



RARE AND INVASIVE PLANT SPECIES OF SOUTHERN TAJIKISTAN: MONITORING RESULTS AND PRIORITIES FOR CONSERVATION

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ANNOTATION

Purpose of the study. To assess the current status of rare and invasive plant species in Southern Tajikistan and to substantiate priority directions for their conservation and management.

Material and methods. The study was based on long-term field monitoring conducted in Southern Tajikistan in 2015-2024. The reliability of the obtained results was supported by revision of herbarium collections, more than 400 geobotanical descriptions, and more than 600 validated geobotanical records used for comparative ecological assessment. The work included route-field surveys, geobotanical analysis, floristic revision, monitoring of rare taxa, and identification of invasive species spreading in natural communities, pastures, and agricultural landscapes.

*Research results. The study identified 87 rare plant species belonging to 74 genera and 44 families included in the Red Book of the Republic of Tajikistan. At the same time, active spread of invasive taxa was recorded, including *Thermopsis dolichocarpa*, *Cyanus depressus*, *Artemisia dracunculus*, *Artemisia scoparia*, *Phlomis bucharica*, *Rumex paulsenianus*, and *Silybum marianum*. A key driver of invasion was the long-term seasonal movement of livestock between winter and summer pastures. Based on monitoring data, the exclusion of *Crocus korolkovii* from the next edition of the Red Book was proposed due to population recovery, while three additional rare and endemic taxa were recommended for inclusion in updated conservation lists. Practical measures include the establishment of micro-reserves, creation of introduction centers and nurseries for threatened plants, restriction of excessive soil-vegetation cover removal, reclamation of disturbed lands, and forest-meliorative measures using native species.*

Conclusions. Southern Tajikistan is characterized by simultaneous concentration of rare floristic elements and increasing pressure from invasive species. Effective conservation requires regular monitoring, adaptive revision of protection lists, local protection of vulnerable habitats, and restoration of disturbed ecosystems.

KEYWORDS. Southern Tajikistan, Rare Plant Species, Invasive Flora, Red Book, Biodiversity Conservation, Floristic Monitoring, Pasture Disturbance, Ecological Management, Restoration.

TOPICALITY

Conservation of plant diversity in regions subject to intensive anthropogenic transformation remains one of the most urgent tasks of modern botany and ecology. Southern Tajikistan is distinguished by considerable floristic richness, high endemism, and pronounced ecological heterogeneity, but at the same time it is increasingly exposed to long-term grazing pressure, agricultural expansion, industrial disturbance, and habitat fragmentation. Under such conditions, not only the reduction of rare native species but also the active spread of invasive taxa becomes a major threat to ecosystem stability and floristic originality. [1-4].

The relevance of this problem is enhanced by the fact that floristic transformation in Southern Tajikistan has a dual character. On the one hand, rare and endemic species require strengthened protection, monitoring, and revision of conservation status. On the other hand, disturbed habitats are becoming increasingly accessible to invasive species that reduce pasture productivity, worsen the state of agricultural lands, and gradually displace valuable native plants. Therefore, the assessment of rare and invasive components of the flora is essential for both biodiversity conservation and practical management of natural resources. [5-8].

PURPOSE OF THE STUDY

To determine the current status of rare and invasive plant species in Southern Tajikistan and to develop priority approaches for biodiversity conservation and ecological management.

RESEARCH MATERIALS AND METHODS

The study was carried out in Southern Tajikistan during 2015-2024 and represents the result of многолетних field expeditions devoted to the assessment of anthropogenic changes in vegetation and flora. The methodological basis included route-field



observations, geobotanical descriptions, revision of herbarium collections, comparative ecological analysis, and floristic monitoring of natural and disturbed plant communities. More than 400 geobotanical descriptions and more than 600 validated geobotanical records were used in the analysis.

Special attention was paid to the identification of rare species included in the Red Book of the Republic of Tajikistan, as well as to taxa showing invasive behavior in pastures, ruderal habitats, and agricultural ecosystems. The work also involved evaluation of anthropogenic drivers affecting species distribution, including long-term seasonal livestock movement, disturbance of soil-vegetation cover, and transformation of local habitats.

RESEARCH RESULTS

Long-term monitoring carried out in Southern Tajikistan showed that the regional flora is characterized not only by high botanical uniqueness, but also by increasing vulnerability under anthropogenic pressure. The reliability of the obtained results is supported by field studies conducted in 2015-2024, revision of herbarium collections from the leading botanical institutions of Tajikistan, more than 400 geobotanical descriptions of vegetation condition, and more than 600 validated geobotanical records used for comparative ecological assessment. These materials made it possible to identify both rare taxa requiring conservation and invasive taxa actively expanding under human-mediated disturbance.

