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A REVIEW OF THE MEDICINAL LYCOPODIOPHYTA OF UKRAINE

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ABSTRACT

The publication presents the results of complex research and analysis of medicinal plain-like of flora of Ukraine. *Lycopodiophyta* of Ukraine includes four families: *Lycopodiaceae* (8 species – *Diphasiastrum alpinum* (L.) Holub, *D. complanatum* (L.) Holub, *D. isseleri* (Rouy) Holub, *D. tristachyum* (Pursh) Holub, *D. zeileri* (Rouy) Holub, *Lycopodiella inundata* (L.) Holub, *Lycopodium annotinum* L., *L. clavatum* L.), *Huperziaceae* (1 – *Huperzia selago* (L.) Bernh. ex Schrank & C. Mart.), *Selaginellaceae* (2 – *Selaginella helvetica* (L.) Spring., *Selaginella selaginoides* (L.) C. Mart.) and *Isoëtaceae* (1 – *Isoëtes lacustris* L.). They have different contents of biologically active substances and all of these species are medicinal or semi-medicinal. The paper presents the characteristics of their distribution in Ukraine, resource importance, population structure, environmental protection status in Ukraine and Europe, main active substances, and medicinal properties.

Keywords: medicinal *Lycopodiophyta*, resources significance, protection, Ukraine

INTRODUCTION

Nowadays, medicinal plants attract attention because they are among the main sources of medical and preventive means of non-traditional and scientific modern medicine (1-5).

One of the oldest and most interesting groups of plants is the representatives of *Lycopodiophyta*, which achieved their greatest development in the late Paleozoic. Currently it is represented by a relatively small number of genera and species, which account

for only 1% of the modern species diversity of vascular plants (6-8).

Extinct lycopods had an important role in the formation of coal (6, 9) while modern species have phytogetic, industrial, decorative and medicinal value (1-6, 10-12).

Lycopods are able to form continuous carpets in the woods and participate in the formation of plant communities, which constitutes their phytogetic value. Spores of Lycopods are rich in fatty oils and aluminum, which is a reason for their use in pyrotechnics (for the manufacture of fireworks), metallurgy (for smoothness of surfaces at packed casting), in the manufacture of photos, where they are a source of green, blue and yellow colors. Plants are harvested for making bouquets and for various rituals, some species of *Selaginella* are indoor ornamental plants (6,9,10,13).

The medicinal properties of the plants were noted by the ancient Romans, who considered them the best remedy for eliminating dullness of the skin (2). Nowadays, spores (*lycopodium*) are used as a

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powder (as a baby powder, for treatment of bedsores), and for pill coating, grass lycopsids are used as a diuretic, anti-rheumatic, anti-inflammatory, and anesthetic agent, in the treatment of mental illness and Alzheimer's disease; species of *Huperzia* are poisonous but used for the treatment of alcoholism and nicotine (1-3,5,11,14).

Lycopodiophyta of Ukraine includes four families: *Lycopodiaceae* (8 species – *Diphasiastrum alpinum* (L.) Holub, *D. complanatum* (L.) Holub, *D. iseleri* (Rouy) Holub, *D. tristachyum* (Pursh) Holub, *D. zeilleri* (Rouy) Holub, *Lycopodiella inundata* (L.) Holub, *Lycopodium annotinum* L., *L. clavatum* L.), *Huperziaceae* (1 – *Huperzia selago* (L.) Bernh. ex Schrank & C. Mart.), *Selaginellaceae* (2 – *Selaginella helvetica* (L.) Spring., *Selaginella selaginoides* (L.) C. Mart.) and *Isoëtaceae* (1 – *Isoëtes lacustris* L.) (7,8) are medicinal or semi-medicinal.

Below we present a more detailed description of these species (Table 1).

