

# NOBANIS –Invasive Alien Species Fact Sheet

## *Ondatra zibethicus*

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### Author of this fact sheet:

Christina Birnbaum, Estonian University of Life Sciences, Institute of Agricultural and Environmental Sciences, Kreutzwaldi 64, 51014 Tartu, [chbirnbaum@yahoo.com](mailto:chbirnbaum@yahoo.com)

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### Species description

**Scientific names:** *Ondatra zibethicus*, (L., 1766) Cricetidae (*Muridae*, *Arvicolinae*)

**Synonyms:** *Ondatra zibethica*, *Castor zibethicus*, *Fiber zibethicus*, *Myocastor zibethicus*, *Mus zibethicus*, *Mussascus*

**Common names:** Muskrat (Musquash) (GB), Swamp rabbit (GB), Marsh rabbit (GB), Marsh hare (GB), Bisam (DE), Bisamratte (DE), Moschusratte (DE), Zwergbiber (DE), Zibethratte (DE), Bisambiber (DE), Biberratte (DE), Sumpfkaninchen (DE), Sumpfhase (DE), Muschmaus (DE), Zibetmaus (DE), Wasserratte (DE), Bisamrotte (DK), Ondatra (EE), Piisamrott (EE), Piisami (FI), Moskusrotta (IS), Ondatra (LT), Ondatra / bizamžurka (LV), Piżmak (PL), Ондатра (RU).



**Fig. 1.** *Ondatra zibethicus*, photo by Nanna Ramsgaard.



**Fig. 2 and 3.** Close-up of tail and hind feet of *Ondatra zibethicus*, photo by Nanna Ramsgaard

### **Species identification**

*O. zibethicus* can attain a head and body length of 40 cm, a tail length of up to 25 cm, and a maximum weight of 1.5 or 2 kg. The species is especially adapted to an aquatic mode of life: its tail is naked and laterally flattened, the nose and ears are closeable, and the edges of its hind feet carry swimming bristles (Burghause 1988). It has a “rat-like” appearance but is actually closely related to voles *Microtus* spp. and lemmings *Lemmus* spp (Banfield 1974).

### **Native range**

*O. zibethicus* originates from North America.

### **Alien distribution**

The central European populations of *O. zibethicus* are recruited from at least two centers of dispersal. Two males and three females were released for hunting purposes at Dobrisch near Prague around 1905 (cf. Hoffman 1958). In 1908 it was introduced to the Czech Republic for fur farming. Some animals were said to have been kept at Krumau on the upper Moldavia River at about the same time (possibly since 1888), and another group of *O. zibethicus* was supposedly released at Tabor in 1905 (according to Hoffman 1958). Within a few years, these private stocks probably gave rise to a wild population in Bohemia, which gradually extended its range, invading Bavaria in 1914, and Saxony and Silesia in 1917. From their Bohemian center, *O. zibethicus* spread across the Sudeten Mountains into the Oder Basin, across the Lausitz Mountains to the Spree River, over the Fichtelgebirge to the rivers Saale and Main, and over the Bohemian Forest to the Naab and Danube. They spread rapidly along the Elbe River, attaining its mouth in 1947 (the first specimens were

found in Hamburg in 1933; *i.e.* after having covered a straight distance of 550 km in only 28 years; their colonization of the Elbe and Havel rivers is described by Hoffmann 1958). *O. zibethicus* subsequently colonized eastern Germany, spreading westward across the Mecklenburg lake district (Kintzel 1985; *cf.* Kirchner 1954). In western Germany, Schröpfer & Engstfeld (1983) state that they have inhabited the entire Emsland, for instance, since 1967.

In southwestern Germany, *O. zibethicus* invaded the counties of Kehl, Offenburg and Lahr in 1932, and the counties of Lörrach, Freiburg, Emmendingen, Müllheim, and Säckingen in 1955. By 1980, it had colonized every county in the State of Baden-Württemberg. *O. zibethicus* is now naturalized throughout all of Germany (Heidecke & Seide 1986).

