

The main purpose of this study is determining the composition of the compounds found in cells of liverwort from *Calypogeia* genus and their antimicrobial activity. Research will cover a total of 9 species occurring in Central Europe, including 5 new taxa recently recognized with the aid of genetic studies. The marker compounds useful for identification of examined species will be proposed. Previous chemical studies of the other difficult to determine liverwort species (e.g. species of the *Aneura pinguis* complex) showed that the chemical composition differentiate genetically detected cryptic species, which do not differ morphologically and cannot be identified based on morphological features.

The basic research planned in the project concerns the determination of qualitative and quantitative composition of compounds present in newly detected and not yet described species of the genus *Calypogeia*. Since the identification of the species based on morphological features is difficult and often ambiguous, therefore for the chemical analysis only plants genetically identified by means of the DNA marker sequences will be used. Analysis of chemical composition will be performed using a gas chromatograph coupled with a mass spectrometer. The compounds which cannot be identified using the available databases of mass spectra and reference substances will be isolated from the biological material and its structure will be determined using the nuclear magnetic resonance spectrometry (NMR). For new detected compounds, instrumental techniques of analysis will be performed. The proposed combination of analytical chemistry and genetic studies will contribute to a more complete characterization of *Calypogeia* species, also from the chemical point of view, including new, previously recognized species. The result of the project will provide an important contribution to the knowledge on the chemical composition and biological activity of the little-known and evolutionarily oldest land plants which are liverworts. It also offers the opportunity to find new, yet not described in biology chemical compounds.

Our interest of liverworts from the genus *Calypogeia* is due to the fact that recently some new species were discovered, moreover the remaining species of the genus were not studied yet in terms of the presence of chemical compounds in relation to their genetic diversity.

The genus *Calypogeia* is the representative of the leafy liverworts. Liverworts, besides mosses and hornworts, are one of three divisions of plants known as bryophytes (about 17 000 species). Liverworts are a diverse phylum estimated to comprise about 5000 - 7000 species in the world, however in Poland this group of plants is represented only by 254 species. These are small and morphologically fairly simple plants, but they are worth devoting of more attention in scientific research, since liverworts are organisms that played a key role in the land plants evolution. Fossil records together with molecular evidence supported hypothesis that liverworts were the first plants that colonized land and were present on the land approximately 475 million years ago – in the middle Ordovician. These findings indicate that metabolic pathways essential for survival under stress conditions on land must have evolved at a very early stage. These plants are extremely sensitive to environmental changes and therefore in many parts of the world are threatened with extinction because of shrinking their habitat, largely as a result of human activity. However, this disappearing group of plants, is still poorly known both genetically (new species are still discovered) as well as in terms of the content of chemical compounds. The results obtained for liverworts can give answers to important questions about the evolution of the plant world.

A unique feature of liverworts is the presence of oil bodies, which shape, color and distribution in cells is an important taxonomic feature. Chemical research revealed that liverworts include many substances of biological activity, such as the terpenes, terpenoids, or simple aliphatic and aromatic compounds, many of which are unique only for liverworts. These compounds are synthesized and accumulated in oil bodies. Studies have shown that numerous terpenoids as well as aromatic compounds isolated from liverworts reveal interesting biological activities, such as: antibacterial, antiviral, antifungal, antioxidant, and even cytotoxic. Chemotaxonomic research has also shown differences in the composition of chemical compounds even in closely related species, therefore they can provide useful species specific markers. However, only a small part of liverwort species was until now examined for the content of chemical compounds, and only a few chemical studies of liverworts are conducted on plants genetically determined. The proposed studies are part of the research in the world dedicated to understanding the chemical composition of liverworts and broaden knowledge about the little known *Calypogeia* genus. The combination of chemical and biological (especially genetic) studies for liverworts is a new research approach that gives greater scope for interpretation of the results in biology and analytical chemistry. Studies on species that have not yet been analyzed make it possible to detect biologically active compounds that have not been known until now.