REVIEW OF SAPROXYLIC BEETLES IN TUGAI FORESTS OF KAZAKHSTAN*

Yu.S. Borissova

Czech University of Life Sciences Prague, Faculty of Forestry and Wood Sciences, Prague, Czech Republic

In the review, the data about the saproxylic beetles in the tugai forests of Kazakhstan is described. The main tree and shrub species related to saproxylic beetles are reported and the beetle species diversity is presented in a table. Of the species listed in the table, 36 species of saproxylic beetles are related to *Populus* sp. (*Populus diversifolia* and *P. pruinosa*), 21 species to *Elaeagnus angustifolia*, 20 species to *Tamarix* sp., and 17 species to *Salix* sp. The least number of saproxylic beetles was related to *Fraxinus sogdiana* (2 species) and *Halimodendron halodendron* (3 species). The author detected data about the representatives of the following families of Coleoptera: Brentidae, Bostrichidae, Buprestidae, Cerambycidae, and Curculionidae on the territory of tugai forests and the arid zone of Kazakhstan. According to the used references, the most numbered family of saproxylic beetles in the tugai forests is Buprestidae: 41 species have been known. The author found out data about 17 species of Curculionidae and 10 species of Cerambycidae. Other families have a lower number of species. It means that Buprestidae is the most studied family in the tugai forests of Kazakhstan. Further research is necessary to extend knowledge about the diversity of saproxylic beetles in the tugai forests of Kazakhstan.

Tugai forests, saproxylic beetles, Coleoptera, trees and shrubs; forest pests

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INTRODUCTION

Tugai forests, known as tugais, are intrazonal forests formations, which grow along bottomlands of rivers in arid regions. These forests are called intrazonal forests because they do not form separate zones. They are like inclusions in an extensive arid zone with intra-area vegetation, which is different from the main background arid flora (P r o h o r o v, 1982). They belong to a special relic type of vegetation. This type saves the old features of Tertiary flora and its centre of origin is Central Asia (T r e s h k i n, 2011).

At present, the world's largest contiguous tugai forests occur along the Tarim River, China and its tributaries in the Tarim basin (T h e v s et al., 2008). In Kazakhstan the tugai forests are tree, shrub, and herb communities in flood plains of the Syr Darya, Chu, Ili, Karatal, Lepsy, Aksu and Charyn rivers with total area of about 400 thousand ha, of which no more than 150 thousand ha is covered by forest (B a i z a k o v et al., 2007).

The tugai forests have a large agricultural and economic significance: they protect against soil erosion, water evaporation, and they strengthen the banks of the rivers. They often play an agricultural field-protection role against wind or snow, for example, and realize bio drainage in slump bottomland regions (K o l e s n i c h e n k o, 2013).

Cuttings in a non-systematic manner destroyed the tugai forests until there was complete extermination in some areas. These forests are damaged also by frequent fires, which in most cases take place when people burn

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the bulrush for agricultural needs (K o l e s n i c h e n k o, 2013). In addition to frequent fires and illegal cuttings of the unique tugai forests, they are constantly reduced because of the growth of pests and diseases loci and an unregulated year-round pasturage of livestock. All these reasons mentioned above essentially influence reproduction, growth and development of the tugai vegetation (P r o h o r o v, 1982). Compared with the other plant communities of the tugai vegetation, the tugai forests are the most threatened ecosystem. The restoration of such unique forest ecosystems is of worldwide significance (T h e v s et al., 2008).

The tugai forests are characterized by specific fauna of saproxylic beetles. These beetles are the main component of the present fauna and are of special importance for biodiversity conservation in the tugai forests. Therefore, data about the saproxylic beetles in the tugai forests of Kazakhstan are described in this review.

MATERIAL AND METHODS

The materials for the review on saproxylic beetles were collected from various literature sources. We applied the systematic of Coleoptera, which was published in the catalogue of B o u c h a r d et al. (2011). The following families of Coleoptera were chosen: Brentidae, Buprestidae, Curculionidae, Cerambycidae, and Bostrichidae, because representatives of these families form the saproxylic beetles community in the tugai forests. Most of them have the host plants in the tugais as well.

RESULTS

According to some authors, the tugai group of saproxylic beetles includes 25 species trophically associated with trees and shrubs (*Populus*, *Salix*, *Elaeagnus*, and *Tamarix*) as well as with the herbaceous (*Alhagi*, *Glycyrrhiza*, *Phragmites*, *Aeluropus* and *Juncus*) vegetation of tugais (V o l k o v i t s h, A l e x e e v, 1994). In recent years, saproxylic beetles have been studied in the tugai forests of the Ili River in Kazakhstan. The results showed that most abundant families in tugais were Curculionidae and Bostrichidae. The rare families were Buprestidae, Cerambycidae, and others (K o l e s n i c h e n k o, N a k l a d a l, 2014; K o l e s n i c h e n k o et al., 2014).

Data on the saproxylic beetles, their host plants and other information undertaken from various researches are presented in Table 1.

