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Botanical end ecological investigations in North Korea by W. Szafer Institute of Botany, Polish Academy of Sciences, Cracow

Abstract: Report about results of scientic cooperation between W. Szafer's Institute of Botany Polish Academy of Sciences and Academy of Sciences of Korean People's Democratic Republic (KPDR) present on Polish Korean Seminar in Pułtusk (Poland).

Key words: Asia, North Korea, forest types, variability of cones, areophytic algae, *Chlorellales*, *Desmidiales*, macrofungi, heavy-metals in litter, mosses, needles of *Pinus*.

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INTRODUCTION

Polish botanists have made several scientific expeditions to North Korea under an exchange programme between the Polish Academy of Sciences and the KPDR Academy of Sciences (Table I).

STUDIES ON HIGHER PLANTS

The vegetation of higher plants of North Korea were studied during two expeditions, which focused on botany and forestry, by L. Stuchlik, K. Zarzycki and P. Skawiński. The participants had an opportunity to study the vegetation of the warm temperate zone in the region of Pyongyang and in the environs of Haeju, Kesong and also in the Myohang-san and Kumgang-san Mountains (Diamond Mountains). Owing to observations made in 16 selected forest areas, seven forest types were tentatively differentiated (Table II).

Floristic material, soil samples, palynological samples were collected and typological measurements of tree stands were made. The samples are now examined and further studies will follow.

Table I. Expeditions to North Korea.

Expedition	Participants
botany – forestry	**paleobotanist** – L. Stuchlik
1982 – September (4 weeks)	**ecologist** – K. Zarzycki
1985 – June/July (5 weeks)	**dendrologist** – P. Skawiński
botanical	**botanist (specialist in plants variability)**
1984 – September/October (4 weeks)	– J. Staszkiewicz
mycological	**mycologists** – W. Wojewoda
1983 – August/September (6 weeks)	– Z. Heinrich
1984 – September/October (4 weeks)	– H. Komorowska
1986 – June/July (5 weeks)	
algological	**algologists:** – T. Mrozińska
1987 – July/August (6 weeks)	– J. Siemińska
1989 – August/September (6 weeks)	
ecological	**ecologists:** – B. Godzik
1989 – August/September (6 weeks)	– G. Szarek-Łukaszewska

The studies on the plant variability rang of selected cones from several species of korean conifers were carried out by J. Staszkiewicz. Material for studies was collected from the Paekdu-san Massif – widely-spread plateau – predominantly covered with forests composed of *Larix olgensis* HENRY, which marks the upper forest limit there and mixed forests, mostly of the taiga type, composed of *Picea jezoensis* (SIEB. & ZUCC.) CARR., *P. koraiensis* NAKAI, *Abies holophylla* MAXIM., *A. koreana* WILS., *Betula ermanii* CHAM., etc.

The collection of plants include samples of cones population of: *Larix olgensis* HENRY, *Picea koraiensis* NAKAI and *P. jezoensis* (SIEB & ZUCC.) CARR., also known as *P. ajanensis* (LIND. & GORD.) FISCH. ex CARR. have been done. The cones were examined in respect of the lenght and width of cones, lenght and width of scale, and at *Picea* also of lenght of the upper part of scale. The amount of samples was limited, however, they helped to determine the variability of cones of the above-given species. Owing to these studies, numerical data were supplied for first time ever for Korean species, which has made it possible to compare them with the taxa of the genera *Larix* MILL. and *Picea* DIET. from Asia and other continents. Results of studies have already been published (STASZKIEWICZ 1992a, 1992b).

STUDIES ON ALGAE AND FUNGI

Algae

The aerophitic and aquatic algae of North Korea were collected and studied by T. Mrozińska and J. Siemińska. Results of studies have been published (MROZIŃSKA 1990, MROZIŃSKA & AN 1993, AN 1992a, b).

Table II. Forest types.

