

1.2. Biological Diversity of Tajikistan

Geographical location of Tajikistan in the southern arid zone and high mountain systems among continental deserts of Eurasia, a combination of latitude zonation and vertical belts from hot deserts and subtropics to permafrost natural complexes, and genetic merging botanical and geographical zones conditioned the rich landscape biological diversity.

The sustainable conservation of biodiversity provides a harmonic development of the society and nature, particularly in countries with transitional economy, which Tajikistan belongs to. This is associated with the formation of a considerable part of the national income due to the use of biological resources (forests, pastures, agriculture).

The mountain landscapes of Tajikistan contain 0.66% of the world animal and 1.8% - plant diversity, including wild relatives of domestic animals and cultivated plants.

Tajikistan has rich genetic resources of species which are a potential source of raising high-productive and resistant cultivated varieties, adornment plants, and medicinal, aromatic, and industrial raw material. One of the world centers of cultivated plant origin is located here. Gathering medicinal and food plants, and fruit in mountain forests, hunting and fishing promote improving the welfare of the Tajik people.

The richness of biodiversity (table 1.1) is observed at the genetic, species, population, biocenosis, and ecosystem levels; there are many relict and endemic species. Most of the components are vulnerable to anthropogenic impacts.

The area of contemporary Tajikistan contains more than 9 thousand species of spore-bearing and flowering plants and over 13 thousand of animal species.

Value of Biological Resources for the Population of Tajikistan

The local population traditionally uses wild nature products as raw materials in construction, utensils and dyers production, etc.

1090.7 thousand head of cattle, 2269.3 thousand sheep and goats, and 71.2 thousand horses are being raised due to the natural vegetation of pastures.

Local people gather wild berries – sea buckthorn (*Hippophae rhamnoides*), barberries (*Berberis*), currants (*Ribes*), raspberries (*Rubus odoratus*), hawthorn (*Crataegus*), etc., as well as mushrooms and dozens of medicinal plant species.

They gather nuts and stone fruits in naturally growing forests – walnut (*Juglans*), pistachio (*Pistacia*), almond (*Amygdalus*), wild apple (*Malus*), pear (*Pyrus*), plum (*Prunus*), cherry plum (*Prunus sogdiana*) etc.

Local people and specialized organizations store up medicinal plants.

Small part of the population is engaged in hunting and fishing.

The number of game mammals is estimated at 11 species, birds – 36, and fish – 20.

Fur-skins of red marmot (*Marmota caudata*), muskrat (*Ondatra zibethica*), fox (*Vulpes vulpes*), badger (*Meles meles*), wolf (*Canis lupus*), etc. are stored up.

International hunting is organized for the following animals: argali (*Ovis ammon*), Siberian ibex (*Capra sibirica*), urial (*Ovis vignei*), and Tajik markhor (*Capra falconeri*).

Game fishing in lakes and water reservoirs is inconsiderable (164 t). Most of fish and animals are caught by poachers.

Table 1.1. Main Components of Biodiversity

No.	Composition	Number
1.	Ecosystems	12 types
2.	Types of vegetation	20 types
3.	Flora	9 771 species
4.	Wild relatives of cultivated plants	1000 species
5.	Endemic plants	1132 species
6.	Plants, listed in the Red Data Book of Tajikistan	226 species
7.	Fauna	13531 species
8.	Endemic animals	800 species
9.	Animals, listed in the Red Data Book of Tajikistan	162 species
10.	Agricultural crops	500 varieties
11.	Domestic animals	30 breeds

1.2.1. Ecological Systems

Hard natural climatic and mountain-formation processes promoted favorable penetration of plant and animal species from neighboring botanical and geographical zones, hybridization, and appearance of new species. Numerous types of ecotopes, biocoenosis, and ecosystems, in contrast combination, were formed in this environment of a relatively small area. Later, as a result of the climate aridization, in a short period of time, the unique ecosystems appeared under the extreme conditions of development in restricted mountainous area with high anthropogenic load. Many natural ecosystems have a considerable anthropogenic impact, some are endangered to complete degradation; a threat to their ecological balance disturbance is growing.

Mountain ecosystems include: nival-glacier, high-mountain-desert, meadow-desert, forest, most of wetland, ruderal, and, sometimes, urban ecosystems.

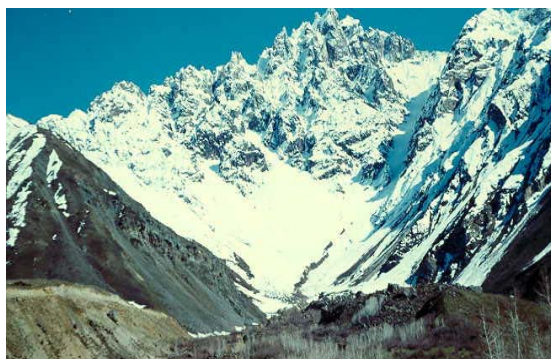
More than 80% of natural watercourses of the country are located in high mountainous areas. The foothills contain a small part of meadow-steppe ecosystems, situated in the lower reaches of the Pyandj, Vakhsh, Kafirnigan, Zeravshan, and Syrdarya rivers. Relatively young ecosystems, with a small number of species, are formed in the artificial watercourses.

Agricultural, ruderal-degraded, and partly urban ecosystems occur in all mountain zones, except for nival.

The main species of valuable forest and meadow communities are accumulated in mid-high and high-mountain zones. The latter contain larger mammals, reptiles, and birds.

Table 1.2. Ecosystems of Tajikistan

Types	Subtypes
Nival glacier ecosystem	- Glaciers and snowfields - Rocks and taluses with rare vegetation
High-mountain desert ecosystem	- Rare vegetation - Wormwood-teresken, steppe - Dwarf-shrub-steppe
High-mountain meadow-steppe ecosystem	- Forbs meadow steppe, thymes - Low-grass meadow, swamp
Mid mountain conifer forest ecosystem	- Various-shrub steppe and light forest - Forbs meadow-forest
Mid mountain mesophyllic forest ecosystem	- Broad-leaf forest - Flood-plain small-leaf forest - Light forest, foliage tree, mesophyllic shrub
Mid mountain xerophytic light forest ecosystem	- High-grass, shrub, pistachio - Forbs wormwood, almond
Mid-low-mountain semisavanna (savannoide) ecosystem	- High-grass - Forbs and shrub - Low-grass semisavanna
Foothill semidesert and desert ecosystem	- Low-grass, saltwort-wormwood - Sand, semi-woody, shrub
Wetland ecosystem	- Tugai - Meadow, swamp - Wetland
Agroecosystem	- Gardens, forest-plantations, personal plots - Rain-fed pastures - Irrigable pastures
Urban ecosystem	- Municipal - Industrial
Ruderal-degraded ecosystem	Weed, ruderal



Nival glacier ecosystems

Geographically, the ecosystems of Tajikistan are subdivided into mountain and foothill-plain ecosystems.

Mountain ecosystems occupy the altitudes from 600 to 7000 masl. This zone contains over 90% of mountain communities. Water resources are formed in mountain ecosystems; over 80% of biodiversity are accumulated here. Most of the areas are highly productive summer pastures.

Foothill-plain ecosystems are located on the flat areas of mountain zones and include: foothill semidesert-desert, wetland, agricultural, urban, and ruderal-degraded ecosystems.

According to their use, ecosystems are subdivided into natural and anthropogenic (table 2.2). The interrelation of ecosystems dependent on the areas and the number of population is shown in table 1.3 and figures 1.11 and 1.12.

Natural Ecosystems

A considerable part of the country possesses natural and relatively undisturbed ecosystems due to their isolation. Though some small fragments of ecosystems are observed at easily accessible places.

1. **Nival glacier ecosystems** occupy high-mountain landscapes of the country, considerable part of the Eastern and Western Pamirs. They are of great importance for climate formation and ecology at the regional and global level. The main water resources of Central Asian region are formed here. The cold glacial rocky landscapes of these ecosystems contain 16-17

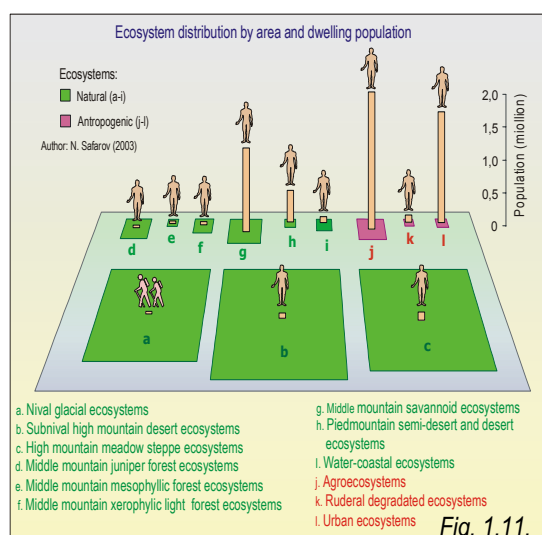


Fig. 1.11.

Table 1.3. Main Ecosystem Components

Name of Ecosystem	Altitude above sea level	Area (m. ha)	Population (thousand)	Number	
				Animal species	Plant species
1. Nival glacier	above 4500	2.9	temporary (mountain-climbers, tourists) ca.1.9	180	16-17
2. High-mountain. desert	3500-4500	3.4	81.9	1100	650
3. High-mountain. meadow-steppe	3200-4000	3.15	150.0	2400	730
4. Mid-high mountain conifer forest	1100-3000	0.8	20.0	2900	1280
5. Mid-high mountain mesophyllic forest	1300-2400	0.2	50.0	3390	1700
6. Mid-high mountain xerophytic forest	1100-2000	0.58	20.0	5950	2400
7. Mid-low mountain semisavanna (savannoid)	600-1600	1.0	1443.0	4500	450
8. Foothill semidesert-desert	400-600	0.34	475.1	2000	520
9. Wetland	300-4200	0.50	90.0	4000	400
10. Agricultural	350-3000	0.85	2070.0	3000	900
11. Urban	400-2000	0.229	1700.0	2000	250
12. Ruderal-degraded	600-2500	0.360	100.0	2000	70
Total:		14.31	6201.9		

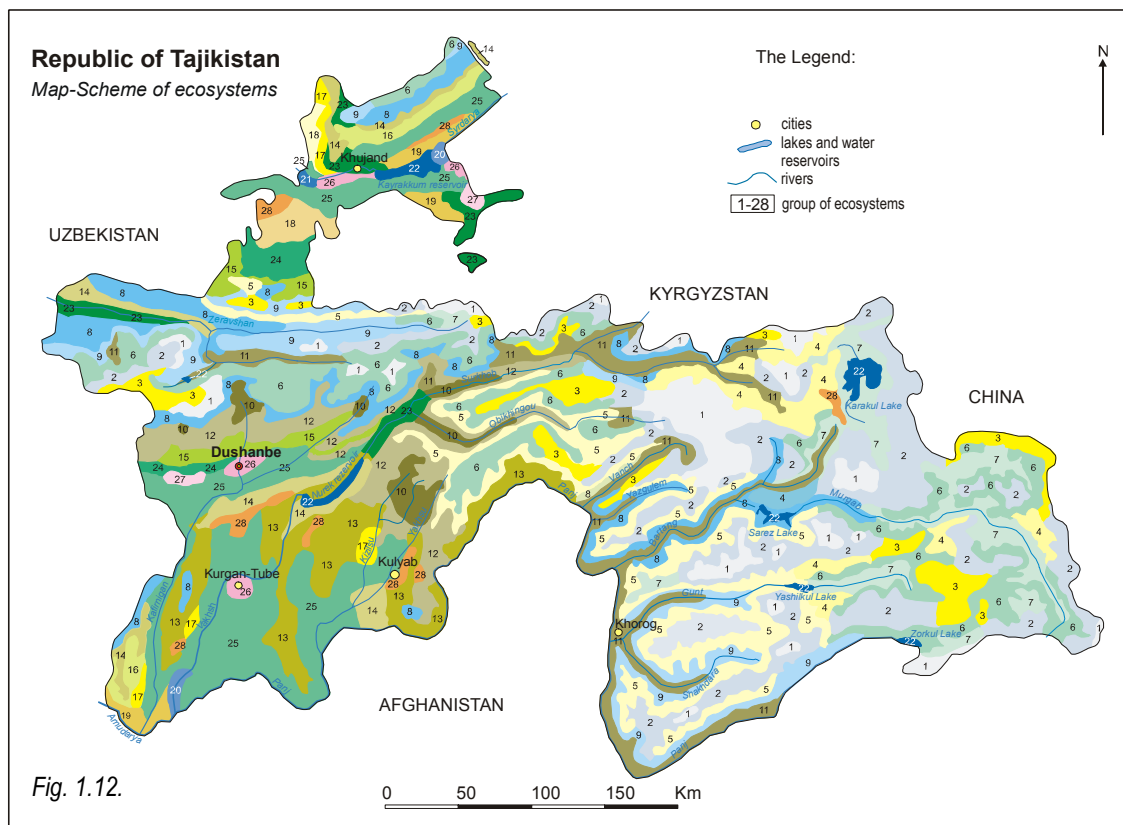


Fig. 1.12. Legend to Map-Scheme of ecosystems

Nival Glacier Ecosystems

- 1 Glaciers and snowfields
- 2 Rocks and taluses with rare vegetation

High Mountain Desert Ecosystems

- 3 Rare vegetation
- 4 Wormwood-teresken, steppe
- 5 Dwarf-shrub-steppe

High Mountain Meadow and Steppe Ecosystems

- 6 Forbs meadow steppe, thymes
- 7 Low-grass meadow, swamp

Mid-Mountain Conifer Forest Ecosystems

- 8 Various-shrub steppe and light forest
- 9 Forbs meadow-forest

Mid-Mountain Mesophyllic Forest Ecosystems

- 10 Broad-leaf forest
- 11 Flood-plain small-leaf forest
- 12 Light forest, foliage tree, mesophyllic shrub

Mid-Mountain Xerophytic Light Forest Ecosystems

- 13 High-grass, shrub, pistachio
- 14 Forbs wormwood, almond

Mid-Low-mountain Semisavanna (savannoide) Ecosystems

- 15 High-grass
- 16 Forbs and shrub
- 17 Low-grass semisavanna

Foothill Semidesert and Desert Ecosystems

- 18 Low-grass, saltwort-wormwood
- 19 Sand, semi-woody, shrub

Wetland Ecosystems

- 20 Tugai
- 21 Meadow, swamp
- 22 Wetland

Agroecosystems

- 23 Gardens, forest-plantations, personal plots
- 24 Rain-fed pastures
- 25 Irrigable pastures

Urban Ecosystems

- 26 Municipal
- 27 Industrial

Ruderal-degraded Ecosystems

- 28 Weed, ruderal

species of flowering plants: ragged robin (*Melandrium apetalum*), whitlow grass (*Draba altaica*), milk vetch (*Astragalus nivalis*), *Saussurea glacialis*, etc. Rare and endangered large mammals listed in the Red Data Book – argali (*Ovis ammon polii*), snow leopard (*Uncia uncia*), and Siberian ibex (*Capra sibirica*) – are found at the lower boundaries of these ecosystems.

