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SCHOENOPLECTUS LACUSTRIS SUBSP. HIPPOLYTI NING TAKSONOMIYASI, EKOLOGIK AHAMIYATI VA FITOKIMYOVIY (UGLEVOD) ANALIZI

ТАКСОНОМИЯ, ЭКОЛОГИЧЕСКОЕ ЗНАЧЕНИЕ И ФИТОХИМИЧЕСКИЙ (УГЛЕВОДНЫЙ) АНАЛИЗ *SCHOENOPLECTUS LACUSTRIS SUBSP. HIPPOLYTI*

TAXONOMY, ECOLOGICAL SIGNIFICANCE AND PHYTOCHEMICAL (CARBOHYDRATE) ANALYSIS OF *SCHOENOPLECTUS LACUSTRIS SUBSP. HIPPOLYTI*

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Annotatsiya

Ushbu maqolada Schoenoplectus lacustris subsp. hippolyti (Cyperaceae) taksonomiyasi, ekologik ahamiyati hamda fitokimyoviy (uglevod) tarkibi tahlil qilindi. Mazkur tur O‘zbekiston hududining bir necha viloyatlarida, asosan suv havzalari va namlik yuqori bo‘lgan erlarda tarqalganligi aniqlandi. Uning ekologik roli, xususan, suvni tabiiy tozalash va gidroekotizimlarning barqarorligini ta’minlashdagi ahamiyati yoritildi.

Kimyoviy tarkibiy tahlil yuqori samarali suyuqlik xromatografiyasi (HPLC, Agilent 1100) yordamida amalga oshirildi. Natijalarga ko‘ra, o‘simlik namunasida uch turdagi uglevodlar – fruktoza (0,07 mg/g), glyukoza (0,05 mg/g) va maltoza (0,06 mg/g) aniqlangan bo‘lib, saxaroza qayd etilmadi. Umumiy erkin uglevodlar miqdori 0,18 mg/g quruq og‘irlikni tashkil etdi.

Olingan natijalar S. lacustris subsp. hippolyti ning uglevodlar bo‘yicha past ko‘rsatkichlarga ega ekanini, bu esa o‘simlikning suvli muhitga moslashuvi bilan bog‘liq bo‘lishi mumkinligini ko‘rsatadi. Shu bilan birga, uning biologik faol moddalar saqlashi ekologik va farmatsevtik tadqiqotlar uchun istiqbolli ob’ekt ekanligini tasdiqlaydi.

Аннотация

В данной статье рассмотрены таксономия, экологическое значение и фитохимический (углеводный) состав Schoenoplectus lacustris subsp. hippolyti (Cyperaceae). Установлено, что данный таксон распространён в ряде регионов Узбекистана, преимущественно вблизи водоёмов и на участках с повышенной влажностью. Освещена его экологическая роль, в частности значение в естественной очистке воды и обеспечении стабильности гидроэкосистем.

Химический анализ проведён методом высокоэффективной жидкостной хроматографии (ВЭЖХ, Agilent 1100). Согласно результатам, в образцах растения выявлены три типа углеводов: фруктоза (0,07 мг/г), глюкоза (0,05 мг/г) и мальтоза (0,06 мг/г), тогда как сахароза не была обнаружена. Общее содержание свободных углеводов составило 0,18 мг/г сухой массы.

Полученные данные показывают, что S. lacustris subsp. hippolyti характеризуется низким уровнем содержания углеводов, что может быть связано с его физиологической адаптатsiей к водной среде. Одновременно наличие биологически активных веществ подтверждает перспективность данного таксона для экологических и фармацевтических исследований.

Abstract

This article examines the taxonomy, ecological significance, and phytochemical (carbohydrate) composition of Schoenoplectus lacustris subsp. hippolyti (Cyperaceae). The subspecies was found to be distributed across several regions of Uzbekistan, mainly in wet habitats and along water bodies. Its ecological role, particularly in natural water purification and the stabilization of hydroecosystems, is highlighted.

Chemical composition was analyzed using high-performance liquid chromatography (HPLC, Agilent 1100). The results revealed the presence of three carbohydrates in the plant material: fructose (0.07 mg/g), glucose (0.05 mg/g), and maltose (0.06 mg/g), whereas sucrose was not detected. The total soluble carbohydrate content amounted to 0.18 mg/g dry weight.

The findings indicate that S. lacustris subsp. hippolyti accumulates relatively low levels of soluble carbohydrates, which may be associated with its physiological adaptation to aquatic environments. At the same time, the presence of biologically active compounds confirms its potential as a promising subject for ecological and pharmaceutical studies.