1. Low canopy pine-oak forest on dry soil and rocks, Tree horizon well-developed, canopy: 70-80%, regenerates through shoots, tree height up to 10 m, trees rarely taller than 16 m. 2 variants: domination of *Pinus densiflora* SIEB. & ZUCC., domination of *Quercus dentata* THUNB. var. *dentata* and *Q. dentata* var. *fallax* NAKAI
2. Low canopy hornbeam-oak forest Tree horizon well-developed, canopy up to 90%, trees 10-12 m tall, stem diameter 25 cm, regenerates well but also through shoots.
3. High canopy oak-chestnut mixed forest Tree horizon well-developed, cover 60-90%, two-floor, trees up to 22 m tall, stem diameter 45 cm.
4. High canopy pine-oak mixed forests (on dry soil) and walnut (*Juglans regia* L.) (in shaded, more humid locations). The forest regenerates perfectly well, all age-groups of trees present, starting from seedlings through small bushes to tall trees. Two floors higher, *Pinus densiflora* SIEB. & ZUCC. or *Juglans mandshurica* MAXIM., up to 30 m tall, stem diameter 55 cm, canopy: 100%
5. High canopy mountain forests (lower zone up to 1000 m and middle zone of the mountain belt), mixed with *Pinus koraiensis* SIEB. & ZUCC. and oaks. Regenerates perfectly well through shoots and seeds, trees up to 25 m tall, stem diameter 50 cm, canopy: 90%, two horizons distinguished.
6. High canopy mountain forests (middle zone, 1170m) with prevailing *Quercus mongolica* FISCH. and *Tilia mandshurica* ROUPR. & MAXIM. Regenerates well, canopy: 80%
7. High canopy, loose coniferous forest Canopy scarce: 25-30%, trees up to 24 m tall, stem diameter 1 m, frequently regenerates through shoots, 3-4 trees clusters, frequently without tops, frequent mosses and epiphytic lichens.

Fungi

Fungi of East Asia (except for Japan) have been fairly little studied. Only scarce information may be found in the world's literature on the fungi of Korea.

Samples of fungi reached Poland for the first time in 1982, they were brought over by. K. Zarzycki. In subsequent years W. Wojewoda, Z. Heinrich and H. Komorowska (mycologists) collected and studied fungi of Korea.

The material was collected in natural areas with comparatively well-preserved forest communities, mainly in the mountains (Paekdu-san, Myohang-san, Kumgan-san), however, fungi were also collected from managed

areas, e.g. cities of Haeju, Kaesong, Nampo, Pyongyang, Wonsan, and adjacent areas.

Macromycetes, *Basidiomycetes*, and partially *Ascomycetes* were mostly collected. Also basic information on fungi of other groups were collected. About 360 species from 42 families were identified on the basis of the gathered material (Table III). The list of recorded species includes 224 species new to North Korea. For example *Radulodon licentii* (PIL.) RYV., known only from East Asia localities (NIKOLAEVA 1961, PILÁT 1940, RYVARDEN 1976) was collected in Paekdu-san (Fig. 1). Especially richer was the list of Korean *Corticiaceae*, 80 species of this family were found for the first time (WOJEWODA et al. 1993). The paper with short descriptions and figures of macro- and micromorphology, habitat, locality for each species found in Korea will be prepared. Apart from *Macromycetes* also some of *Deuteromycetes* fungi were collected, which were then sent to A. Borowska at the Warsaw University.

Table III. *Macromycetes* collected in North Korea (1982–1986)

Family	Number of species	Family	Number of species
Clavicipitace	1	*Hygrophoraceae*	1
Helotiaceae	1	*Trichlomataceae*	51
Helvellaceae	1	*Pleurotaceae*	2
Xylariaceae	3	*Entolomataceae*	3
		Amanitaceae	7
Septobasidiaceae	1	*Cortinariaceae*	24
Auriculariaceae	3	*Crepidotaceae*	4
Tremellaceae	11	*Strophariaceae*	12
Dacryomyceteceae	8	*Bolbitiaceae*	8
		Coprinaceae	7
Auriscalpiaceae	1	*Paxillaceae*	2
Cantharellaceae	2	*Boletaceae*	16
Coniophoraceae	3		
Corticiaceae	96	*Russulaceae*	17
Ganodermataceae	2		
Gomphaceae	1	*Asteraceae*	1
Hericiaceae	3	*Sclerodermataceae*	2
Hydnaceae	1	*Rhizopogonaceae*	1
Hymenochaetaceae	15	*Nidulariaceae*	2
Lachnocladiaceae	2	*Lycoperdaceae*	11
Polyporaceae s. l.	20	*Geasteraceae*	4
Schizophyllaceae	1	*Clathraceae*	2
Thelephoraceae	2	*Phallaceae*	4
		Total:	359

