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STUDIES ON THE FLORA OF MAJOR LINEAR OBJECTS IN THE WORLD

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Annotation:
The growth of the Earth's population and the reduction of natural flora under the influence of various anthropogenic factors have both negative and positive impacts on the plant world. One such factor can be considered the flora of major linear objects. This article analyzes studies on the flora of major linear objects in the Nuratau botanical-geographical district.

Key words: Nuratau, Aktau, linear objects, flora, adventive species, Red Book.

Year by year, humanity's influence on nature continues to intensify. Anthropogenic factors introduce new adventive species into flora, while at times causing the extinction of aboriginal ones [8]. Due to the expansion of human activity, technogenic zones have been formed in nature. The flora of major linear objects can be attributed to such technogenic territories. Major linear objects refer to automobile highways, railways, gas and water pipelines, and electric networks located in a specific area [5].

For many years, the flora of major linear objects remained outside the focus of scientists. In recent years, however, this field has become relevant, and the number of studies in modern floristic research has been increasing.

The collection of the first herbarium samples related to the flora of linear objects dates back to the 1840s, as noted by F.I. Ruprecht in his work *"Flora Ingrica..."*. One of the first to study road flora was the botanist Eduard Lehmann [3]. He conducted long-term studies in Latvia and noted the increasing importance of railways in the distribution of plants. In 1926, D.I. Litvinov studied the spread of plants along linear objects. Later, between 1965 and 1970, Yu.D. Gusev analyzed the flora of railway stations and railway stretches in the northwestern part of Russia. In the regions studied by Gusev — Novgorod (430 species), Southern Karelia (375 species), Northern Karelia (296 species), Pskov (470 species), Murmansk (233 species), and St. Petersburg (526 species) — representatives of the *Asteraceae* and *Poaceae* families were dominant. He explained this dominance by the adaptability of these families to extreme technogenic conditions. The flora of linear objects in northwestern Russia consisted of 26% of these families.

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In the 19th century, interest in the flora of linear objects increased, with special attention paid to the adventive composition of flora [4]. Between 1983 and 1986, E.G. Guschina, M.S. Ignatov, and V.V. Makarov studied the flora of linear objects. During the 1990s, the flora of linear objects was studied in detail in Poland, the Czech Republic, Germany, Italy, Ukraine, Russia, and Sweden (Suominen, 1969; Neimi, 1969; Shuls, 1976; Kucera & Jehlik, 1991; Toxtar, 1993, 1994; Prasse & Ristow, 1995; Paolo & Paolo, 1997; Nowak, 1997) [8]. In particular, between 1989 and 1992, V.K. Tokhtar analyzed the flora of 44 railway stations and 24 stopping points in southeastern Ukraine. Field research identified 33 adventive plant species in the flora of southeastern Ukraine [10].

In the 20th century, interest in railway flora increased, especially as a channel for the introduction of new adventive species into regions (Borisova, 2006; Tarasova, 2006; Tretyakova & Mukhin, 2006; Skvortsova & Berezutskiy, 2008; Kukharskaya, 2008; Tretyakova, 2010). Numerous studies of the flora of various regions and cities have highlighted railway stretches as separate complexes of technogenic habitats (Grigoryevskaya & Lepeshkina, 2005; Borisova, 2006; Panasenko, 2006; Puzyrev, 2006; Shvetsov, 2006; Rybakova, 2008; Arepeva, 2008; Ivanova, 2008; Tokhtar, 2013, etc.).

In Poland, scientists such as Lukasz Dylewski, Przemyslaw Kurek, Blanka Wiatrowska, Leszek Jerzak, and Piotr Tryjanowski, in their article *"Man-made perching sites – electricity pylons accelerate fleshy-fruited plant succession in farmlands"*, showed that electricity pylons play an important role in the succession of fleshy-fruited shrubs and trees. Their 2013 research demonstrated that in intensively cultivated agricultural areas, power lines and pylons serve as artificial perching sites for birds, which in turn disperse seeds of fleshy-fruited plants around these structures. The results revealed 32 tree and shrub species (22 with fleshy fruits, 10 with dry fruits), of which 30% were adventive. Between 2017 and 2018, the same group, led by Lukasz Dylewski, studied abandoned linear objects (railway lines). They found that unused railways can serve as important refuges for pollinator communities in intensively managed farmlands, compensating for the loss of semi-natural habitats [7].