These are areas of world mountain-climbing, tourism and international hunting. The long-term tourist and mountain-climbing activity resulted in the area pollution with garbage producing a negative effect on the quality of water in the below rivers.

2. High mountain desert ecosystems occupy the vast areas of the Eastern and Western Pamirs; fragmentarily, they occur in the Zervashan River Valley. They are used for summer pasturing, tourism, and international hunting. Vegetation consists mostly of teresken (*Ceratoides Krascheninnikovia*), wormwoods (*Artemisia pamirica*, *A. Korshinskyi*), *Ajania tibetica*, feather-grasses (*Stipa glareosa*), *Oxytropis immerge*, *Acantholimon diaspenioides*, *A. pamiricum*. They sustain the ecological balance and are used as forage areas. The most valuable communities are wormwood-teresken and meadow-steppe. They include some endemic, rare, and endangered plants – Badakhshan dandelion (*Taraxacum badachschanicum*), Pamir desederia (*Desideria pamirica*), etc.

The main background animals are: argali (*Ovis ammon*), snow leopard (*Uncia uncia*), Siberian ibex (*Capra sibirica*), red marmot (*Marmota caudata*), and *Syrrhaptes tibetana*, as well as some nature embellishing butterflies: machaon (*Papilio machaon*), apollo (*Parnassius apollo*), and alexanor (*Papilio alexanor*).

As the anthropogenic impact on the vegetation and animal worlds is increasing, pastures are degrading, causing reduction of the areas



High mountain desert ecosystems



High-mountain meadow-steppe ecosystems

and populations of wild animals. In recent ten years, poaching alone caused a drop in numbers of argali and Siberian ibex by 50%.

The current measures on animal and plant conservation are low-efficient. Even the creation of the National Park, comprising nearly 40% of these ecosystems, cannot improve their condition.

3. High-mountain meadow and steppe ecosystems occur fragmentarily, sometimes as wide belts, in all mountain ranges of Tajikistan and are of great ecological importance. The great part of the ecosystems includes habitats of rare endemic mammals, birds, insects, and valuable vegetation communities. Grass productivity of meadow and meadow-steppe ecosystems is 5-6 times higher as compared to others. They make over 90% of summer pastures.

The main coenosis-forming species of this type of ecosystem are: fescue (*Festuca altaica*, *F. pamirica*), feather grass (*Stipa kirghisorum*), meadow grass (*Poa alpina*), sedge (*Carex melanantha*, *C. stenocarpa*), cobresia (*Cobresia stenocarpa*), *Oxytropis savellanica*, thyme (*Thymus seravshanicus*), etc. The most valuable communities include forbs meadow and steppe, and thyme swamp, most common in the high mountains of the Eastern and Western Pamirs. The forbs meadow-steppe and thyme ecosystems are typical for Central and Northwestern Tajikistan. In overgrazing areas, the ecosystems are strongly degraded (over 30% of the total area), the grass productivity being reduced from 20-25 to 10-12 centners per ha. Periodically, the communities lose the most valuable species, including at least 150 rare and endangered species. The animal world of these ecosystems includes: snow leopard (*Uncia uncia*), argali (*Ovis ammon polii*), red marmot (*Marmota caudata*),

Syrrhaptes tibetana, Siberian ibex (*Capra sibirica*), Tibetan snow partridge (*Tetrogallus tibetanus*), etc.

This type of ecosystems is an intermediate link between forest (low borders), subnival and nival ecosystems (top borders). Many communities of this type become secondary due to the anthropogenic impact.

4. Mid-mountain conifer forest ecosystems compose nearly 50% of the total forested areas of the country. They are common in northern Tajikistan, within the Kuramin, Turkestan, and Zeravshan ranges. In small fragments, they occur in Central, Southwestern Tajikistan, and in the Western Pamirs mountains. Juniper and light forests are important for regulating and conserving water resources, protecting slope soils, fortifying river banks, and preventing mudflows.

Juniper forests and light forests are represented by 4 species: *Juniperus seravschanica*, *J.turkestanica*, *J.semiglobosa* and *J.sibirica*, among which Zeravshan juniper (*J.seravschanica*), Turkestan j. (*J.turkestanica*), and semicircular j. (*J.semiglobosa*) are forest-forming species.

There are some rare and endangered animal species in the juniper forests: Tien Shanian brown bear (*Ursus arctos*), urial (*Ovis vignei bochariensis*), Tajik markhor (*Capra falconeri*), *Vipera lebetina*, and ring dove (*Columba palumbus*).

The most valuable communities are motley-shrub-steppe and forbs-meadow juniper forests.

The main juniper and light forest areas are annually reduced by 2-3%. Nearly 30% of their specific diversity is endangered.

The main reasons for worsening the state of juniper forests are:

- Intensive cuttings for a number of centuries;



Mid-mountain conifer forest ecosystems



Mid mountain mesophyllic forest ecosystems

- Complete absence of biotechnical measures;
- Lack of forest monitoring and treatment;
- Intensive uncontrolled cattle grazing;
- Slow growth of juniper forests;
- Lack of juniper nurseries.

5. Mid-mountain mesophyllic forest ecosystems are represented by maple-walnut and willow-poplar-birch forests with light forest mesophyllic shrubs. They are important for the socio-economic activity (gathering fruit and berries) and sustain the ecological balance. These forests contain a considerable number of rare endemic species of animals and plants. They are suitable for an optimal life and recreation zones. They are common all over the country, except for northern and southern Tajikistan.

The most valuable communities of these ecosystems – broad-leaf mesophyllic relict forests: walnut (*Juglans regia*) and maple (*Acer turkestanicum*) – are widespread in Central Tajikistan. Great areas of small-leaf forests – birch (*Betula tianschanica*) – occur in the Zeravshan River Valley, within the Karateghin Range, and in the Western Pamirs; mesophyllic shrubs are mainly observed in Central Tajikistan.

The most valuable walnut-maple forests are located in the Sarikhosor, Childukhtaron, and Dashti-Jum zakazniks. These forests include a

considerable number of rare and endangered species of flora and fauna. Among plants, there are: Victor's ungernia (*Ungernia Victoris*), magnificent ostrowskia (*Ostrowskia magnifica*), cousinia darvazica (*Cousinia darvasica*, *Cousinia leptocampyla*), Hissar iskandera (*Iskandera hissarica*), Yagnob feather grass (*Stipa jagnobica*); mammals: weasel (*Mustela pallida*, *M.n. heptneri*), Turkestan lynx (*Felis lynx*), snow leopard (*Uncia uncia*), urial (*Ovis vignei bochariensis*), Tien Shan brown bear (*Ursus arctos*), yellow porcupine (*Hystrix leucura*); birds: ring dove (*Columba palumbus*), pheasant (*Phasianus colchicus*), golden eagle (*Aquila chrysaetus*), and Egyptian vulture (*Neophron percnopterus*), etc..

The forest vegetation communities have a considerable number of wild relatives of fruits: apple (*Malus*), pear (*Pyrus*), cherry plum (*Prunus*), hawthorn (*Crataegus*), barberries (*Berberis*), and other species, which form a favorable environmental niche for large mammals, including rare and endangered species.

Forested areas are annually reduced, while no restoring work is carried out. Nearly 50% of flora and fauna species are endangered.

6. Mid-mountain xerophytic light forest ecosystems occupy vast areas of southern and western Tajikistan; small fragments occur in northern Tajikistan. They include: pistachio, forbs wormwood, almond. In dry hot regions, pistachio forest's function is to regulate water resources; they also are an optimal habitat for wild animals from arid zones. No natural restoration of pistachio forests occurs due to their intensive use as pastures and haylands. Vast areas (80%), earlier occupied by pistachio communities, are now overgrown with shrubs.

The animal world of this ecosystem type is much richer than that of others. Of large mammals, there are: Persian gazelle (*Gazella subgutturosa*), urial (*Ovis vignei bochariensis*), wolf (*Canis lupus*), fox (*Vulpes vulpes*); reptiles: Central Asian cobra (*Naja oxiana*), and steppe tortoise (*Testudo horsfieldi*).



Low-mountain savannoid ecosystems

This type of ecosystems contains wild relatives of barley (*Hordeum spontaneum*), vetch (*Vicia tenuifolia*), almond (*Amygdalus bucharica*), persimmon (*Diospyros lotus*), jujube (*Zizyphus jujuba*), pomegranate (*Punica granatum*), grapes (*Vitis vinifera*), etc. They become secondary communities due to intensive cuttings. Large areas of winter pastures, non-irrigable crops, and settlements, situated in these ecosystems, cause a reduction of xerophytic light forest areas.

In order to preserve and sustainably manage this type of ecosystems, cattle grazing in young pistachio forests has to be completely stopped, protected area should be created to preserve the unique high-altitude communities and rare endemic animals (uriel, Tajik markhur, Persian gazelle, etc.).

7. Mid-low mountain semisavanna (savannoid) ecosystems are widespread in southern and northern Tajikistan. They develop under hot climatic conditions.

Here, a considerable part of animals and insects with summer aestivation period dwell. High-productive winter pastures and leguminous crops are common. Vast areas of these ecosystems (40-50%) have degraded pastures, thus became low-productive.

The main valuable communities of this type are high-grass and forbs-shrub communities. The dominant species are: barley (*Hordeum bulbosum*), meadow grass-sedge (*Poa bulbosa*, *Carex pachystylis*), ferule (*Ferula kokanica*, *F.kuhistanica*), Jerusalem sage (*Phlomis bucharica*), etc.

The animal world of this ecosystem type is much richer than that of others. Of large mammals, there are: Persian gazelle (*Gazella subgutturosa*), urial (*Ovis vignei bochariensis*), wolf (*Canis lupus*), fox (*Vulpes vulpes*); reptiles: Central Asian cobra (*Naja oxiana*), and steppe tortoise (*Testudo horsfieldi*).



Mid-mountain xerophytic light forest ecosystems

The animal world, except for insects, is presented by a small number of species with summer and winter aestivation periods. Background amphibians are: steppe tortoise (*Testudo horsfieldi*) and *Ophisaurus apodus*. Rare and endemic species are also found here : seese partridge (*Ammoperdix griseogularis*), white bustard (*Otis tarda*), skink (*Eumeces schneideri*), Persian gazelle (*Gazella subgutturosa*), Turkestan saker falcon (*Falco cherrug*), and golden eagle (*Aquila chrysaetus*).

Vast areas of these ecosystems (70%) are strongly degraded. The main reasons of the degradation are:

- Cutting trees and shrubs;
- Intensive ploughing of steep-slope areas;
- Frequent fires;
- Complete absence of crop and pasture rotation;
- Violation of the haymaking technology;
- Unregulated cattle grazing in fall and spring period.

8. Foothill semidesert-desert ecosystems occupy high terraces of the plains in the lower reaches of large rivers: Pyandj, Vakhsh, Kafirnigan, Syrdarya, and Zeravshan.

The major communities of this type are: saxaul, black saxaul, calligonums, and perennial saltwort thickets. They play an important role in protecting soils, preventing erosion, and providing winter pasturing. These ecosystems include 30-40% of the total winter pasture areas, most of which are degraded and cultivated for irrigable agricultural crops. One can find here endemic animal species of regional and global value, many of which are endangered.

The vegetation dominants are: saxaul (*Haloxylon persicum*), calligonum (*Calligonum litvinovii*), saltwort (*Salsola richteri*), wormwood



Semidesert-desert ecosystems



Wetland ecosystems

(*Artemisia tenuisecta*), harmel (*Hammada leptoclada*), sedge (*Carex physodes*), halostachys (*Halostachys belangeriana*), halocharis (*Halocharis hispida*).

The animal world of the ecosystems is represented by unique species which are adapted solely to open areas, with rare vegetation and hot and dry climate. Mammals are represented mainly by: Persian gazelle (*Gazella subgutturosa*), jakal (*Canis aureus*), big-eared hedgehog (*Paraechinus hynomelus*), and steppe cat (*Felis libyca*). Of reptiles, there are: steppe agama (*Agama sanguinolenta*), gray monitor lizard (*Varanus griseus*), shaft-snake (*Taphrometopon lineolatum*), and sand echis (*Echis carinatus*); of insects the xerophyllous species prevail.

In southern Tajikistan, nearly 30 thousand hectares of this ecosystem type are near-protected areas of the Tigrovaya Balka Reserve. Considerable areas of the sand-desert ecosystems are cultivated for cotton growing.

9. Wetland ecosystems include tugai (sometimes tugai forests), meadow-swamp (the river lower reaches), and wetland ecosystems.

They are very important for the preservation of the global ecological balance, particularly for regulating the numbers of waterfowls of Eurasia, as some waterfowls of the continent hibernate here. Due to the worsening state of the Aral Sea, numerous waterfowls (from the Amudarya River lower reaches), among which there are rare and relict species, have found "shelter" and new habitats in the tugai of the Tigrovaya Balka Reserve.

