History and peculiarities of study of the Far Eastern species of *Euonymus* in Russia and neighboring countries

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ABSTRACT

The Russian Far East is of particular interest to monographers of the genus *Euonymus*, because this is where the northern distribution limits of many East Asian species are. At the same time, the main problem is different understanding of the scope and status of a number of taxa by Russian and foreign botanists. The article presents the chronology of the most prominent results of various authors, Russian and foreign (primarily Chinese, Korean and Japanese), who contributed to taxonomic, environmental and chorological studies of the genus *Euonymus*. The contributions of N.S. Turczaninow, K.J. Maksimovich, F.B. Schmidt, V.L. Komarov, T. Nakai, Ya.I. Prokhanov, A.I. Tolmachev, B.A. Shukhobodsky, T.G. Leonova, N.N. Tzvelev, S.K. Cherepanov, K.V. Kiseleva, V.A. Nedoluzhko to the formation of the modern taxonomic concept of the genus *Euonymus* are analyzed. Unresolved issues of biology of the Far Eastern species are emphasized, the ways of to solve them are outlined.

Keywords: history of botanical research, Russian Far East, China, Korea, Japan, *Euonymus*

РЕЗЮМЕ

Савинов И.А. История и особенности изучения дальневосточных видов *Euonymus* в России и соседних странах. Дальний Восток России представляет особый интерес для монографов рода *Euonymus*, поскольку здесь находятся северные границы распространения многих восточноазиатских видов. В то же время основной проблемой является разное понимание объема и статуса ряда видов российскими и зарубежными ботаниками. В статье представлена хронология наиболее выдающихся результатов исследований различных авторов, российских и зарубежных (в первую очередь китайских, корейских и японских), которые внесли свой вклад в систематику, экологию и распространение дальневосточных видов рода *Euonymus*. Приведен анализ вклада Н.С. Турчанинова, К.И. Максимовича, Ф.Б. Шмидта, В.Л. Комарова, Т. Накаи, Я.И. Проханова, А.И. Толмачева, Б.А. Шухободского, Т.Г. Леоновой, Н.Н. Цвелева, С.К. Черепанова, К.В. Киселевой, В.А. Недолужко в формирование современной таксономической концепции рода *Euonymus*. Освещены нерешенные вопросы биологии дальневосточных видов, намечены пути их решения.

Ключевые слова: история ботанических исследований, российский Дальний Восток, Китай, Корея, Япония, *Euonymus*.

Eleven species of the genus *Euonymus* (Celastraceae) are found in the Russian Far East:

- Euonymus alatus* (Thunb.) Siebold 1827, Syn. Fl. Oecon. Jap.: 49 (Type: Japan, UPS)
Euonymus sieboldianus Blume 1827, Bijdr. Fl. Nederl. Ind.: 1147 (Type: Japan, L)
Euonymus maackii Rupr. 1857, Bull. Phys.-Math. Acad. Sci. Petersb. 15: 358 (Type: Russia, LE)
Euonymus macropterus Rupr. 1857, Bull. Phys.-Math. Acad. Sci. Petersb. 15: 358 (Type: Russia, LE)
Euonymus pauciflorus Maxim. 1859, Mém. Prés. Acad. Sci. Pétersb. Div. Sav. 9: 74 (Prim. Fl. Amur.) (Type: Russia, LE)
Euonymus oxyphyllus Miq. 1865, Ann. Mus. Bot. Lugduno-Batavi 2: 86 (Type: Japan, L)
Euonymus sachalinensis (F. Schmidt) Maxim. 1882, Bull. Acad. Sci. Petersb. 27: 446 (Type: Russia, LE)
Euonymus planipes (Koehne) Koehne 1906, Mitt. Deutsch. Dendr. Ges. 15: 62 (Type: cult.*)
Euonymus sacrosanctus Koidz. 1925, Bot. Mag. Tokyo 39: 12 (Type: Japan, KYO)
Euonymus maximowiczianus Prokh. 1949, Fl. URSS, 14: 744,

nom. altern. (Type: Russia, LE)

Euonymus × *miniatus* Tolm. 1957, Bot. Mater. Gerb. Bot. Inst. Komarova Akad. Nauk S.S.S.R., 18: 159. (Type: Russia, VLA)

Behind each species is the history of its discovery, including its collection in the nature and valid description, scientific interests and lives of botanists. 6 *Euonymus* species were described from the territory of the Russian Far East. This all sheds light on the understanding of plant diversity and contributes to better understanding the contemporary distribution pattern of certain species.

This article is based on the study of historical information and on the critical analysis of literary and herbarium specimens (mainly Russian herbaria, over 4000 specimens in total), acquaintance with archived materials of natural science and local history museums.

The history of study of *Euonymus* in the Russian Far East shows several significant stages and is summarized in Table 1.