Kalit so'zlar: *Schoenoplectus lacustris subsp. hippolyti; taksonomiya; ekologik ahamiyat; fitokimyoviy tahlil; uglevodlar; yuqori samarali suyuqlik xromatografiyasi (HPLC); suv ekotizimlari; O'zbekiston florasi.*

Ключевые слова: Schoenoplectus lacustris *subsp.* hippolyti*; таксономия; экологическое значение; фитохимический анализ; углеводы; высокоэффективная жидкостная хроматография (ВЭЖХ); водные экосистемы; флора Узбекистана.*

Key words: Schoenoplectus lacustris *subsp.* hippolyti*; taxonomy; ecological significance; phytochemical analysis; carbohydrates; high-performance liquid chromatography (HPLC); aquatic ecosystems; flora of Uzbekistan.*

INTRODUCTION

Wetlands are highly productive ecosystems that provide essential services such as biodiversity support and water purification. Aquatic plants, including *Schoenoplectus lacustris* subsp. *hippolyti* (Cyperaceae), play a key role in maintaining ecological balance. However, little is known about the phytochemical profile of this subspecies. Studying its carbohydrate composition helps to explain its adaptation to aquatic habitats and assess its ecological and potential pharmacological value. This study presents taxonomic data, ecological significance, and carbohydrate analysis of *S. lacustris* subsp. *hippolyti*, offering new insights into its biology and applied importance.

LITERATURE REVIEW AND METHODOLOGY

Schoenoplectus (Reichenb.) Palla is a genus belonging to the family Cyperaceae, distributed across both hemispheres of the Earth, primarily in temperate, subtropical, and tropical regions, and includes approximately 70 species.[1]

Among the most important morphological differences is that *Schoenoplectus* possesses pseudolateral (false lateral) spikelet clusters and leaves located only at the basal nodes, which are either reduced or develop into variously shaped blades.

For the purpose of studying its chemical composition and biological activity, the object selected was the subspecies *Schoenoplectus lacustris* subsp. *hippolyti*, a minor taxon of *Schoenoplectus lacustris* (common reed).

This taxon was originally described under the name *Scirpus hippolyti* V.I. Krecz. (this name is still used in Russian literature and floras). Subsequently, these materials and taxa were re-examined in several studies and were reclassified by Kukkonen (1996) as *Schoenoplectus lacustris* subsp. *hippolyti* (V.I. Krecz.) Kukkonen.

Scientific Name and Taxonomic Status: *Schoenoplectus lacustris* (L.) Palla subsp. *hippolyti* (V.I. Krecz.) Kukkonen — family Cyperaceae.

Figure 1."*Global distribution of Schoenoplectus lacustris subsp. hippolyti, based on GBIF (https://www.gbif.org/) records.*"

This subspecies, *S. lacustris* subsp. *hippolyti*, is reported to be distributed from the Caucasus to Central Asia. Its presence in Uzbekistan is indicated in sources such as PlantList and World Plants.

The rhizome is thick and creeping. Stems are grayish-green, round (sometimes triangular), 80–150 cm tall, strongly thickened at the base, and covered with wide sheaths usually without leaves. The inflorescence is paniculate, spreading, with 1–2 very short basal leaves and unequal, twice-branched rays reaching up to 15 cm in length. Spikelets are light brown, ovoid and pointed, 8–15 mm long and 5–6 mm wide, with 1–5 spikelets located at the tips of the branches. The glumes of the spikelets are ovoid or obovoid, 3–4 mm long, brown, keeled, narrowing upwards and rough; edges are wide, membranous, with ciliate hairs, and the upper part has a small depression from which a long, strong, rough tip emerges, giving the glume a keeled and pointed appearance. The perianth bristles are as long as the achene. The achene is obovoid, flat-convex, light brown, slightly shiny, and 2–2.5 mm long. Styles number 2 or 3. Flowering and fruiting occur from August to September. It is commonly found along water bodies, rivers, springs, and at the foothills of mountains.

In Uzbekistan, it is distributed in the regions of Tashkent, Fergana, Samarkand, Bukhara, and Khorezm, as well as in the territory of Karakalpakstan.[2]