Specific species of a number of families mentioned in Table 1 are typical inhabitants of the tugai flora. Most of them are connected with the tugai vegetation, primarily with *P. diversifolia*, *P. pruinosa,* and *Tamarix* sp. (K h a m r a e v, 2003).

The family Buprestidae is among the largest beetle families, with nearly 15 000 species known in 511 genera. As the latter common names suggest, these insects are wood-boring as larvae, with the immature forms slowly tunneling through a variety of woody tissues of many tree and shrub species (G h a h a r i et al., 2008). The species of this family are important pests groups in forest trees of almost all regions (B í l ý, 2003). Many publications about Buprestidae have been devoted to the study of pests of forest tree species (M i t y a e v, 1955; S i n a d s k i y, 1964). Among those trees were also tugai species of trees and shrubs (A y b a s o v, 1974; M i t y a e v, Y a s c h e n k o, 2007). Data about buprestids, damaging *Tamarix* sp., are available in the article of M i t y a e v (1955), where he gave four species of buprestids. A y b a s o v (1974) identified Buprestidae species composition of turanga (*P. diversifolia* and *P. pruinosa*). There are seven species of buprestid beetles, which damage *Tamarix* sp. (M i t y a e v, Y a s c h e n k o, 2007).

The family Cerambycidae is poorly represented in the tugai forests of Central Asia. The reason of this is the comparative poverty of the Central Asian forests. Among found data, *Prionus anguslatus* (Jakovlev, 1887) is typical for deserts and semi-deserts (P l a v i l s t s h i k o v, 1936, 1958).

As mentioned in the past, *Scolytus jaroschevskyi* Schevyrew, 1893 and *Taphronurgus exul* (Reitter, 1913) (Curculionidae: Scolytinae) were found in the tugai forests (S t a r k, 1952; K o s t i n, 1973). However, other scientists found other species of this subfamily on *Populus* sp., *Salix* sp., *Ulmus* sp., and *Fraxinus* sp. (Table 1).

Among the species of the saproxylic beetles listed in Table 1, 33 species are related to *P.diversifolia* and *P.pruinosa*, 21 species to *E.angustifolia,* 20 species to *Tamarix* sp., and 17 species to *Salix* sp. in the tugai forests of Kazakhstan. The least number of saproxylic beetles are related to *Fraxinus sogdiana* (2 species) and *Halimodendron halodendron* (3 species).

According to data of Table 1, the most numbered family of saproxylic beetles is Buprestidae. It has 41 species. The family Curculionidae has 17 species that of Cerambycidae has 10 species. It means that Buprestidae is the most studied family in the tugai forests of Kazakhstan.

DISCUSSION

Scientists gave definition of tugai forests. According to Z a k t r e g e r (1927), tugai forests are unique island plant communities, the origin and life of which is closely associated with the activities of peculiar rivers. S i n a d s k i y (1968) mentioned that tugais are desert forests with tree, shrubby and grassy thickets in floodplains and deltas of Central Asia and Kazakhstan rivers. They are presented by xeromezophylous mezothermous trees, shrubs and herbs. Other scientists noted that tugai forests are the riparian forests along the rivers in the continental, winter-cold deserts of Central Asia (T h e v s et al. 2008). The tugai forests are also named oases of deserts (K o l e s n i c h e n k o , 2013). Deserts, the floodplains along the large river systems such as the Amu Darya, Syr Darya, and Tarim harbor the highest biodiversity and the natural vegetation with the highest productivity (T h e v s et al., 2012). The most important condition of tugai existence is flood regime, which lasts from several weeks to several months (S i n a d s k i y , 1968).

The tugais do not form continuous forest areas along the rivers. They look like separate groves, ribbons rotating with meadows, tangles of a bulrush or sand barchans which are covered with aculeate bushes. The tugai forests are characterized by a closest level of fresh groundwater, periodic summer flooding of the floodplain, moist microclimate in the zone of tugais, and high temperatures in summer. Due to frequent changes in riverbeds and the accumulation of new sediments, changes occur in groundwater levels, which lead to the natural change of the vegetation (Thevs et al., 2008). A special microclimate always arises in the tugai forests. This distinguishes them from ecosystems, which are normally situated around deserts (K o l e s n i c h e n k o , 2013).

The turanga, willow and oleaster are the main tree species of the tugai forests. Shrub tugais are tamarisk forests. Herbal tugais are reed thickets (S i n a d s k i y , 1968).Tugai forests are associated with shrub communities (mainly *Tamarix* and *Halimodendron* species) and grassland vegetation, i.e. *Phragmites australis* Trin. ex Staud. (T h e v s et al., 2008). The plant species of the tugai forests and associated plant communities are so-called phreatophytes. They depend on groundwater or phreatic water along riverbanks, piedmont springs, and lakeshores (T h e v s et al., 2008).