For financial reasons, Finland imported about 1, 100 *O. zibethicus* from Germany, Czechoslovakia and North America (Artimo 1960). The animals were released in a total of 293 localities all over Finland from 1919 and onwards. Within 35 years (1920-1955) *O. zibethicus* had established in almost all available habitats, with the exception of those in the northernmost parts of Finland. In northern Finland, the spread has been distinctly slower than in southern Finland. The spread has varied within limits of 4-120 km per year, but usually *O. zibethicus* has spread at rate of 10-20 km per year.

From northern Finland *O. zibethicus* spread into Sweden, and in 1957 the species had fully occupied the lower region of the border river Torneälven (Artimo 1960). In Sweden, there have been and still are excellent possibilities of studying the dispersal rate of the *O. zibethicus* southwards in the country (Danell 1996).

In 1927, 10 *O. zibethicus* were introduced from Finland to Russia. Twenty individuals from Finland were released to the wild (nature) near the islands of Solovets. Beginning in 1928, *O. zibethicus* was released in massive numbers in the territory of the Soviet Union. By 1955 large areas near different water bodies were occupied by about 160,000 *O. zibethicus* (Lavrov 1957).

In the early 1930s *O. zibethicus* was also introduced to the Kola Peninsula (Lund and Wikan 1995). In total, about 1,000 *O. zibethicus* were released on the Kola Peninsula during 1931-1936. Just before 1950 *O. zibethicus* occurred all over the peninsula (Semjonov-Tian-Sjanskij 1987).

1650 *O. zibethicus* were imported into Russia in 1928 - 1932 from Finland, Canada and England. After that ten thousand animals caught in new settlements, were released in the nature. Natural moving happened very quickly too and by 1970 the muskrat has occupied almost all suitable territories. Their distribution in Russia is from the western border up to Kamchatka. It exceeds the natural area significantly.

Between 1980 and 1988 there are very few observations of *O. zibethicus* in Norway. Since 1988 there has been a rapid population increase in Sör-Varanger, and today *O. zibethicus* has spread to almost every part of the municipality (Danell 1996). Little is known about the distribution and abundance of *O. zibethicus* in other parts of Finnmark or the rest of Norway, but it seems likely that the species has a scattered distribution and low population numbers (Lund 1995). *O. zibethicus* has, however, been documented shot or caught in gillnets intended for fishing, in Hattfjelldal in Nordland county and in Lierne in North Trøndelag county in 2005. For both areas it appears that *O. zibethicus* has migrated into Norway along watersheds crossing the mountain range along the border. South of the mountainous areas the *O. zibethicus* probably will spread easier across the border and also spread north-south on rivers in southern Norway.

The incidental record of *O. zibethicus* in Denmark was from the island of Rømø in 1989 (Ramsgaard and Christensen 2006). Since 2000, *O. zibethicus* has been regularly reported from the southern parts of Denmark close to the German borders, the size of the population has, however, not been determined yet (Ramsgaard 2005, Ramsgaard and Christensen 2006).

In France, *O. zibethicus* farms were founded in the southern Vosges Mountains after World War I. When the price of *O. zibethicus* furs plunged during the 1920s, a number of farms closed and released their animals (e.g. 500 animals in 1928 near Belfort). This population spread to Switzerland and Alsace by 1930, and the Meuse and Moselle rivers in 1935.

*O. zibethicus* was introduced twice to Estonia: in 1947, 190 animals and in 1952, 361 animals, raised from the original stock, were released to water bodies in southern and western parts of Estonia (N. Laanetu, pers.comm.).

The first record of *O. zibethicus* in Latvia is from 1961; it spread from Belarus and later also from Estonia and Lithuania, where it was introduced (Ozols 1997).

### **Pathways of introduction**

*O. zibethicus* was introduced for fur farming and breeding purposes.