The watercourses of the southern landscapes of Tajikistan are the base of water game species development and provide sustainable reproduction of fish, fur-bearing animals, and birds.



Tugai ecosystem

In the presence of biomass, tugai ecosystems equal subtropical forests of South Asia.

The world intact tugai ecosystems have been preserved only in the Tigrovaya Balka Reserve. 645 plant species, over 70% of which are assigned solely to tugai, and nearly 30% are common of meadow-swamp and sand-desert ecosystems, are defined here.

The main vegetation dominants are: *Populus pruinosa*, elaeagnus (*Elaeagnus angustifolia*), desert thorn (*Lycium dasystemum*), macereed (*Typha angustifolia*), alang grass (*Imperata cylindrica*), bur reed (*Phragmites communis*), sugarcane (*Saccharum spontaneum*), Kashgar tamarisk (*Tamarix hispida*), black grass (*Juncus articulatus*), etc.

The animal world of the tugai is much richer than that of the sand-desert ecosystems. Many of the animals find shelter in the tugai, where the following bird species hibernate: white and gray herons (*Egretta alba*, *Ardea cinerea*), bittern (*Botaurus stellaris*), garganey teal (*Anas querquedula*), European teal (*A. crecca*), marsh harrier (*Circus aeruginosus*), mud hen (*Rallus aquaticus*), moor hen (*Gallinula chloropus*), pheasant (*Phasianus colchicus*), pygmy cormorant (*Phalacrocorax pugmeus*), great cormorant (*Ph. carbo*), serpent eagle (*Circaetus ferox*), etc. The background species of the tugai mammals are: jungle cat (*Felis cnans*), jakal (*Canis aureus*), Bukhara Red deer (*Cervus elaphus*), etc.

The biodiversity specific composition of watercourses is usually variable. Mountain and high-mountain water reservoirs mainly contain the Arcto-alpine species of sedge (*Carex diandra*, *C. oliveri*, *C. stenocarpa*, *C. parva*), cobresia (*Cobresia pamiroalaica*, *C. capillifolia*, *C. persica*, *C. stenocarpa*), meadow grass (*Ranunculus songoricus*), primrose species (*Primula capitellata*, *P. Kaufmanniana*, *P. algida*, *P. farinose*, etc.).

The low-mountain and plain reservoirs are characterized by the presence of common horsetail (*Equisetum arvense*), macereed (*Typha angustifolia*), potamogeton (*Potamogeton crispus*), anagalis (*Anagalis arvensis*), sedge (*Carex orbicularis*), bur reed (*Phragmites communis*), and many others.

Nearly 330 species of higher plants inhabit water reservoirs of Tajikistan; 145 of these are typical solely of the mountain and high-mountain areas, others are water and wetland in the low-mountain and plain areas of the country.

The biodiversity of wetland ecosystems is very important for keeping the natural balance and improving the socio-economic situation in the country. The vegetation and animal organisms inhabiting the reservoirs form organic and mineral complexes. They promote water purification, regulate the mountain water regime, enrich both water and air with oxygen. Many wetland plants are used as haylands, pastures and forage for cattle, though the overgrowing of plain water areas with thick grass is harmful for some fish species raising.

Currently, the biodiversity of foothill wetland ecosystems is in the most critical state, as they are contaminated with a great volume of water flowing from irrigated lands.

Anthropogenic Ecosystems

These ecosystems include agricultural, urban, and ruderal-degraded areas. Over 30% of the country area has been transformed into anthropogenic systems which meet the general needs of the population. Increasing the anthropogenic impact on the environment, without considering its capacity, is dangerous for the socio-economic development. It is particularly well observed in the mountain agricultural areas.

10. Agroecosystems (agricultural ecosystems) are located in all natural zones, from hot foothills (300 masl) to high-altitude deserts of the Eastern Pamirs (3000-3500 masl). The main varieties of agricultural crops, local species of wild relatives of cereals, leguminous, industrial, vegetation and melon, and forage plants (genetic resources) grow on unprotected areas.

In recent decade, the area of the agricultural ecosystems has been considerably increased, particularly due to the development

**Agroecosystems**

of rain-fed and irrigable lands, which, together with pastures, are estimated at slightly over 4 m. ha. 1550 varieties of fruits and berries, 463 – vegetable and melon, 46 – cereal, 39 – leguminous, 25 – industrial, 39 – forage, and about 1850 decorative crops are raised and adapted to local environment within wide range of soil and climatic conditions. Nearly 50% of the cultivated crops are local varieties. There are about 30 breeds of domestic animals.

Most vivacious example of conservation of the animals genetic pool is the extension of yaks habitats within mountainous Tajikistan.

Violation of the regulations of agricultural irrigational technologies and crop rotation results in annual destruction of soil fertile layer, salinization and swamping of some areas; this is primarily due to the destruction of soil-forming fauna and flora. Steep-sloped lands are prone to landslides.

11. Urban ecosystems comprise the cities of Dushanbe, Khudjand, Isfara, Kanibadam, Istravshan, Kulyab, Kurgan-Tybe, Tursunzade, large settlements, and industrial enterprises. They are located in the most vulnerable environ-

**Yaks herd in the Pamirs**

mental areas (forests, river banks, lakes, ponds, etc.). Here, the main structure of natural ecosystems is completely destroyed, the process being irreversible. The urban zone around the cities is being increased, new system of water supply, central heating, sanitary-purifying zones, and green plantations, which is to be maintained artificially, being created. The ecological load on the area unit is increasing annually, while measures on stabilization get more complicated. The majority of introduced species are found in urban ecosystems including cities (table 1.4).

12. Ruderal-degraded ecosystems occur in all zones of human activity, being particularly well observed in cattle breeding areas. Stable communities adapted to external impacts are formed locally in high-mountain pastures and in low-mountain areas.

On the pastures and sown areas, the most dangerous plants for people and animals are: colchicum (*Colchicum luteum*), *Thermopsis dolichocarpa*, *Trichodesma incanum*, heliotrope (*Heliotropium dasicarpum*), and some wormwood species (*Artemisia*). The main dominant communities of ruderal ecosystems are the representatives of compositae (*Compositae*), cereals (*Gramineae*), buckwheats (*Polygonaceae*), meadow grasses (*Ranunculaceae*), St. John's-worts (*Guttiferae*), and often labiates (*Labiatae*).

Table 1.4. General Flora Composition in Urban Ecosystems

Name	Total area (thousand ha)	Green zone (thousand ha)	Number of plant species		
			Total	Including introduced	Including local
Dushanbe	12.5	3.60	800	150	70
Khudjand	3.0	0.82	900	120	50
Kurgan-Tyube	3.4	0.96	500	40	35
Khorog	0.23	0.07	1200	50	20
Kulyab	0.27	0.77	600	70	40
Tursunzade	11.75	3.2	300	80	25
Istravshan	0.75	0.03	900	55	25
Isfara	8.35	2.8	1000	60	30

**Ruderal-degraded ecosystems**

Ruderal ecosystems of the foothills are generally represented by one species open plant communities: caper (*Capparis spinosa*), fragments of wall barley (*Hordeum leporinum*), annual saltworts (*Salsola pestifera*, *S.turkestanica*, *S.forcipitata*), and camel's thorn (*Alhagi kirghisorum*).

Ruderal communities of the low-mountain zone are represented by *Cynodon dactylon*, *Prosopis farcta*, cousinia (*Cousinia Olga*), *C.polycephala*, *C.ambigens*, *C.dichromata*, *C.microcarpa*, *C.radians*, *C.pseudoarctium*, etc.), and forbs.

Licorice, together with reed (*Saccharum spontaneum*) and camel's thorn (*Alhagi kirghisorum*), are formed after cuttings in the forest ecosystem zone. *Imperata cylindrica* is usually formed in the deserted fallow lands of the light forest zone.

In the sites of long-term pasturing in the sub-alpine zone, *Rumex Paulsenianus* and *Polygonum coriary* are formed.

In the alpine zone, ecosystems are represented by wormwood species, combined with meadow-steppe vegetation.

The ruderal type is characterized by a displacement of typical zonal ecosystems to inter-zonal, in most cases from the lower belts. The flora of the ruderal ecosystems consists of 690 species and 30 communities.

The weed-ruderal species and communities are very dangerous for the forest communities, preventing the restoration of wood varieties. The low-mountain areas are characterized by monodominant communities of dwarf shrubs and rude grass, which hamper the development of leguminous crops and valuable forb grass.

1.2.2. Specific diversity

For thousands of years, people of Tajikistan lived in harmony with the natural diversity of flora and fauna. In the process of historical development, they created many new forms of food, medicine, and forage crops, and domestic animals, promoted their conservation, thus enriching the natural biodiversity. The recent century was marked by an increased human negative impact on biodiversity, due to the population growth and active land mastering.

The conservation of vegetation biodiversity in the mountains prevents the fertile soil layer from erosion and destruction by mudflows, and regulates groundwater formation.

A. Vegetation world

The vegetation world is represented by a great genetic and environmental diversity, and a unique specific diversity; it includes 9771 species and 20 formations.

The processes of xerophytization, ephemeralization, mesophyllization, cryophytization, and migration processes in Tajikistan caused an extensive formation of flora species and forms. This resulted in the appearance of numerous vicarious plants, altitudinal and ecological vicariants that considerably enriched the flora specific composition as compared to other countries, the areas of which are many times bigger than that of Tajikistan (table 1.5).

Table 1.5. Comparative characteristics of vascular plants in Central Asian countries*

Country	Area / thous. km ²	Number			
		Species	Genera	Families	Endemics
Tajikistan	143.1	4511	996	123	882
Kazakhstan	2715	4750	1022	126	550
Uzbekistan	450	3663	880	140	366
Kyrgyzstan	198	3276	831	113	321
Turkmenistan	488	2200	683	133	325

*Flora of Tajik SSR (v. Kh. - L.: Nauka, 1991 - 624 p), Cherepanov S.K. (Vascular plants of USSR L.: Nauka, 1981, - 510 p.) - 4511 species, according to M.I. Ismailov (Identification of vascular plants of Tajikistan // Dep. in SPI center, edition 2, №44(1186), D.: 1999.) - 4095 species.

In addition to the specific and genera diversity, the flora of Tajikistan is marked by rich systematic units of the highest rank – genera, families, and types (table 1.6).

Algae (Algae) 2145 species of algae have been registered in Tajikistan. Most of them are assigned to diatomaceous (*Bacillariophyta*) – 650 species, blue-green (*Cyanophyta*) – 580, and green algae (*Chlorophyta*) – 570. Being an integral part of natural ecosystems, algae are indicators of their state.

Fungi (Fungi). Fungi flora includes lower micromycetes – 91,5% and macromycetes. According to the current scientific data, nature of Tajikistan is rich with as many as 2233 specific and intraspecific taxa of micro- and macroscopic fungi, belonging to 6 classes, 284 genera and subgenera, 78 families, 26 new species are discovered. There are 7 species of poisonous fungi; 4 species of fungi are rare and listed in Red Data Book.

Lichens (Lichenes) in Tajikistan are represented by 524 species, 11 of these are endemic. Some lichens (*Evernia prumastri*, *Pseudovarnia furfuraceae*, *Loboria pulmonaria*, and *Ramalina*) contain aromatic stuff and essential oils, which are widely used as raw material in producing wool and silk dyers for traditional trades.



Bryophyta, Fungi and Lichenes community

Bryophytes (Bryophyta) in Tajikistan include 358 species, belonging to 144 genera and 52 families; 51 species are endemic, 1 is a relict (*Mielichhoferia himalayana*) was formed as early as Paleogene. Moss is common all over the republic from valleys and foothills to high mountains, from desert to cryophyte meadows and swamps of the alpine belt.

Filices (Pteridophyta) are represented in the republic by 22 species belonging to 5 families and 14 genera. There are 14 species of ferns (*Polypodiaceae*), 1 species of *Salvinia*, 1 species of *Marsinia*; 1 species – waterwort (*Asplenium pseudofontanum*) – is considered extinct, 3 species – Steller's fern (*Cryptogramma Stelleri*), Komarov's buckler fern (*Dryopteris Komarovii*), and marsh fern (*Dryopteris thelyp-*

Table 1.6. Flora of Tajikistan

№	Type, class	Total			Introducent			Wild relatives		
		species	genus	family	species	genus	family	species	genus	family
1.	Algae	2145	500	100	–	–	–	2145	500	100
2.	Fungi	2233	284	78	–	–	–	2233	284	78
3.	Lichenes	524	85	27	–	–	–	524	85	27
4.	Bryophyta	358	144	52	–	–	–	358	144	52
	Total:	5260	1013	257	–	–	–	5260	1013	257
5.	Pteridophyta	22	14	5	–	–	–	22	14	5
6.	Gymnospermae	35	9	5	9	6	3	26	3	2
7.	Angiospermae, including:	4454	973	113	312	106	4	4142	867	109
	• Monocotyledonae	752	161	18	22	6	–	730	155	18
	• Dicotyledonae	3702	812	95	290	100	4	3412	712	91
	Total :	4511	996	123	321	112	7	4190	884	116
	Grand total:	9771	2009	380	321	112	7	9450	1897	373

teris) – are endangered; and 2 species – Bukhara adder's-tongue (*Ophioglossum bucharicum*) and Fedchenko's *Gymnocarpium Fedtschenkoanum* – are rare.

Eguisetophyta (Eguisetophyta) – are represented by two species (*Eguisetum ramosissimum*, *E.arvense*). They are common on damp soils along river banks, within valley and foothill zones. They are used in traditional medicine.

Gymnospermae (Gymnospermae) – are represented by 35 species. Pinophyta (*Pinophyta*) – by 16 species of cypress family and juniper genera, 3 species of which: *Juniperus turkestanica*, *J. zeravshanica*, *J. semiglobosa* are the endemics of Western Tien-Shan and Pamiro-Alai. They form forests at 1200-3200 masl with area over 1/3 of total forested area. Ephedra (*Ephedra*) are represented by 19 species. The natural resource of these shrubs has considerably reduced due to uncontrollable cutting.