AIM AND METHODS

The object of our study are the medicinal and semi-medicinal species of the *Lycopodiophyta* representatives of the flora of Ukraine. The basis of the work is the data obtained during the field research as a result of working on literary materials and maps, and herbarium collections of Ukraine gathered in the period 2010–2019.

RESULTS AND DISCUSSION

Lycopodiophyta species are of no economic value in Ukraine due to several reasons. The results of the study are presented in Table 1 in which the checklist of representatives of the studied department is given in alphabetical order. The name of each species is in Latin and English (9 species), presented are also family, distribution in Ukraine, resource value, population structure, conservation status in Ukraine and Europe, main active substances, and medicinal properties.

We analyzed the distribution of plant species in Ukraine and established that the majority – 42% (5 species) — is known from several localities, mainly growing in the Carpathians and Polissya (10,12,13,15,16).

The studied species of *Lycopodiophyta* have no resource values since most species (83% or 10 species) in the wild are not available.

The population structure of the species is unstable. However, 42% (5 species) are represented by several individuals, which is caused by a number of threats, but the main one is the anthropogenic factor (cutting, grazing, recreation, etc.) to which species are very sensitive (10,13).

All species are listed in the Red Book of Ukraine and require conservation measures. Most of them – 42% (5 species) — are vulnerable and only one species (*Lycopodium clavatum*) is regionally rare. *L. clavatum* and *Huperzia selago* are included in the European Red List, to the IUCN database with LC status, and to the European Red List of Medicinal Plants (13,17-19).

The pharmacological properties of the species emerge due to the chemical composition and the ratio of active ingredients. For medicinal purposes, spores and aerial parts of plants are used as raw material. The analysis of literary data enabled us to establish that model species that are taken as the basis for the research of pharmacological properties usually are *L. clavatum* and *H. selago*. It is caused by their chemical composition, which slightly differs from “other composition and ratio of components”, while the properties, uses, and dosage forms are similar (1,20-24).

The main common active substances of *Lycopodiophyta* are alkaloids (lycopodine, clavatin, lycopodine, etc.), flavonoids, triterpenoids, flavones, gupercine, carotenoids, fatty oils (spores) (1-3,5,6,11,20-38).

The spores of Lycopods contain about 50% non-drying fatty oil and glycerides, stearic, oleic, arachidonic, palmitic and other acids, therefore, they are used as a powder for infants, for the treatment of eczema, adulthood, bedsores, wounds, burns (1,2,4-6,11).

Spores and herbs are used in liver disease, respiratory tract diseases, and as diuretic, antirheumatic, anticonvulsant and anti-inflammatory, antibacterial and antifungal, antiviral and antiemetic agents, etc., as well as for the treatment of psychological disorders, Alzheimer's disease, alcoholism and nicotine (1-5,11,38).

Table 1. The state and medicinal values of *Lycopodiophyta* of Ukraine

Latin Name	English Name	Family	Distribution in Ukraine	Resource Value	Number of Individuals in Population	Protection Status in Ukraine	Protection Status (by Global and European Regional Assessment)	Medicinal Value
<i>Diplhasiastrum alpinum</i> (L.) Holub	Alpine Clubmoss	Lycopodiaceae	R	0	F	RB, rare	-	Alkaloids – O-acetylepivalonine, O-acetylfawcettiine, O-acetyllofoline, lycodoline, clavolonine, flavonoids, triterpenoids. It has an anesthetic effect, used in hydrophobia; some alkaloids of the species have proven to be effective inhibitors of acetylcholinesterase and are potentially able to alleviate the symptoms of Alzheimer's disease. Spores used as a dusting powder.
<i>Diplhasiastrum complanatum</i> (L.) Holub	Ground-cedar	Lycopodiaceae	R	0	F	RB, rare	-	Serratane triterpenoids, including serratane-3 α ,14 α ,15 α ,20 β ,21 β ,24,29-heptol, 3 α ,20 β ,21 β -trihydroxyerrat-14-en-24-oic acid, 3 β ,20 β ,21 β -trihydroxyerrat-14-en-24-oic acid, 3 α ,20 β ,21 β -trihydroxy-16-oxoserrat-14-en-24-oic acid, and 16-oxolycanitin-29-yl E-4'-hydroxyl-3'-methoxycinnamate, sterols, lyconadins D, E and complanadine E, β -carotene, lipids, fatty oil; triterpenoids, lysine-derived alkaloids. It has an anesthetic, diuretic and sedative effect; used in the treatment of tachycardia, flu, migraine, spasms, liver disease, diarrhea, infertility, metabolic disorders, externally used in alopecia, baldness, dermatomycosis. Spores used as a dusting powder.
<i>Diplhasiastrum issleri</i> (Rouy) Holub	Issleri's Clubmoss	Lycopodiaceae	L	0	I	RB, vulnerable	-	Lycopodine (C ₁₆ H ₂₅ NO); lysine-derived alkaloids. Ways to use in medicine aren't explored. Spores used for powders.