The study identified 87 rare plant species included in the Red Book of the Republic of Tajikistan. These taxa belong to 74 genera and 44 families, which reflects a broad taxonomic representation of rare flora in Southern Tajikistan. On average, the identified rare fraction comprised 1.18 species per genus and 1.98 species per family, indicating that most rare plants are represented by isolated or narrowly distributed taxa rather than by taxonomically rich clusters. Among the representative rare species recorded during monitoring were *Allium bucharicum*, *Berberis iliensis*, *Berberis stolonifera*, *Cleome lipsky*, *Hammada leptoclada*, *Crocus korolkovii*, and *Fritillaria eduardii*. The principal quantitative characteristics of the rare flora are presented in **Table 1**.

Table 1. Quantitative characteristics of rare plant species identified in Southern Tajikistan

Indicator	Value	Interpretation
Rare species included in the Red Book of Tajikistan	87	High conservation value of the regional flora
Number of genera represented by rare species	74	Broad generic representation of rare taxa
Number of families represented by rare species	44	Wide family-level taxonomic diversity
Mean number of rare species per genus	1.18	Rare taxa are mostly represented by isolated species
Mean number of rare species per family	1.98	On average, fewer than 2 rare species per family

As shown in Table 1, the rare flora of Southern Tajikistan is characterized by both high taxonomic diversity and a predominance of narrowly represented taxa, which increases its vulnerability under anthropogenic disturbance.

At the same time, monitoring demonstrated that the natural flora is increasingly affected by invasive species. One of the principal drivers of this process was identified as the long-term seasonal transfer of livestock between winter and summer pastures, which facilitates the spread of plastic and highly adaptive weed species across different altitudinal belts. The dissertation explicitly recorded at least seven named invasive species and additionally noted the progressive spread of invasive representatives of four plant genera in natural communities and agricultural crops. The most widespread invasive plants documented in the monitored territory were *Thermopsis dolichocarpa*, *Cyanus depressus*, *Artemisia dracunculus*, *Artemisia scoparia*, *Phlomis bucharica*, *Rumex paulsenianus*, and *Silybum marianum*. In addition, invasive representatives of the genera *Cuscuta*, *Artemisia*, *Origanum*, and *Thermopsis* were reported as actively spreading in disturbed communities. Their expansion leads to lower crop yield, reduced pasture productivity, and gradual displacement of valuable native taxa. The main invasive taxa recorded in the study are summarized in **Table 2**.

Table 2. Invasive taxa recorded in the flora of Southern Tajikistan

Taxon/group	Main ecological/agricultural effect
<i>Thermopsis dolichocarpa</i>	Spreads in pastures and disturbed habitats
<i>Cyanus depressus</i>	Weed contamination of plant communities
<i>Artemisia dracunculus</i>	Expansion in disturbed vegetation
<i>Artemisia scoparia</i>	Spread in natural and semi-natural communities
<i>Phlomis bucharica</i>	Competitive displacement in local vegetation
<i>Rumex paulsenianus</i>	Reduces forage and community quality
<i>Silybum marianum</i>	Weed spread in disturbed lands
<i>Cuscuta</i> spp.	Infestation of crops and native communities
<i>Artemisia</i> spp.	Expansion in degraded habitats
<i>Origanum</i> spp.	Progressive spread in communities and crops
<i>Thermopsis</i> spp.	Suppresses productive species in pastures



As shown in Table 2, the invasive fraction of the flora includes both clearly identified species and broader invasive genera, confirming that biological invasion in Southern Tajikistan has a multi-taxon character and directly affects both natural and agricultural ecosystems.

An important applied result of the monitoring was the substantiation of revising the conservation status of certain taxa. Based on the collected field data, the exclusion of *Crocus korolkovii* from the next edition of the Red Book of the Republic of Tajikistan was proposed due to the increase in its population. At the same time, the dissertation recommended including three additional rare and endemic taxa in future conservation lists: Tien Shan birch, tanning sumac, and Semenov honeysuckle. In practical terms, the author proposed a set of management measures aimed at stabilizing the rare flora and restoring disturbed habitats. These included the establishment of micro-reserves, organization of introduction centers and nurseries for threatened psammophilous plants, restriction of excessive removal of soil-vegetation cover on industrial sites, implementation of intermediate reclamation, and forest-meliorative measures using native tree and herbaceous species. The main applied conservation outputs are presented in Table 3.