Table 1. The main stages in studying *Euonymus* of the Russian Far East and neighboring countries. For herbaria acronyms author follows Thiers (continuously updated).

Stages of research	Main researchers (* – main collectors), their life dates, places of birth	Collection years and regions, herbaria acronyms	Described species and other taxa	Total number of <i>Euonymus</i> spp. described/ Russian Far East species/ new spp.	Publications and notes
Beginning	C.P. Thunberg (1743–1828), Jönköping, Sweden	1775–1776, Japan, UPS	<i>Euonymus japonicus</i> Thunb., <i>E. tobiro</i> Thunb., <i>Celastrus alatus</i> (= <i>Euonymus alatus</i> (Thunb.) Siebold)	3/1/1	"Flora of Japan" (Thunberg 1780, 1784)
	P.F. von Siebold (1796–1866), Würzburg, Germany	1823–1829, Japan, L, LE			"Flora Japonica" (Siebold 1835)
	R.K. Maack* (1825–1886), A(h)rensburg (Kuressaare), Russia	1855, Amur, LE 1859, Ussuri, LE			Maack 1859, Regel 1862, in Russian. Collections were prepared by Ruprecht (1857), Regel (1861) and Maximowicz
	C.L. Blume (1796–1862), Braunschweig, Germany	1822–1826, L	<i>E. sieboldianus</i> Blume, <i>E. subtriflorus</i> Blume (= <i>E. alatus</i> (Thunb.) Siebold), <i>E. thunbergianus</i> Blume (= <i>E. alatus</i> (Thunb.) Siebold)	5/3/3	1827
	C. Ledebour (1785–1851), Stralsund, Germany	1826, 1829–1831, LE		6/0/0	"Flora Rossica" (Ledebour 1841–1842); only European and Crimean-Caucasian species (with a note about the collection of <i>E. verrucosus</i> – also from "Siberia Uralensi", coll. Lessing)
	N.S. Turczaninow (1796–1863), Nikitovka, Russia	KW, LE	Genus <i>Melanocarya</i> Turcz., (now as the section <i>Melanocarya</i> (Turcz.) Nakai in <i>Euonymus</i>)		1858
	F.J. Ruprecht (1814–1870), Freiburg im Breisgau, Germany	LE	<i>E. maackii</i> Rupr., <i>E. macropterus</i> Rupr.	2/2/2	"Die ersten botanischen Nachrichten über das Amurland", 1857
Pioneer studies	F.B. Schmidt* (1832–1908), Kaisma, Russia	1859–1862, Amur, Sakhalin, LE		2/2/0	"Amguno-Bureinskaya flora" (Schmidt, 1874a; Dutch ed. – 1868)
			<i>E. latifolius</i> var. <i>sachalinensis</i> F. Schmidt	4/4/1	"Sachalinская flora" (Schmidt, 1874b, in Russian; Dutch ed. – 1868)
	C.J. Maximowicz* (1827–1891), Tula, Russia	1854–1857, Amur, Ussuri, LE; 1860–1864, Japan, LE	<i>E. pauciflorus</i> Maxim., <i>E. sachalinensis</i> (F. Schmidt) Maxim., <i>E. ussuriensis</i> Maxim.	17/6/3	"Primitiae florae amurensis" (Maximowicz 1859, in Latin); "Diagnoses plantarum novarum asiaticarum" (Maximowicz 1881, 1882, in Latin); from territories, adjacent to Russia, such species as <i>E. bungeanus</i> Maxim., <i>E. nipponicus</i> Maxim., <i>E. przewalskii</i> Maxim., <i>E. schensianus</i> Maxim.
		Central Asia, coll. N.M. Przewalskii (1839–1888), prepared by Maximowicz, LE			"Flora Tangutica" (Maximowicz 1889, in Latin). Based on materials provided by C.J. Maximowicz, other authors have described a few more species
"Flora of Manchuria" and others floristic works	V.L. Komarov* (1869–1945), St. Petersburg, Russia	1895–1897, Amur, South-Ussuri Territory, Manchuria, North Korea, LE, LECB	<i>E. hamiltonianus</i> Wall. in Roxb. var. <i>maackii</i> (Rupr.) Kom., <i>E. hamiltonianus</i> Wall. in Roxb. var. <i>sieboldianus</i> (Blume) Kom.	6/5/0	"Flora of Manchuria" (Komarov 1904, in Russian); "Introduction to the floras of Mongolia and China" (Komarov 1908, in Russian): 50 000 specimens and about 6 000 species from China, Korea, Japan, Mongolia and Tibet (the family Celastraceae ranks 25th with its 9 genera and 84 species)
	A.N. Krishtofovich (1885–1953), Krishtopovka, Russia	1914, 1917, Amur, Sakhalin, LE		7/5/0	Krishtofovich 1914, in Russian
"Die Naturlischen Pflanzenfamilien"	Ludwig Eduard Theodor Loesener (1865–1941), Germany	B			1st ed. – 1896, 2nd ed. – 1942; 36 species out of 60 known at that time; in the second edition – 96 species out of 170; original system of the genus, with 11 sections, which was criticized by many subsequent authors (for a review see: Blakelock 1951)

Table 1. Continued.