Thickets of shrubby willows (*Salix* sp.) usually grow like narrow strips along the coastal sediments, as well as lowering flat floodplains, flooded by spring floodwaters. Plantations of oleaster *Elaeagnus angustifolia* L. are situated in higher places of the first terrace. Sparse turanga or Asiatic poplar forests presented by *Populus diversifolia* Schrenk and *Populus pruinosa* Schrenk are located at the second terrace with undulating relief (B a i z a k o v et al., 2007). *Populus pruinosa* Schrenk is in the Red List of trees of Central Asia as a near threatened species. Although the species has a wide distribution, it has a very narrow ecological range, restricted to riverbanks in arid areas. The species is threatened by changes in water regime (irrigation and hydroelectric power stations), cutting, and agricultural conversion (E a s t w o o d et al. 2009). Willow (*Salix* sp.), oleaster (*Elaeagnus angustifolia*) and individual trees of turanga (*Populus diversifolia, P. pruinosa*) form the willow-oleaster type of tugai forests, where the undergrowth consists of *Rosa iliensis* Chrshan., *Lonicera iliensis* Pojark., *Berberis iliensis* Popov, *Lycium dasystemum* Pojark., *Tamarix* spp., and *Halimodendron halodendron* (Pall.) Voss, as well as mesophytic herbaceous vegetation (I s h k o v , 1995; T l e p p a e v a , 2013). Impassable thickets of tamarisk *Tamarix sp.* and salt trees *Halimodendron halodendron* grow along the second terrace. Stands of relic hygrophilous ash *Fraxinus sogdiana* Bunge, which grow in alluvial-meadow soil near the floodplain of the Charyn River in Almaty region, have a special place among the tugai forests (B a i z a k o v et al., 2007). *Fraxinus sogdiana* Bunge is in the Red List of Trees of Central Asia as a near threatened species. This species of ash, which grows along rivers in open deciduous forest, is threatened in Kazakhstan. Threats in Central Asia include cutting for timber and changes in water regimes (E a s t w o o d et al., 2009).

According to dominant trees or bush species, the tugais are divided into the following types: oleasters, Asiatic poplars, willows, and ashes. The oleaster tugais are often situated along the bottomlands of lower riches of the rivers Syrdarya, Chu, Karatal, and Ili. The Asiatic poplar tugais are situated mainly along the bottomland of the Ili River and the Syrdarya River. The willow tugais sometimes occur along the bottomlands of the rivers Chu, Ili, Karatal, and others. They grow even in a treeless area. The Charyn ash forest, which grows along the bottomland of the Charyn River, is an example of the Ash tugais (K o l e s n i c h e n k o , 2013).

The tugai forests have a large agricultural and economic significance: they protect against soil erosion, water evaporation and they strengthen the banks of rivers. They often play an agricultural field-protection role against wind or snow, for example, and realize bio drainage in slump bottomland regions (K o l e s n i c h e n k o , 2013). The riparian forests along the Tarim River and the Amu Darya, as well as along other rivers in Central Asia, provide a regionally remarkable amount of biomass, additionally to other ecosystem services such as animal shelter, renewable energy sources, sand fixation, and the provision of habitats (T h e v s et al., 2012). However, the total area of tugai forests in the Tarim basin declined from 500 000 ha in 1958 to 200 000 ha in 1978. In the Aral Sea Basin, the area of tugai forests shrunk from 500 000 ha in 1950 to 70 000 ha in 1998 (T h e v s et al., 2008, 2012).

Large activities of flow regulation in the main water arteries (the Ili River and the Syrdarya River) were performed in the Soviet Union period. The aim of these activities was an agricultural reclamation of arid regions in Kazakhstan for growing cotton, rice, and other crops. At that time, the water intake from other rivers of the desert zone increased drastically in volume and flow. The change of the hydrological regime influenced negatively the condition of the tugai forests (Prohorov, 1982). Because of economic interests and in the course of land use changes, natural tugai

Table 1. Species diversity of Saproxylic beetles in tugai forests and arid zone of Kazakhstan -Part 1