<i>Diphasiastrum tristachyum</i> (Pursh) Holub	Blue ground-cedar	Lycopodiaceae	L	0	I	RB, endangered	-	Lysine-derived alkaloids; lycopodine; alkaloid L 13-15, carotenoids, a small amount of nicotine, rare flavones - chrysoeriol, selgin and triclin; triterpenoids; Lycopodium type alkaloids, tetracyclic alkaloids, clavine alkaloid, huperizine A. Antifungal, antibacterial, antiviral properties; relieve spasms, increase urine flow, estrogenic; reduce pain, fever, inflammation; insecticidal. Disputes are used as a baby powder and in the treatment of bedsores; in pharmacy - for powder tablets.
<i>Diphasiastrum zeileri</i> (Rouy) Holub	Zeiller's clubmoss	Lycopodiaceae	L	0	I	RB, endangered	-	Lycopodium type alkaloids, lycopodium alkaloids, tetracyclic alkaloids, clavine alkaloid, huperizine A. Antifungal, antibacterial, antiviral; relieve spasms, increase urine flow, estrogenic; reduce pain, fever, inflammation; insecticidal.
<i>Lycopodiella inundata</i> (L.) Holub	Northern bog clubmoss	Lycopodiaceae	M	0	N	RB, vulnerable	-	Rare flavones chrysoeriol, selgin and triclin; triterpenoid: o-onocerin; lysine-derived alkaloids; lycopodium type alkaloids, lycopodium alkaloids, tetracyclic alkaloids, clavine alkaloid, huperizine A; fatty oil, which consists of glycerides of higher fatty acids - palmitic, stearic, dioxy-stearic, oleic, linoleic and myristic; polymeric terpin, sporonin, phytosterol, glycerol, proteins, fiber, sugars and minerals; in the grass of plants plant are presence near 0.12% alkaloids, including lycopodine, clavatin, clavatoxine and lycopodine. Antifungal, antibacterial, antiviral; relieve spasms, increase urine flow, estrogenic; reduce pain, fever, inflammation; insecticidal. Spores have anti-inflammatory, analgesic and diuretic effects and Used as a powder for infants, for the treatment of eczema, bedsores, wounds, burns and frostbite; At skin diseases - scabies, psoriasis, rashes, abscesses, boils; For local baths during seizures. In traditional Chinese medicine, an overground part of a plant that contains alkaloids is used to treat memory illnesses and Alzheimer's diseases.