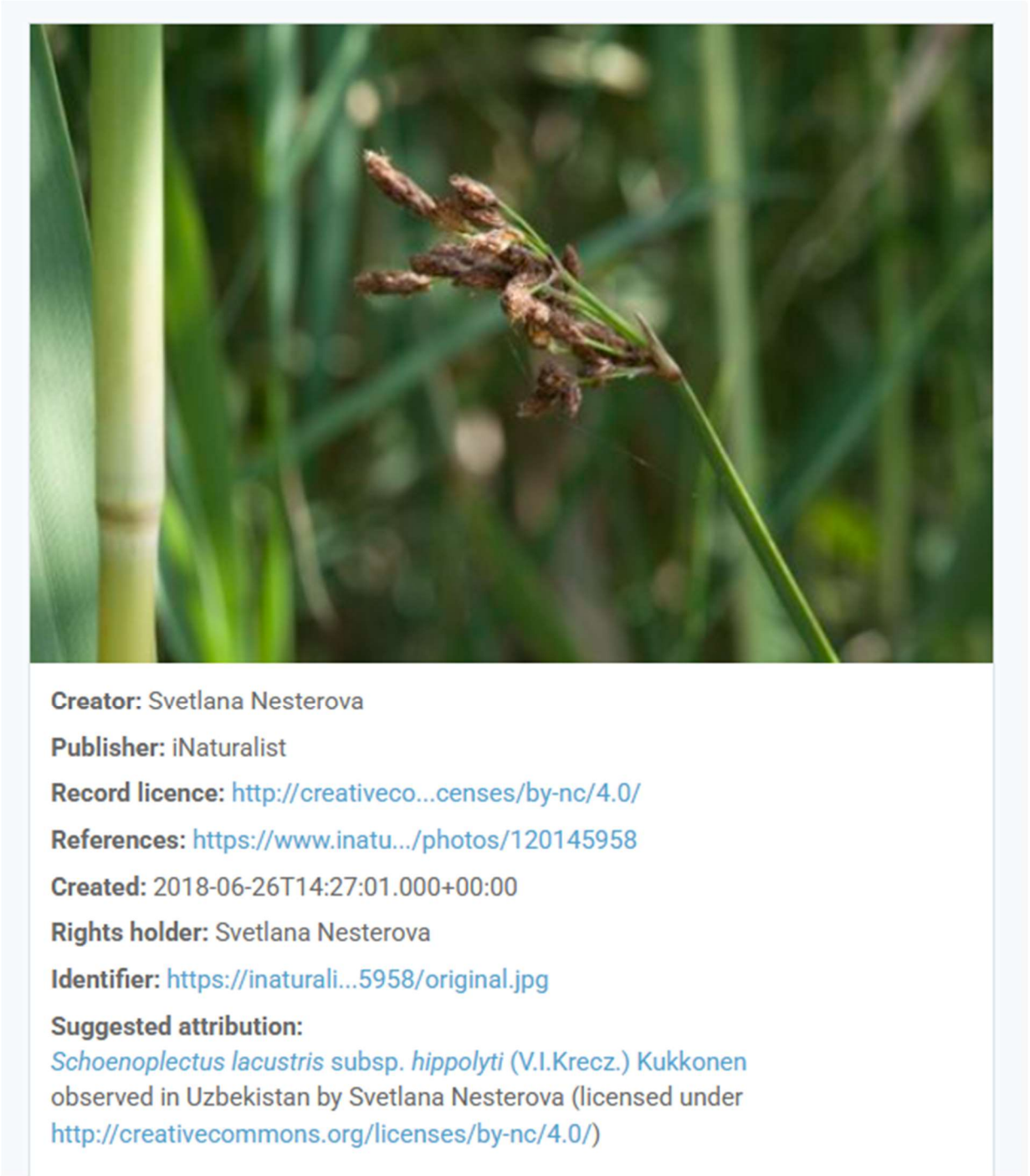

Figure 2. *Schoenoplectus lacustris* subsp. *hippolyti* observed in Uzbekistan by Svetlana Nesterova (photo: iNaturalist, 26 June 2018, licensed under CC BY-NC 4.0).

This species' presence in the territory of Uzbekistan is also confirmed by the GBIF database (https://www.gbif.org/). The plant was recorded on June 26, 2018, by Svetlana Nesterova at the coordinates 41.5°N, 69.6°E.

Figure 3. Distribution map of *Schoenoplectus lacustris* subsp. *hippolyti* in the Chirchiq district, based on GBIF occurrence records.

Schoenoplectus lacustris subsp. *hippolyti* is an aquatic-marsh plant, typically growing in wetlands and along water bodies. This species plays a significant role in maintaining environmental stability, naturally purifying water, and sustaining healthy ecosystems. Due to the biologically active compounds identified in its roots, flowers, and leaves, it is considered a valuable resource for ecological, pharmaceutical, and other applications. This thesis focuses on studying the chemical composition of *S. lacustris* subsp. *hippolyti*, as well as analyzing its ecological and practical significance.

Schoenoplectus lacustris subsp. *hippolyti* can be found in several regions of Uzbekistan, particularly in areas with high moisture or near water bodies. In some cases, it grows directly in water. For example, this subspecies has been observed in Chirchiq District of Tashkent Region.