Family	Species	Host plants	Authors	Notes
Brentidae: Nanophyinae	*Allomalia quadrivirgata* (Costa, 1863)	*Tamarix* sp.	Baitenov, 1974; Mityaev, Yashenko, 2007; Temreshev, 2014	pest
Brentidae: Nanophyinae	*Titanomalia komaroffi* (Faust, 1877)	*Tamarix* sp.	Baitenov, 1974; Mityaev, Yashenko, 2007; Temreshev, 2014	pest
Brentidae: Apioninae	*Perapion chioneum* (Jablokov-Khnzorian, 1957)	*E. angustifolia, Tamarix* sp.	Temreshev, 2014	
Ptinidae: Anobiinae	*Gastrallus insuetus* (Logvinovskiy, 1978)		Logvinovskiy, 1978	
Ptinidae: Anobiinae	*Hemicoelus rufipes* (Fabricius, 1792)	*Populus* sp., *Salix* sp., *Quercus robur*	Logvinovskiy, 1985; Volodchenko, 2015	dendro-philous
Bostrichidae	*Bostrichus capucinus* (Linnaeus, 1758)	*Tamarix* sp.	Mityaev, Yashenko, 2007	
Bostrichidae	*Enneadesmus scopini* (Fursov, 1936)	*E. angustifolia*	Mityaev, 1955; Sinadskiy, 1968; Kostin, 2007	
Bostrichidae	*Lyctus turkestanicus* (Lesne, 1935)	*E. angustifolia*	Sinadskiy, 1963; Kostin, 1973	
Bostrichidae	*Xylogenes dilatatus* (Reitter, 1889)	*Tamarix* sp.	Mityaev, 1955; Sinadskiy, 1968; Kostin, 2007	
Buprestidae	*Acmaeoderella flavofasciata tschitscherini* (Semenov, 1895)	*E. angustifolia*	Sinadskiy, 1963; Volkovitsh, 2006	
Buprestidae	*Acmaeoderella* (*Carininota*) *dsungarica* (Obenberger, 1918)	*Halimodendron halodendron*	Volkovitsh, 1979a, 1979b, 1987, 2006	
Buprestidae	*Agrilus cuprescens cuprescens* (Ménétriés, 1832)	*Salix* sp.	Tleppaeva, 2013; Volkovitsh, 2006	
Buprestidae	*Agrilus ganglbaueri* (Semenov, 1891)	*P.diversifolia*, *Salix* sp.	Aybasov, 1974; Jendek, 2006; Kostin, 2007	
Buprestidae	*Agrilus uzbekistanus* (Stepanov, 1958)	*Salix* sp.	Sinadskiy, 1963; Jendek, 2006	
Buprestidae	*Agrilus pratensis pratensis* Ratzeburg, 1837	*P. diversifolia*	Sinadskiy, 1964; Jendek, 2006	
Buprestidae	*Agrilus albogularis albogularis* (Gory, 1841)	*P. diversifolia*	Jendek, 2006; Tleppaeva, 2013	
Buprestidae	*Agrilus* (*Xeragrilus*) *sericans s ericans* (Kiesenwetter, 1857)	*P. diversifolia*	Ishkov, 1995; Jendek, 2006; Tleppaeva, 2013	
Buprestidae	*Agrilus* (*Spiragrilus*) *vaginalis vaginalis* (Abeille de Perrin, 1897)	*Salix* sp.	Jendek, 2006; Tleppaeva, 2013	
Buprestidae	*Agrilus viridis viridis* (Linnaeus, 1758)	*E. angustifolia*, *Salix* sp.	Kostin, 1973; Jendek, 2006; Tleppaeva, 2013	damages wood
Buprestidae	*Agrilus tschitscherini* (Semenov, 1895)	*Salix* sp.	Jendek, 2006; Tleppaeva, 2013	damages wood
Buprestidae	*Anthaxia heydeni* (Abeille de Perrin, 1894)	*E. angustifolia*	Kostin, 1973, 2007; Bily, 2006	thin branches
Buprestidae	*Anthaxia elaeagni* (Richter, 1945)	*E. angustifolia*, *Salix* sp.	Bily, 2006; Tleppaeva, 2013	
Buprestidae	*Anthaxia nanissima* (Alexeev, 1964)	*Populus* sp., *Salix* sp. etc.	Volkovitsh, Alexeev, 1994; Bily, 2006	

Table 1. Species diversity of Saproxylic beetles in tugai forests and arid zone of Kazakhstan -Part 2