Angiospermae are characterized by the largest variety of the country flora. They include 4454 species belonging to 973 genera and 113 families. They comprise monocotyledonous and dicotyledonous plants.

Monocotyledonae are represented by 752 species belonging to 161 genera and 18 families. These are mainly perennial and annual herbs, with long and short vegetation period. They include species inhabiting reservoirs, swamps, and wetlands – mace reeds (*Typhaceae*), *Sparganiaceae*, pondweeds (*Potamogetonaceae*), naias (*Najdaceae*), rush (*Juncaceae*), water plantain *Alismataceae*, sedges (*Cyperaceae*), *Hydrocharitaceae*, duckweeds (*Lemnaceae*), *Eriocaulaceae*, orchids (*Orhidaceae* *Eriocaulaceae*). They also include other families, e.g. cereals (*Gramineae*) – toetoe (*Arundo*), reed (*Phragmites*), *Eriathus*, etc.



Ephedra



Sub-alpine meadows

The families of the class are cereals (*Poaceae*), consisting of 325 species and 90 genera. The richest genera are: spear grass (*Poa*) – 36, feather-grass (*Stipa*) – 30, couch-grass (*Elitrigia*) – 24, *Piptatherum* – 19, fescue grass (*Festuca*) – 16, *Puccinellia*, brome (*Bromus*), and barley (*Hordeum*) – 11 each. Cereals are widespread over all vegetation zones and ecosystems.

Cyperaceae Family (sedges) consists of 15 genera with 86 species of herbaceous, mainly perennial mesohygrophytes. Most of the species are plants from wet, swamped areas, weeds of rice fields, and components of alpine meadows and waste grounds. Found at 300 to 3800(4600) masl (some sedges and all *Cobresia*). The major genera are: sedges (*Carex*) – 40 species, cane (*Erianthus*) – 12, cyperus (*Cyperus*) – 7, spike rush (*Heleocharis*) – 6. They are used as food and forage.

The following families: *Eriocaulaceae*, rushes (*Juncaceae*), *Araceae*, duckweeds (*Lemnaceae*) are not numerous; they are represented by water and swamp plants, which do not require special protection.

Iridaceae Family (irises) is grouped in 7 genera and 27 species. They include: fine-flowerig – saffron (*Crocus korolkovii*), iris species (*Iris sp.div.*) – 9, and *Junona sp. div.* – 15.

Amaryllidaceae Family has 7 species related to four genera, the most valuable food, decorative, and medicine species are those of *Allium* genus (onion) – 84, and *Ungernia* genus – 3 species. The natural resources of many onion species, particularly *Allium stipitatum*, *A.Rosenbachianum*, *A.oschninii*, *A.cepa*, *A.giganteum*, etc. are being exhausted due to an active gathering for sale and preservation. Among onions, there are many endemic species – Mogoltau o. (*A.mogoltavicum*), Darvaz o. (*A.darwasicum*),

Shugnan o. (*A.schugnanicum*), crown-bearing o. (*A.stephonophorum*), etc., 14 in all. Victor's ungernia (*Ungernia Victoris*) is an endangered species, listed in the Red Data Book of Tajikistan.

Liliaceae Family (lilies) is mostly rich in specific diversity (118 species), the major species are: *Gagea* genus (goose's onion) with 34 species, *Eremurus* (desert-candle) – 29, *Tulipa* (tulip) – 24, and *Asparagus* (asparagus) – 8.

Dicotyledonae are represented by a great number of living forms. Many species are dominants and subdominants of the republic vegetation.

Dicotyledons are the base of the floristic composition of all types of vegetation; they include pistachio and xerophyllous light forest, tugai (riparian woodland), mesophyllous broad-leaf forest, etc.

In Tajikistan, there are 3702 dicotyledonous species, which belong to 812 genera and 95 families.

Juglandaceae Family (walnuts) in Tajikistan are represented by 1 species – English walnut (*Juglans regia*), which is a dominant of broad-leaf forests and can be easily reproduced either by seedage or vegetation.

Salicaceae Family (willows) is represented by 14 species of willow and 5 species of poplar that grow in tugai and mountain river valleys and often form independent thick brushwoods.

Betulaceae Family (birches) is represented by 1 genus, Tien Shan birch (*Betula tianschanica*), which is a polymorphic species. It forms independent groves on river sides at 1200-3600 masl. Easily reproduced by shoots and seeds.



Tugai



Tulipa praestans

Ulmaceae Family (elms) consists of 3 wild species, belonging to 2 genera (*Ulmus*, *Celtis*), Caucasus false elm (*Celtis caucasica*) is of a special interest.

Moraceae Family (mulberries). Of great interest is a fig (*Ficus carica*) as a valuable fruit-tree and a component of xerophytic light forests. Occurs in fragments as small thickets near settlements in the mountainous valleys of Central and Southern Tajikistan.

The major dicotyledon families, which are important in forming many vegetation complexes, are: buckweats (*Polygonaceae*), Roman plants (*Chenopodiaceae*), pinks (*Caryophyllaceae*), ranunculaceae (*Ranunculaceae*), crucifers (*Cruciferae*), rosaceous (*Rosaceae*), leguminous (*Leguminosae*), elaeagnus (*Elaeagaceae*), umbelliferous (*Umbelliferae*), labiatiflorous (*Labiatae*), compositae (*Compositae*).

Polygonaceae Family (buckweats) in the republic is represented by 98 species, belonging to 7 genera. The major genus is *Polygonum* (pepper plant), which contains 46 species of annual and perennial grass, shrubs, and subshrubs. These are common everywhere at 300 to 4700 masl and are components of various formations and florocoenotypes. Many species are forage, medicinal, tanniferous, food, and decorative. The following species need protection: Baljuan pepper plant (*Polygonum baldshuanicum*), Hissar pepper plant (*P.hissaricum*), hydropepper plant (*P.hydro-piper*), tanniferous pepper plant (*P.coriarium*), rhubarb (*Rheum Maximoviczii*) due to the unrestrained gathering are damaged, and species of the shrub genus *Calligonum* mainly growing in consolidated and blown sands at 400-800 masl.

Chenopodiaceae Family (Roman plants) are represented by 150 species, belonging to 40 genera. Most species are herbaceous

plants; woody plants are rare. Almost all species are xerophytes and halophytes growing on valleys and foothills. The exceptions are: *Ceratoides ewersmaniana*, *C.ceratoides*, *Salsola Richteri*, *S.Paletzkiana*, *S.dendroides*, *Sympagma Regelii*, *Hammada vakhanica*, found in the Pamirs 3600-4000 masl. They are used as forage and fuel. Their natural resources have greatly reduced. Roman plants are good forage plants of winter pastures; they are the source of valuable alkaloids, dye-stuffs, soda, etc. There are many vegetables among them. Saxaul (*Haloxylon aphyllum*, *H.persicum*) and *Salsola richteri*, *S.paletzkiana*, *S.dendroides* can be used as sand-binding and forage plants of winter pastures.

Caryophyllaceae Family (pinks) – 153 species, 25 genera; except for 7 species of dwarf subshrubs of *Acanthophyllum*, all species are annual and perennial grass. The natural resource of 3 species of *Allochrysa paniculata*, *A. gypsophiloides* and *A.tadshikistanica* is rapidly disappearing due to an uncontrolled storing of its roots.

Ranunculaceae Family (ranunculaceae). There are 112 species belonging to 22 genera. The major genera are: buttercups – 36 species, *Delphinium* – 16, and anemones (*Anemone*) - 9). The majority of these are annual and perennial herbs. The clematis genus contains 3 species of climbing shrubs (*Clematis orientalis*, *C.asplenifolia*, *C.hilariae*) and one shrub liana - *Atragene sibirica*. The latter is very rare in Tajikistan and needs protection.

Brassicaceae, Cruciferae Family (crucifers) includes 252 species of 86 genera. This is one of the largest dicotyledon families. There are many vegetable, field, forage, oil, and dye plants, alkaloid-bearing and melliferous grass, etc.



Astragalus eximius



Rhodiola pamiroalaica

Crucifers are common over the entire area of the country in all types of vegetation, including juniper and broad-leaf forests, in xerophyllic light forests and semi-savannas. Most genera are represented by 1 to 3 species. The major genera are: whitlow grass (*Draba*) – 25 species, strigosella (*Strigosella*) – 15, parrya (*Parrya*) – 13, *Erysimum* – 11, and *Lepidium* – 10. More than half of all genera (43 of 83) are represented by 1 species each.

Crassulaceae Family (crassulaceae) are represented by 7 genera and 29 species. Of special attention are 5 species of *Rhodiola* genus, which occur at 2100-4800 masl on rubble slopes and in rock fissures, and are medicinal plants.

Rosaceae Family (rosaceae) are represented by 131 species belonging to 27 genera. The family is rich in woody and brush forms, including many fruit-trees and berries: pear (*Pyrus*) – 4 species, apple (*Malus*) – 1, hawthorn (*Crataegus*) – 9, almond (*Amygdalus*) – 3, plum (*Prunus*) – 2, cherry (*Cerasus*) – 2, blackberry (*Rubus*) – 1, strawberry (*Fragaria*) – 1. This group also includes: cotoneaster (*Cotoneaster*) – 15, ash-tree (*Sorbus*) – 3, dog-rose (*Rosa*) – 17, aflatunia (*Aflatunia*) – 1.

Fabaceae Family (leguminous) in the republic is represented by 520 species belonging to 40 genera. These are annual and perennial herbs, trees, shrubs, subshrubs, and dwarf subshrubs. Among them, there are many valuable, forage, and medicinal plants, which enrich soil with nitrogen-bearing compounds. 314 species belong to 2 genera: *Astragalus* (275) and *Oxytropis* (66). 19 genera have 1 species each: *Lagonychium farctum*, *Cercis griffithii*, *Keyserlingia mollis*, *Halimodendron halodendron*, etc.



Prunus

The following families: sumacs, elaeagnuses, pomegranates, pincushion shrubs, maples, buckthorns, grapes are represented by a small number of woody and shrub species: pistachio (*Pistacia vera*), sumac (*Rhus coriaria*), pincushion shrub (*Euonymus Semenovi*), maple (*Acer Semenovii*), Christ's-thorn (*Paliurus spinachristi*), common jujube (*Ziziphus jujuba*), grapes (*Vitis vinifera*), *Tamarix sp.div.*, elaeagnus (*Elaeagnus angustifolia*), sea buckthorn (*Hippophae rhamnoides*), pomegranate (*Punica granatum*), etc.

Umbelliperae Family (umbelliferous) is represented by 172 species and 66 genera. The absolute majority of the species are concentrated in mid-high mountains. They are typical both of xerophyllic light forests and juniper forests. There are many valuable food (ferule species), forage, spice-aromatic, essential oil plants: coriander (*Coriandrum*), caraway (*Carum carvi*), *Galagana*, *Antriscus*, *Scaligeria*, *Bunium persicum*, celery (*Apium graveolens*); medicinal plants (*Ammi majus*, *Angelica ternata*, *Carum carvi*, *Daucus carota*, etc.). The major genera are: ferule – 39 species. The rest 58 genera have 2 species each, only 5 of them are polymorphic. The following species need urgent protection: *Bunium persicum*, *Galagania fragrantissima*, caraway (*Carum carvi*), celery (*Apium graveolens*), fennel (*Foeniculum vulgare*), angelica (*Angelica ternata*), ferule (*Ferula sp. div.*).

Labiatae Family (labiatiflorous). There are 38 genera and 196 species in the republic. Some species are found from valleys to high mountains (*Perovskia scrophulariifolia*, *Thymus seravschanicus*, *Ziziphora pamiroalaica*, *Nepeta pamirensis*, *N.kokanica*, *Salvia sclarea*, *Origanum tittanthum*) which often form independent types of vegetation – thymes. The family con-

tains many endemic species. There are 18 genera with 1 and 4 species, and 3 genera with over 20 (up to 33) species in the family. There are no endangered species among them.

Compositae Family (compositae). This is the major family of higher flowering plants. In Tajikistan, there are 655 wild species and 118 genera. The absolute majority of genera have one (53) or two (24) species. The major genera are: cousinia (*Cousinia*) – 111 species, wormwood (*Artemisia*) – 47, *Echinops* – 29, jurinea (*Jurinea*) – 26, erigeron (*Erigeron*) – 24, *Saussurea* and dandelion (*Taraxacum*) – 15 species each.

Some compositae are important for landscapes. They are common in all vegetation zones up to 5000 masl. These are species of wormwood (*Artemisia sp.div.*), *Cousinia pannonosa*, *C.Franchetii*, *C.macilenta*, *C.splendida*, *Centaurea squarrosa*, inula (*Inula macrophylla*, *I. grandis*), *Ligularia Thomsonii*, *L.macrophylla*. They contain many food (*Taraxacum*, *Cicorium Cirsium*), forage (*Tragapogon*, *Artemisia*, *Carduus*, *Taraxacum*, *Saussurea*, etc.), oil (*Carthamus tinctorius*, *Onopordium acanthium*), essential oil (*Lachno-phyllum gossipum*, *Pulicaria salvifolia*, *Achillea Wilhelmsii*, *Tanacetum santhoanum*), melliferous, medicinal (*Achillea millefolium*, *Artemisia cina*, *Calendula officinalii*, *Taraxacum* species) plants; they also include ill weeds and noxious plants..

Of other small families, the following plants require protection: date-plum (*Diospyros lotus*) belonging to the Ebenaceous family (*Ebenaceae*), *Vitex agnuscastus* of the Verbena family (*Verbenaceae*), and of the *Limoniaceae* – *acantholimon* (*Acantholimon diapensioides*), *A. hedinii*, *A.tianschanicum*, *A.velutinum*, *A. pamiricum*, *A.varivtzevae*) etc.



Ferula fedtschenkoana

Spore-bearing vegetation is very rich. It is very important for maintaining the ecological balance of forest, meadow, water, steppe, and semi-desert ecosystems and the formation of the fertile soil layer. Many species of spore-bearing plants need protection due to their restricted range.

The specific features of flora distribution correspond to particular types of zones, into which the botanic-geographical areas of Tajikistan are subdivided.

