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Translations by David E. Zaurov, Sasha W. Eisenman,
Dilmurad A. Yunusov, and Venera Isaeva

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Editors
Dr. Sasha W. Eisenman
College of Liberal Arts, School of Environmental Design
Department of Landscape Architecture and Horticulture
Temple University
580 Meetinghouse Road
Ambler, PA 19002
USA

Dr. David E. Zaurov
School of Environmental and Biological Sciences
Department of Plant Biology and Pathology
Rutgers University
20 Ag. Extension Way
New Brunswick, NJ 08901
USA

Dr. Lena Struwe
School of Environmental and Biological Sciences
Department of Plant Biology and Pathology
Rutgers University
59 Dudley Road
New Brunswick, NJ 08901
USA

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Preface

In ancient times, people used the gifts of nature found in their surrounding environments to treat their illnesses. Medicinal plants were of great significance, and the utilization of various plants in folk medicine has a very long history. As far back as 3000 BCE, herbs such as poppy, rhubarb, ginseng, etc., were well known. Hippocrates listed around 200 different medicinal herbs. In the first century, Dioscorides described about 400 medicinal plants, and the *Avesta*, the holy book of the Zoroastrians, included a thousand plants. In the eleventh century, Al-Beruni and Avicenna, two great scholars of Central Asia, made important contributions to the science of medicinal plants. Al-Beruni conceived a new area of science concerning medicinal herbs, now called pharmacognosy, and classified and described numerous plant species. In the year 1025, Avicenna gave the world *The Canon of Medicine*, where he described the herbs that were most widely researched and used in medical practice of the time.

Today, many of those plants are still used in medicine in Central Asia. Many centuries of herbal use has proven that plants contain substances that have healing power. Folk medicine has also shown that different parts of each plant often have different effects and, therefore, are used for different diseases, for example, roots for one type of disease and the aboveground parts for another. Similarly, leaves, flowers, fruits, and seeds may have different medicinal uses. Active compounds usually accumulate in large amounts in only certain parts of a plant (Wink 1999). The amounts of active substances in a plant, and consequently their physiological effect when taken as a medicine, significantly fluctuate depending on the season of the year, habitat, altitude, yearly climatic conditions, soil composition, and other factors (Evans 2002).

There are more than 20,000 plant species in the former Soviet Union. Of these, 4,500 grow in Uzbekistan and 4,100 in Kyrgyzstan (Komarov 1934; Pratov 1998; Umralina and Lazkov 2008). There are about 35,000–70,000 plants used in folk and scientific medicine worldwide (Hamilton 2004). As of 2004, at least 200,000 phytochemicals (excluding DNA-encoded proteins and peptides) have been characterized, but this is still thought to represent only a small percentage of phytochemicals that exist in nature (Raskin and Ripoll 2004). This further indicates the importance of drugs of herbal origin for folk and modern medicine. Currently, more than 400 wild and cultivated medicinal plants in Uzbekistan have been studied and described and more than 200 in Kyrgyzstan as well (Nikitina 1962). However, many medicinal plants found in Uzbekistan and Kyrgyzstan have not been thoroughly scientifically evaluated for their potential value in modern medicine.

Due to the increased interest in medicinal plants from different countries, the issue of preservation of the natural environment becomes important and, in particular, the conservation of medicinal plants in their original habitat. Habitat destruction and environmental pollution are factors that strongly affect medicinal plants in the wild. This complex issue is the subject of international agreements, which are united under the general concept of environmental preservation. For adequate conservation, it is important to identify the plant species that are most threatened due to over-collection in the wild. These species must receive the highest prioritization for preservation. It is important to bring the most utilized plants in medicine and veterinary science into cultivation with the goals of increasing the content of basic active compounds in the plants and providing a sustainable source of plant material. With the implementation of new agricultural practices, the industrial and medical sectors can be supplied with necessary amounts of high-quality product without depleting wild populations. Additional research is necessary to identify plants that have medicinal properties and to scientifically validate their pharmacological activities. It is important to conduct these efforts with the involvement of a wide circle of international researchers. Information exchange, job creation, and joint conferences will undoubtedly help researchers in their work and will also increase the conservation of the rich floras of Central Asian countries. A logical starting point for such systematic research would be the plants that were studied by our great ancestors and have traditionally been used in folk medicine in the different regions of Central Asia.

More than 200 of the most important medicinal plants of Central Asia are listed in this book, and it includes many whose medicinal uses and activities are being compiled for the first time. Most of the plants described grow wild in Central Asia, and some are endemic (e.g., *Vinca erecta* and *Ajuga turkestanica*). This book is aimed at scientists engaged in research on medicinal plants; physicians; as well as students of biology, pedagogy, agriculture, forestry, pharmacology, and medicine. This book is also a valuable reference for biodiversity conservation efforts and protection of rare and endangered species of the Central Asian flora.

We would like to warn our readers that conducting self-treatment with herbs and herbal preparations is dangerous. Medicinal plants can contain extremely strong physiologically active compounds and are often very poisonous. Without the proper recommendations of a medical doctor, no preparations of medicinal plants should be taken. The information in this book is not to be used to diagnose or treat any medical conditions.

Dr. Ravshanbek D. Kurbanov
Dr. Khasan Ch. Buriev
Dr. Djamin A. Akimaliev
Dr. Ilya Raskin

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Contents

Contributors

Dr. Anarbek A. Akimaliev Biology and Soil Science Institute of the National Academy of Science of Kyrgyzstan, Bishkek, The Kyrgyz Republic

Dr. Djamin A. Akimaliev Kyrgyz Agricultural Research Institute, Bishkek, The Kyrgyz Republic

Dr. Igor V. Belolipov Tashkent State Agrarian University, Tashkent, The Republic of Uzbekistan

Dr. Khasan Ch. Buriev Tashkent State Agrarian University, Tashkent, The Republic of Uzbekistan

Dr. Sasha W. Eisenman College of Liberal Arts, School of Environmental Design, Department of Landscape Architecture and Horticulture, Temple University, Ambler, PA, USA

Dr. Ravshanbek D. Kurbanov The Specialized Center for Cardiology, Tashkent, The Republic of Uzbekistan

Dr. Anvar G. Kurmukov The Specialized Center for Cardiology, Tashkent, The Republic of Uzbekistan

Dr. Ilya Raskin Department of Plant Biology and Pathology, Rutgers University – School of Environmental and Biological Sciences, New Brunswick, NJ, USA

Dr. Ishenbay S. Sodombekov Kyrgyz Botanical Garden of the National Academy of Kyrgyzstan, Bishkek, The Kyrgyz Republic

Dr. David E. Zaurov School of Environmental and Biological Sciences, Department of Plant Biology and Pathology, Rutgers University, New Brunswick, NJ, USA

1 The Geography, Climate and Vegetation of Kyrgyzstan

Djamin A. Akimaliev, David E. Zaurov, and Sasha W. Eisenman

Kyrgyzstan is a mountainous country in the northeastern part of Central Asia. The Kyrgyz Republic shares borders to the south and southeast with Tajikistan and China, to the north and northwest with Kazakhstan, and with Uzbekistan to the west. The country covers 198,500 km^2 (76,621 sq miles) and has a population of approximately 5.3 million. Kyrgyzstan is divided into seven provinces (Fig. 1.1).

The highest point of elevation is in the Kakshaal-Too range, along the Chinese border, where Jengish Chokusu (Pik Pobedy) is the highest peak at 7,439 m (24,400 ft). The lowest point of elevation, 132 m (433 ft) above sea level, occurs along the Kara Darya River in the Fergana Valley. Other notable valleys are the low-montane Talas and Chui valleys, the mid-montane Issyk-Kul and Middle Naryn valleys, and the high-montane Ak-Say and Alai valleys. Ninety-four percent of the country is montane with the Tian Shan mountain system covering the major portion of the country. Lake Issyk-Kul, in the north western Tian Shan, is the largest lake in Kyrgyzstan and the second largest mountain lake in the world.

The principal river in Kyrgyzstan is the Naryn, which flows west through the Fergana Valley into Uzbekistan. There it meets another of Kyrgyzstan's major rivers, the Kara Darya. They merge to form the Syr Darya, which eventually flows into the Aral Sea. Heavy water usage for irrigation in Uzbekistan now causes the river to run dry before reaching the sea. The Chu River also briefly flows through Kyrgyzstan before entering Kazakhstan.