### **Alien status in region**

*O. zibethicus* is present in most of the countries of the region (see table 1). In some parts of Estonia the American mink (*Mustela vison*) has displaced *O. zibethicus* by taking its habitat (Kukk 2001). However, in other parts of Estonia *O. zibethicus* is still present, e.g. in South-Estonia and near the Narva reservoir (in north-east of Estonia) (Kull *et al.* 2005).

*O. zibethicus* occurs throughout Poland. However, within the last 15 years, the numbers have dropped significantly (by 81% in NW Poland). This is partly due to the presence of *Mustela vison*, since *Mustela vison* occurs only in the northern part of the country and the decrease in *O. zibethicus* was recorded in all of Poland ([Polish Alien Species Database](#)).

In Norway *O. zibethicus* occur in areas with quite unfavourable habitats where population density is very low (Danell 1996).

The status of *O. zibethicus* in Latvia is not known; but in later years the number of *O. zibethicus* has decreased, because of its natural enemies, such as *Mustela vison* and *Arvicola terrestris* (Ozols 1997, J. Ozoliņš, pers. comm.).

In Russia *O. zibethicus* kept its new huge area, but its quantity has significantly decreased for the last 15 - 20 years. There are many reasons for the quantity decline, but in the north of the area there has been a reduction of edible plants and intensive growth of inedible plants (Павлов, и др.1973, Соколов, Лавров, 1993.)

Country	Not found	Not established	Rare	Local	Common	Very common	Not known
Denmark				X			
Estonia			X				
European part of Russia					X		
Finland					X		
Faroe Islands	X						
Germany					X		
Greenland	X						
Iceland	X						
Latvia				X			
Lithuania				X			
Norway			X				
Poland					X		
Sweden				X			

**Table 1.** The frequency and establishment of *Ondatra zibethicus*, please refer also to the information provided for this species at [www.nobanis.org/search.asp](http://www.nobanis.org/search.asp). Legend for this table: **Not found** –The species is not found in the country; **Not established** - The species has not formed self-reproducing populations (but is found as a casual or incidental species); **Rare** - Few sites where it is found in the country; **Local** - Locally abundant, many individuals in some areas of the country; **Common** - Many sites in the country; **Very common** - Many sites and many individuals; **Not known** – No information was available.

## Ecology

### Habitat description

The animals live semi-aquatically. They are crepuscular, spending the day in burrows or floating reed lodges up to 1.5 m in height (mostly during winter – depending on habitat and climate) (Heidecke & Seide 1986, Ramsgaard 2005).

### Reproduction and life cycle

Females usually throw 3 or 4 times per year from late April on, producing 2 to 12 offspring (4 to 7 on average) annually. In colder climates females may throw only twice a year (Ramsgaard 2005). The young grow a nest coat after 18 days, an adolescent coat after about 4 weeks, and the adult coat at about 4 months (Burghause 1988). The rate of reproduction depends on food supply, population density, and water temperature. The mortality of the offspring increases at low water temperatures and high population densities (*cf.* Meinert & Diemer 1977). Females may attain sexual maturity at the age of five months, and the males after seven months (Heidecke & Seide 1986).

### Dispersal and spread

The principal migration period of *O. zibethicus* is during spring (peaking in March) and fall (peaking in October). The migration period may extend from fall to spring during very mild winters. The rate of dispersal varies from year to year, depending mostly on the survival rate of the litter in spring, as well as on the amount of precipitation during the summer, as low water levels strongly impede the dispersal of the species (Burghause 1996). Dispersal rates of 6-8 km/year have been reported from several countries in Europe including Denmark (Ramsgaard and Christensen 2006 and references therein). High water levels may provide stochastic dispersal opportunities (Ramsgaard 2005). For example *O. zibethicus* can migrate long distances (up to 160 km/day) by rafting, being carried long distances by river currents (Böhmer *et al* 2001)