Each botanico-geographical area is characterized by particular vegetation, which differs in the origin and ecological features and is assigned to particular altitude belts.

B. Valuable communities

The natural vegetation of Tajikistan annually produces over 80 million tonnes of land (31 mln.) and underground (48 mln.) phytomass (table 1.7), a considerable part of which forms valuable communities.

The valuable communities of Tajikistan are forest, meadow, steppe, tugai, semidesert to desert, and semisavanna vegetation (fig. 1.13), a considerable part of which are relic, endemic, and endangered species. All these species are of a genetic, ecological, economical, food, and forage significance.



Pistacia verae

Many species and their communities exist under extreme conditions and restricted environmental ranges in various mountainous ecosystems.

The main types of vegetation are:

- broad-leaf forest (*Acer turkestanicum*, *Juglans regia*),
- tugai forest (*Populus pruinosa*, *Elaeagnus angustifolia*),
- small-leaf forest (*Betula tianschanica*),
- juniper forest (*Juniperus turkestanica*, *J. seravschanica*, *J. semiglobosa*),
- xerophyllous light forest (*Pistacia vera*, *Amygdalus bucharica*),
- brushwood (*Rosa kokanica*, *R. divina*, *Aflatinia ulmifolia*, *Exchorda Albertii*, *Ephedra equisitina*),

Table 1.7. The land phytomass of major plant communities (air-dry weight)

Name of plant community	Area, thou. hectares	Phytomass		
		thou. hectares	thou. tons	B %
Juniper forests	400	28.0	11200	36.1
Shiblyak	650	9.3	6030	20.0
Deciduous forest	140	30.3	4200	13.0
Tugai with savannoide	70	42.5	2975	9.6
Semisavanna:				
• High grass	600	4.5	2700	9.0
• High cereal	300	3.1	900	3.0
• Low grass	500	0.6	300	1.0
Desert	700	1.2	840	2.6
Tragacants	400	1.5	600	2.0
Meadow, wetlands	170	2.5	425	1.3
Steppe	420	1.0	420	1.3
Jangal	70	2.0	140	0.4
Cryophyton	100	2.4	120	0.4
Halophyton	80	1.2	96	0.3

- semiwoody-semibrush vegetation (*Haloxylon persicum*, *Salsola richterii*, *Calligonum caput medusae*, *C.griseum*, *C.arborescens*, *C.calcareum*, *Hammada leptocloda*, *Artemisia kochiiformis*, *Ceratoides papposa*),
- *Cousinia pannosa*, *C.stephanophora*,
- steppe (*Festuca alaica*, *F.subcata*, *F.pamirica*, *Artemisia dracunculus*),
- semisavanna (*Prangos pabularia*, *Inula grandis*, *Ferula kuhistanica*),
- meadow (*Polygomonum coriarum*, *Ligularia thomsonii*),
- *Acantholimon tatarica*, *Onobrychis echidna*.

More than 70 species of valuable communities form independent flora formations. Among them the most valuable are: nuts (*Juglans regia*), apples (*Malus Sieversii*), maples (*Acer turkestanicum*), junipers (*Juniperus seravschanica*, *J. semiglobosa*, *J.turkestanica*, *J.sibirica*), birches (*Betula tianschanica*), sea buckthorns (*Hippophae rhamnoides*), populus (*Populus pruinosa*), elaeagnus (*Elaeagnus angustifolia*), pistachios (*Pistacia vera*), common jujube (*Ziziphus jujuba*), figs (*Ficus carica*), hawthorns (*Crataegus pontica*), saxaul (*Haloxylon persicum*).

The woody and shrub plants of Tajikistan make over 60% of valuable juniper, 50% of pistachios, 95% of tugai, 65% of mesophyllic, 20% of small-leaf and mesophyllic-shrub communities of Central Asia. 90% of large mammals inhabit forests formed by these communities.

Representatives of valuable communities occur almost on the whole territory of Tajikistan (fig. 1.14). A considerable part of them are high-productive pastures, hayfields, and food, medicinal, and technical resources.

Grass communities are most diverse in composition and structure. They include 10 of 20 types of vegetation, 4 of them belong to subshrubs and 6 – to woody-shrubs.

Grass and subshrub communities make over 70% of arable lands (3.5 million hectares of pastures) and 90% of natural medicinal resources of vegetation origin.

The most valuable communities of medicinal plants are the following formations: licorice (*Glycyrrhiza glabra*), origanum (*Origanum tytanthum*), *Lagochilus seravschanicus*, *Bunium persicum*, rhubarb (*Rheum maximoviczii*), inula (*Inula grandis*), *Ungernia tadshicorum*, allseed (*Rhodiola heterodonta*), ferule (*Ferula foetidissima*, *F.kuhistanica*), onion species (*Allium stipitatum*, *A.seravschanicum*, *F.suvorovii*).



Juniperus

All these formations are preserved as small communities, including numerous relic and endemic species and genera (*Ostrovskia*, *Cephalopodium*, *Spyrostegia*, *Kuhitangia*, *Korshinskya*, *Paulia*, *Thlaspidium*, *Chaetolimon*). In Tajikistan, there are many plants valuable for the whole Mediterranean area that have a common origin, such as trees, shrubs, and herbaceous plants (*Rhus coriaria*, *Juglans regia*, *Punica granatum*, *Ficus carica*, *Vitex agnus-castus*, *Palurus spina Christi*, *Prunus divaricata*, *Elytrigia trichophora*, *Hordeum spontaneum*, *H. bulbosum*).

Of ancient Mediterranean flora elements, communities of broad-leaf forests or xerophytic light forests (*Juglans regia*, *Acer turkestanicum*, *Exochorda Alberti*, *Aflatunia ulmifolia*), xerophytic light forests (*Celtis caucasica*, *Acer regeli*, *Crataegus pontica*, *Fraxinus raibocarpa*, *Calophaca grandiflora*, *Pistacia vera*, *Keyserlingia mollis*), numerous relic shrubs (*Ribes*, *Lonicara*, *Cotoneaster*, *Fraxinus*), and herbaceous plants (*Buchingera*, *Ostrovskia*, *Petilium*, *Imperata*) still exist in Tajikistan (fig. 1.15).

One can still find well-preserved motley grass steppes, semisavannas and cryophyte meadows widely used as natural pastures. Valuable wild fruits and genetic resources of fruit, food, medicinal, decorative, and forage plants which are typical for valuable communities.

The most valuable representative communities of biodiversity which need protection are as follows: juniper, birch, and walnut forests, ash trees, aflatunia, and pagoda tree brushwoods, mountainous steppes, meadows, tugai, saxaul, and pistachios. They are threatened not only by a reduction of their areas, but also by a destruction of their community structures and a loss of valuable plant and animal species.

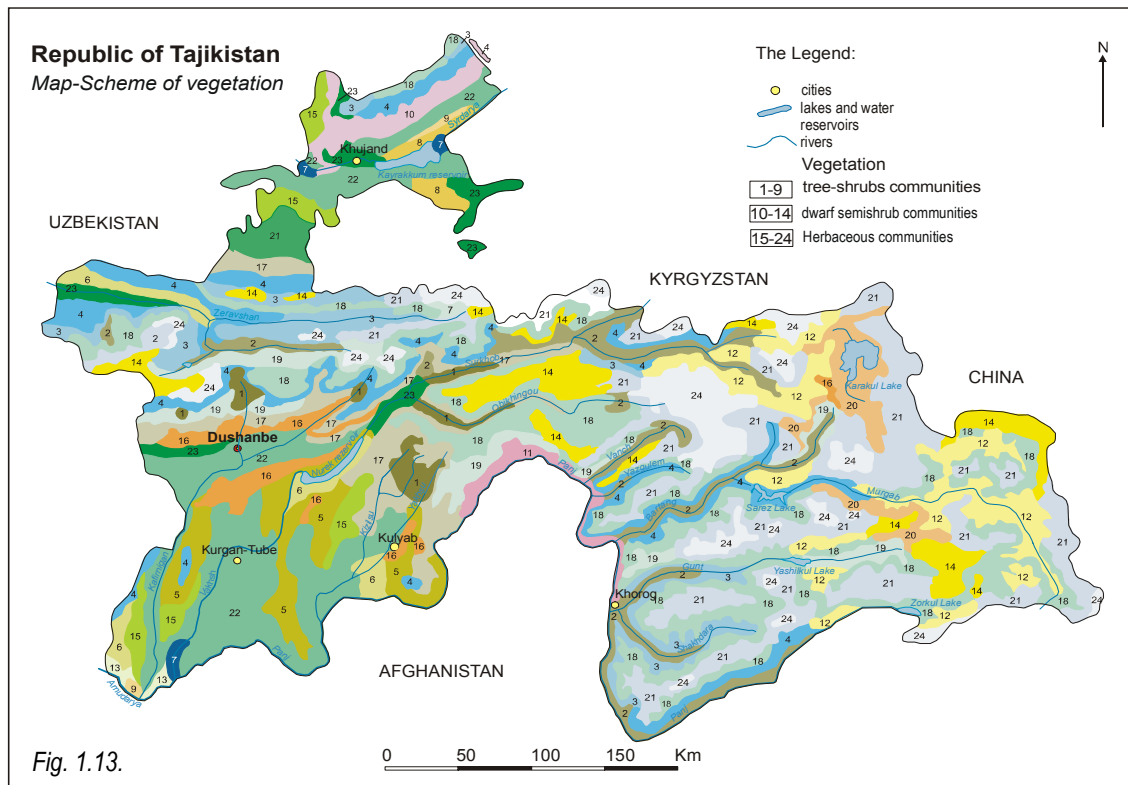


Fig. 1.13. Legend to Map-scheme of vegetation

Woods and shrubs

- 1 Deciduous maple-shrub-walnut forests
- 2 Small-leaf meadow-sea buckthorn-birch forests
- 3 Juniper forests in combination with shrubs, meadows and steppes
- 4 Open juniper forests in combination with tall-herbs, xerophytes and shrubs
- 5 Xerophytic open ephemeroide-maple-pistachio woodlands
- 6 Xerophytic open ephemeroide-sagebrush-zygophyllaceous-almond woodlands
- 7 Tugai with domination of meadow-marsh-oleaster-poplar communities
- 8 Psammophytic vegetation ephemeroide-halophytic-perennial saltwort-saxaul
- 9 Halophytic saltwort-ephemeroide vegetation

Dwarf semishrub communities

- 10 Fergana-like deserts with domination of saltwort-ephemeroide-sagebrush communities
- 11 West Pamir-like deserts with domination of acantholimon-sagebrush communities
- 12 High mountain East Pamir-like deserts with domination of aiania-ceratoides-sagebrush communities

- 13 South Tajikistan-like deserts with domination of ephemeroide-sagebrush-hamada communities
- 14 Traganthoides with domination of thorn pulvinate-prickly herb-cousinia communities

Herbaceous vegetation

- 15 Semi-savannas with domination of low herbs
- 16 Semi-savannas with domination of tall grasses
- 17 Semi-savannas with domination of tall herbs
- 18 Steppe with domination of forb-tussock-grasses
- 19 Sub alpine tall herb meadows
- 20 Cryophytic meadows dominated with sedge and cobresia
- 21 Cryophytic-petrophytic vegetation
- 22 Irrigated lands
- 23 Rain feed lands
- 24 Glaciers

fig. 1.13.

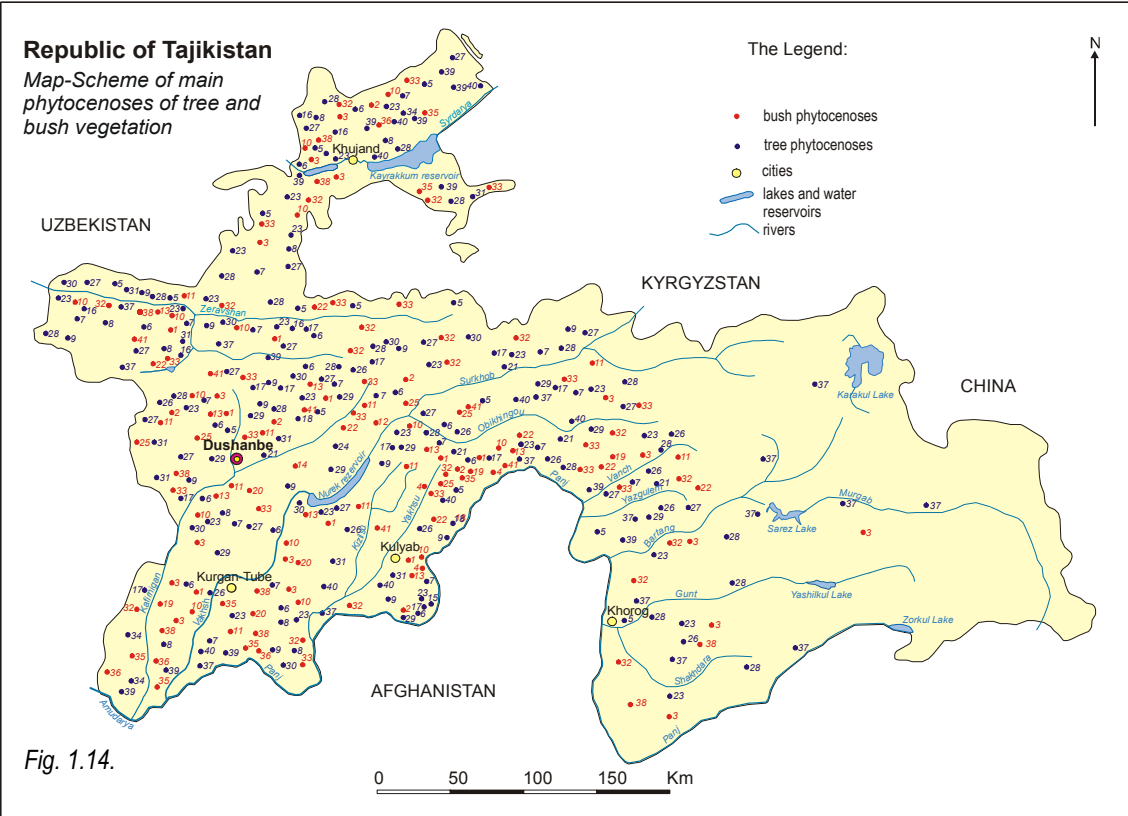


Fig. 1.14. Legend to Map-scheme of main valuable formations of wood and shrub vegetation