Family	Species	Host plants	Authors	Notes
Buprestidae	*Anthaxia syrdarjensis* (Obenberger, 1934)	*Salix* sp.	Bily, 2006; Tleppaeva, 2013	
Buprestidae	*Buprestis salomonii* (Thomson, 1878)	*Populus* sp., *Salix* sp. etc.	Volkovitsh, Alexeev, 1994; Kuban, 2006a	
Buprestidae	*Capnodis miliaris* (Klug, 1829)	*P. diversifolia*	Sinadskiy, 1963; Kuban, 2006b; Ghobari et.al., 2012	rare species
Buprestidae	*Capnodis sexmaculata* (Ballion, 1871)	*Fraxinus sogdiana*	Kuban, 2006b; Kazenas et. al., 2013	monitoring insect species
Buprestidae	*Cratomerus elaeagni* (Richter, 1945)	*E. angustifolia*	Richter, 1949; Bily, 2006; Kostin, 2007	damages trunks and branches
Buprestidae	*Cratomerus fariniger* (Kraatz, 1882)	*Salix* sp., *Populus* sp.	Kostin, 1973, 2007; Bily, 2006	
Buprestidae	*Cratomerus fedtschenkoi* (Semenov, 1896)	*H. halodendron*	Kostin, 1973, 2007; Bily, 2006	serious pest
Buprestidae	*Cratomerus* (*Cratomerus*) *medvedevorum* (Alexeev, 1978)		Volkovitsh, Alexeev, 1994; Bily, 2006	endemic species
Buprestidae	*Chrysobothris deserticola* (Semenov, Richter, 1934)	*E. angustifolia*, *H. halodendron*	Kostin, 1973; Seitova, 1974	
Buprestidae	*Chrysobothris nana* (Fairmaire, 1892)	*Populus* sp., *Salix* sp. etc.	Volkovitsh, Alexeev, 1994; Kuban, 2006a	
Buprestidae	*Cylindromorphus popovii* (Mannerheim, 1853)	*P. diversifolia*	Ishkov, 1995; Kuban, 2006c; Tleppaeva, 2013	
Buprestidae	*Cyphosoma tataricum* (Pallas, 1771)	*Tamarix* sp.	Kuban, 2006a; Kostin, 2007; Tleppaeva, 2013	feeds on assi-milating twigs
Buprestidae	*Dicerca aenea validiuscula* Semenov, 1896	*E. angustifolia*	Arnoldi, 1952; Kuban, 2006a; Tleppaeva, 2013	
Buprestidae	*Eurythyrea aurata* (Pallas, 1776)	*P. diversifolia*	Sinadskiy, 1964; Kuban, 2006b	
Buprestidae	*Habroloma aureum* Semenov, 1890	*Salix* sp., *Tamarix* sp.	Tleppaeva, 2013; Kuban, 2006c	
Buprestidae	*Julodis variolaris* (Pallas, 1771)	*P. diversifolia*, *F. sogdiana*	Aybasov, 1974; Volkovitsh, Kuban, 2006; Kazenas et al., 2013	monitoring insect species
Buprestidae	*Melanophila picta picta* (Pallas, 1773)	*P. diversifolia*	Richter, 1949; Aybasov, 1974; Kuban, 2006c	inhabits in wood
Buprestidae	*Meliboeus* (*Meliboeus*) *reitteri* (Semenov, 1890)	*P. diversifolia*	Ishkov, 1995; Kuban, 2006c; Tleppaeva, 2013	
Buprestidae	*Paracylindromorphus subuliformis subliformis* (Mannerheim, 1837)	*P. diversifolia*, *Salix* sp.	Ishkov, 1995; Kuban, 2006c; Tleppaeva, 2013	
Buprestidae	*Sphenoptera balassagloi balassogloi* (Jakovlev, 1885)	*Tamarix* sp.	Volkovitsh, Alexeev, 1994; Volkovitsh, 2006	
Buprestidae	*Sphenoptera exarata* Fischer von Waldheim, 1824)	*Salix* sp.	Volkovitsh, Kalashian, 2006; Tleppaeva, 2013	
Buprestidae	*Sphenoptera ignita* (Reitter, 1895)	*Tamarix* sp.	Mityaev, 1955; Volkovitsh, Kalashian, 2006; Kostin, 2007	
Buprestidae	*Sphenoptera mesopotamica* (Marseul, 1865)	*Tamarix* sp.	Volkovitsh, Kalashian, 2006; Tleppaeva, 2013	damages stems

Table 1. Species diversity of Saproxylic beetles in tugai forests and arid zone of Kazakhstan -Part 3