Table 3. Main applied conservation outcomes and recommendations of the study

Conservation action / outcome	Interpretation
Species proposed for exclusion from the next Red Book edition	Population increase justified revision of protection status
Additional taxa recommended for inclusion in updated conservation lists	Expansion of regional conservation priorities
Micro-reserves proposed	Local protection of valuable plant gene pools
Introduction centers / nurseries for threatened psammophilous plants	Ex situ support for rare flora conservation
Restriction of soil-vegetation cover removal on industrial sites	Reduction of habitat destruction
Intermediate reclamation of disturbed lands	Restoration of ecologically significant sites
Forest-meliorative measures using native species	Slope stabilization and habitat rehabilitation

As shown in Table 3, the study produced not only floristic documentation, but also a set of concrete management recommendations combining in situ protection, ex situ conservation, and habitat restoration approaches.

Additional conservation-context data presented in the dissertation further emphasize the exceptional floristic value of Southern Tajikistan and adjacent protected territories. In the Dashti-Jum Reserve alone, the flora includes more than 105 endemic and rare species, 2 species listed in the IUCN Red List, 3 relict species, and 11 plant species of global importance for plant breeding. The broader protected-area network of Tajikistan comprises 13 sanctuaries, 4 reserves, and 2 natural parks, while 40 plant species associated with this territory are included in the Red Book of Tajikistan. These data underline the high regional importance of protected areas as reservoirs of genetic diversity and as the main spatial framework for flora conservation. The supplementary conservation indicators are summarized in Table 4.

Table 4. Additional conservation-context indicators relevant to flora protection in Southern Tajikistan

Indicator	Value	Interpretation
Endemic and rare species in the Dashti-Jum Reserve	>105	Very high local floristic uniqueness
IUCN-listed species in the same territory	2	International conservation importance
Relict species	3	Presence of ancient floristic elements
Species of global significance for breeding	11	High genetic and breeding value
Plant species of this territory included in the Red Book of Tajikistan	40	Strong national conservation relevance
Sanctuaries (zakazniks) in Tajikistan	13	Existing protected-area framework
State reserves in Tajikistan	4	Core areas for in situ conservation
Natural parks in Tajikistan	2	Additional protected landscapes

As shown in Table 4, the conservation importance of Southern Tajikistan is determined not only by the number of rare taxa revealed in the present monitoring, but also by the broader regional concentration of endemic, relict, and globally valuable plant resources.

Overall, the obtained results indicate that the flora of Southern Tajikistan is simultaneously characterized by high conservation value and growing biological instability. On the one hand, the monitoring confirmed the presence of 87 rare species belonging to 74 genera and 44 families; on the other hand, it documented the active expansion of invasive taxa associated with livestock movement and anthropogenic disturbance. These findings show that regional plant diversity should be managed through a combined strategy including regular monitoring, revision of conservation lists, strengthening of protected micro-sites, introduction support for threatened species, and restoration of disturbed habitats.