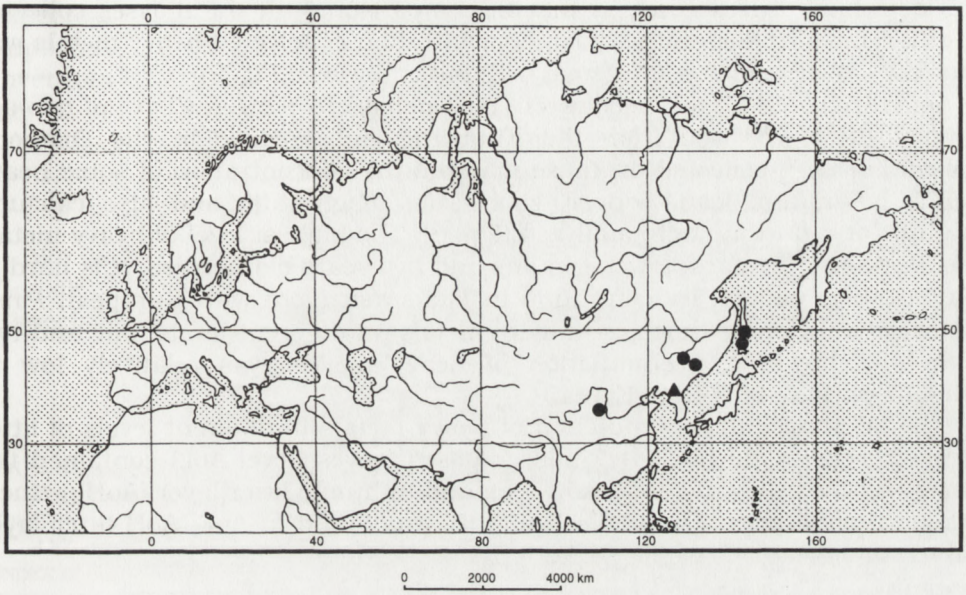

Fig. 1. Distribution map of *Radulodon licentii* (PIL.) RYV. *(Basidiomycetes, Corticiaceae)* prepared W. Wojewoda, ● – localities known hitherto from China and Russia, ▲ – new locality found in North Korea.

An index of cryptogamic plants of Korea (Pyongyang 1983) with a chapter on the fungi of entire Korean Peninsula was the basic source for the comparison of fungi from Korea (Table IV) Data quoted, however, are probably incomplete especially in reference to South Korea where only available. Among other things, this has also been the result of the absence of contacts with South Korea. First mycological studies of South Korea reached our Institute in 1991. It is possible that somewhere an up-dated list of species recorded from this country has been made.

Table IV. Fungi known from Korea until 1983.

Class	Number of species
Archimycetes	8
Phycomycetes	133
Ascomycetes	110
Basidiomycetes	956
Fungi imperfecti	208
Total:	1415

STUDIES ON ECOLOGY

In 1989, environmental pollution using biological methods was evaluated by B. Godzik and G. Szarek-Łukaszewska. The most frequently applied bioindicators of heavy-metal pollution are mosses. The content of five heavy metals (cadmium, lead, nickel, copper, and zinc) in two moss species: *Pleurozium schreberi* (BRID.) Mitt. and *Hylocomium splendens* (HEDW.) B. S. G. collected from few localities in the northern part of the Ryangang Province

was determined. It was found that in comparison with the mosses collected from localities in Poland the mean concentration of selected heavy metals was markedly lower and was congenial with natural levels (Fig. 2)

Apart from the above, needles of *Pinus densiflora* SIEB. & ZUCC. of two age groups, litter and soil from the Kumgang-san Province in the Diamond Mountains were collected. In these material the concentration of some heavy metals, cadmium, lead, copper, zinc, iron, magnesium and also calcium, sulphur, and fluorine were analyzed (Fig. 3). The highest level of heavy metals was found in pine bark, lower – in one and two years old needles. It is hard to compare heavy-metal concentration in *Pinus densiflora* with European *Pinus sylvestris* L, because they accumulate metals on different levels, one and two years old, however, accumulation of heavy metals was relatively low in different parts of pine from Korea.