D.A. Akimaliev (✉)
Kyrgyz Agricultural Research Institute,
73/1, Timur Frunze St., Bishkek 720027, The Kyrgyz Republic
e-mail: krif@mail.kg

D.E. Zaurov
School of Environmental and Biological Sciences, Department of Plant Biology and Pathology, Rutgers University, 20 Ag. Extension Way, New Brunswick, NJ 08901, USA

S.W. Eisenman
College of Liberal Arts, School of Environmental Design, Department of Landscape Architecture and Horticulture, Temple University, 580 Meetinghouse Rd., Ambler, PA 19002, USA

Kyrgyzstan's climate is influenced by its position between the temperate and sub-tropical zones, its high elevation and its distance from oceans. These conditions cause intense sun radiation, lack of precipitation and a harsh continental climate. The mountain relief causes altitudinal zoning of climate parameters such as temperature and moisture. In July the average air temperature in the lowlands can range from 17 to 40°C (62.6–104°F), whereas at a higher elevation the temperature may be much cooler. During winters frosts may occur in all regions of Kyrgyzstan.

The southwestern Fergana Valley is dry-subtropical and hot in summer, with air temperatures reaching 40°C (104°F). The plains of southern and northern Kyrgyzstan have a hot desert or semi-desert climate and in these areas air temperatures can reach 35–40°C (95–104°F) during the summer months as well (Mamitov 1965). The northern foothills have a temperate climate and the climate in the Tian Shan mountain system varies from dry continental to polar, depending on elevation. The mountain regions have steppe, meadow-steppe, meadow, and high-mountain tundra climates and the highest areas are permanently snow covered (Ryazantseva 1965).

The yearly precipitation in Kyrgyzstan varies between 100 and 1,000 mm (3.9–39 in.) and is distributed unevenly throughout the country. The highest levels of precipitation (>900 mm; 35.4 in.) occur in the mid-belt of the southwestern slopes of the Fergana and Chatkal ranges, the high mountain areas of the northern slopes in the Kyrgyz Range, in the Kemin valley, and in the eastern Issyk-Kul area. The Talas and Chui valleys receive from 250 up to 500 mm (9.9–19.7 in.) precipitation and the valley and foothills in Fergana receive from 300 to 700 mm (11.8–27.6 in.) per year. Most of the internal and central areas of the Tian Shan system average 200–300 mm (7.9–11.8 in.) of rain annually and western Issyk-Kul and portions of Fergana may have less than 150 mm (5.9 in.) per year. On average, the foothills of the north and the eastern Issyk-Kul basin receive 15–20 cm (5.9–7.9 in.) of snow annually. The amount of snow fall in the high-altitude valleys of the Tian Shan is distributed very unevenly. The Ak-Shiyrak and Karakol valleys receive an

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Fig. 1.1 Kyrgyzstan with provincial boundaries

average of 3 cm (1.2 in.) of snow whereas, on average, the Karakudjur valley receives 9 cm (3.5 in.). The mid-altitude and high-altitude belts of the Fergana range can receive upwards of 150 cm (59 in.).

The flora of the Kyrgyzstan contains more than 4,100 species of vascular plants (Umralina and Lazkov 2008). Around 1,600 species have economic and/or useful value including species for fodder (450 species), for honey production (300 species) for medicinal use (200 species), for essential oils (62 species), and for food (50 species; Nikitina 1962). The largest portion of land used for agriculture is devoted to the cultivation of grain crops. Vegetables, oil crops and cotton are also grown to a lesser extent (UNDP 2007).

The distribution of the vegetation follows a pattern of elevation belts and is mainly influenced by land relief, climate, and soil zones. Twenty-two classes of ecosystems have been identified in Kyrgyzstan. The ecosystems are unevenly distributed throughout the country. Fourteen of the ecosystems occur in middle mountain zone (2,000–3,000 m), which occupies just 30% of the country's area. The Western and Central Tian Shan regions have 16 and the Alai has 13 ecosystems. In the Northern Tian Shan and Issyk-Kul regions 10 ecosystems can be found. The southern Kazakhstan biogeographic region has five of the ecosystems and the Fergana valley has the fewest with only three (Ministry of Environmental Protection 1998).

The ecosystems include deciduous and evergreen forests, shrublands, grasslands (savannahs, meadows and steppes), deserts, various wetlands and bodies of water. The river floodplains have shrubby forests (tugai) with *Rhamnus* spp., *Salix* spp., *Rosa* spp., etc. The valleys and foothills contain perennial herbs, ephemerals, and on stony soils, thorny herbs and succulents. In the mid-belt of the mountains, depending on precipitation levels, there are deserts, steppes, meadows and shrublands. The high elevation areas consist of glacial and subglacial areas as well as cryophylic steppes, alpine meadows and deserts. The majority of these deserts are *Artemisia* spp. dominated, fewer being *Salsola* spp. deserts, and a very few dominated by *Ephedra* spp. (Golovkova 1990).

In spring and in the beginning of the summer, *Astragalus* spp., *Crocus* spp., *Gagea* spp., *Iris kolpakowskiana*, *Ranunculus* spp. and *Tulipa* spp., as well as medicinal plants like *Betonica* spp., *Salvia* spp., *Thymus* spp., *Ziziphora* spp., etc. are found in the low- and middle mountain steppes. Meadows are less common than steppes, but they have a diverse floral composition including *Aconitum* spp., *Androsace ovczinnikovii*, *Aster alpinus*, *Cerastium* spp., *Codonopsis clematidea*, *Delphinium* spp., *Erigeron aurantiacus*, *Gentiana karelinii*, *Primula algida*, etc.

Only about 4.0% of Kyrgyzstan is covered with forests. Spruce and juniper forest account for a major portion of the forested area and over 350 herbaceous plant species can be found in the spruce forests. In the southern part of Kyrgyzstan the world's largest naturally occurring nut tree forests occupy about 608,500 ha (2,350 sq miles). These forests occur mainly in the Chatkal and Fergana ranges at an elevation of 1,000–2,200 m (3,280–7,218 ft). Many of the species in these forests are wild relatives of domesticated nut and fruit crops. These wild populations are important reservoirs of genetic diversity, which can be utilized in breeding programs to develop cultivars with cold tolerance, disease and insect resistance, and other important characteristics. The main forest species is *Juglans regia* (Persian walnut), which occupies about 40,000 ha (155 sq miles). Other wild fruits and nuts include *Prunus amygdalus* (almond) and *Pistacia vera* (pistachio), *Berberis oblonga*, *Cerasus mahaleb* and *C. tianschanica*, *Crataegus songorica* and *Cr. turkestanica*, *Malus kirghisorum* and *M. sieversii*, *Prunus sogdiana*, *Pyrus communis*, *P. korshinskyi,* and *P. regelii*.

Due to their extreme environment and climate, portions of the country have limited or no biodiversity. These areas account for around 45% of the country and consist of high altitude areas (above 3,500 m [11,483 ft]) of rock and glaciers, open areas of rock, gravel or clay, and deserts.

There are 65 plant species on the list of endangered species in the *Red Data Book of Kirghiz SSR* (1985). Sultanova et al. (1998) published a more up-to-date list with 386 species recommended for inclusion to the red book. At the present time there is a need for the establishment of organized medicinal plant farming and for the protection of endangered species. Many of the plants used in Kyrgyz folk medicine have not been studied using modern scientific techniques. Pharmacological studies are necessary to characterize the biological activity of the medicinal plants and their components. Folk medicine is an invaluable source of information on the properties and activities of medicinal plants and for discovery of novel medicines. Further study of the Kyrgyz ethno-medicine will help facilitate the identification of new medicinal plants, which may possibly serve as sources for new pharmaceuticals. Further expansion of botanical and floristic research is also necessary, including detailed mapping of all medicinal plant resources and determination of regions for cultivation of valuable and rare species.

Currently all ecosystems are subject to human influence. The overall biodiversity of Kyrgyzstan is threatened as a result of human disturbance. Over-grazing has degraded many of the plant communities and over-use has greatly reduced the overall size of forest ecosystems. Intensifying anthropogenic influence threatens the diversity of the natural resources of the country. Preservation and conservation of these unique natural resources is of extreme importance for future generations of Kyrgyz people.

The Geography, Climate and Vegetation of Uzbekistan

2

Igor V. Belolipov, David E. Zaurov, and Sasha W. Eisenman

Uzbekistan is a country in Central Asia that extends from the foothills of the Tian Shan and Pamir mountains in the east to just west of the Aral Sea. In the north Uzbekistan borders Kazakhstan, in the east and southeast Kyrgyzstan and Tajikistan, in the west Turkmenistan, and in the south Afghanistan. The country covers 447,400 km^2 (172,742 sq miles) and has a population of about 26 million. Uzbekistan is divided into 12 provinces and 1 autonomous republic (Fig. 2.1).