## Impact

### Affected habitats and indigenous organisms

*O. zibethicus* feeds mainly on the plants of reed belt communities (Pietsch 1982; Krauss 1990; Diemer 1996), particularly on common reed (*Phragmites communis*). According to Burghause (1988), one animal is capable of cropping 1.5 m<sup>2</sup> per night. *O. zibethicus* also likes to dig for roots, and it is particularly attracted to the tubers of Jerusalem artichoke (*Helianthus tuberosus*), a common neophyte in river plains (Burghause 1988, 1996). *O. zibethicus* is a generalist but usually only eats a few species, which for example could be the plant species mentioned above (Ramsgaard 2005). Small well-vegetated lakes with relatively stable water levels are especially favored by *O. zibethicus* in Finnish waters, but heavy impacts have also been reported in waters with poor stands of helophytes (Rintanen 1976). *O. zibethicus* grazing affects the structure of littoral vegetation (Danell 1977, 1979). This change in vegetation affects communities of aquatic invertebrates (Nummi et al. 2005).

*O. zibethicus* may sometime feed on crayfish, zebra mussels, crustaceans, and insects (cf. Ulbrich 1928, Hoffmann 1958), bivalves - including threatened taxa such as *Anodonta*, *Unio*, and the freshwater pearl mussel *Margaritifera margaritifera* (cf. Brander 1955; Baumann & Everding 1986; Hochwald 1990; Zimmermann et al. 2000). This indirectly affects rare fish species that deposit their eggs in bivalves, such as the bitterling (*Rhodeus amarus*).

The effects of spreading of *O. zibethicus* are often linked with those of anthropogenic pollution, as in the case of the decline of reed belts in many lakes (Kintzel 1985; Barthelmes 1991). According to Barthelmes (1991), long-term observations at a lake in Berlin (Grosser Müggelsee) have shown that the decline in reed cover may have been due mainly to the feeding pressure exerted by *O. zibethicus*. In Kintzel (1985), Stüber reports that at the Lake of Döbberlin "the plant cover was usually destroyed completely after one or two years, after which *O. zibethicus* moved on". Bernhardt and Schröpfer (1992) have shown that in the Ems region *O. zibethicus* removes bulrushes (*Typha latifolia*), promoting the development of club-rushes (*Schoenoplectus lacustris*).

All in all, the general opinion on the impact of *O. zibethicus* on their habitat is mixed, especially in northern Europe. On one hand, the animal is regarded as a positive factor because it creates openings in dense vegetation stands and it prevents lakes from being overgrown by vegetation. On the other, it has been blamed for destroying valuable vegetation and creating mud-flats. Depending on human interest in the development of the particular wetland, *O. zibethicus* may be regarded as a valuable element or as a "pest" species (Danell 1996).

The American mink (*Mustela vison*), which is now spreading throughout Germany, is an important predator of *O. zibethicus* (Burghause 1988; Stubbe 1993). Other natural enemies are martens, European polecats, weasels, foxes, lynxes and various birds of prey and large owls; however, the populations of these predators have been anthropogenically decimated, so that their predation pressure on *O. zibethicus* is low. (*O. zibethicus* is difficult to catch for most of the predators since it spends most of its time in the water. The *O. zibethicus* taken by the mentioned predators are often sick or young animals which spend more time on land (Ramsgaard 2005).

### Genetic effects

No known genetic effects.

### Human health effects

According to Hoffmann (1958), *O. zibethicus* is host to a great number of parasites (41 species of

trematodes, 22 species of cestodes, 27 species of nematodes, and others), notably various species capable of infesting humans, such as the dog tapeworm (*Taenia hydatigena*), the cat tapeworm (*Taenia taeniaformis*), and the dwarf tapeworm (*Echinococcus multilocularis*; cf. Diemer 1996). *O. zibethicus* only occasionally affect humans directly. This occurs in situations when the animals are cornered. They defend themselves vigorously and may even attack humans (Danell 1996).