Stages of research	Main researchers (* – main collectors), their life dates, places of birth	Collection years and regions, herbaria acronyms	Described species and other taxa	Total number of <i>Euonymus</i> spp. described/ Russian Far East species/ new spp.	Publications and notes
"Flora of the USSR", ed. by V.L. Komarov and other publications 1940–1960s	Ya.I. Prokhanov (1902–1965), Zheleznovodsk, Russia	LE	Genus <i>Kalonymus</i> (Beck) Prokh.; Ser. <i>Semenovianae</i> Prokh.; Ser. <i>Oxyphyllae</i> Prokh.; Ser. <i>Latifoliae</i> Prokh.; Ser. <i>Sachalinensis</i> Prokh.; Ser. <i>Macrogemmae</i> (Nakai) Prokh.; Sect. <i>Uniloculares</i> (Rouy et Fouc.) Prokh.; <i>E.</i> (= <i>Kalonymus</i>) <i>maximowiczianus</i> Prokh.	16/8/1	Prokhanov 1949, in Russian, English edition – 1974), additions – Prokhanov 1960
	B.A. Shukhobodsky (1920–?), USSR	LE, VLA		29/10/0	"Trees and Shrubs of the USSR" (Shukhobodsky 1958)
	A.I. Tolmachev* (1903–1979), St. Petersburg, Russia	1947–1955, Sakhalin, LE, VLA	<i>E. × miniatus</i> Tolm.	6/6/1	Tolmachev 1957, 1959; Tolmachev & Shukhobodsky 1963
	S.N. Moiseenko, USSR				Moiseenko 1954, in Russian; brief review of the Far Eastern species
Monograph "The genus <i>Euonymus</i> L. of the USSR and neighboring countries"	T.G. Leonova (born 1930), Leningrad, USSR	LE		54/10/0	Leonova 1974, in Russian
	E.I. Shimanovich, USSR			31/11/0	Shimanovich 1987, in Russian; the author follows the taxonomic structure of the genus <i>Euonymus</i> proposed by T.G. Leonova (1974)
"Vascular plants of the Soviet Far East", ed. by S.S. Kharkevich	V.N. Woroshilov (1908–1999), Khomaykovo (Moscow Reg.), Russia	MHA, MW, VLA	<i>E. alatus</i> subsp. <i>alatus</i> ; <i>E. alatus</i> subsp. <i>sacro-sanctus</i> (Koidsz.) Worosch.; <i>E. macropterus</i> var. <i>miniatus</i> (Tolm.) Worosch.	11/11/0 8/8/0	Woroshilov 1966, 1982, in Russian; the identification key for <i>Euonymus</i> species in paper (Woroshilov 1982) should be considered inappropriate
	K.V. Kiseleva (born 1929), USSR	MW		10/10/0	Kiseleva 1988, in Russian; excluding <i>E. oxyphyllus</i> Miq.
	V.A. Nedoluzhko (1953–2001), Ussuriysk, USSR	VLA	<i>E. planipes</i> subsp. <i>planipes</i> ; <i>E. planipes</i> subsp. <i>maximowiczianus</i> (Prokh.) Nedoluzhko	11/11/0	Nedoluzhko 1995, in Russian
	S.K. Cherepanov (1921–1995), Vятка, USSR	LE		19/10/0	Cherepanov 1994
	V.I. Baranov, USSR	VLA		6/6/0	Baranov 1998, 1999, in Russian; data on distribution of individual species and rhythms of their seasonal development in the Russian Far East are presented
	N.N. Tzvelev (1925–2015), Tambov, USSR	LE		18/8/0	"Flora of Eastern Europe", ed. by N.N. Tzvelev: 2004, in Russian
Current studies	V.Yu. Barkalov, USSR	VLA		6(7)/6(7)/0	"Flora of the Kuril Islands" (Barkalov 2009); <i>E. oxyphyllus</i> Miq. in the Russian flora (Kunashir island), the second record (the first record – Tatewaki 1957: was collected on Kunashir Island in 1929, and kept in SAPS)
	I.A. Savinov (born 1977), Moscow, USSR	2007, 2017, 2019, Sakhalin, Primorye Territory, MHA		15(16)/10(11)/0	Savinov 2009, 2011, Savinov & Trusov 2018

As the new data on the polymorphism and species diversity within *Euonymus* have been accumulated, from time to time there came a temptation to split some species into several independent ones, rejecting the broad Linnean interpretation. However, the entire history of taxonomic studies of the genus clearly demonstrates the importance of its broad treatment (Savinov & Baikov 2007).