The highest point of elevation is in the Gissar mountain range at 4,643 m (15,233 ft), and the lowest point of elevation is the Sarykamysh depression at 20 m (ca. 65.6 ft) below sea level. About 80% of Uzbekistan's land consists of plains and deserts. The vast Kyzlkum desert lies in central Uzbekistan and is largely uninhabited except for mining towns.

There is a wide spectrum of natural environments from the hot sand and gypsum deserts of Kyzlkum to the eternal snows and glaciers of the Pamiro-Alai mountains. All valleys receive their water from glaciers in the Tian Shan and Pamiro-Alai mountains. Uzbekistan's two most important rivers, the Syr Darya and Amu Darya, flow from the Tian Shan and Pamiro-Alai mountain ranges to the Aral Sea.

The climate of Uzbekistan is continental with predominance towards harsh continental. It is characterized by low precipitation (70–100 mm [~2.75 to 3.94 in.] per year) in the plains of the northern-western part of the country and up to 1,200 mm (47.25 in.) of precipitation in mountainous regions. Over 70% of the precipitation falls in the autumn to spring period, with a maximum in March and April. Summers in Uzbekistan are long, dry, and hot, summer rains are very rare, and summer temperatures may reach 45°C (113°F). In the south the winter is mild, but sometimes with considerable frosts. In the northern regions winters are cold and temperatures may drop to −37°C (−35°F).

The flora of Uzbekistan contains more than 4,500 vascular plants in 650 genera, in 115 families (Chemonics International Inc. 2001). More than 4,000 species of algae and more than 2,000 species of fungi also occur in Uzbekistan (National Biodiversity Strategy Project Steering Committee 1998). The most species-rich plant families account for a large portion of the flora. These families include Asteraceae (600 species), Fabaceae (450 species), Poaceae (>250 species), Brassicaceae, Lamiaceae, Rosaceae, Boraginaceae and Apiaceae.

Agriculture and cultivated crops occupy considerable areas of irrigated and non-irrigated land. Some of the major crops are cotton, maize (corn), alfalfa, wheat, barley, sorghum, rice, mulberry for silkworm culture, vegetables, melons, fruit trees, and others. The natural vegetation of Uzbekistan is a very rich source of fodder (more than 1,700 species), medicinal plants (600 species) and plants with essential oils (>650 species), saponins (>100 species), and tannins (ca. 400 species).

The vegetation of Uzbekistan is divided into four main ecosystems. The main cause for ecosystem zonation is change in hydrothermal conditions. These zones form belts which are directly correlated to an increase in precipitation and elevation. As elevation increases there are changes in environmental conditions. Growing periods become shorter, temperature decreases and precipitation increases. Due to the increase in precipitation water is no longer a limiting factor above 2,500 m (~8,200 ft). Diverse soil conditions, in combination with the environmental conditions, result in a great diversity of vegetation. The local names "chul" (arid plain, desert), "adyr" (foothills), "tau" (mountains), and "yailau" (alpine zone) are widely used by the people of Uzbekistan and correspond to the zones produced by vertical changes in the landscape.

I.V. Belolipov (✉)
Tashkent State Agrarian University, Tashkent-140, Tashkent 100140, The Republic of Uzbekistan
e-mai: ivbelolipov@mail.ru

D.E. Zaurov
School of Environmental and Biological Sciences, Department of Plant Biology and Pathology, Rutgers University, 20 Ag. Extension Way, New Brunswick, NJ 08901, USA

S.W. Eisenman
College of Liberal Arts, School of Environmental Design, Department of Landscape Architecture and Horticulture, Temple University, 580 Meetinghouse Rd., Ambler, PA 19002, USA

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Fig. 2.1 Uzbekistan with provincial boundaries

The chul zone (arid plain, desert): The chul consists of the flat territory of Uzbekistan, which is usually considered desert. The chul continues up to 500–600 m (~1,640 to 1,970 ft) above sea level and has a dry period of 3–6 months. The climate of the chul zone is ultra-continental and is characterized by low precipitation of 70–208 mm (~2.75 to 8.2 in.) per year and humidity levels that drop to as low as 1–2%. The dry period in the chul zone lasts from May to October. Summer temperatures can reach 45°C (113°F) while winter temperatures often drop below −30°C (−22°F).

The chul zone occupies most of the Central Asian plain (Turan) and displays four soil types: salty chul, sandy chul, gypsum (stony) chul, and clay chul (National Biodiversity Strategy Project Steering Committee 1998). Portions of the salty chul ecosystem that have extremely high salt concentrations support no plant life. Areas of salty chul with lower salt content are dominated by *Artemisia halophila* and species in the Chenopodiaceae family such as *Halocnemum strobilaceum*, *Halostachys caspica*, *Haloxylon aphyllum*, *Salicornia herbacea*, *Salsola dendroides*, *Suaeda dendroides* and *S. microphylla.* Sandy chul is dominated by *Acanthophyllum korolkowi*, *Ammodendron conollyi*, *Astragalus villosissima*, *Calligonum aphyllum*, *Convolvulus hamadae*, *Ephedra strobilacea*, *Ferula foetida*, *Salsola arbuscula* and *S. richteri*. The gypsum chul is located in the hills of the southwestern and central Kyzylkum desert. *Artemisia* associations predominate in the gypsum chul zone. The most common association is *Artemisia diffusa* (less frequently *A. ferganensis*) with *Convolvulus hamadae* or with co-dominance of *Aellenia subaphylla*, *Anabasis eriopoda*, *Anabasis turkestanica* and *Salsola arbuscula*. The species *Calligonum junceum* and *Reaumuria turkestanica*, and others are commonly found in the gypsum chul and are characteristic for the area. *Nanophyton erinaceum* is less frequent and restricted mainly to the hills.

Where river valleys cut into the chul zone the increased humidity in the valleys facilitates the development of special mesophytic communities that are locally called "tugai". Common species that occur in these communities are *Alhagi persarum*, *Apocynum scabrum*, *Asparagus persicus*, *Clematis* *orientalis*, *Elaeagnus orientalis*, *Erianthus purpurascens*, *Glycyrrhiza glabra*, *Halimodendron halodendron*, *Hippophae rhamnoides*, *Karelinia caspia*, *Limonium otolepis*, *Lycium ruthenicum*, *Phragmites communis*, *Populus diversifolia* and *P. pruinosa*, and *Tamarix* spp.

The adyr zone (lowlands and foothills): The adyr zone is a broad belt at an elevation of around 500–1,500 m (1,640–4,921 ft). This band is found around all the mountains of Central Asia. It occupies the range between two contrasting ecological zones: the xerothermic chul (desert) and the mesothermic tau (mountain region). The soils of the adyr zone contain less salt and more humus than the chul soils and are classified as sierozem (Makhmudov 2001). Bedrock is often found exposed on the surface.

The annual precipitation is between 250 (9.8 in.) and 400 mm (15.7 in.) and rarely reaches 500 mm (19.7 in.). The mean monthly temperature for July is 25°C (77°F), which is 3–4°C lower than in the chul and 5–6°C higher than in the tau zone. The dry period lasts from June to September. Due to its location the adyr zone is exposed to the influence of both the hot desert along its lower edge, and the cooling effects of the mountains on its upper edge. This causes the lower section of the adyr zone to be closer to the environmental conditions of the chul and the upper section to be similar to the mountainous environment of the tau zone. Because of this gradient the adyr is divided into subzones: the lower adyr with rolling relief and the upper adyr with broken relief.

Typical species found in the lower adyr area are *Amygdalus spinosissima*, *Artemisia sogdiana*, *Carex pachystylis*, *Mediasia macrophylla*, *Phlomis thapsoides*, *Pistacia vera* and *Psoralea drupacea*. At altitudes of 1,200–1,500 m in the upper adyr zone, typical species are *Acanthophyllum gypsophiloides, Agropyron trichophorum*, *Astragalus eximius*, *Bunium persicum*, *Centaurea squarrosa*, *Cousinia pulchella, Onobrychis* spp., *Phlomis salicifolia* and *P. olgae*, *Potentilla soongarica*, *Scabiosa songarica* and *Ziziphora pamiroalaica*.

The tau zone (mid-mountain zone): The tau zone is a broad belt at an elevation of around 1,500–2,800 m (4,921–9,186 ft). The dominant soil of the tau zone is of the brown soil type. Precipitation in this zone exceeds more than 500 mm (19.7 in.) per year, with a dry period that lasts for 3 months from July to September. The growing period is in spring, summer, and autumn with a dormant period in the winter. The mean monthly temperature in July is 19°C (66°F).