Family	Species	Host plants	Authors	Notes
Buprestidae	*Sphenoptera semenovi* (Jakovlev, 1889)	*Tamarix* sp.	Volkovitsh, Kalashian, 2006; Kostin, 2007; Tleppaeva, 2013	
Buprestidae	*Sphenoptera* (*Chrysoblemma*) *t amarisci beckeri* (Dohrn, 1866)	*P. diversifolia*	Ishkov, 1995; Volkovitsh, Kalashian, 2006; Tleppaeva, 2013	
Buprestidae	*Trachypteris picta picta* (Pallas, 1773)	*Salix* sp.	Volkovitsh, Alexeev, 1994; Kuban, 2006b; Tleppaeva, 2013	inhabits under bark
Buprestidae	*Xantherimia koenigi* (Ganglbauer, 1888)	*P. diversifolia*	Ishkov, 1995; Volkovitsh, 2006; Tleppaeva, 2013	
Cerambycidae	*Aromia pruinosa* (Reitter, 1903)	*P. diversifolia*	Sinadskiy, 1963	branches, trunks, hollow trees
Cerambycidae	*Chlorophorus faldermanni* (Faldermann 1837)	*P. diversifolia, E. angustifolia, H. halodendron*	Plavilstshikov, 1940; Sinadskiy, 1963; Kostin, 1973	serious pest
Cerambycidae	*Chlorophorus elaeagni* (Plavilstshikov, 1956)	*E. angustifolia*	Sinadskiy, 1963; Kostin, 1973, 2007	
Cerambycidae	*Cleroclytus semirufus* (Kraatz, 1884)	*E. angustifolia*	Kostin, 1973	
Cerambycidae	*Molorchus kiesenwetteri* (Mulsant, 1861)	*E. angustifolia*	Kostin, 1973, 2007	
Cerambycidae	*Prionus angustatus* (Jakovlev, 1887)	*P. diversifolia*	Plavilstshikov, 1936; Sinadskiy, 1963; Kostin 2007	serious pest
Cerambycidae	*Saperda populnea* (Linnaeus, 1758)	*Populus* sp.	Kolov, Temreshev, 2012	found in the flood-land of the Chilik River, Kazakhstan
Cerambycidae	*Tetrops elaeagni* (Plavilstshikov, 1954) = *Tetrops plaviltshikovi* (Kostin, 1973)	*E. angustifolia*	Sinadskiy, 1963; Kostin, 1973	
Cerambycidae	*Turanium scabrum* (Kraatz, 1882)	*P. diversifolia, E. angustifolia*	Sinadskiy, 1963	serious pest
Cerambycidae	*Xylotrechus grumi* (Semenov, 1889)	*E. angustifolia*	Khamraev, 2003; Kostin, 2007	trunks and branches; serious pest
Cerambycidae	*Xylotrechus namanganensis* (Heyden, 1885)	*P. diversifolia*	Plavilstshikov, 1940; Sinadskiy, 1963; Khamraev, 2003; Kostin, 2007	inhabits wood; serious pest
Anthribidae	*Tropideres* sp.	*P. diversifolia*	Sinadskiy, 1963	trunks and branches
Anthribidae	*Tropideres albirostris* (Herbst, 1783)	*P. diversifolia*	Temreshev, 2014	trunks and branches
Curculionidae: Scolytinae	*Eremotes subasperatus* (Reitter, 1898)	*P. diversifolia*	Sinadskiy, 1963	trunks and branches
Curculionidae: Scolytinae	*Rhyncolus culinaris* (Hustache, 1931)	*E. angustifolia*	Sinadskiy, 1963	trunks and branches
Curculionidae: Scolytinae	*Scolytus jaroschevskyi* (Schevyrew, 1893)	*E. angustifolia*	Kostin, 1973; Petrov, Kuzmichev, 1994	trunks and branches
Curculionidae: Scolytinae	*Taphronurgus exul* (Reitter, 1913)	*Clematis* sp.	Stark, 1952; Kostin, 1973, 2007	
Curculionidae: Scolytinae	*Xyleborus dryophagus* (Ratzeburg, 1837)	*Populus* sp.	Izhevskiy et al., 2005; Temreshev, 2013	

Table 1. Species diversity of Saproxylic beetles in tugai forests and arid zone of Kazakhstan -Part 4

Family	Species	Host plants	Authors	Notes
Curculionidae	*Amesostylus amudarjensis* (Arnoldi, 1952)	*P. diversifolia*	Arnoldi, 1952; Baitenov, 1974	damages leaves
Curculionidae	*Chloebius turangi* (Bajtenov, 1974)	*P. diversifolia*	Baitenov, 1974; Temreshev, 2014	endemic
Curculionidae	*Coniatus schrenki* (Gebler, 1841)	*Tamarix* sp.	Baitenov, 1974; Mityaev, Yashenko, 2007	
Curculionidae	*Coniatus splendidulus* (Fabricius, 1781)	*Tamarix* sp.	Baitenov, 1968, 1974; Mityaev, Yashenko, 2007	inhabits floodplain of the Ili River
Curculionidae	*Corigetus setulifer* (Reitter, 1902)	*P. diversifolia*	Baitenov, 1974	
Curculionidae	*Liocleonus clathratus* (Olivier, 1807)	*Tamarix* sp.	Baitenov, 1974; Mityaev, Yashenko, 2007; Kostin, 2007; Temreshev, 2014	serious pest; inhabits roots
Curculionidae	*Lixus algirus* (Linaeus, 1758)	*Tamarix* sp.	Baitenov, 1968, 1974; Temreshev, 2014	
Curculionidae	*Lixus causticus* (Faust, 1886)	*Tamarix* sp.	Baitenov, 1968, 1974; Temreshev, 2014	
Curculionidae	*Lixus incanescens* (Boheman, 1835)	*Tamarix* sp.	Mityaev, Yashenko, 2007	stems and roots
Curculionidae	*Megamecus urbanus* (Reitter, 1915)	*Tamarix* sp.	Baitenov, 1968, 1974; Temreshev, 2014	
Curculionidae	*Megamecus variegatus* (Gebler, 1830)	*Tamarix* sp.	Baitenov, 1968, 1974; Temreshev, 2014	
Curculionidae	*Polydrosus tscharynensis* (Bajtenov, 1971)	*P. diversifolia*	Baitenov, 1974	
Curculionidae	*Phyllobius piri* (Linnaeus, 1758)	*P. diversifolia*	Baitenov, 1974	
Curculionidae	*Rhyncolus nefaris* (Faust, 1885)	*P. diversifolia*	Baitenov, 1974; Temreshev, 2014	wood
Curculionidae	*Temnocerus elaeagni* (Legalov, 2006)	*E. angustifolia*	Legalov, 2006; Legalov, Korotyaev, 2006	
Curculionidae	*Temnorhinus strabus* Gyllenhal, 1834)	*Tamarix* sp.	Temreshev, 2014	
Curculionidae	*Valichanovia kostini* (Bajtenov, 1969)	*Populus pruinosa*, *E. angustifolia*	Baitenov, 1974; Temreshev, 2014	timber and roots; endemic species

forest ecosystems increasingly have been replaced by agricultural land, in particular cotton plantations (Thevs et al., 2012). Currently, due to widespread regulation of the flow and hydraulic engineering in Central Asia, the natural regeneration of tugai forests ceased (Treshkin, 2011).