<i>Lycopodium annotinum</i> L.	Stiff club-moss	Lycopodiaceae	M	0	N	RB, vulnerable	-	Carotenoids, flavonoids, triterpenoids, nicotine, rare flavones chrysoeriol, selgin and tricin; triterpenoid: 21-episeratriol; lysine-derived alkaloids; lycodine type alkaloids, lycopodine alkaloids, tetracyclic alkaloids, clavine alkaloid, huperizine A. Has hemostatic, weakening, diuretic, contraceptive, anticonvulsant, anesthetic, anti-inflammatory, astringent, insecticidal (veterinary) action. Antifungal, antibacterial, antiviral; relieve spasms, increase urine flow, estrogenic; reduce pain, fever, inflammation; insecticidal. Used for diseases of the stomach, liver, alcoholism, asthenia; for abrasions, eczema and hair loss.
<i>Lycopodium clavatum</i> L.	Common club-moss	Lycopodiaceae	M	II	N	RP	LC	Fatty oil (spores), phenolcarbonic acids and their derivatives (spores), licopoclavamine A and B, carotenoids, Flavonoids, sugars, minerals; rare flavones chrysoeriol, selgin and tricin; triterpenoid: o-onocerin; lysine-derived alkaloids; Lycodine type alkaloids, lycopodine alkaloids, tetracyclic alkaloids, clavine alkaloid, huperizine A. Action - antitumor, sedative, antispasmodic, diuretic, contraceptive, anti-rheumatic, adsorbent, normalizes menstruation and the function of the gastrointestinal tract. Used in the treatment of metabolic, gout, rheumatic diseases, Alzheimer's disease, chronic kidney disease, mental illness. Antifungal, antibacterial, antiviral; relieve spasms, increase urine flow, estrogenic; reduce pain, fever, inflammation; insecticidal.

<i>Huperzia selago</i> (L.) Bernh. ex Schrank & C. Mart.	Northern fir-moss	Lycopodiaceae	R	0	F	RB, invaluable	LC	Selagoline, huperzine A and serratidine, carotene seriea β -C, Alpha-obscurine, nankakurine A, acrifoline, des-N-methyl- β -obscurine, huperzine, lycónadin, lycodoline, lycodine, cermizine B, lycoposerramine-G, lycopodine, fawcettidine, serratidine, lysine-derived alkaloids; Lycodine type alkaloids, lycopodine alkaloids, tetracyclic alkaloids, clavine alkaloid. Antifungal, antibacterial, antiviral properties; relieve spasms, increase urine flow, estrogenic; reduce pain, fever, inflammation; insecticidal. Actions - vomiting, anticonvulsant, anti-inflammatory, diuretic, antitumor; analgesic. Used in the treatment of alcoholism, nicotine addiction, psoriasis, hysteria, neurasthenia, pulmonary tuberculosis, metabolic disorders.
<i>Selaginella helvetica</i> (L.) Spring.	Swiss spike-moss	Selaginellaceae	L	0	I	RB, extinct		Biflavonyl compounds (amentoflavone, sotetsuflavone); steroids, alkaloids, secolignans, neolignans, caffeine derivatives, alkaloid glycosides, phenylpropanes, lignans. Used to treat diseases of the skin, gastritis, urinary tract, diabetes, hepatitis, cardiovascular problems
<i>Selaginella selaginoides</i> (L.) C. Mart.	Northern spike-moss	Selaginellaceae	R	II	F	RB, vulnerable	-	Biflavonyl compounds (amentoflavone, hinokiflavone, robustaflavone).
<i>Isoetes lacustris</i> L.	Lake quillwort	Isoëtaceae	L	0	F	RB, vulnerable	-	Rare flavones chrysoeriol, selgin and triclin; luteolin bearing an extra hydroxyl group in 6-, 8- or 2'-position

After analyzing the State Register of Medicinal Products of Ukraine (14) we found out that most of the available drugs on the territory of Ukraine are manufactured and purchased abroad (Table 2).

In addition to the above-mentioned comprehensive homeopathic medications, there is also a

well-known cosmetic product - a powder on the basis of dry extract of *L. clavatum* (double-acting powder), which has a calming effect, and helps to reduce irritation and redness. The country of origin of the product is Israel.