In terms of economy, the tau zone is an important area for growing cereals and leguminous crops, for producing hay, and for use as pastures. The dominating wild and cultivated shrub and arboreal species (*Crataegus* spp., *Juglans regia*, *Malus* spp., *Prunus* spp., etc.) of the area provide the local population with fuel, building materials, and food. In the tau zone shrubs can be found in large groups or as individuals. The common species of shrubs are *Berberis oblonga*, *Cerasus tianshanica*, *Ephedra equisetina*, *Lonicera microphylla*, *Rosa kokanica* and *Spiraea hypericifolia*. Some of the woody species found in the tau zone are gymnosperms such as *Juniperus semiglobosa*, *J. seravschanica* and *J. turkestanica*, and broad-leaved deciduous trees such as *Acer turkestanicum*, *Betula tianschanica*, *Crataegus pontica* and *C. turkestanica*, *Juglans regia*, *Malus sieversii*, *Prunus sogdiana*, *Sorbus persica*, *Ziziphus jujuba* and others.

The yailau zone (high mountain zone): The yailau zone is the high-altitude, subalpine to alpine zone and extends from 2,800 to around 3,400 m (9,186–11,155 ft). This zone is characterized by environmental conditions that will not support the development of arboreal and shrub vegetation. The soil is mainly light brown and of the meadow-steppe type (Kaurichev 1989). Summer is short and rather warm, with sharp changes between day and night temperatures. Summer daytime temperature reaches up to 25°C (77°F), but can drop to 0°C (32°F) at night. In the winter the temperature may drop to −40°C (−40°F). Precipitation varies from 400 (15.7 in.) to more than 600 mm (23.6 in.) per year. This zone has stony taluses, glacial valleys, glacial cirques, and glacial tongues, and fields with heavy clay soils. There are many sheer rock formations in the southwestern Tian Shan and the western Pamiro-Alai.

In terms of economy, the yailau region is utilized as the main summer pasture. While the Karakul sheep graze mainly in the chul, the Merinos and fat-tailed breeds of sheep (including the Gissar breed) are pastured mainly in the yailau. Other agriculture is limited by low temperatures.

Tallgrass meadows are an important portion of the vegetation cover of the yailau. These meadows also contain *Polygonum bucharicum* and *P. hissaricum*. In western Tian Shan and the southern Pamiro-Alai there are Apiaceae-rich meadows with *Ferula tenuisecta* and *Prangos pabularia*. Meadows containing *Alopecurus*, *Artemisia*, and *Geranium* spp. are also common in the yailau zone. Shortgrass meadows, also known as alpine meadows, are found in small patches in the upper yailau. The high-altitude meadows are comprised of a diversity of grasses and other herbaceous genera such as *Gentiana*, *Oxytropis*, *Potentilla* and *Ranunculus*. Meadows of grasses such as *Alopecurus* spp., *Festuca* spp., *Poa alpina* and *Phleum alpinum*, and sedges such as *Carex* and *Kobresia* are also characteristic of the upper yailau zone.

The great extremes of elevation, temperature, precipitation, and soil types found in Uzbekistan provide a wide range of habitats, which support a great diversity of vegetation. Due to human activities many of the natural areas of the planet are being disturbed or destroyed. Conservation of natural environments and resources are of great importance for the future of mankind and the conservation of Uzbekistan's natural resources is no exception.

A Short History of Medicinal Plant Use in Central Asia

3

Anvar G. Kurmukov and Anarbek A. Akimaliev

Central Asia is a synthesis of many nations and many cultures. There is a long history of using and documenting medicinal plants in this region. Great contributions to the knowledge of medicinal plants were made by the Greeks as early as the seventh century BCE. In the sixth century BCE, Central Asia was part of the Persian Empire founded by Cyrus (Bobokhanova and Bekturgunava 1996). In the first half of the fourth century BCE, Alexander the Great helped expand the Greek empire into the regions of Bactria and Sogdiana (territories that included much of present-day Central Asia) and formed the Greco-Bactrian Kingdom. It is known that Chinese travelers visited Central Asia and surrounding regions since the establishment of the Great Silk Road. China has a long history of herbal medicine and undoubtedly had a great influence on the development of Central Asian herbology. The Zoroastrian holy book, the *Avesta*, written over a long period (the nineth century BCE – third century CE), is a valuable source of information about the social structure, medicine, and way of life in the ancient societies of Central Asia, Iran, and Azerbaijan. The book includes information concerning all aspects of life, including natural philosophies and medical views. In the *Avesta*, medicine is described as the art of keeping the body in health. There were several kinds of treatments: (1) surgery, (2) treatment with herbs, and (3) treatment with words. This source was expanded by other researchers and physicians up to the eighth century and by that time, contained information on 1,000 plants. The *Avesta* contains information about useful and unhealthy plants, herbs that were used as sedatives, anesthetics, narcotics, restoratives, tonics, antiseptics, antidotes, and as other types of remedies. In the fifth and sixth centuries CE a large Turkic kaganate was developed as result of the unification of diverse nomadic tribes. In the seventh century Arabs brought Islam to Central Asia and during this time the knowledge and science of medicinal plants grew greatly. In 1220 CE the Mongols, led by Genghis Kahn, invaded Central Asia and there is no doubt that this invasion had an influence on the culture of the local population.

The Central Asian scientists Abu Rayhan Muhammad ibn Ahmad Al-Beruni (973–1048) and Abu Ali ibn Sina (Avicenna; 980–1037) made considerable contributions to the knowledge of medicinal plants. Both were great scholars, and besides other sciences, studied pharmacognosy and pharmacology. The work *Kitab-al-Saidana* (*Materia Medica*) was written by Beruni towards the end of his life (1041–1048). It describes about 750 plants and contains information about the botanical characteristics of plants and their geographical locality. About 400 geographical place names from where the plants had been brought (Central Asia, Afghanistan, Iran, Arabia, Azerbaijan, Armenia, and others areas) are mentioned.

Abu Ali ibn Sina (Avicenna) is famous due to his works on philosophy and medicine. Being a doctor, he studied botany as well, and often used medicinal plants to treat his patients. His most important medical work is the *Al-Qanun fi al-Tibb* (*The Canon of Medicine*). The second volume of this work is dedicated to medicinal remedies used during his time. The book describes more than 800 pharmaceutical substances of vegetative, animal, and mineral origin. Besides remedies produced in Central Asia and other countries of the Near and Middle East, Avicenna described a number of drugs brought from India, China, Greece, Africa, Mediterranean islands, and other parts of the world. The book includes the practices of scientific medicine as well as the traditional folk medicine of the time. Many medicines (drugs) described by Avicenna have entered the pharmacopoeia and are still in use. The fifth volume of *The Canon of Medicine* represents his pharmacopoeia. It describes how to make and use different forms of drugs and complex medicinal formulations. In the chapter named "Necessity of complex drugs", Avicenna

A.G. Kurmukov (✉)
The Specialized Center for Cardiology, 4 Murtozoev St., Tashkent 100052, The Republic of Uzbekistan
e-mail: kurmukov_anvar@mail.ru

A.A. Akimaliev
Biology and Soil Science Institute of the National Academy of Science of Kyrgyzstan, 265 Chuy St., Bishkek 720071, The Kyrgyz Republic

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recommended making complex drug formulations in order to increase effects of a drug; to prevent side effects of one drug by another drugs composition; to strengthen the effect of the main drug by adding another one (synergy); to increase penetration of one drug into tissues with the help from another drug, or to slow down an effect of a drug by reducing absorbability caused by a second drug and this way elongate the effect of the first drug; and to use drugs for guiding delivery of the main active substance to a point (organ) of action. Carl Linnaeus later named *Avicennia*, a genus of tropical mangrove trees, in honor of Avicenna.

