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THE ORIGIN AND SPREAD OF ALKALINE CONDITIONS

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Abstract
Fungi are known as a major group of decomposers, possessing extensive physiological plasticity and high adaptive potential to various abiotic factors. Most cultivated species prefer acidic conditions for growth and development. While alkaliphilic and alkaline have been studied extensively, the study of fungi tolerant to high pH values is relatively recent. A number of Russian studies of micromycetes in soda lakes and salt marshes have made a significant contribution to this topic. The authors developed a comprehensive method for isolating and identifying the functional components of alkaline habitat communities, demonstrating for the first time the phenomenon of obligate alkaliphilia in fungi. This large-scale study raised new questions about the diversity, distribution, and role of alkaliphilic and alkalitolerant fungi in both consistently alkaline habitats (only a small fraction of which have been studied) and in habitats (saline and nonsaline) where alkalization can occur locally. The question of how alkali-tolerant fungi adapt to high pH values also remains relevant. Such data are fragmentary in the literature, with all studies conducted on alkalitolerants, not alkaliphiles. There is no information on the role of changes in the composition of soluble cytosolic carbohydrates and membrane lipids in adaptation to external pH, although these adaptation mechanisms are known to be among the most important under the influence of many other stress factors.

Introduction
The aim of this study was to investigate the diversity, ecophysiological characteristics , and adaptation mechanisms of alkaliphilic and alkalitolerant fungi isolated from soils with different pH values and different types of salinity.
To achieve this goal, the following tasks were set **:** to isolate alkali-tolerant fungi from the stable alkaline soils of the soda lake; neutral hypersaline soils of the lake; acidic sod-podzolic and neutral cultivated soils; and to study the taxonomic diversity and conduct a phylogenetic analysis of the isolated fungi; and to study the dynamics of membrane and storage lipids of alkaliphilic and alkalitolerant fungi in response to changes in external pH .

Research Results
Alkaline conditions with consistently high pH values occur in natural habitats such as soda lakes and soda solonchaks, where alkalization typically occurs through the accumulation of sodium carbonate and bicarbonate as a result of carbon dioxide weathering of calcium- and magnesium-poor rocks. The development of soda salinization in lakes is facilitated by the lack

of surface runoff and poor drainage, while evaporitic processes summarize the effects of carbon dioxide weathering for the catchment area. Complex and diverse processes can also lead to soil alkalization. These are predominantly soda-salinated soils, including soda, soda-chloride, soda-sulfate, and soils containing soda. Soda salinization is most typical of arid zones in the forest-steppe belt, semi-deserts, and savannas, although it is found elsewhere. Regarding the global distribution of soda salinization, examples of soda lakes and solonchaks are known in North, Central, and South America, Europe, Asia (Siberia, Mongolia, Tibet), throughout Africa, and Australia. The water-salt regime of alkaline soils and soda solonchaks is highly dependent on precipitation and drainage (this is especially true for soils). Soda lakes exhibit less dramatic changes in water mineralization with changing atmospheric conditions. These are the most stable of the highly alkaline habitats, where pH values above 11.5 can be maintained.

In terms of hydrochemical processes, increased alkalinity is typically accompanied by the removal of calcium as a macronutrient. Sodium becomes the dominant cation, while carbonate/bicarbonate and chloride ions become the dominant anions. As a result of a shift in the CO2/HCO3-/CO3-/OH- ratio, depending on the mineralization, these anions create a more or less powerful alkaline buffer system (with a pH of up to 12). Unstable local alkaline conditions can arise everywhere as a result of microbial activity through ammonification, sulfate reduction, and photosynthesis. This fact should undoubtedly facilitate the widespread distribution of species adapted to high pH values. Human activity also makes a significant contribution to the creation of alkaline conditions: the operation of cement factories, paper and pulp mills, mining, the discharge of various wastes, and agricultural activities (especially the application of certain fertilizers to the soil) are accompanied by local alkalization of the environment, down to pH 11. In addition to the studies listed above, the transcription factor PacC, which is involved in signal transduction when the external pH changes, has been studied in S. alkalinus, and its conservatism has been demonstrated. Double-stranded RNA mycoviruses have been detected in several isolates of the fungus. S. alkalinus has proven to be an extremely promising model object for studying the phenomenon of obligate alkaliphilia in fungi. Mechanisms of fungal adaptation to external pH. History of the study of the mechanisms of fungal adaptation to external pH. All known studies concerning the mechanisms of fungal adaptation to alkaline pH values have been conducted on neutrophilic species such as Aspergillus niger.