No.	Latin Names	fig. 1.14.	
1	2	1	2
1	<i>Zizyphus jujuba</i>	22	<i>Betula tianschanica</i>
2	<i>Cercis griffithii</i>	23	<i>Juniperus seravschanica</i>
3	<i>Cerasus verrucosa</i> , <i>C. erythrocarpa</i>	24	<i>Biota orientalis</i>
4	<i>Punica granatum</i>	25	<i>Exochorda alberti</i>
5	<i>Celtis caucasica</i>	26	<i>Juglans regia</i>
6	<i>Pistacia vera</i>	27	<i>Juniperus turkestanika</i> , <i>J. sibirica</i> , <i>J. semiglobosa</i>
7	<i>Amygdalus bucharica</i>	28	<i>Populus bachofenii</i> , <i>P. tadshikistanica</i>
8	<i>Amygdalus spinosissima</i>	29	<i>Platanus orientalis</i>
9	<i>Acer regelii</i> , <i>A. pubescens</i>	30	<i>Acer turkestanicum</i>
10	<i>Ephedra equisetina</i> , <i>E. intermedia</i>	31	<i>Fraxinus sogdiana</i>
11	<i>Fraxinus raibocarpa</i>	32	<i>Cotoneaster hissaricus</i> , <i>C. nummularius</i>
12	<i>Calophaca grandiflora</i>	33	<i>Rosa divina</i> , <i>R. ecae</i> , <i>R. ovczinnikovii</i>
13	<i>Rhus coriaria</i>	34	<i>Haloxylon persicum</i>
14	<i>Palinrus spina-christi</i>	35	<i>Salsola paletziana</i> , <i>S. richteri</i>
15	<i>Ficus carica</i>	36	<i>Calligonum microcarpum</i> , <i>C. litvinovii</i>
16	<i>Pyrus regelii</i>	37	<i>Hippophae rhamnoides</i>
17	<i>Pyrus bucharica</i>	38	<i>Tamarix arceuthoides</i> , <i>T. ramosissima</i>
18	<i>Diosphyros lotus</i>	39	<i>Elaeagnus angustifolia</i>
19	<i>Zigophillum gontscharovii</i>	40	<i>Populus pruinosa</i>
20	<i>Vitex agnus-castus</i>	41	<i>Restella alberti</i>
21	<i>Malus sieversii</i>		

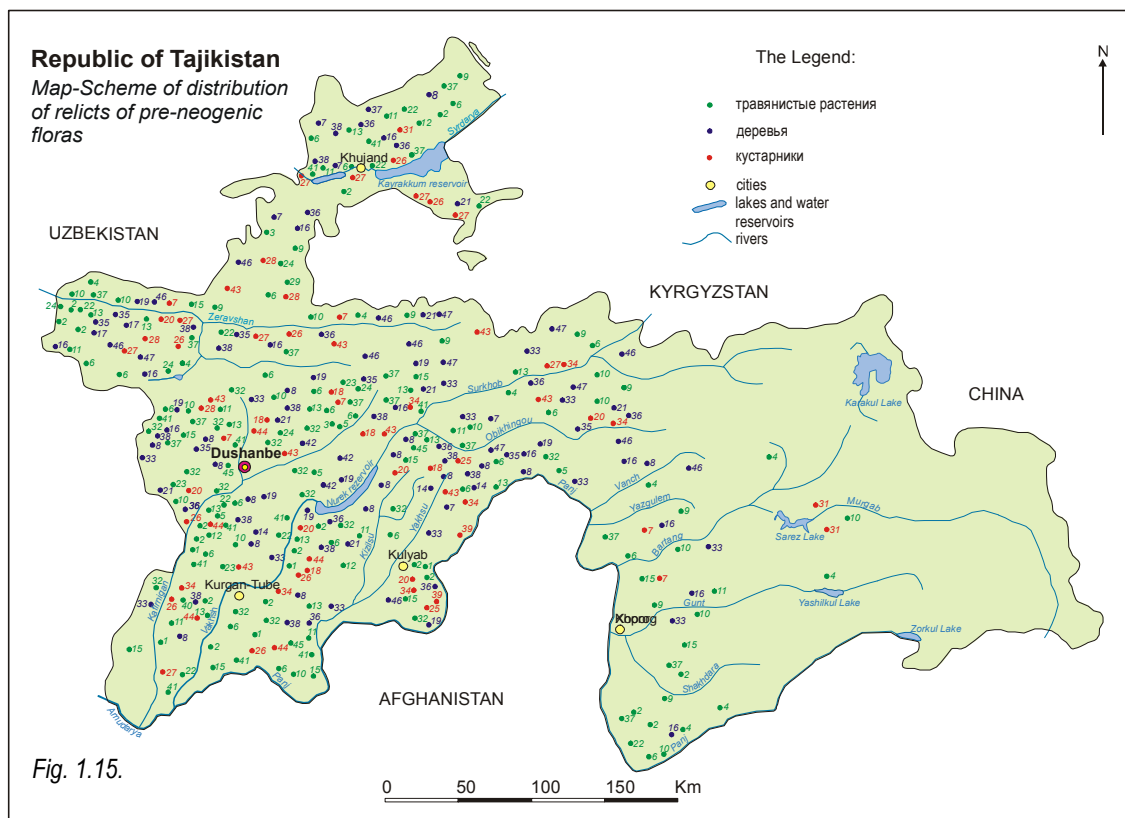


Fig. 1.15. Legend to Map-scheme of distribution of relicts of pre-neogenic floras

No.	Latin Names
1	2
1	<i>Arundo donax</i> L.
2	<i>Aeluropus litoralis</i> Parl.
3	<i>Arthraxon langsdorfii</i> Trin. Hochst.
4	<i>Achantherum splendens</i> Nevski.
5	<i>Botriochloa caucasica</i> Trin. Henr.
6	<i>Botriochloa ischaemum</i> L. Henr.
7	<i>Celtis caucasica</i> Willd.
8	<i>Cercis griffithii</i> Boiss.
9	<i>Calamagrostis macrolepis</i> Litv.
10	<i>Calamagrostis pseudophragmites</i> Hall. Koeler.
11	<i>Cynodon dactylon</i> L. Pers.
12	<i>Crypsis schoenoides</i> L. Lam.
13	<i>Datisca cannabina</i> L.
14	<i>Diospyros lotus</i> L.
15	<i>Erianthus ravennae</i> L. Beauv.
16	<i>Elaeagnus orientalis</i> L.
17	<i>Elaeagnus songarica</i> Bernh. ex Schlecht.
18	<i>Exochorda alberti</i> Rgl.
19	<i>Ficus carica</i> L.
20	<i>Fraxinus raibocarpa</i> Rgl.
21	<i>Fraxinus sogdiana</i> Bunge

fig. 1.15.

1	2
22	<i>Halimodendron halodendron</i> Pall. Voss.
23	<i>Imperata cylindrica</i> L. Beauv.
24	<i>Iskandera hissarica</i> N. Busch
25	<i>Keyserlingia mollis</i> Royle Boiss.
26	<i>Lycium ruthenicum</i> Murr.
27	<i>Lycium dasystemum</i> Pojark.
28	<i>Lonicera paradoxa</i> Pojark.
29	<i>Malacocarpus crithmifolius</i> C.A. Mey
30	<i>Myrtama elegans</i> Royle Ovcz. et Kinz.
31	<i>Nitraria schoberi</i> L.
32	<i>Ostrowskia magnifica</i> Rgl.
33	<i>Platanus orientalis</i> L.
34	<i>Populus pruinosa</i> Shrenk
35	<i>Populus talassica</i> Kom.
36	<i>Populus tadshikistanica</i> Kom.
37	<i>Phragmites communis</i> Trin.
38	<i>Pistacia vera</i> L.
39	<i>Punica granatum</i> L.
40	<i>Ranunculus chodzhastonicus</i> Ovcz. et Junus.
41	<i>Saccharum spontaneum</i> L.

fig. 1.15.

1	2
42	<i>Biota orientalis</i> (L.) Endl.
43	<i>Vitis hissarica</i> Vass.
44	<i>Vitex agnus-castus</i> L.

fig. 1.15.

1	2
45	<i>Zeuxine strateumatica</i> (L.) Schlechter
46	<i>Juniperus seravschanica</i> Kom.
47	<i>Juniperus sibirica</i> Burgsd.

Relic species forming valuable communities

No.	Latin Names
1	2
1.	<i>Arundo donax</i>
2.	<i>Aflatus ulmifolia</i>
3.	<i>Juniperus semiglobosa</i> , <i>J. seravschanica</i> , * <i>J. sibirica</i> , <i>J. turkestanica</i>
4.	* <i>Acantholimon komarovii</i> , * <i>A. Varivtzevae</i> , * <i>A. Zaprjagaevii</i>
5.	<i>Betula tianschanica</i>
6.	<i>Cercis Griffithii</i>
7.	* <i>Crataegus darvasica</i> , * <i>C. pamirolaica</i> , <i>C. turkestanica</i> , <i>C. pontica</i>
8.	<i>Ampelopsis vitifolia</i>
9.	<i>Cerasus verrucosa</i>
10.	<i>Vitis vinifera</i>
11.	<i>Peganum harmala</i>
12.	<i>Punica granatum</i>
13.	<i>Pyrus cajon</i>
14.	<i>Paliurus spina Christi</i>
15.	<i>Calligonum griseum</i> , <i>C. Prszevalskii</i> , <i>C. microcarpum</i>
16.	<i>Origanum tyttanthum</i>
17.	<i>Dionysia involucrata</i>
18.	<i>Rubus caesius</i> , <i>R. turkestanicus</i>
19.	<i>Lonicera Korolkovii</i>
20.	<i>Hypericum perforatum</i> , <i>H. scabrum</i>
21.	<i>Ziziphora pamirolaica</i>
22.	<i>Salix alba</i> , <i>S. babilonica</i> , <i>S. excelsa</i> , <i>S. pamirica</i> , <i>S. picnostachya</i> , <i>S. schugnanica</i> , <i>S. turanica</i> , <i>S. Wilhelmsiana</i>
23.	<i>Imperata cylindrica</i>
24.	<i>Incarvillea Olgae</i>
25.	<i>Celtis caucasica</i>
26.	<i>Acer turkestanicum</i>
27.	<i>Acer pubescens</i>
28.	<i>Festuca sulcata</i>
29.	<i>Calophaca grandiflora</i>
30.	<i>Cousinia Fedtschenkoana</i> , <i>C. Franchetii</i> , <i>C. pannosa</i> , <i>C. stephanophora</i>
31.	<i>Caragana turkestanica</i>
32.	<i>Atraphaxis pyrifolia</i>

1	2
33.	<i>Cotoneaster nummularioides</i> , <i>C. nummularius</i> , <i>C. hissaricus</i>
34.	<i>Clematis orientalis</i>
35.	<i>Elaeagnus angustifolia</i>
36.	<i>Amygdalus bucharica</i>
37.	<i>Padellus mahaleb</i>
38.	<i>Ostrowskia magnifica</i>
39.	<i>Juglans regia</i>
40.	<i>Hippophae rhamnoides</i>
41.	<i>Zygophyllum Gontscharovii</i>
42.	<i>Prangos pabularia</i>
43.	<i>Artemisia persica</i> , <i>A. baldshuanica</i> , <i>A. tenuisecta</i> , <i>A. turanica</i> , <i>A. vachanica</i>
44.	<i>Perovskia scrofularifolia</i>
45.	<i>Platanus orientalis</i>
46.	<i>Rheum Maximoviczii</i>
47.	<i>Rosa Ovczinnikovii</i>
48.	<i>Glycyrrhiza glabra</i>
49.	<i>Rhus coriaria</i>
50.	<i>Thelycrania darvasica</i>
51.	<i>Scorzonera acanthoclada</i>
52.	<i>Prunus sogdiana</i>
53.	<i>Ribes Meyeri</i>
54.	<i>Saccharum spontaneum</i>
55.	<i>Populus alba</i>
56.	<i>Zizyphus jujuba</i>
57.	<i>Pictacia vera</i>
58.	<i>Ferula kokanica</i>
59.	<i>Diospyros lotus</i>
60.	<i>Ephedra intermedia</i> , <i>E. ciliata</i> , <i>E. equisetina</i>
61.	<i>Erianthus Ravennae</i>
62.	<i>Onobrychis echidna</i>
63.	<i>Exochorda Albertii</i>
64.	<i>Eremurus Aitchinsonii</i> , <i>E. candidus</i> , <i>E. Olgae</i> , <i>E. robustus</i> , <i>E. stenophyllus</i>
65.	<i>Malus Sieversii</i>

*Rare species

C. Animal World

A considerable diversity of environmental conditions, ecosystem variations and plant communities rich in composition and structure, as well as ancient many-pole faunogeneses promoted the conservation and development of over 12 thousand species of invertebrates and 531 species of vertebrate animals on the territory of Tajikistan (table 1.8).

Vertebrates

Mammals (*Mammalia*) of Tajikistan include 84 species, grouped in 47 genera, 22 families, and 6 orders: insectivorous, cheiroptera, hares, rodents, carnivorous, and ungulates.

Insectivorous Order (*Insectivora*) – the oldest branch of mammals in Tajikistan - is represented by only 6 species, belonging to 4 genera and 2 families. Widespread and numerous representative of this group is *Crociodura suaveolens*, which occurs both in natural and cultivated landscapes, from tugai to highlands. Long-spined hedgehog (*Paraechinus hypomelas*) occurs in foothill zone and adjacent valleys (350-1200 masl). Negative impact on the long-spined hedgehog habitats and numbers was produced by ploughing of virgin lands and uncontrolled cattle grazing. *Sorex buchariensis*, the endemic of Tajikistan, has restricted habitats in local areas of the Hissar Range and the Peter the Great Range. *Crociodura pergrisea*, a specialized mountainous species, belongs to rare species; it occurs on the slopes of the Hissar, Shugnan, and Ishkashim ranges, at 2500-3600 masl.