Far Eastern species of *Euonymus* as treated by Chinese taxonomic school

Out of the earlier works, the paper by Wang Chen-Hwa (1936) must be mentioned. It is of a huge interest because China is one of the main centers of species diversity for *Euonymus*. Wang cited diagnoses and keys for identification of 35 *Euonymus* species. The author also provided the

data on distribution, herbarium specimens examined and possible relationships between certain species.

For the current "Flora of China", the authors (Ma 2001, Ma & Funston 2008) accepted 5 sections of the genus *Euonymus* (*Uniloculares* Rouy et Foucaud, *Echinococcus* Nakai, *Melanocarya* (Turcz.) Nakai, *Ilicifolia* Nakai, *Euonymus*) and 90 species (50 of which are endemic). Unfortunately, many species from the Russian Far East territory are reduced to synonyms of closely related Chinese species there (among them there are *E. planipes*, *E. maximowiczianus*, *E. × miniatus*, *E. sacrosanctus*, *E. sieboldianus*, *E. pauciflorus*). This by no means can be considered a good solution, because, apart from clearly separated ranges, these species have solid morphological distinctions.

Far Eastern species of *Euonymus* as treated by Korean taxonomic school

In a series of works by Kim & Kim (1994a-c), Kim et al. (1997) a complex approach to investigating the species diversity of *Euonymus* from the Korean Peninsula was introduced. It involves the analysis of morphological and anatomical features of vegetative and reproductive organs (the shape of stem and buds, leaf morphology: the shape of leaf blade, edge and top, petiole and leaf blade anatomy, structure of flowers, inflorescences and capsules), numerical analysis of 60 characters, for 16 taxa (9 species, 4 varieties and 3 forms). Our knowledge on *Euonymus* for Korean Peninsula was enriched with the new treatment by Ka (2006) for the "New flora of Korea" that includes 19 (!) species, subspecies, varieties and forms of *Euonymus* found on the peninsula, some of them being the same as in Russia.

Far Eastern species of *Euonymus* as treated by Japanese taxonomic school

Takenoshin Nakai (1882–1952) is one of the most prominent Japanese botanists, who studied not only floras of Korea and Japan, but also authored some critical monographic treatments of the genus *Euonymus* (Nakai 1934, 1943). In his first paper, 36 *Euonymus* species from Eastern Asia are investigated and subdivided into a number of sections; in the other work (Nakai 1943) he subdivided the genus *Euonymus* into 6 subgenera, also describing 3 new genera – *Genitia* Nakai, *Masakia* (Nakai) Nakai and *Turibana* (Nakai) Nakai, however, later they were included into *Euonymus* L. s.l. T. Nakai greatly improved the Japanese taxonomic system of *Euonymus*, and some sections proposed by him were accepted by other researchers. In particular, Prokhanov (1949) in the "Flora of the USSR" in general follows Nakai (1943) in delimiting the volume of sections. Some new species were also described by Nakai.

Japanese botanists (Sugawara 1940, Tatewaki 1957) contributed to the study of *Euonymus* diversity in Sakhalin and the southern Kuril islands.

In "Flora of Japan", Ohwi (1984, English edition, Japanese – 1965) listed 15 species of *Euonymus* (some of them including varieties and forms), 6 of the presented species were common in Japan and Russia, – *E. alatus*, *E. sieboldianus*, *E. macropterus*, *E. oxyphyllus*, *E. planipes*, *E. tricarpos* = *E. sachalinensis*.

Recent taxonomical treatments suggest that *E. maximowiczianus* Prokh. occurs not only in south of Primorye Territory

(Russian Far East), but also in the neighboring parts of northeast China and North Korea (in the latter case it mistakenly considered as *E. sachalinensis* (F. Schmidt) Maxim., incl. *E. planipes* (Koehne) Koenhe). *E. sachalinensis* (F. Schmidt) Maxim. and *E. × miniatus* Tolm. occurs in northern Japan (both species are considered to be *E. tricarpos* by Japanese authors).

The following issues of biology of the Far Eastern *Euonymus* species of the can be considered unresolved or under-investigated: 1) phenology and rhythms of seasonal development in all species; 2) details of ecology and distribution of separate species, in particular, vicarious (e.g., *Euonymus alatus* and *E. sacrosanctus*); 3) life form morphogenesis taking into account its polyvariety for all Far Eastern species according to the approach by Bezdelev & Bezdeleva (2006); 4) taxonomic status of some species in the neighboring countries (Russia, DPRK and Republic of Korea, China and Japan).

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