The existence of the tugais is closely connected with the level of underground water and the overflow of the rivers. All tugai vegetation stops growing and becomes dry when the level of underground water decreases during the poor overflow of the rivers (Kolesnichenko, 2013). According to the study of some authors, if a river branch falls dry or turns into an episodic river branch, the tugai forests will survive as long as they can reach the groundwater. Therefore, along the Tarim River, they found a high diversity regarding ground-water levels under tugai forests (T h e v s et al., 2012). Along the Amu Darya's middle reaches, the establishment of tugai forests is only possible in the river valley; because the river will not flood the desert out-side the valley (T h e v s et al., 2012). Drying of the Amu Darya River delta led to a reduction in the occupied areas of basic tugai phytocenosis. For example, if the total area of tugai woodlands amounted to 120 000 ha in the early 1960s (B a h i y e v, T r e s h k i n, 1994), in 1970s it was no more than 52.3 000 ha (B a h i y e v, 1985).

Because of the specificity of the tugai forests, such as peculiarity of the trees and shrubs, climatic conditions, soil and hydrology, they have their own species of insect fauna. In spite of the harsh climatic conditions, low humidity and species limitations of trees and shrubs, the forest insect fauna is very diverse in the tugais (S i n a d s k i y, 1963). Beetles (Coleoptera) are the most important component of the insect fauna of the tugai forests (B u r d a y e v, 2002). Representatives of Coleoptera hold a dominant position in the number of species and the importance (S a m e d o v, M i r z o y e v a, 1985).

Saproxylic beetles are a key group for assessing forest biodiversity (H o r a k, 2011; H o r a k et al., 2012). The obligate saproxylic beetles are dead wood dependent; indicator species prefer close-to-natural forests (H o r a k, 2011; H o r a k, R e b l, 2012). Saproxylic beetles do account for a large portion of saproxylic biodiversity (just behind fungi) (S c h i e g g, 2000; M a r t i k a i n e n, K o u k i, 2003). They are widespread, numerous, species-rich, and easy to sample; they include representatives of many trophic guilds with a wide range of microhabitat preferences (B o u g e t et al., 2008; B r i n et al., 2009). They are known to exhibit greater site specificity than vertebrates, and they often respond to environmental changes more rapidly than vascular plants or vertebrates (M a r t i k a i n e n, K a i l a, 2004; F a y t et al., 2006). Therefore, they are assumed to provide valuable information on the quality and continuity of woodland habitats (S e b e k et al., 2012).

Xylophilous beetles, a part of the saproxylic beetles, are the ecological group that brings together species with all or most of their life cycle under bark or in the wood of dead or weakened trees (P l a v i l s t s h i k o v, 1932; V o r o n t s o v, 1963, 1984). The representatives of xylophilous beetles are a fundamental component of insect communities living in decaying wood (R a p h e s, 1968, 1980; I s a y e v, G i r e, 1975). By participating in the processes of the natural thinning of forest stands, the destruction of bark and wood, they accelerate the cycle of matter and energy, as well as maintaining the stability of forest ecosystems (E m e t s, L o g v i n o v s k i y, 1977; N i k i t s k i y, 1980). The important biogeocenotic role of xylophilous Coleoptera makes them an integral component of forest biogeocenosis (K r i v o l u t s k a y a, 1983; K r i v o s h e i n a, P a n o v, 1993; L i n d e m a n, 1994). Stadial distribution of xylophilous Coleoptera was expressed in the formation of specific groups in different types of forest stands and on different tree species (C h e r n y s h e v, 1996; D e m a k o v, 2000; B u r d a y e v, 2002).

Species richness and species composition of saproxylic beetles depend on factors such as forest stand age, silvicultural treatment, dead wood, etc. (R o s e n b e r g et al., 1986; V a i s a n e n et al., 1993; S i i t o n e n, 1994). Young forests had lower species richness and hosted a significantly different suite of species than medium-aged or older ones (N i l s s o n et al., 1995; O k l a n d et al., 1996; K a i l a et al., 1997). Harvested stands had lower species richness and were host to a significantly different suite of species than unharvested stands (K l i m m i n s, 1997; M u o n a, 1999; N o s s, 1999).

Saproxylic beetles are considered stands pioneers, as they are often the first to colonize dead wood (H a m m o n d et al., 2001; S i i t o n e n, 2001; G r o v e, 2002). These beetles are a functional group of Coleoptera that depend, at some point in their life cycle, on dead or decaying wood or fungi associated with deadwood (R a n i u s, L a n s s o n, 2002; S v e r d r u p - T h y g e s o n, I m s, 2002; W e r m e l i n g e r et al., 2002). Beetle assemblages are different in forests with different disturbance histories and the turnover of beetle assemblages is higher among naturally disturbed forests than among managed forests (W i k a r s et al., 2005; G i b b et al., 2006; B i s h o p et al., 2009).