In Sweden, in 2020, Juliana Daniel-Ferreira, Riccardo Bommarco, Jörgen Wissman, and Erik Öckinger studied the flora and fauna of linear infrastructures such as highways and power lines. To determine whether such infrastructures contribute to landscape-scale biodiversity, they examined the species richness, evenness, and phylogenetic diversity of plants, butterflies, and beetles in 32 landscapes (4 km² each) with and without power lines. A total of 2,704 butterflies (51 species), 1,316 beetles (19 species), and 128 plant species were recorded. The

most common butterfly was *Aphantopus hyperantus* (974 individuals), the most common beetle *Bombus pascuorum* (347), and dominant plants included *Achillea millefolium*, *Agrostis capillaris*, *Dactylis glomerata*, and *Taraxacum vulgare*. On average, landscapes with power lines had six more plant species than those without, though such a difference was not observed for fauna. The study concluded that power lines contribute to plant diversity on a landscape scale, while road verges have less noticeable effects [2].

European researchers Thomas Vanneste, Sanne Govaert, Willem De Kesel, and Sanne Van Den Berge, in their 2018–2020 study *"Plant diversity in hedgerows and road verges across Europe"*, compared road verge flora across different climates in Norway, Belgium, and Sweden. Their results showed 52% similarity between meadows and roadside meadows. Species confined to forests or meadows were 11% less common in linear habitats, whereas generalist species adaptable to various environments were 14% more common.

In China, scientists from the Chinese Academy of Sciences (CAS) and the Northwest Institute of Plateau Biology conducted studies between 2020 and 2022 on the flora of linear objects across the Tibetan Plateau—the world's highest and largest mountain region. Twenty-five research sites were selected across alpine meadows (10) and alpine steppes (15). Roads contributed only 8.98% to overall plant diversity at the landscape level. The authors concluded that, at present, road construction poses no significant threat to plant biodiversity in Tibet. However, with climate change, the opportunities for exotic species to expand may increase, necessitating caution in future road planning at high altitudes.

In the United States, Alberto Suárez-Esteban, Lenore Fahrig, Miguel Delibes, and José M. Fedriani analyzed research on the flora of linear objects in their 2016 paper *"Can anthropogenic linear gaps increase plant abundance and diversity?"* [9]. Their analysis showed that in most studies (69.2%), linear objects were found to increase plant numbers or diversity, facilitating the dispersal of populations. However, they noted that these conclusions may reflect bias toward studies focusing on adventive species. They also emphasized the lack of mechanistic studies assessing the relative effects of seed dispersal and post-dispersal processes [9].

Researchers from the University of Mississippi, Adrián Lázaro-Lobo and Gary N. Ervin, analyzed scientific publications on the flora of linear objects worldwide in 2018–2019. Over the past 70 years, many studies have examined how roadsides influence plant distribution, yet no comprehensive review had been conducted. To address this, they screened 8,845 articles from the Scopus database and selected 1,098 that met inclusion criteria. Their results showed

that over half of the studies indicated a positive influence of roadsides on the spread of newly introduced plants. More than 75% of the studies involving native species also reported positive effects. Research on the spread of adventive species along roadsides was primarily conducted in the USA, Europe, Australia, Canada, China, and India. Conversely, Africa, Southeast Asia, and northern regions remain poorly studied in this regard [1].

The results indicate that although the flora of major linear objects has been studied worldwide for many years, no such floristic research has yet been conducted in Uzbekistan. Our goal is to study and analyze the flora of major linear objects within the Nuratau botanical-geographical district. In this region, automobile highways and gas pipelines represent the main linear objects. Currently, highways have been selected as the primary research focus, and new floristic studies are underway.

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