In the eleventh to twelfth centuries, Ismail al-Jurjani (Ismail ibn Muhammad al-Husayn Jurjani), wrote an encyclopedic work on medicine called *Zakhirah-i Khvarazm'Shahi* (*Treasure of Khorezm Shah*). Later, in the fourteenth century, Mansur ibn Ilyas (Mansur ibn Muhammad ibn Ahmad ibn Yusuf ibn Ilyas) published his work *Kifayah-i Mansuri* (*Mansur's Sufficient Book*), which was also known as *Kifayah-i Mujahidiyah* (*The Sufficient* [*Book*] *for Mujahid*). Besides being summaries of medical theory and practice, these works gave basic information about plant-based medicine. In the eighteenth century, Muhammad Husayn (Muhammad Husayn ibn Muhammad Hadi al-Aqili al-Alavi al-Khurasani al-Shirazi, also known as or Hakim Muhammad Hadikhan) described the therapeutic qualities of more than 2,000 plants, preparations of animal origin and minerals in his works *Majma al-javami va-zakha'ir al-Tarakib* (*The Assemblage of Generalities and Treasuries of Compounds*) and Makhzan-al-*Adviyah* (*The Storehouse of Medicaments*). These works were largely based on the earlier writings of his great uncle Alavi Khan and documented centuries of past achievements in the field of folk medicine, the practices of previous physicians, and his personal research.

In the past, the use of plants for medicine was not rigorously based in science. Modern scientific techniques have been used to prove the effectiveness of many plant remedies used in folk medicine and prescribed by ancient physicians. For instance, *Rauvolfia serpentina* has been used in Indian medicine for about 2,000 years, while Europeans discovered the value of this plant only in the middle of twentieth century (Balick and Cox 1996; Gupta 2002). Since ancient times, Africans have used *Strophanthus* seeds to make arrow poison and as a cardiac remedy, but only at the end of nineteenth century did *Strophanthus* enter the European pharmacopoeia (Norn and Kruse 2004). To the present day, these plants are considered irreplaceable cardiac remedies used to treat cardio-vascular diseases.

Many of the specific activities of plant remedies described by Avicenna have been confirmed by modern research conducted at the Institute of Chemistry of Vegetative Substances (ICVS) of the Academy of Sciences of the Republic of Uzbekistan. For example, according to Avicenna, the plant *Haplophyllum perforatum* has anti-inflammatory and sedative effects. The alkaloids perforine, evoksine, skimmianine, and others have been isolated from this plant. It has been found that at medium doses these alkaloids have sedative, and in higher doses sleep-inducing effects. Some of these alkaloids also have an anti-inflammatory action (Sadritdinov and Kurmukov 1980). Another example is *Khiltit* (the gum from *Ferula foetida*), which Avicenna noted could be used as a treatment for malignant and fatal tumors by cutting the tumor open and applying the gum. According to Avicenna this gum also strengthens the libido and stimulates menstruation. The esters of sesquiterpene alcohols, ferutinine, ferutin and others have been isolated from this species. A preparation from this plant, *Panoferol*, and also the individual compounds ferutin and ferutinine, have pronounced estrogenic action. *Panoferol* strengthens the libido and increases impregnation in sheep, pigs, and cattle. A mixture of ferutin and ferutinine (under the name *Tefestrol*) has been introduced to obstetric-gynecologic practice as an estrogenic preparation (Kurmukov and Akhmedkhodzhaeva 1994). There are many more examples of corresponding effects of various plants described by Avicenna and recent data gathered by modern pharmacologists (Sadritdinov and Kurmukov 1980).

In the twentieth century, research on Central Asian medicinal plants was especially productive, particularly in Uzbekistan. In 1943, the Laboratory of Chemistry of Alkaloids (headed by Professor S.Yu. Yunusov) was founded at the Institute of Chemistry in the Uzbek branch of the Academy of Sciences of the USSR. Due to the successful activity of the laboratory, Yunusov created the Institute of Chemistry of Plant Substances at the Academy of Sciences of Uzbek Soviet Socialist Republic in 1956. The Institute had laboratories devoted to distinct chemical groups including alkaloids, glycosides, fats, proteins, terpenes and acids, lignin, coumarins and phosphorous-containing organic compounds, as well as botany, laboratories of pharmacology and toxicology, phytotoxicology, experimental technology and physical and quantitative analysis and others.

The Institute's scientific directions consisted of a complex of investigations into plant substances. All plant parts collected during different growth periods and from different regions, were investigated. Applied laboratories had the task of studying the pharmacological activity of compounds; to determine the possibility of introduction into medical practice; to study the natural habitat of the medicinal plants; to organize long-term plant collecting; to maintain the safety of natural populations; and to organize the development of medicinal formulations and their production. The overall goal of the institute was to create medicinal products following a research pipeline, which included collecting of data on pharmacognosy, isolation of individual compounds, study of their pharmacological activity and creation of medicinal preparations up to the point of introduction into medical practice.

Researchers in the Laboratory of Alkaloid Chemistry isolated and studied many alkaloids, including a number of new alkaloids belonging to various chemical groups. Research on alkaloid chemistry was summarized in the monograph *Alkaloids* by Yunusov (1974, 1981). These newly isolated alkaloids were also studied by the pharmacology and toxicology labs. The Glycoside Chemistry Laboratory (headed by Professor N.K. Abubakirov) studied cardiac glycosides. This laboratory made significant contributions to the knowledge of the chemistry of triterpene glycosides. Among the studied compounds, glycosides with immunomodulatory, gonadotropic, and hypolipidemic activities were identified. Studies of *Astragalus* led to the isolation of methyl-steroids of the cycloartan series. Many species of *Allium* (onions) native to Central Asia were investigated and as a result more than 30 new compounds were isolated. One of the most important scientific directions of the laboratory during the past years has been investigations of phytoecdysteroids. This laboratory identified the structure of 25 of the 95 phytoecdysteroids described in the literature by 1980. Studies of *Amorpha fruticosa* led to the discovery of a new class of plant glycosides containing rotenone derivatives as the aglycone.

The Laboratory of Lactones, Coumarins, and Terpenoids (headed by Prof. G.P. Sidyakin) studied various plants for lactone content, particularly for the lactones leucomisine and austricine, which were isolated from *Artemisia leucodes*. Both lactones possess pronounced anti-inflammatory action. As a compound possessing pronounced angio-protective, hypolipidemic, hypo-cholesterolemic, and anti-inflammatory actions, leucomisine has passed medical tests and has been introduced into medical practice under the preparation name *Oligvon*. Since 1970, systematic studies of chemical compounds found in various species of the genus *Ferula*, which grows in the territory of Uzbekistan and adjacent republics, have been conducted. As a result, more than 50 species of *Ferula* have been investigated, from which more than 250 new terpenoids, coumarins, and esters have been isolated and their chemical structures determined. Natural esters of mono- and sesquiterpene alcohols with aromatic acids were discovered for the first time in this lab (Kurmukov and Akhmedkhodzhaeva 1994).

In 1957, the Pharmacology Laboratory was founded at the Institute (headed by associate prof. I.K. Kamilov). The initial activities of the laboratory were related to alkaloids. The findings were mainly summarized in the books *Pharmacology of Plant Alkaloids and Their use in Medicine* (Sadritdinov and Kurmukov 1980) and *Alkaloids and Herbal Preparations for Hypertensive Treatmen*t (Kurmukov and Zakirov 1992). During these years preparations containing the alkaloids vincanine (a preparation of vincanine hydrochloride, a strychnine-like analeptic), vincamine (a preparation of vincametrine, a stimulator of uterine smooth muscles), ervinine (a CNS analeptic with primary stimulating effect on the respiratory center) and others were introduced into medical practice. Later the alkaloid lappaconitine, in the preparation *Allapenin* developed by S.Yu. Yunusov and F.N. Dzhakhangirov and isolated from *Aconitum soongaricum*, was introduced into medical practice and was widely used as an antiarrhythmic drug. The same authors developed the compound preparation *Aklezin* from similar alkaloids and which was also used as an antiarrhythmic drug. Pharmacological investigations of alkaloids from *Peganum harmala* resulted in the introduction of an anticholinesterase preparation, *Desoxypeganine*, into medical practice (Tulyaganov et al. 1986). The rotenoid glycoside amorphine was isolated from the plant *Amorpha fruticosa* in the laboratory of chemistry of glycosides. Pharmacological studies revealed the hypolipidemic, hypocholesteremic, and angio-protecting actions of the preparation (Aizikov et al. 1984; Kurmukov et al. 1982, 1984a, b, 1986). After completion of clinical tests, the preparation *Glirofam* (containing amorphine), was introduced as a prophylaxis and treatment of atherosclerosis.

A series of studies on the pharmacology of phytoecdysteroids (ecdysterone, turkesterone, ciasterone, viticosterone) isolated from *Rhaponticum carthamoides, Ajuga turkestanica*, and various species of *Serratula* have been conducted. These compounds possess tonic and anabolic actions, and unlike the steranabols (nerobol) do not have androgenic effects. They increase exercise performance, accelerate rehabilitation of lost physical capabilities, and increase an organisms' ability to adapt to extreme environmental conditions (Kurmukov and Syrov 1976; Syrov and Kurmukov 1975a, b, c, 1976a, b, c, d, 1977, 1980; Kurmukov et al. 1980, 1982; Syrov 1984, 1994; Syrov et al. 1986; Saatov et al. 1994). The preparation *Ecdisten* was developed from ecdysterone, and is used in medical practice as a restorative, to improve memory, as a prophylaxis for and treatment of myocardial infarction, and especially for rehabilitation after cardiac infarction.

