INTRODUCTION

The reduction of biological diversity (BD) due to human activity is a sad sign of our time. It is necessary to ensure the efficient monitoring of this process and to develop a system of actions able to reduce the negative human influence on the flora and fauna, as well as to conduct a deep investigation of the BD nature in a wide range of ecosystems ranging from tropical forests to agricultural and urban ecosystems. The study of the species diversity of plant communities (SDPCs), which represents the most available monitoring object, reflecting the state of ecosystems, plays a special role in such investigation. According to the principle of "diversity gives birth to diversity," SDPC determines the diversity of heterotrophic biota. Moreover, plant communities indicate the environmental conditions that predetermine the existence of many heterotrophic species of animals, fungi, and bacteria. Both lower (biogeocenoses) and higher (biomes) units of the ecosystem classification are formed along the borders of phytocoria of different ranks. This paper discusses the current state of studies devoted to the factors that determine the SDPC composition.

DEVELOPMENT OF THEORY OF SPDC FORMATION

The study [30] shows that it is impossible to develop an algorithm that explains SDPC because of the large number of factors that form this algorithm, and their complex and nonadditive interactions. At the same time, the SDPC of different organization models is formed under the influence of various factors [17]. However, the number of attempts to formulate any hypotheses about the SPDC formation, not to mention any theory, has never been very large. Palmer [95] mentioned about 100 hypotheses, and no unification of these ideas is observed. The process of the formulation of new hypotheses continues; for example, the very eccentric key—hole hypothesis was proposed in [67]. Microhabitats are considered to be “hole” analogs, whereas species are considered to be “keys.” Therefore, if the number of “holes” and “keys” is large, then the community is rich in species. This hypothesis is not too realistic, since it does not take into account the competition potential of different species; i.e., a strong key can push a lot of weak rivals out of their holes and, as a result, SPDC exhaustion will occur according to the Keddy centrifugal model [76].

Beginning in the 2000s, the formulation of the SPDC formation hypotheses was stopped. It became clear that the formation of the SDPC phenomenon cannot be explained based on any universal hypothesis. This fact reflects the character of modern ecology, which has rejected attempts to formulate stringent laws described by mathematical formulas, such as physical laws. Attempts to develop a universal methodology were typical of the Romantic period in the history of ecology (the first half of the 20th century), which was known as the golden age of the theory of ecology. The situation that arose in ecology is adequately reflected by the titles of some studies published at the time, including “Are There General Laws in Ecology?” [83], “Ecology: In Search of a Universal
Paradigm” [6], and “Changes in the Theory of Ecology in the 20th Century: From Universal Laws to the Search for Methodologies” [66]. As a result of the paradigm change, ecologists began to search for partial laws that reflect the structure and functions of individual ecosystem types.

The general mechanisms of SPDC maintenance were considered by Chesson [52], who emphasized the existence of two basic mechanisms, i.e., equalizing and stabilizing. In the first case, species have equal competitive abilities and their mutual negative influence is rather low. In the second case, the level of competition is high, but coexistence is possible, since species occupy different ecological niches. In addition, the formation of communities can conform to the model of unstable coexistence; in this case, some species increase their participation, whereas other species reduce it, i.e., ecological succession occurs.

The role of equalizing mechanisms was recently discussed in a series of publications devoted to the neutral model [7, 73, 74]. According to this model, a high SPDC level of tropical forests is explained by the fact that the species that make up these ecosystems evolved towards the unification of their ecological features and competitive ability. Therefore, there are no winners or losers in their interrelations, and Gause’s law does not work. One should note that the neutral model was previously described by Vasilevich (without the use of this concept), who considered the nondisjunction of species concerning their ecological niches to be the main factor for their coexistence in communities with a high level of species diversity [2, 3]. It seems that the neutral model is manifested not only in tropical forests, but also in steppe meadows, alvar meadows, meadow steppes, and other phytocenoses characterized by a high level of SPDC.

Wilson [119], who has analyzed 12 theories of the species coexistence in communities, considers the neutral model to be incompetent. However, this statement is unfounded. Authors believe that, even in the case of the same community, the coexistence of species can be provided by two mechanisms, i.e., dominants can be differentiated based on their ecological niches, whereas low-abundance species coexist due to the equalization of their ecological needs, i.e., several species can occupy the same ecological niche.

Recent SPDC studies formed a new paradigm [69] that orients investigators to study SPDC under experimental, rather than natural conditions; these experimental conditions include the influence of the fertilization, watering, and other man-made factors on phytocenoses, the reciprocal transfer of species between different communities, the removal of dominants, etc. [24]. J.P. Grime emphasizes that the extrapolation of the results of these experiments on natural communities is not always possible.

The authors of this paper offered a scheme of the influence of basic factors on SPDC [22]. The factors shown in the figure play different roles in different communities. The ecotope, or abiotic matrix, represents the main SPDC-determining factor. It can influence SPDC both directly (in the case of unfavorable conditions) and indirectly (via the dominant composition and general competition mode). The influence of dominants can be reduced by the action of phytophages and pathogens. In addition, SPDC can be determined by the following factors:

1. The species pool, i.e., floral resources of the region. This influence also depends on the efficiency of the delivery of diaspora into the community.

2. Succession status. This concept combines the influence of any successions, including autogenic primary and secondary (restoration) successions and allogenic successions, provided by the human activity (pasturing, recreation, pollution, etc.). The role of the