Table 2. Medications containing Lycopodium represented in the State Register of Medicines, Ukraine

Name of the Drug	Active Substance	Producer	Applicant
METRO-ADNEX-INJEEL®	<i>Lycopodium clavatum</i>	Biologische Heilmittel Heel GmbH., Germany	Biologische Heilmittel Heel GmbH., Germany
NUX VOMICA-HOMACCORD®	<i>Lycopodium clavatum</i>	Biologische Heilmittel Heel GmbH., Germany	Biologische Heilmittel Heel GmbH., Germany
HEPEEL® N	<i>Lycopodium clavatum</i>	Biologische Heilmittel Heel GmbH., Germany	Biologische Heilmittel Heel GmbH., Germany
HEPEEL®	<i>Lycopodium clavatum</i>	Biologische Heilmittel Heel GmbH., Germany	Biologische Heilmittel Heel GmbH., Germany
PEKANA NATURHEILMITTEL.	<i>Lycopodium clavatum</i>	Biologische Heilmittel Heel GmbH., Germany	Biologische Heilmittel Heel GmbH., Germany
MOMORDICA COMPOSITUM	<i>Lycopodium clavatum</i>	Biologische Heilmittel Heel GmbH., Germany	Biologische Heilmittel Heel GmbH., Germany
TESTIS COMPOSITUM	<i>Lycopodium clavatum</i>	Biologische Heilmittel Heel GmbH., Germany	Biologische Heilmittel Heel GmbH., Germany
WEIGHT NORM	<i>Lycopodium clavatum</i>	PC "National Homeopathic Union", Ukraine	PC "National Homeopathic Union", Ukraine
HOLE-GRAN	<i>Lycopodium</i>	PC "National Homeopathic Union", Ukraine; Ferrer Internacional, S.A., Spain	PC "National Homeopathic Union", Ukraine; Ferrer Internacional, S.A., Spain
SCLERO-GRAN	<i>Lycopodium clavatum</i>	PC "National Homeopathic Union", Ukraine	PC "National Homeopathic Union", Ukraine
<u>GRAPHITES COSMOPLEX S</u>	<i>Lycopodium clavatum</i>	Biologische Heilmittel Heel GmbH., Germany	Biologische Heilmittel Heel GmbH., Germany
<u>ENERCEL® PLUS I. M</u>	<i>Lycopodium clavatum</i>	Laboratories Vijosa S.A. de C.V.	Laboratories Vijosa S.A. de C.V.
<u>ENERCEL® FORTE</u>	<i>Lycopodium clavatum</i>	Laboratories Vijosa S.A. de C.V.	Laboratories Vijosa S.A. de C.V.
<u>SOLVENCIMUM</u>	<i>Lycopodium clavatum</i>	PC "Biolik"	LLC «Ukrainian pharmaceutical company»
<u>GEPATIUS "SPAG" PEKANA</u>	<i>Lycopodium clavatum</i>	Pecana Heilmittel Heel GmbH., Germany	Pecana Heilmittel Heel GmbH., Germany

**Drugs are in bold and underlined - the term of registration has expired.*

Medication containing Lycopods is also used in veterinary medicine. For example, Liarsin, which includes *L. clavatum*, is a complex homeopathic product, which has a corrective effect on protein, hydrocarbon, metabolism, restores impaired gastrointestinal function, stimulates the body's immune system. Its country of origin is Russia.

However, it should be noted that Lycopods have poisonous properties and their use should be carried out under medical supervision.

It is likely that this situation with the research and use of Lycopods is primarily conditioned by the absence of a raw material base in Ukraine and their conservation status.

CONCLUSION

The results obtained from the use of *Lycopodiophyta* indicate that there is no medical or any other economic importance in Ukraine. Most species of Lycopods are distributed only in certain regions and have a conservation status. The populations of the studied species are few and sensitive to anthropogenic factors. Most homeopathic preparations containing Lycopods are produced in other countries, which is caused by a number of factors listed above.

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