The Institute of Bioorganic Chemistry of the Academy of Sciences of Uzbekistan was founded by academician A.S. Sadikov. Besides various chemical laboratories, there is also a Laboratory of Pharmacology at this Institute (headed by Prof. S.Kh. Nasirov). In addition to natural compounds, the institute has studied medicinal plants, particularly alkaloids from the species *Anabasis aphylla* and *A. jaxartica*, *Ammodendron argenteum*, *Calligonum minimum*, *Colchicum kesselringii, Merendera raddeana* and others. Other plant compounds, including proanthocyanidins from the seeds of grapes, are studied at the institute as well (Pirniyazov et al. 2003).

Medicinal plants and their compounds are studied in the Pharmaceutical Institute of the Ministry of Health of The Rep. of Uzbekistan, especially in the subdepartments of Pharmacognosy (Prof. Kh.Kh. Khalmatov and his students), Pharmacology (Prof. Kh.U. Aliev) and Botany. Prof. Khalmatov and his associates published a series of books about the medicinal plants of Central Asia and Uzbekistan, and about their use in medicine. Similar studies are conducted in the subdepartments of the medical institutes and related laboratories of the scientific research institutes. As a result of the research on plant substances in the Laboratory of Experimental Cardiology of the Scientific Research Institute of Cardiology, now known as the Republican Specialized Center for Cardiology (headed by Prof. R.D. Kurbanov), the preparations *Oligvon*, *Glirofam*, *Ecdisten*, *Kavergal* and others were introduced into medical practice.

In Kyrgyzstan scientific studies of medicinal plants began in the pharmacology laboratory of the Institute of Regional Medicine of the Kyrgyzstan National Academy of Science in 1954. Later the name of the lab was changed to laboratory of pharmacognosy. The laboratory developed a tincture and the preparation *Foetidin* from the aboveground parts of *Thalictrum foetidum*, which was used to treat the first and second stages of hypertension. Later, Dr. P.K. Alimbaeva studied all species of the genus *Lagochilus* found in Kyrgyzstan. These studies showed that *Lagochilus platyacanthus* and *L. platycalyx* had the same effects on the cardiovascular system and blood coagulation as the species *L. inebrians*. Dr. B.N. Aronova conducted pharmacognostical studies of *Betonica foliosa*. As a result, a liquid extract of the aboveground parts of this species was introduced into medical practice as a treatment for uterine diseases.

The department of biopharmacology (headed by Academician Altimishev) was organized in 1969. This department included the laboratory of pharmacology and toxicology (led by Academician Altimishev), lab of resources (led by Dr. A.A. Akimaliev), and the lab of pharmacognosy (led by Dr. P.K. Alibaeva). The main scientific goals of the department were pharmacotoxicology studies and justification for the use of natural and synthesized physiologically active compounds. The preparation *Licorin* was introduced into medical practice to treat bronchial and lung diseases. The Ministry of Public Health Committee of the USSR (Pharmacology committee) permitted the use of the linament *Karagai* and *Hippophae rhamnoides* oils, in the preparation *Gippol*, which were developed by scientists from the department. The medicinal balsams (alcoholic plant extracts), including *Arashan*, *Uccurisky*, *Kobuctan* and *Sibir*, were developed and commercialized. *Arashan* was awarded a seal of quality by the USSR and a gold medal at an international exhibition in Leipzig in 1977.

With support from the Soviet Space Program, Drs. O.I. Gorelkina, E.P. Zotov and S.N. Khabibrakhmanov of the department of biopharmacology, developed and introduced special adaptogens such as *Gipkos*, *Giprex*, *Gipomin*, *Daugil*, etc. for use in the space program and in sports medicine. The preparation *Dipsacozide*, prepared from *Dipsacus azureus* roots, was developed and studied. Experiments showed that this preparation increased organisms' resistance to hypoxia and had hepatoprotective and antiatherosclerotic activities, which were proven after clinical studies. A non-alcoholic drink called *Omur*, based on the preparation *Dipsacozide*, was developed and recommended as a prophylactic for atherosclerosis. Additionally, the glycoside fraction, *Zongorozid*, was isolated from the roots of *Scabiosa songorica*. In experiments with animals the fraction significantly decreased arterial blood pressure and had sedative effects (Alimbaeva et al. 1986).

In recent years medicinal plants have been studied at the laboratory of biopharmacology (led by Dr. A.A. Akimaliev) at the Soil Biology Institute of the Kyrgyzstan National Academy of Science. Based on edible and medicinal plants, this lab developed the dietary supplement *Chabal*, which is recommended to people who have been exposed to radiation (such as atomic power station workers), as well as recommended to weak patients and athletes as a general tonic. *Chabal* has been approved by the Pharmacology and Pharmacopeia Committee of the Ministry of Public Health of the Kyrgyz Republic.

Many therapeutic syrups have been developed using medicinal plants from the flora of Kyrgyzstan. The syrup *Beykut* is used as a sedative and *Glitimal* is used as an expectorant and anti-inflammatory. The syrup *Akan* is used to prevent the development of stones in the urinary tract and bile pathways and is also recommended as a treatment for cholecystitis and hepatitis. All of these syrups were approved by the Pharmacology and Pharmacopeia Committee of the Ministry of Public Health of the Kyrgyz Republic. At the Medical Academy of Science, under the leadership of the Corresponding Academician of the National Academy of Science of the Kyrgyz Republic Professor A.Z. Zurdinov, a preparation *Immunaz*, with immunomodulatory properties, was developed from the leaves of *Padus grayana* and introduced into medical practice.

4 Phytochemistry of Medicinal Plants

Anvar G. Kurmukov

Plants contain organic as well as inorganic substances that can provide therapeutic effects. Different plants may possess a wide spectrum of effects due to the presence of various groups of chemical compounds and various microelements. A preparation obtained from one plant can simultaneously be an analgesic, sedative, cardiotonic, anti-inflammatory, and expectorant. Well-formed herbal preparations can be used protractedly when necessary, without injury to a patient, which is very important when treating chronic ailments. Medicinal plants are widely used as prophylaxis for, and treatment of, many diseases, including gastritis, stomach and duodenal ulcers, cholecystitis, colitis, enteritis, pyelonephritis, cystitis, atherosclerosis, cardiac insufficiency, and arrhythmia. They are also used for treatment of hypertensive and hypotensive neurocirculatory dystonia, neurosis and asthenia, menopausal disorders, and also to boost the body's immune system during times of disease, for rehabilitation of post-infarction conditions, as a tonic, and to increase adaptive capabilities of the organism.

Rational phytotherapy can promote recovery from dysbolism, normalize nervous system function, contribute to stabilization of blood pressure, improve coronary blood circulation and cerebral blood supply, help reduce insomnia and increase capacity for work. Herbal preparations promote excretion of toxic substances, help individuals to regain normal strength, increase energy metabolism and stop further disease progress during atherosclerosis and hypertension.

It is known that the effectiveness of medicinal plants and their pharmacotherapeutic action is due to their complex diversity of chemical compounds. Among these compounds are alkaloids, glycosides, lactones, tannins, proanthocyanidins, pigments, ecdysones, saponins and others.

Alkaloids – Alkaloids are nitrogen-containing organic bases. They are characterized by high pharmacological activity. In small doses, alkaloids represent valuable pharmaceutical substances such as lappaconitine, vincamine, reserpine, morphine, quinidine, strychnine, atropine, caffeine, ephedrine, nicotine and others. They form the main active ingredients of many medical products used for treatment of various diseases. Decoctions, infusions, extracts and others are made of alkaloid-containing plants.

Glycosides – Glycosides are organic compounds of vegetative origin, composed of a sugar component (glycoside, glycone) and a non-sugar component (aglycone, genin). The aglycone forms the main physiologically active part. Depending on their chemical nature and structure, glycosides are divided into cyanogenic glycosides (aglycones contain prussic acid), cardiac glycosides (aglycones are cardinolides and bufadienolides), saponins (aglycones are triterpene and steroid compounds), anthraglycosides (aglycones are derivatives of anthracene), phenolics (aglycones are coumarins, flavonoids, and others), and glycoalkaloids (aglycones are nitrogen-containing steroid compounds). Cardiac glycosides are used in medicine to treat cardiac disorders. They are toxic and have to be used under the supervision of a physician.