Scientists use different methods for trapping saproxylic beetles. Some of them use light traps while others use nets. More usually, window traps are used for catching saproxylic beetles. Some authors found that window traps were the most efective type in sampling saproxylic beetles (M a r t i k a i n e n, K o u k i, 2003; S i m i l a et al., 2003; H a m m o n d et al., 2004; D o l l i n et al., 2008).

Window-flight trapping (WFT, also called Flight-Intercept Trapping (FIT), window/barrier trapping or collision trapping), developed by C h a p m a n, K i n g h o r n (1955) and later by P e c k, D a v i e s (1980), is currently the most frequently used technique for catching flying active saproxylic beetles (O k l a n d, 1996). Window flight traps consist of a vertical barrier to insect flight that is considered invisible to the insect. On hitting the barrier, most beetles drop down and fall into a collection container with liquid preservatives (B o u g e t et al., 2008).

Window trap captures are more suitable for comparing different forest environments (K a i l a et al., 1994; O k l a n d, 1996). For example, *Agrilus planipennis* (Fairmaire) (Coleoptera, Buprestidae) catch occurred on purple traps than on red or white traps. Traps placed in the mid-canopy of ash trees (13 m) caught significantly more beetles than those placed at ground level (F r a n c e s e et al., 2008).

CONCLUSION

In this review, using different references, 85 species from 7 families (Brentidae, Ptinidae, Bostrichidae, Buprestidae, Cerambycidae, Anthribidae, and Curculionidae) were mentioned. The most abundant families of saproxylic beetles in the tugai forests of Kazakhstan are Buprestidae (41 species), Curculionidae (22 species), and Cerambycidae (11 species). Many species of these families are serious pests for the main trees of the tugai forests. Among Buprestidae, *Agrilus viridis viridis* (Linnaeus, 1758), *Anthaxia heydeni* (Abeille de Perrin, 1894), and *Cratomerus elaeagni* (Richter, 1945) are pests of *E. angustifolia*. *Sphenoptera mesopotamica* (Marseul, 1865) is the pest of *Tamarix* sp. *Cratomerus (Cratomerus) medvedevorum* (Alexeev, 1978) is an endemic species of the tugai forests. *Capnodis sexmaculata* (Ballion, 1871) and *Julodis variolaris* (Pallas, 1771) are monitoring insect species. Among Cerambycidae, *Aromia pruinosa* (Reitter, 1903) and *Chlorophorus faldermanni* (Faldermann 1837) are pests serious for *P. diversifolia, E. angustifolia,* and *H. halodendron*. *Prionus angustatus* (Jakovlev, 1887) is a serious pest of *P. diversifolia,* as well as *Turanium scabrum* (Kraatz, 1882) is a serious pest of *P. diversifolia* and *E. angustifolia.* Among Curculionidae, *Liocleonus clathratus* (Olivier, 1807) is a serious pest of *Tamarix* sp. *Chloebius turangi* (Bajtenov, 1974) and *Valichanovia kostini* (Bajtenov, 1969) are endemic species of *P. diversifolia*, *P. pruinosa,* and *E. angustifolia* in the tugai forests of Kazakhstan. Other families have a lower number of species, but some of them are also pests. For example, *Allomalia quadrivirgata* (Costa, 1863) and *Titanomalia komaroffi* (Faust, 1877) of Brentidae: Nanophyinae are pests of *Tamarix* sp.; *Tropideres albirostris* (Herbst, 1783) of Anthribidae is the pest of *P. diversifolia.*

According the used references, most species (36) of the saproxylic beetles are related to *Populus* sp. (*P. diversifolia* and *P. pruinosa*). Furthermore, 21 species inhabit *E. angustifolia*, 20 species *Tamarix* sp., and 17 *Salix* sp. The least number of saproxylic beetle species are found in *F. sogdiana* (2 species) and *H. halodendron* (3 species). Thus, the saproxylic beetle fauna of *Populus* sp. (*P. diversifolia* and *P. pruinosa*) is the most diverse and the most studied.

According to the results, the saproxylic beetle fauna in the tugai forests of Kazakhstan is very diverse (85 species from 7 families). However, the degradation processes which take place in the tugais lead to reduction of the saproxylic beetle fauna. Therefore, the activities towards restoration of the tugai forests should be done in Kazakhstan.

Despite the valuable data on the diversity of saproxylic beetles provided by different researchers, their further study is required to extend knowledge about the beetle fauna diversity in the tugai forests of Kazakhstan.

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Corresponding Author:

Ing. Yuliya B o r i s s o v a , MSc., Czech University of Life Sciences Prague, Kamýcká 129, 165 00 Prague 6-Suchdol, Czech Republic, phone: +7 705 550 11 56, e-mail: yuliyakaznau2015@gmail.com