The differences in accumulation of heavy metals in different levels of litter and soil were found (Fig. 4). Undecomposed leaves (level AoL) contained the lowest level of heavy metals, lead was found in humic litter layer (AoH) , zinc – in layer AoF, copper – in similar quantity was found in AoF, AoH litter layer and in soil layer.

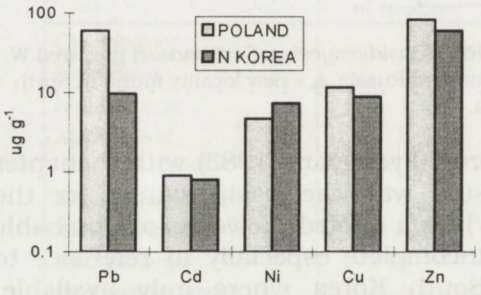

Fig. 2. Concentration of heavy metals in *Pleurozium schreberi* – mosses collected from Poland and North Korea.

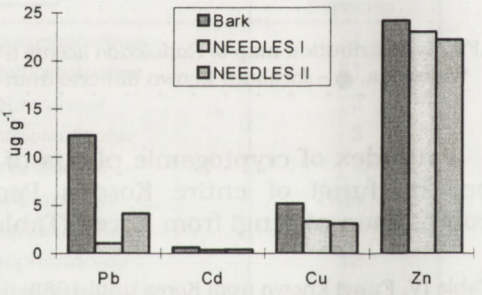

Fig. 3. Concentration of some heavy metals in pine bark and needles.

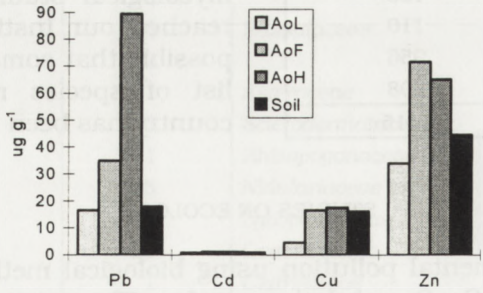

Fig. 4. Accumulation of heavy metals in different levels of litter and soil.

According to the results of studies, the area of North Korea may be a control area for other regions. Scarce enclaves of clean wilderness are under effect of pollution coming here with long-distance transport. They may be

expected to be deformed in the years that will follow. Therefore, it seems important to record natural levels of, inter alia, heavy metals and making an inventory of changes in the environment of such unpolluted regions as North Korea.

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STRESZCZENIE

[Tytuł: Botaniczne i ekologiczne badania prowadzone wKorei Północnej prze Instytut Botaniki im. W. Szafera Polskiej Akademii Nauk, Kraków]

Praca zawiera informację o rezultatach badań botanicznych prowadzonych dzięki wymianie naukowej między akademiami nauk Polski i KRL-D. Zostały one przedstawione na Seminarium Polsko-Koreańskim w Pułtusku (1996 r).

Naukowcy z Instytutu Botaniki im. W. Szafera w Krakowie odbyli kilka ekspedycji do KRL-D (Tabela I). Jedna z nich – botaniczno-leśna – z udziałem prof. L. Stuchlika, prof. K. Zarzyckiego i dr P. Skawińskiego. przeprowadził obserwacje na 16 wybranych powierzchniach leśnych, co pozwoliło wyróżnić 7 typów lasów (Tabela II). Prof. J. Staszkiewicz ocenił zmienność wybranych cech szyszek kilku gatunków drzew szpilkowych (STASZKIEWICZ 1992a, 1992b).

Badano również glony i grzyby (MROZIŃSKA 1990, MROZIŃSKA i AN 1993, AN 1992a, b).

Mykolodzy – prof. W. Wojewoda, dr Z. Heinrich i dr H. Komorowska, zbierali głównie grzyby wielkoowocnikowe *Basidiomycetes* w różnych regionach KRL-D (WOJEWODA et al. 1993).

Dr B. Godzik i G. Szarek-Łukaszewska przeprowadziły badania ekologiczne dotyczące oceny skażenia środowiska metodami biologicznymi (Fig. 2, 3, 4) i stwierdziły, że obszar Korei Północnej może być kontrolnym dla innych regionów, jako enklawa nieskażonej przyrody.