Saponins – Saponins are glycosides that make suds when shaken in water. The name comes from the Latin word "Sapo" meaning soap. Saponins are used as expectorants, diuretics, hypotensives and hypocholesterolemics. Saponins from *Aralia mandschurica*, *Echinopanax elatus*, *Eleutherococcus* spp., and *Panax* spp. have stimulating effects. Saponins cause hemolysis after intravenous introduction. Because of this, they are only introduced orally.

Anthraglycosides – Substances which belong to anthraglycosides look like red-orange crystals. Plant extracts containing anthraglycosides usually have a blood-red color. These compounds have purgative and choleretic actions.

Phenol compounds – Simple phenols, coumarins, chromones, lignan, tropolones, flavonoids and their glycosides, tannins, proanthocyanidins and others are in this group. This group of substances has the most diverse pharmacological activity. Among them there are substances that have antihypoxic, antioxidant, choleretic, cardio-, angio-, and hepatoprotecting and hemostatic actions.

A.G. Kurmukov (✉)
The Specialized Center for Cardiology,
4 Murtozoev St., Tashkent 100052, The Republic of Uzbekistan
e-mail: kurmukov_anvar@mail.ru

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Proanthocyanidins – These are polyphenol compounds, which possess pronounced antihypoxic, antioxidant and anti-inflammatory actions. They have vitamin-P activity.

Flavones and flavonoids – This group includes heterocyclic compounds, uneasily dissolved in water. Flavones and their derivatives have a yellow color, due to which they obtained their name (flavum = yellow). These compounds (rutin, quercetin, hesperidin, citrin and others) have the ability to decrease the permeability of vascular walls and fragility of capillary walls, have antispasmodic actions used for spasms of vessels and smooth-muscle organs, and are used to treat stomach and duodenal ulcers, and hepatitis.

Coumarins and furocoumarins – These compounds increase human and animal sensitivity to ultraviolet light and are used to treat vitiligo. Some have phyto-estrogenic action. When eaten by sheep and other animals, plants containing coumarins and furocoumarins have contraceptive action. Ingestion can cause fetal death in early pregnancy as well.

Tannins – Tannins promote inhibition of pathogenic microbial growth and reduce reproduction of viruses and bacteria. They also have astringent, tanning and hemostatic actions, and increase stability of capillary walls.

Organic acids – These acids are contained in plants in free form as well as in the form of salts and esters. Among them there are malic, citric, succinic, tartaric, oxalic, formic, acetic and other acids. They participate actively in metabolism, strengthen activity of salivary glands, and increase bile excretion and gastric juices. Organic acids are contained in lemons, apples, cranberries, currants, rosehips, sea-buckthorn berries, sorrel leaves, asparagus, greater celandine and other plants. Valeric and isovaleric acids (valerian, milfoil and others), and benzoic acid (in red whortleberry) have medicinal effects.

Esters of mono – and sesquiterpene alcohols with aromatic acids – These have estrogenic, hypolipidemic, and hypo-triglyceridemic activity and moderately increase blood pressure.

Fatty oils and fat-like substances – Fats and oils are esters of glycerin and higher fatty acids. In pure form, oils (castor, sea-buckthorn and others) are used as remedies or as solvents for pharmaceutical substances. Fatty oils are used in medicine to make ointments, liniments and emollients, and for skin care and therapeutic massage. Some oils have therapeutic action. For example castor oil is used as a purgative and sea-buckthorn is used internally to treat stomach and duodenal ulcers and externally for skin burns. Plant waxes, sterols and other substances are fat-like substances. Some of them are used in medicinal preparations. Unsaturated fatty acids (oleic, linoleic, linolenic, palmitic and other acids) prevent development of atherosclerosis. They are contained in plant seeds (almond, sunflower, flax and others), and fruits (olives and sea-buckthorn).

Mucilage – Consists of nitrogen-free compounds of various chemical compositions, mainly polysaccharides. They have coating and emollient actions, and can be found in *Althaea* roots and flax seeds.

Gums – Gums are polysaccharides. They are hardened fluids released out of damaged tree and shrub bark. They are used as emulsifying agents and also as adhesives. Apricot, cherry, plum and others are sources for gum.

Pectins, starch, and various sugars – Like mucilage and gums, these are related to carbohydrate groups and are used as additives in drug formulations.

All of the above mentioned groups of chemical compounds are the main active principles of the medicinal plants that are used today. However, only a very small percentage of the great diversity of plant-based compounds that exist in nature has been explored. Through the scientific process, new compounds having other effects are currently being revealed and will continue to be revealed in the future.

Milligram% (mg%) – A unit used to describe concentration. Milligrams of a specific substance contained in 100 ml of a solution or in 100 g of the analyzed material. This unit of measure is often used to describe vitamin content in plants and foods.

The Medicinal Plants of Uzbekistan and Kyrgyzstan

5

David E. Zaurov, Igor V. Belolipov, Anvar G. Kurmukov,
Ishenbay S. Sodombekov, Anarbek A. Akimaliev,
and Sasha W. Eisenman

D.E. Zaurov
School of Environmental and Biological Sciences, Department of Plant Biology and Pathology, Rutgers University, 20 Ag. Extension Way, New Brunswick, NJ 08901, USA

I.V. Belolipov
Tashkent State Agrarian University, Tashkent-140, Tashkent 100140, The Republic of Uzbekistan

A.G. Kurmukov
The Specialized Center for Cardiology, 4 Murtozoev St., Tashkent 100052, The Republic of Uzbekistan

I.S. Sodombekov
Kyrgyz Botanical Garden of the National Academy of Kyrgyzstan, 1A Akhunbabaev St. Bishkek 720064, The Kyrgyz Republic

A.A. Akimaliev
Biology and Soil Science Institute of the National Academy of Science of Kyrgyzstan, 265 Chuy St., Bishkek 720071, The Kyrgyz Republic

S.W. Eisenman
College of Liberal Arts, School of Environmental Design, Department of Landscape Architecture and Horticulture, Temple University, 580 Meetinghouse Rd., Ambler, PA 19002, USA

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Achillea asiatica Serg. – Asteraceae

Synonyms: *Achillea millefolium* var. *manshurica* Kitam., *Achillea setacea* ssp. *asiatica* (Serg.) Worosch.

English name: Chinese yarrow, Mongolian yarrow

Russian name: Тысячелистник азиатский (Tysyachelistnik aziatskiy)

Uzbek name: Unknown

Kyrgyz name: Азия каз тандайы (Aziya kaz tandayy)

Description: Herbaceous perennial with thin, branched rhizomes. Stems few or solitary, usually 25–50 cm tall, grayish with long, entangled, white hairs, often with short leafy branches in mid and upper leaf axils. Leaves bipinnatisect, usually oblong, green or grayish-green, more or less densely hairy; leaves of sterile shoots up to 25 cm long, long-petiolate; lower stem leaves 7–20 cm long, petiolate to subsessile; upper leaves sessile, usually 1–6 cm long. Inflorescences capitula arranged in loose, convex corymbs of unequal heights. Involucre cup-shaped; involucral bracts oviform, pale yellowish-green. Ray flower ligules pink, very rarely white. Fruits oblong, wedge-shaped achenes, truncated at the apex.

Other distinguishing features: Bases of mid-stem leaves partially clasping to auriculate. Ray flower ligules usually 1–3 mm long and 1.5–2.5 mm wide.

Phenology: Flowers in August and fruits in August and September.

Reproduction: By seeds and rhizomes.

Distribution: Ysyk-Kol, Osh, Jalal-Abad, and Chuy Provinces of Kyrgyzstan; not found in the flora of Uzbekistan.

Habitat: Found in forests, steppes, and abandoned fields.

Population status: Common, forming dense groups.

Traditional use: The aboveground parts are used as a hemostatic for bloody noses, bleeding gums, small wounds, abrasions, scratches, lung and uterine hemorrhages, and hemorrhoidal hemorrhages. It is used to treat inflammation, metropathy, and for gastrointestinal diseases, such as colitis and ulcers. It is also recommended for treating inflammation of the urinary tract (Plant Resources of the USSR 1993).

Documented effects: This species is used in the same manner as *Achillea millefolium*, and is anti-inflammatory, hemostatic, and antibacterial (Tolmachev 1976).

