetation dynamics, palaeoclimatology, archaeology, forensics, and plant systematics). The main functions of the collection are identification of pollen grains and spores, dissemination of information about them, and creation of an accessible and searchable global database. The purpose of the present article was to publicise existence of the Bulgarian PSRC and encourage exchanges with international academic institutions and universities.

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REZIME

PSRC, referentna kolekcija polena i spora Instituta za biodiverzitet i istraživanja ekosistema pri Bugarskoj akademiji nauka

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Referentna kolekcija polena i spora je važan instrument u forenzičkoj palinologiji, studijama o praistoriji, aerobiologiji i drugim oblastima istraživanja. Kolekcija polena i spora (PSRC) Instituta za biodiverzitet i istraživanja ekosistema pri Bugarskoj akademiji nauka (BAS), razvijena je pre više od 40 godina. Referentna kolekcija trenutno uključuje 7270 slajdova polena/spora biljaka rasprostranjenih u Bugarskoj, kao i vrsta čestih u tropskim i suptropskim regionima. U radu se razmatra uloga kolekcije kao referentnog materijala u palinološkim istraživanjima fosilnih ostataka iz paleogena, neogena i kvartara.

Ključne reči: Bugarska, kolekcija, palinologija, polen, spore