Table 1.8. Specific diversity of animals

Taxa	Number		
	Total	Endemic	Listed in the Red Data Book
Invertebrates	12619	799	58
<i>Protozoa</i>	300	–	–
<i>Vermes</i>	1400	–	–
<i>Arachnida</i>	715	–	–
<i>Insecta</i>	10 000	796	50
<i>Mollusca</i>	204	3	8
Vertebrates	531	1	104
<i>Amphibia</i>	2	–	–
<i>Reptilia</i>	47	–	21
<i>Pisces</i>	52	–	4
<i>Aves</i>	346	–	37
<i>Mammalia</i>	84	1	42
Total:	13150	800	162



Cervus elaphus

Cheiroptera Order (*Chiroptera*) of Tajikistan includes 19 species of bats, belonging to 3 families and 9 genera. Out of three species of horseshoe bats (*Rhinolopidae* Family), lesser (*Rhinolophus hipposideros*) and Bukhara horseshoe bat (*R.bucharicus*) are rare. The family of bats (*Vespertilionidae*) includes 15 species. Common representative of the family is dwarf noctule (*Pipistrellus pipistrellus*), which occurs everywhere in various natural and man-made shelters, and buildings, in the mountains – up to 2000 masl. Mostly rare and not numerous are: *Barbastella leucomelas*, noctule (*Pipistrellus savii*), wide-eared free-tailed bat (*Tadarida teniotis*), and *Otonycteris hemprichi*. The typical man-made shelters, used by bats for concentration and wintering, are abandoned mines. 14 species of bats are listed in the Red Data Book of Tajikistan.

Order *Rodentia* (rodents) is the most numerous orders of mammals in Tajikistan, represented by 29 species, belonging to 7 families and 17 genera. The family of hamsters (*Cricetidae*) includes 14 species and makes almost 50% of all rodent species of Tajikistan. Background representative of the family within the desert complex is *Meriones erythourus*, inhabiting valleys and foothills of northern and southwestern Tajikistan. *Rhombomys opimus*, *Meriones tamariscinus* and *M. meridianus* are narrow-area species of sandy lands of northern and southwestern Tajikistan.

The genus of gray field mice (*Microtus*) is represented by 6 species of field mice: Pamirian (*Microtus juldachi*), juniper (*M.carruthersi*), *M. socialus*, Afghan (*M.afghanus*), common (*M. arvalius*), and Kyrgyz (*M.kirgizorium*). All these species, except for Afghan field mouse, occur in mountainous landscapes.

Only one species of the genus *Ellobius* occurs in Tajikistan - *Ellobius tancrei*; it is common everywhere, except for the Pamirs.



Lepus tolai

Second to hamsters (in specific biodiversity) are mice (*Muridae*). This family of Tajikistan includes 5 species. Common representatives of the family are: house mouse (*Mus musculus*), common field mouse (*Apodemys sylvaticus*), Turkestan and Norway rat (*Rattus turkestanicus* and *R. norvegicus*).

The family of squirrels (*Sciuridae*) of Tajikistan includes 5 species: *Spermophilopsis leptodactylus*, relic (*Citellus relictus*), and yellow squirrels *C. fulvus*, red marmot (*Marmota caudata*), and Menzbier's marmot (*M. Menzbieri*). Due to ploughing steppe and sand areas, the populations of *Spermophilopsis leptodactylus* and yellow squirrels are on the verge of vanishing.

Red marmot (*Marmota caudata*) is a typical mountainous species. It occurs in all mountainous ranges of Tajikistan, except for the Kuramin Range. Red marmot is a very important species among game fur-bearing mammals of Tajikistan. The density of the animal population in the Pamirs and Badakhshan remains rather high.

Endemic of Western Tien Shan – Menzbier's marmot (*Marmota menzbieri*) – was first found in Tajikistan in summer, 1960, in the eastern part of the Kuramin Range, at the Aktash mine. Due to the industrial development of the Aktash upper reaches and the adjacent parts of the Kuramin Range, the isolated population of the marmot completely disappeared in the early 1980s of 20 century.

Very important game species are muskrats and nutrias. Nutrias (*Myocastor coypus*) were first brought into Tajikistan in 1949 and placed into reservoirs of the Tigrovaya Balka Nature Reserve. Due to the successful acclimatization, it formed wild population inhabiting all watercourses and wetlands in the lower reaches of the Kafirnigan, Vakhsh, Pyanj, Kyzylsu, and Yakhsu rivers. Muskrats (*Ondatra zibethica*) entered the territory of northern Tajikistan from Uzbekistan at

the beginning of the 1950s and occupied the entire irrigation system of the Fergana Valley, the Farkhad and Kairakkum reservoirs. Porcupine (*Hystrix indica*) – the only representative of the family of porcupines (*Hystriidae*) in Tajikistan – is common everywhere, except for Badakhshan and the Pamirs.

The rare representatives of the rodents order include small five-toed jerboa (*Allactaga elater*) and Severtzov's jerboa (*A. severtzovi*), which are narrow-area species within Tajikistan territory; their sparse settlements are preserved in clay, rubble, and saline areas of deserts in northern and southeastern Tajikistan.

Order Lagomorpha (hares). This order includes only 3 species, belonging to 2 families: hares (*Leporidae*) – 1 species, piping hares (*Lagomyidae*) – 2 species. The Tolai hare (*Lepus tolai*) has a wide geographic and vertical range (300-5100 masl), occurs from the river valleys and deserts to the mountainous forests and highlands. The mountainous representative of hares – large-eared piping hare (*Ochotona roylei*) – is common in Badakhshan and the Pamirs (2200-4800 masl), while red piping hare (*Ochotona rutila*) occurs only in the Pamirs.

Order Artiodactyla (cloven-ungulate). There are 7 species of cloven-hoofed animals in Tajikistan, belonging to 3 families and 4 genera. A widespread representative of this order is wild boar (*Sus scrofa*). Bukhara Red deer (*Cervus elaphus bactrianus*), the largest representative of cloven-ungulate mammals of Tajikistan (the greatest weight of males is 250 kg), is listed in the Red Data Book of the IUCN. The native habitats of the Bukhara Red deer – tugai – due to agricultural development, are almost entirely trans-



Gazella subgutturosa

formed. Nowadays Bukhara Red Deer is really threatened species. Its *in-situ* dwelling is in Ti-grovaya Balka reserve and in tugai of right side of Pyanj river till Afghanistan border. Introduct populations of Bukhara Red Deer are preserved in Zeravshan zakaznik, Sarikhosor and in Shakhrinau nursery.

Persian gazelle (*Gazella subgutturosa*) inhabits semi-desert hard-soiled areas, flat foothill plains, and lowlands (400-1800 masl). The Persian gazelle became very rare, listed in the Red Data Books of IUCN and Tajikistan. By the early 1990s, its population in Tajikistan was estimated at 100-150. The Persian gazelle is an endangered species, due to poaching and habitats degradation, its population in the country not exceeding 80.

Siberian mountain goat (*Capra sibirica*) is a common representative of cloven-ungulate animals in Tajikistan, occurring at 1600-5000 masl. The total number of the Siberian mountain goat over the total area of Tajikistan in the first half of the 1980s was estimated at 41 thousand. In recent 10-15 years its population is threatened by poaching.

Markhur (*Capra falconeri*) is an endangered species listed in the Red Data Book of the IUCN. Its main population is preserved at the border with Afghanistan on the southwestern ridges of the Darvaz Range and southern ridges of the Khazratishokh Range. The present area of the markhur is preserved as a narrow band, up to 80 km long and 5-25 km wide. In the early 1980s, the animal population disappeared from the Sarsayak Range, where its area was 30 thousand hectares, because of the poaching. At present the markhur's population of the Dashti-Jum zapovednik counts 120-130 individuals.



Ovis ammon

Urial (*Ovis vignei bochariensis*) was a very common species in the past. In the early 1950s, the total population of the urial in Tajikistan was estimated at 5 thousands. Only 400-500 individuals are preserved at the present time.

Argali or wild ram (*Ovis ammon polii*) – the largest representative of wild rams of Central Asia. It occurs in the Pamirs. The vertical range of the argali is 3600-5300 masl, its main habitats being at 4100-4300 masl. The uncontrolled international hunting and poaching considerably reduced its resources in recent 10-15 years. The argali population in the present territory of the Pamirs does not exceed about 3.5-4 thousand individuals.

Order Carnivora (carnivorous) of Tajikistan is represented by 20 species, belonging to 5 families and 10 genera. The family of martens (*Mustelidae*) is marked by the greatest specific diversity. It includes 8 species, i.e. 40% of the carnivorous mammals of Tajikistan. The most common representative of the family is stone marten (*Martes foina*), inhabitant of broad-leaf and juniper forests.

Badger (*Meles meles*) – one of the largest representatives of the family of martens – completely disappeared from the valley zone, due the anthropogenic landscape transformation; only a small number of the animals are preserved in the woody and shrub zone.

Least weasel (*Mustela nivalis*) – the finest representative of carnivorous mammals – occurs in southwestern, Central Tajikistan, and Gorno-Badakhshan, the Pamirs from 400 to 4000 masl and its population is not numerous. It is listed in the Red Data Book of Tajikistan and needs protection.

Alpine weasel (*Mustela altaica*) occurs only in Badakhshan and the Pamirs at 2700-3700 masl. It settles in stone debris near mouse colonies. It is listed in the Red Data Book of Tajikistan.

Vormela peregusna, was widely spread in the lowlands of southeastern, Central, and northern Tajikistan, and assigned to rare or endangered species. It is listed in the Red Data Book of Tajikistan.

Central Asian otter (*Lutra lutra*) is common in all river valleys of Tajikistan with the exception of the Western Pamirs. It is not numerous and needs protection.



Uncia uncia

Steppe polecat (*Mustela eversmanni*) is not numerous; currently occurs in northern Tajikistan; listed in the Red Data Book of Tajikistan.

Common weasel (*Mustela erminea*) occurs in Badakhshan and the Pamirs, in the vicinity of the Zorkul zapovednik at 4600 masl.

There is only one species of the hyenas family (*Hyaenidae*) in Tajikistan: striped hyena (*Hyaena hyaena*). This rare animal was earlier common in tugai forests and foothill semi-deserts of southwestern and northern Tajikistan at 300-1200 masl. Owing to actively developing the lands of its natural habitats and direct killing, the population of the hyenas has been shrinking rapidly all over the republic.

The cat family (*Felidae*) of Tajikistan is represented by 5 species: Turan tiger (*Panthera tigris virgata*), leopard (*Pardus pardus*), snow leopard (*Uncia uncia*), Turkestan lynx (*Felis lynx*), jungle cat (*Felis chaus*), and wild cat (*Felis libyca*).

Turan tiger (*Panthera tigris virgata*) has become extinct. In the late 1940s, the tugai forests of Tajikistan contained just 15-20 individuals. The tiger's tracks were last seen in the Tigrovaya Balka Reserve, south of Khalkakul Lake, on the 8th of July, 1954.

Earlier, the leopard (*Pardus pardus*) was common in the mountains of southwestern Tajikistan. In recent years, there have been no valid data on the presence of leopard in Tajikistan. The tracks of leopard were last seen in the Sarsaryak Range in 1967.

Snow leopard or irbis (*Uncia uncia*) is quite common but it is not numerous. This species area covers the total mountainous zone of Tajikistan. The typical habitats are at 2500 to 5500 masl. The population of snow leopard in the early 1990s was estimated at approximately 160-200 individuals.

Brown bear (*Ursus arctos*) is common in the mountain ranges of Northern, Central Tajikistan, Badakhshan, and the Pamirs, at 1500-5000 masl. The resources of this animal in Tajikistan are 250-300 individuals. Poaching and mountainous forest mastering are factors promoting the decline of the brown bear's population.

Among mammals, the narrow-endemic species is: Menzbier's marmot. 11 of 84 mammal species are assigned to game species.

Aves (birds) is the most numerous (in specific composition) class of vertebrates of Tajikistan. Ornithofauna includes 346 species of birds related to 16 orders (table 1.9). According to the type of residence, birds are subdivided into resident, migratory-nesters, birds of passage, and wintering. Birds occur in all ecosystems, and many of their representatives are background. Nearly 10% (37 species) are assigned to rare or endangered. The most critical species are falcons and bustards. There are cases of illegal fowling, aimed at selling falcons abroad.

Resident birds include 82 species, nesters – 150, migratory – 108, wintering – 80, and birds of passage – 21. Among waterfowl and near-water birds, over 20 species of ducks and sandpipers, wintering at wetlands, lakes, reservoirs, man-made ponds, and rivers, are important game species. The representatives of the order of gallinaceous (*Galliformes*) – partridge (*Alectorius keklik*), quail (*Coturnix coturnix*), Tibetan snow partridge (*Tetraogallus tibetanus tibetanus*), and pheasant (*Phasianus colchicus*) – are also assigned to game species.



Phasianus colchicus

Table 1.9. Systematic groups of birds

No.	Order name	Number of species	
		Total	Listed in the Red Data Book
1.	Dabchiks (<i>Podicipediformes</i>)	3	–
2.	Totimplates (<i>Pelecaniformes</i>)	4	–
3.	Waders (<i>Ciconiformes</i>)	12	2
4.	Lamellirostral (<i>Anseriformes</i>)	25	1
5.	Birds of prey (<i>Falconiformes</i>)	35	11
6.	Gallinaceous (<i>Galliformes</i>)	7	4
7.	Cranes (<i>Gruiformes</i>)	12	2
8.	Plovers (<i>Charadriiformes</i>)	51	5
9.	Pigeons (<i>Columbiformes</i>)	12	4
10.	Cuckoos (<i>Cuculiformes</i>)	2	–
11.	Owls (<i>Strigiformes</i>)	8	–
12.	Goatsuckers (<i>Caprimulgiformes</i>)	2	–
13.	Coraciiformes	5	–
14.	Swifts (<i>Apodiformes</i>)	3	1
15.	Woodpeckers (<i>Piciformes</i>)	2	–
16.	Passerines (<i>Passeriformes</i>)	163	7
Total:		346	37

The main biotopes for wild birds nesting in Tajikistan are: river valleys, flood-plain shrub and grassy communities, mountain forests and lakes, less often – meadows and steppes.