Phytochemistry: The plant contains alkaloids, flavonoids, sesquiterpene lactones, essential oils, vitamins C and K, resin, carotene, phytoncides, and bitter and astringent substances (Plant Resources of the USSR 1993; Glasl et al. 2001).

Achillea filipendulina Lam. – Asteraceae

Synonyms: *Achillea eupatorium* M. Bieb.

English name: Fern-leaf yarrow

Russian name: Тысячелистник таволголистный (Tysyachelistnik tavolgolistnyy)

Uzbek name: Dastarbosh

Kyrgyz name: Табылгы жалбырактуу каз тандай (Tabylgy zhalbyraktuu kaz tanday)

Description: Perennial herb. Stems erect, up to 60–80 cm tall, thick, striated, densely hairy, densely-leafy. Leaves pubescent, punctate glandular; basal leaves petiolate, oblanceolate, 10–20 cm long and 3–7 cm wide, pinnatipartite with acute segments; upper leaves pinnatifid with large, incised-dentate segments, sessile. Inflorescences capitula gathered into thick, unequally high, terminal corymbs. Ray flowers 1–4, yellow, trilobate. Disc flowers yellow with flattened corolla tube. Fruits oblong, wedge-shaped achenes, 2–2.25 cm long, grayish-black.

Other distinguishing features: Flowers have a specific pungent smell.

Phenology: Flowers in June-beginning of September, fruits in the end of August-September.

Reproduction: Reproduces abundantly by seeds and vegetatively by rhizomes.

Distribution: Widespread in Kyrgyzstan; Toshkent, Samarqand, Andijon, Farg'ona and Surxondaryo provinces of Uzbekistan.

Habitat: The adyr and tau zones. On stony, shallow-soiled, slopes with rocky debris, in mountain fissures, in valleys along rivers and brooks, in agricultural zones, and rarely along the banks of small irrigation canals.

Population status: Common, often found in large populations.

Traditional use: A decoction of the herb is used to treat gastric diseases, hemorrhoids, and as an abortifacient (Khalmatov 1964; Sadyrbekov et al. 2006a).

Documented effects: An extract of the inflorescences has anti-inflammatory activity and strongly inhibited expression of genes associated with inflammation processes (Dey et al. 2008).

Phytochemistry: The herb contains 0.07–0.26 % essential oil, alkaloid traces, asparagine, amino acids and nitrogen-containing substances. Plants growing in Uzbekistan have high variation in the amount of essential oils, which can vary from 0.04 % to 0.5 %. Around 3 % aldehydes and ketones and 0.5 % phenols are found in the oil composition. Flowering plants from Burchmulla village (Toshkent province, Uzbekistan) contained 0.2–0.27 % essential oil, which contained 10 % octylene, ~5 % pinene, 8 % camphene, 0.35 % $C_{10}H_{18}O$ alcohol, about 30 % borneol and formic, acetic and caprylic acid (Khakimov and Tsukervanik 1948; Khalmatov 1964). Essential oil extracted from plants growing in the Botanical Garden of the Institute of Phytochemistry, Karaganda, Kazakstan, consisted mainly of santolina alcohol (29 %), 1,8-cineol (19.1 %) and borneol (27.8 %; Sadyrbekov et al. 2006a). The sesquiterpene lactone leucomisine was isolated from the aboveground parts (Konovalov and Nesterova 2003).

Achillea setacea Waldst. & Kit. – Asteraceae

Synonyms: None
English name: Unknown
Russian name: Тысячелистник щетинистый (Tysyachelistnik shchetinistyy)
Uzbek name: Unknown
Kyrgyz name: Катуу туктуу каз тандай (Katuu tuktuu kaz tanday)
Description: Herbaceous perennial. Stems up to 80 cm tall, whitish hairy. Leaves linear-lanceolate, 3–10 cm long, up to 2 cm wide, bi- or tripinnatisect, lobes linear-lanceolate; basal and lower stem leaves petiolate; upper leaves sessile. Inflorescences capitula, densely arranged in convex, compound corymbs; involucres oblong-cylindrical; involucral bracts greenish-yellow. Ray flowers 4–5, white, slightly 3-lobed; disc flowers 10–20, yellow, 5-lobed. Fruits oblong achenes, 1.8–2 mm long, light brown.
Other distinguishing features: Capitula 2.5–3 mm across, with peduncles ca. 3 mm long.
Phenology: Flowers in April-June and fruits in July-August.
Reproduction: By seeds and rhizomes.
Distribution: Kungay Ala-Too and Terskey Ala-Too, Chuy valley, Kyrgyz Ala-Too and Alai mountain ranges of Kyrgyzstan; not found in the flora of Uzbekistan.
Habitat: Steppes, meadow-steppes, meadows, among shrubs, forests edges, in abandoned fields, and near roads.
Population status: Common.
Traditional use: Used in the same way as *Achillea millefolium* and *A. asiatica*. A decoction is used to treat internal and external bleeding and hemorrhoids (Plant Resources of the USSR 1993; Alimbaeva and Shambetov 1988).
Documented effects: The essential oil had antimicrobial effects against *Clostridium perfringens*, *Acinetobacter woffii*, and *Candida albicans* (Unlu et al. 2002). Sesquiterpenes isolated from this species exhibited anti-inflammatory activity in the croton oil ear test (Zitterl-Eglseer et al. 1991).
Phytochemistry: This plant contains essential oil, alkaloids, glycosides, tannins, resins, organic acids, vitamins C and K (Plant Resources of the USSR 1993). The aboveground parts contain sesquiterpenes (Zitterl-Eglseer et al. 1991). The essential oil, isolated from air-dried aerial parts, contained over 51 constituents with eucalyptol (1,8-cineole) being the major component (Unlu et al. 2002).

Aconitum karakolicum Rapaics. – Ranunculaceae

Synonyms: *Aconitum napellus* var. *turkestanicum* B. Fedtsch., *Aconitum soongaricum* Stapf. (some authors recognize this as a separate species), *Aconitum winkleri* Rapaics.

English name: Unknown

Russian name: Аконит каракольский (Akonit karakol'skiy)

Uzbek name: Karakool parpisi

Kyrgyz name: Исыккол уу коргошуну (Isykkol uu korgoshchunu)

Description: Herbaceous perennial with conical tuber-like roots. Stems up to 2 m tall, branched. Leaves appressed to stem, short-petiolate; blade circular, up to 10 cm long and 15 cm wide, palmatisect with 5 segments divided to the base; each segment pinnatifid with 2–3 linear lobes, lobes 1.5–3 mm wide. Inflorescence an dense apical raceme; pedicels with two bracteoles. Flowers irregular, with 5 petaloid sepals, dark-violet. Upper sepal hood-shaped, semispherical, with a small beak. Petals 2, each with a spur. Fruit a follicetum with 3–5 glabrous follicles.

Other distinguishing features: The roots form horizontal, chain-like rows. Distinguised from *Aconitum soongaricum* by having narrower leaf lobes and appressed pubescence on the inflorescence rachis and pedicels.

Phenology: Flowers in July-September and fruits in August-October.

Reproduction: By seeds.

Distribution: Ysyk-Kol province of Kyrgyzstan; not found in the flora of Uzbekistan.

Habitat: In meadows with diverse grass species and in spruce forests.

Population status: Common, forming dense groups.

Traditional use: In Kyrgyz folk medicine, an infusion of the tubers in fermented horse milk or water and ground tubers added to meat broth, are used to treat tuberculosis, radiculitis, and headaches. Tubers are also used to treat different types of cancer (Khalmatov et al. 1984).

Documented effects: An alcoholic tincture of the roots is applied externally to treat radiculitis, neuralgia, rheumatism, and as an analgesic. This tincture is a component of the preparation *Akofit*. An infusion of the tubers and the aboveground parts is used as a component of the preparation *Anginol*, which is used to treat sore throats. Because of the high toxicity the plant is not widely used in medicine (Khalmatov et al. 1984). Compounds isolated from the plant exhibited anti-tumor activity in vitro (Chodoeva et al. 2005).

Phytochemistry: The roots contain up to 2.35 % alkaloids and the aboveground parts up to 0.5 %. The roots contain starch and organic acids as well (Khalmatov et al. 1984). The alkaloids phenyl-β-naphthylamine, karakoline, neoline, delsosine, monticamine, songorine, napelline, acetylnapelline, isoboldine, karasamine and 1-benzoylkarasamine, etc. were found in the aboveground parts (Sultankhodzhaev et al. 1973; 1986; Sultankhodzhaev and Tadzhibaev 1976; Sultankhodzhaev 1993; Atta-ur-Rahman et al. 2005; Chodoeva et al. 2005).