Representatives of group 3 are characterized primarily by the fact that in most cases they form limited localized foci of infection in the above-ground parts of the plant, spread horizontally, and are distinguished by high biodiversity within specific host tissues and individual plants. This is especially pronounced among inhabitants of tropical and subtropical regions. This group includes representatives of most orders of ascomycetes and basidiomycetes. Group 4 includes the so-called dark septate fungi. endophytes (TC - endophytes, DSE - Dark Septate Endophytes (Table 1), whose presence in the rhizosphere and roots of various plants has been noted by many scientists studying mycorrhizas. TC endophytes colonize plant roots, developing intracellularly and without forming structures characteristic of mycorrhizal fungi. Their name derives from their dark coloration and the presence of a melanized septum. Taxonomically, this

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group is quite diverse: they do not exhibit specificity to specific hosts or habitats and are found everywhere from the Arctic to Antarctica. TC endophytes are believed to spread horizontally; dissemination by mycelial fragmentation and conidia has been demonstrated in laboratory conditions. The ecological role of this group remains poorly understood, but it has been shown that in many cases, the presence of an endosymbiont has a positive effect on the host plant, helping it survive abiotic stress, such as drought or soil contamination with heavy metals. Endophyte groups described,researchers propose classifying a number of entomopathogenic fungi as a separate group. Their life cycle may include a fairly long stage of asymptomatic endophytic growth preceding the development of infection in insects. Such fungi may potentially serve as potential biocontrol agents. Active research into such associations in recent years has resulted in thousands of articles. However, endophytic fungi remain poorly understood, despite their crucial role in the formation, stabilization, and evolution of plant communities and other organisms associated with them. This is due to the influence of numerous factors, including their hidden lifestyle, difficulties in detecting, isolating, cultivating, and identifying endophytes, and the individual reactions of different community members to each other. Taxonomic position of endophytes of cereals: clavicipitales Endophytic fungi are a group that includes symbionts of grasses and some sedges, engaging in various types of interactions with their host plants, ranging from fully mutualistic to pathogenic. They form a monophyletic group that includes members of the Clavicipitaceae family, although the question of monophyletic status is still debated.

Conclusions. Thus, in the Clavicipitaceae family, four tribes are usually distinguished (Cordycipeae , Clavicipeae , Balansieae , Ustilaginoideae), three of which infect only grasses and sedges, and the fourth, Cordycipeae (genus Cordyceps), is a pathogen of insects, some other invertebrates or fungi (Kuldau et al ., 1997, cited in: Clay , Schardl , 2002). The tribe Ustilaginoideae includes three anamorphic genera that infect grasses in South and Central America, as well as in other tropical regions, producing conidial sporulation similar to the ustospores of Ustilago spp. (Bischoff et al., 2004). The tribe Clavicipeae are known causative agents of diseases collectively known as "ergots." They parasitize a wide range of grasses, where they form sclerotia, infecting single flowers of cereals and producing alkaloids. The most diverse representatives of the tribe Balansieae are those that include seven genera that cause systemic infections of cereals and sedges and are also capable of synthesizing alkaloids. This group includes endophytes that form associations with grasses, primarily from the subfamily Pooideae, which are the subject of study in this work.

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