Considerable part of ornithofauna nests in the upper reaches of the mountains in northern, Central Tajikistan, and Badakhshan. The ornithofauna of the Eastern Pamirs is notable for its number and specific diversity.

*Haliaeetus albicilla*

Order Podicipediformes (dabchiks) represented by 3 species. *Podiceps cristatus* is wintering and nesting in reservoirs of south-western Tajikistan. *Podiceps ruficollis* is a settled bird spread in reservoirs of south-western and Central Tajikistan. *Podiceps caspicus* is a rare bird of passage, occur in reservoirs of the plain area of Tajikistan.

Order Totimplate (*Pelecaniformis*) includes 4 species. Great cormorant (*Phalacrocorax carbo sinensis*) is wintering and a bird of passage, and scarce individuals occur in summer. It is spread on the greatest part of Tajikistan area including high-mountain lakes of the Pamirs. Pygmy cormorant (*Phalacrocorax pugmaeus*) is the most common among wintering waterfowls of south Tajikistan.

Order Ciconiformes (waders) include 12 species. White and black storks (*Ciconia ciconia asiatica*, *Ciconia nigra*) are birds of passage and nesters, listed in Red Data Book of Tajikistan. Main reasons of the reduction of their population is land mastering and trouble factor. White and gray herons (*Egretta alba alba*, *Ardea cinerea*) are birds of passage, wintering and also nesters. Small bittern (*Ixobrychus minutus minutus*) is

Table 1.10 Dynamics of numbers of some game birds (individuals)**

Name	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Tibetan snow partridge (<i>Tetraogallus tibetanus tibetanus</i>)	3220	3350	3250	3000	3050	3749	4239	3988	9533	2713	1232
Pheasant (<i>Phasianus colchicus</i>)	585	565	571	570	610	790	565	405	404	321	310
Bar-headed goose (<i>Anser indicus</i>)	740	730	680	660	640	630	704	783	805	652	652
*Partridge (<i>Alectorius kakelik</i>)	44.2	44.5	45.2	44.8	45.0	45.8	40.5	47.5	37.9	44.8	26.0
*Pigeon (<i>Columba leuconota</i>)	9.2	9.5	9.3	8.0	9.0	10.4	10.1	20.0	30.3	25.7	25.1
*Waterfowls	34	35	35	35	33	37	38	69	69	134	57

*Thousands

** Number is varied from 8-10%



Falco cherrug

a bird of passage, nesting in lowlands of north and south-western Tajikistan.

Order Anseriformes (lamellirostral) is represented by 25 species. Bar-headed goose (*Anser indicus*) is listed in the Red Data Book of Tajikistan. Because of poaching and nest destroying, the number of the bar-headed goose dropped rapidly, their nests being preserved only on the islands and shores of the Eastern Pamirs lakes – Karakul, Rangkul, and Zorkul. Since the Zorkul zapovednik was established, the population of the bar-headed goose in this territory has been under protection.

Order Falconiformes (birds of prey) includes 35 species, 11 of which are listed in the Red Data Book. Of the family of hawks (*Accipitridae*), bearded vulture (*Dypaetus barbatus hemachalanus*) nests in the mountain environment, at 1400-1800 masl, with seasonal vertical migration. Egyptian vulture (*Neophron percnopterus*) is a rare, not numerous species, which inhabits the foothills and the mid zone of mountains. It travels up the Pyanj River to Kalai-Khumb, Rushan, and Khorog, nesting at 1800-2000 masl. It is listed in the Red Data Book of Tajikistan. Golden eagle (*Aquila chrysaetus laphanea*) is a settled bird, nesting in mountainous rocks, with seasonal vertical migration.

Order Galliformes (gallinaceous) is represented by 7 species, 4 of which are listed in the Red Data Book. The rarest valuable species is seese partridge (*Ammoperdix griseogularis*), common in the southwestern part of the republic. Beard partridge (*Perdix daurica turcamona*) is a settled species, common on the northern sides of the Turkestan Range. It nests at 1200-2200 masl. Another rare and not numerous species, listed in

the Red Data Book, – Tibetan snow partridge (*Tetraogallus tibetanus*), – is a typical high-mountainous bird, included in the group of endangered species.

Pheasant (*Phasianus calchicus*) of Tajikistan forms 3 subspecies: black-golden or Tajik (*Ph.c.bianchii*), Zeravshan (*Ph.c.zeravcschanicus tarn*) and Syrdarya (*Ph. c. turkestanicus forens*) pheasants. All these species are listed in the Red Data Book of Tajikistan.

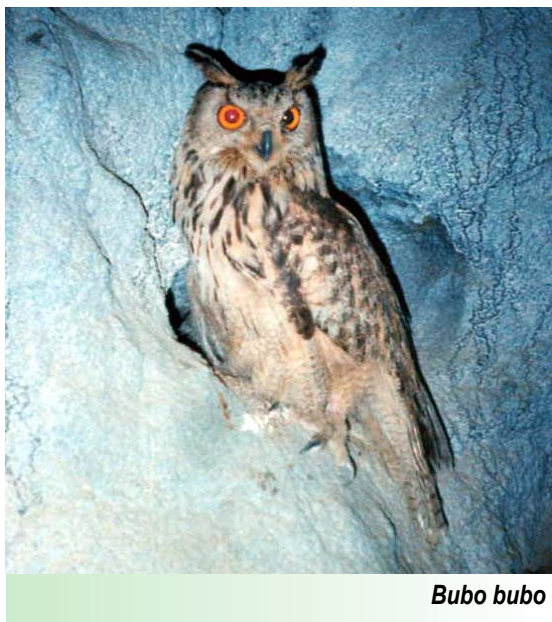
Order Gruiformes (cranes) includes 13 species, 2 of the family of bustards (*Otididae*) being listed in the Red Data Book of Tajikistan. Bustard (*Otis tarda*) occurs in Tajikistan in winter. It is a rare threatened species.

Order Charadriiformes (plover) is represented by 51 species, 5 of which are listed in the Red Data Book. *Ibidorhyncha struthetrsi* is a very rare, dropping in number, species. It is assigned to endangered species. There are some wintering and rare nesting populations. The total number of *Ibidorhyncha struthetrsi* in Tajikistan does not exceed 30 pairs. It is assigned to settled species, with seasonal migration. The vertical range covers the altitudes from 1600 to 3500 masl. It is listed in the Red Data Book of Tajikistan.

Order Columbiformes (pigeons) includes 12 species. The representatives of the order are common all over the territory of the Republic. Three species are listed in the Red Data Book of Tajikistan: *Columba leuconota* is a rare, narrow-area species, occurs in the Pamirs; *Pterocles orientalis orenarius* is a threatened, not numerous, species; (*Syrhaptes tibetana*) is a threatened species; wood pigeon (*Columba palumbus casiotis*) is listed in the Red Data Book, occurs in juniper and broad-leaf forests, at 1200-3000 masl, nesting in trees.



Otis tarda

*Bubo bubo*

Order Cuculiformes (cuckoos) is represented by 2 species: *Cuculus canorus* and *C. saturolas* are birds of passage, rare in numbers.

Order Strisiformes (owls) is represented by 8 species. The representatives of the order are quite common. They nest in the mountains and plain areas; some of them are migratory. A typical representative is eagle-owl (*Bubo bubo omissus*).

Order Caprimulgiformes (goatsucker) is represented by 2 species: *Caprimulgus europaeus sarudnyi* and *Caprimulgus aegyptius arenicolor* sev. These species in Tajikistan are nesting birds and birds of passage.

Order Coraciiformes includes 5 species: kingfisher (*Alcedo atthis atthis*, *Merops apiaster* and *Merops superciliosus persicus*, *Coracias garulus semenowi*), hoopoe (*Upupa epops epops*). All of them are birds of passage and nesting in low and high mountains.

Order Apodiformes (swifts) is represented by 3 species. Alpine swift (*Apus melba tuneti*) and black swift (*A. apus pekinensis swinhoe*) are migratory, nesting in the low-mountainous Pamiro-Alay. Little swift (*A. affinis galibejensis*) is listed in the Red Data Book of Tajikistan.

Order Piciformes (woodpeckers) includes 2 species. White-winged woodpecker (*Dendrocopos leucopterus*) is rather widespread species, nesting within the Pamiro-Alay area, *Jynx torquilla* occurs in Pamiro-Alay only as a bird of passage.

Order Passerioformes (passerines)

contains 163 species, including 7 species, listed in the Red Data Book of Tajikistan: *Carrulax lineatus*, paradise flycatcher (*Terpsiphone paradis*), *Muscicapa ruficauda*, *Microcichla scouleri*, *Chaimarrornis leucocephala*, *Myophonus caeruleus*, *Leptopoecile sophia*.

In autumn, more than 80 species of birds fly to Tajikistan from the northern latitudes and stay here until late spring, due to the favorable conditions. The most numerous group of wintering birds are waterfowl and wetland species. The rivers and lakes of Tajikistan attract large flocks of seagulls (*Larus*), *Corvus*, partridge-passerines (*Caltris*), cormorants (*Phalacrocorax*). It should be noted that the territory of Tajikistan is considered one of the main passages of bird migration in the Asian continent. The migration routes of hundreds species of birds run through the mountainous systems of Tajikistan.

Reptiles (Reptilia) of Tajikistan are very diverse, being represented by 47 species (table 1.11), included in 2 orders, 13 families, and 23 genera.

Table 1.11. Systematic structure of reptile specific diversity

Name	Number of species
Order Testudines (Tortoise)	1
Hidden-neck turtle Suborder (Cryptodira)	1
Land tortoise Family (<i>Testudinidae</i>)	1
Order Squamata (Scaly animals)	46
Suborder Sauria (Lizards)	30
Gecko Family (<i>Gekkonidae</i>)	5
Agama Family (<i>Agamidae</i>)	9
Monitor lizard Family (<i>Varanidae</i>)	1
Anguidae Family	1
Lizard Family (<i>Lacertidae</i>)	9
Family Skink (<i>Scincidae</i>)	5
Suborder Ophidia, seu Serpentes (Snakes)	16
Blind-snake Family (<i>Typhlopidae</i>)	1
Boa Family (<i>Boidae</i>)	1
Grass-snake Family (<i>Columbridae</i>)	8
Asp Family (<i>Elapidae</i>)	1
Viper Family (<i>Viperidae</i>)	4
Crotalidae Family	1

The richest specific diversity is observed in lizards – 30 species. There are 16 species of snakes and 1 species of tortoise. The Red Data Book of Tajikistan comprises 21 species of reptiles.

Numerous and common representative of reptiles is steppe tortoise (*Testudo horsfieldi*), which occurs in loess adyrs and foothill steppes. In recent years, poaching and illegal exporting has negative impact on the population of this species in the country. Lizards, inhabiting deserts, semi-deserts, foothill steppes, and (to a lesser degree) mountains, are also common and numerous (30 species).

All species of geckoes: *Crossobamon eversmanni*, *Teratoscincus scincus*, *Gymnodactylus caspius*, *Alsophylax loricatus*, are considered rare and endangered species. They occur mainly in the lower reaches of the Pyanj and Vakhsh rivers, in northern Tajikistan – in desert-tugai complexes at the Kairakkum Reservoir.

The most critical species is a gray monitor lizard (*Varanus griseus*) – the largest representative of lizards, which is endangered due to the strong transformation of their habitats. In recent decade, scarce individuals of the gray monitor lizard have been observed only in sands near the Kairakkum Reservoir and in the low reaches of the Kafirnigan, Vakhsh, and Pyanj rivers. Over 14 lizard species are rare, listed in the Red Data Book of Tajikistan.

Of 16 snake species, the most critical ones are: sand snake (*Echis carinata*), blind snake (*Typhlops vermicularis*), Central Asian cobra (*Naja oxiana*), the populations of which are being less and less numerous, because of illegal catching and keeping them in serpentaria, aimed at receiving snake's venom. One of the



Naja oxiana



Varanus griseus

main reasons for the drop in numbers of the blind snake and oriental boa is the poaching, aimed at their medicinal use. The typical habitats of most reptile species are in the areas of human activity, which causes negative impact on reptiles, mostly on the area and numbers of steppe tortoise.

Amphibians (Amphibia) are represented by 2 species: – lake frog (*Rana ridibunda*) and green toad (*Bufo viridis*). The cultivation and watering of desert and fallow lands caused the lake frog area expansion. The green toad in Tajikistan has vertical range spreading and occurs at 300-3800 masl.

Fish (Pisces). Numerous watercourses of Tajikistan are currently inhabited by 52 species and forms of fish, belonging to 12 families. The most diverse fish populations are those of rivers – 52 species, ponds – 17, lakes – 20, springs – 10. The whole diversity of fish has nearly 20 game species (table 1.12, fig. 1.16), including Amudarya trout (*Salmo trutta morfa fario*), pike (*Esox lucius*), redeye (*Scardinius erythrophthalmus*), Aral asp (*Aspius aspius taeniatus*), etc. The relic and endemic species contain 3 sturgeon species (genus of shovel-nosed pseudosturgeons): Amudarya great – (*Pseudoscaphirhynchus kaufmannii*), Amudarya small (*P. hermannii*) and Syrdarya pseudosturgeon (*P. fedtschenkoii*). Some valuable game fish – pike-asp (*Aspiolucius esocinus*), Aral barbel (*Barbus brachycephalus*) – are listed in the Red Data Book. In recent years, Aral asp (*Aspius aspius taeniatus*), *Acipenser nudiventris* have become less numerous, rare, and endangered.