The species' role in naturally purifying water bodies highlights its importance in maintaining ecological health. Furthermore, the biologically active components present in the plant indicate its potential applications in medicine and pharmaceuticals. In particular, its cytotoxic effects against cancer cells and antioxidant properties have attracted scientific interest. At the same time, the declining population of this subspecies in certain areas emphasizes the need for its conservation. Overall, research suggests that *Schoenoplectus lacustris* subsp. *hippolyti* (related species) can be evaluated not only from a biological but also from an ecological and economic perspective as a promising plant.

Using aqueous and alcoholic extracts of *Schoenoplectus lacustris* subsp. *hippolyti*, researchers have isolated polyphenols, cinnamic acid, flavonoids, and many other biologically active compounds. In particular, phytotoxic compounds play an important role in studying aquatic ecosystems and pollution-related issues.

MATERIALS AND METHODS

For the carbohydrate analysis, plant material of *Schoenoplectus lacustris* subsp. *hippolyti* was collected in Uzbekistan, Tashkent region, Chirchiq district (41.5°N, 69.6°E). The samples were air-dried, finely ground, and prepared for chromatographic analysis.

The analysis was performed on an **Agilent 1100 high-performance liquid chromatograph (HPLC)** equipped with a degasser (Degasser G1379A), quaternary pump (QuatPump G1311A), autosampler (ALS G1313A), column thermostat (Colcom G1316A), refractive index detector (RID G1362A), and data processing system (Agilent ChemStation Rev. B.01.03). Separation was achieved on a **Supelcosil LC-NH2 column** (5 µm, 4.6 × 250 mm, Supelco, USA).

Auxiliary laboratory equipment included micropipettes of 100 and 1000 µL capacity ("VWR", Poland), a 5 mL pipette ("Biohit", Finland), analytical balances AnD GR-202 with a precision of

0.00001 g (“AnD”, Japan), a Millipore Simplicity water purification system (“Millipore”, France), an ultrasonic bath S 30 H Elmasonic (“Elma”, Germany), and 0.45 μm Nylon filters (13 mm). Standard reference substances used for calibration were fructose, glucose, sucrose, and maltose (imported). Acetonitrile (HPLC grade) was obtained from “Sigma-Aldrich” (USA).

Chromatographic separation was carried out under **isocratic elution mode** using a mobile phase consisting of **acetonitrile/water (82/18, v/v)** without premixing from separate reservoirs. The flow rate was set at **1.0 mL/min**, injection volume at **10 μL**, and column thermostat temperature maintained at **35 °C**. Retention times of carbohydrate standards were as follows: fructose – 4.9 ± 0.2 min, glucose – 5.7 ± 0.2 min, sucrose – 10.4 ± 0.2 min, and maltose – 12.1 ± 0.2 min.

Results. The HPLC analysis revealed the presence of three carbohydrates in the studied plant material (Table 1). Fructose (0.07 mg/g), glucose (0.05 mg/g), and maltose (0.06 mg/g) were detected, whereas sucrose was absent. The total soluble carbohydrate content was **0.18 mg/g dry weight**.

Table 1. Carbohydrate composition of *Schoenoplectus lacustris* subsp. *hippolyti*

Carbohydrate	**Concentration (mg/g)**
Fructose	0.07
Glucose	0.05
Sucrose	0.00
Maltose	0.06
Total	**0.18**

Discussion. The obtained data demonstrate that *Schoenoplectus lacustris* subsp. *hippolyti* accumulates only a small amount of soluble carbohydrates, with fructose, glucose, and maltose as the dominant sugars, while sucrose was not detected. This pattern may be linked to the species’ physiological adaptations to aquatic habitats, where carbohydrate metabolism plays a crucial role in energy storage and osmotic regulation.

The relatively low total carbohydrate content (0.18 mg/g) suggests that this taxon relies more on structural polysaccharides and other biochemical pathways rather than soluble sugars for its ecological strategy. Comparative studies with related taxa could further clarify the role of carbohydrate composition in the taxonomy and ecology of *Schoenoplectus*.

CONCLUSION

The present study provides an integrated assessment of the taxonomy, ecological significance, and phytochemical (carbohydrate) composition of *Schoenoplectus lacustris* subsp. *hippolyti* in Uzbekistan. Field observations confirmed its distribution in wet habitats and along water bodies, highlighting its ecological role in water purification and hydroecosystem stability. High-performance liquid chromatography (HPLC) analysis revealed the presence of three soluble carbohydrates—fructose, glucose, and maltose—at relatively low concentrations, while sucrose was absent. The low total carbohydrate content suggests specific physiological adaptations of this subspecies to aquatic environments. At the same time, the occurrence of biologically active compounds supports its potential as a promising subject for further ecological and pharmaceutical research. Overall, the findings contribute to a deeper understanding of the biological and applied importance of *S. lacustris* subsp. *hippolyti* and provide a foundation for future comparative and conservation studies.

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