DISCUSSION

The obtained results show that the flora of Southern Tajikistan is currently shaped by two parallel and mutually reinforcing processes: the depletion of rare native species and the expansion of invasive taxa into disturbed habitats. The identification of 87 rare species belonging to 74 genera and 44 families confirms the high conservation value of the region, while at the same time indicating that a substantial part of the rare flora is represented by taxonomically isolated and ecologically vulnerable species. In practical terms, such a structure makes the regional gene pool especially sensitive to habitat fragmentation, overgrazing, land conversion, and other forms of long-term anthropogenic pressure. The long monitoring period, the use of more than 400 geobotanical descriptions, and the validation of more than 600 geobotanical records substantially strengthen the ecological reliability of these conclusions. The data presented in Tables 1 and 2 indicate that the problem is not limited to a simple reduction in the number of valuable species. Rather, it reflects a deeper reorganization of plant communities under the influence of repeated disturbance. The spread of invasive species such as *Thermopsis dolichocarpa*, *Cyanus depressus*, *Artemisia dracuncululus*, *Artemisia scoparia*, *Phlomis bucharica*, *Rumex paulsenianus*, and *Silybum marianum*, together with the progressive expansion of invasive representatives of *Cuscuta*, *Artemisia*, *Origanum*, and *Thermopsis*, suggests that disturbed ecosystems are becoming increasingly open to biological invasion. The dissertation directly associates this process with long-term seasonal livestock movement between winter and summer pastures, which creates a persistent dispersal corridor for ecologically plastic weeds and facilitates their penetration into different ecological belts. As a result, floristic transformation affects both natural communities and agricultural lands, leading to reduced pasture productivity, lower crop yield, and gradual displacement of native species. An important theoretical implication of the study is that conservation in Southern Tajikistan cannot rely on static species lists alone. The proposed exclusion of *Crocus korolkovii* from the next edition of the Red Book due to population increase demonstrates that conservation categories should be periodically revised on the basis of real monitoring data rather than maintained unchanged by inertia. At the same time, the recommendation to include three additional rare and endemic taxa in future conservation lists shows that the regional protection system must remain dynamic and evidence-based. This approach is especially important in landscapes undergoing active anthropogenic transformation, where both decline and recovery of species can occur within relatively short ecological timeframes. The applied significance of the results lies in the fact that the proposed management measures form a multilevel conservation strategy. The creation of micro-reserves, establishment of introduction centers and nurseries for threatened psammophilous plants, restriction of excessive removal of soil-vegetation cover on industrial sites, intermediate reclamation of disturbed lands, and forest-meliorative measures using native species together represent a combination of in situ and ex situ conservation tools. This is particularly relevant because the dissertation shows that the materials can be used not only by research institutions, but also by state agencies responsible for environmental assessment, plant resource management, and species introduction. Therefore, the study moves beyond descriptive floristics and offers a practical framework for biodiversity management in Southern Tajikistan. The broader regional context further supports the importance of such an approach. Protected territories associated with Southern Tajikistan already contain high concentrations of endemic, rare, relict, and globally valuable taxa. In the Dashti-Jum Reserve alone, more than 105 endemic and rare species, 2 IUCN-listed species, 3 relict species, and 11 taxa of global breeding importance have been recorded. At the republic level, the protected-area network includes 13 sanctuaries, 4 reserves, and 2 natural parks, which together form the principal spatial basis for gene pool conservation. However, the very existence of this network does not eliminate the need for targeted local action, because rare flora loss and invasive spread continue to occur outside and around protected cores. Thus, long-term preservation of the flora of Southern Tajikistan requires not only protected areas, but also continuous field monitoring, adaptive revision of conservation lists, and active restoration of disturbed habitats. Overall, the results of the present study show that the flora of Southern Tajikistan should be regarded as a highly valuable but dynamically changing system under strong anthropogenic influence. The coexistence of rare endemic-rich elements and actively spreading invasive taxa makes the region ecologically unstable and conservation-priority at the same time. For this reason, the most effective strategy is an integrated one combining regular floristic monitoring, adaptive conservation planning, reinforcement of local protection regimes, and practical restoration measures aimed at maintaining the structural and genetic integrity of native plant communities.

CONCLUSION

The conducted study demonstrated that Southern Tajikistan is characterized by a high floristic value combined with increasing ecological vulnerability under anthropogenic pressure. Long-term monitoring performed in 2015-2024, supported by herbarium revision, more than 400 geobotanical descriptions, and more than 600 validated geobotanical records, made it possible to identify the main patterns of rare flora distribution and invasive species expansion in the region.

It was established that the rare component of the flora includes 87 species belonging to 74 genera and 44 families, confirming the exceptional taxonomic richness and conservation significance of the region. At the same time, the study revealed active spread of invasive taxa, including *Thermopsis dolichocarpa*, *Cyanus depressus*, *Artemisia dracuncululus*, *Artemisia scoparia*, *Phlomis bucharica*, *Rumex paulsenianus*, and *Silybum marianum*, as well as progressive expansion of invasive representatives of the genera *Cuscuta*, *Artemisia*, *Origanum*, and *Thermopsis*. Their distribution is closely associated with anthropogenic disturbance and long-term seasonal livestock movement between ecological belts.

An important applied outcome of the research was the substantiation of revising the conservation status of individual taxa. The exclusion of *Crocus korolkovii* from the next edition of the Red Book of the Republic of Tajikistan was proposed due to population



recovery, while three additional rare and endemic taxa were recommended for inclusion in updated conservation lists. These findings confirm the necessity of adaptive and evidence-based revision of regional conservation priorities.

The study also developed a set of practical measures aimed at preserving the native flora and restoring disturbed habitats. These include the establishment of micro-reserves, creation of introduction centers and nurseries for threatened psammophilous plants, restriction of excessive removal of soil-vegetation cover in industrial areas, intermediate reclamation of disturbed lands, and forest-meliorative measures using native woody and herbaceous species.

Thus, the flora of Southern Tajikistan should be regarded as a conservation-priority system requiring integrated management. Effective protection of its plant diversity should be based on regular floristic monitoring, timely revision of protection lists, strengthening of local conservation mechanisms, and scientifically grounded restoration of anthropogenically transformed ecosystems.

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