### **Economic and societal effects (positive/negative)**

*O. zibethicus* may dig far into the banks of water bodies. Their extended burrowing activity can cause serious economic damage (undermining of banks, dams, road and railway embankments) causing their collapse during floods. Also damage to flood protection structures (destabilization of flood dikes), and to fish farms (chewing through nets and fish traps) have been observed (Burghause 1996). The system of passages of one *O. zibethicus* family may extend up to 25 m along the bank and 15 m inland. In Germany the costs of economical impacts caused by *O. zibethicus* are regarded to be 12,400,000 euros (Reinhardt *et al* 2003).

*O. zibethicus* may also reduce the ecological value of wetlands of interest to nature conservation destroying the reed belts, feed on endangered plant species and prey upon rare freshwater bivalves. The animal moves four times its own weight in gnawed off plants. About a quarter of this is eaten by the animal, creating quite a lot of dung which usually goes into the water. In Sweden *O. zibethicus* is called a “keystone” species because it creates better living areas for water fowls and insect as it creates openings in dense vegetation stands and thus prevents lakes from being overgrown by vegetation (Danell 1996).

## **Management approaches**

### **Prevention methods**

Indications that the spreading of *O. zibethicus* would result in serious damages already existed at the beginning of the 20th century. The first police regulations in Germany on *O. zibethicus* control were enacted in Saxony and Bavaria in 1917, and provided the basis for the organization of the first control institutions after World War I (Hoffmann 1958, Burghause 1996). The increasing problems caused by *O. zibethicus* in Germany led to the creation of a State Control Service (*Reichsbekämpfungsdienst*) in 1933. The State Regulation on *O. zibethicus* Control (*Reichsverordnung zur Bekämpfung der Bisamratte*) came into effect on July 1<sup>st</sup> 1938, based on the Act for the Protection of Cultivated Plants (*Gesetz zum Schutze der Kulturpflanzen*) of 5 May 1937.

The Bern Convention on the Preservation of European Wild Plants and Animals and their Natural Habitats lists *O. zibethicus* in Recommendation No. 77 among those species which demonstrably pose a threat to biological diversity, and therefore recommends its extermination. However, Burghause (pers. comm.) asserts that it has been obvious for decades that an extermination of *O. zibethicus* is no longer possible, not even at considerable effort.

According to Estonian List of Invasive Alien Species (Ordinance of the Minister of Environment, no 126 of 7th Oct. 2004) it is forbidden to bring *O. zibethicus* in the country for artificial breeding or keeping. In the Nature Conservation Law in §49 and §57. cases are described where particular prevention actions should take place (considering the problems of (invasive) species and their massive distribution.

### **Eradication, control and monitoring efforts**

The choice of the control method depends on the specific features of the problem and the characteristics of the impacted area.

In some countries the control of *O. zibethicus* is no longer focused on the extermination of the species, which is judged impossible. Instead, it is targeted at slowing down the rate of spreading and at controlling the population size in critical situations. By these measures, Rhineland-Palatinate has succeeded in preventing serious *O. zibethicus* damage, according to Burghause (1996). However, statewide control in Germany of *O. zibethicus* was only regarded as a reasonable task as long as there was hope of keeping certain areas pest-free (Burghause, pers. comm.).

Direct control of *O. zibethicus* in Germany, for example, has been conducted with traps (*cf.* Bothe 1993), poisoned bait (chlorphacinon), ferrets, poison gas, and firearms (Burghause 1996).

In the Netherlands *O. zibethicus* are caught in underwater traps constructed to make entry easy but exit difficult. The animals drown using this method, but this is accepted in the Netherlands as the period between when *O. zibethicus* realizing there is no way out and it is drowned within the internationally accepted time limit. In the Netherlands during the last decade of last century the number of catches was about 30,000 animals and in 2002, 363.042 *O. zibethicus* were caught ([Landelijk Jaarverslag 2002](#)).

In Sweden, trapping of *O. zibethicus* has been insignificant due to the low price of *O. zibethicus* furs and the banning of leghold traps. Furthermore, the species has not been regarded as a “pest” animal in Sweden and therefore there have been no campaigns to reduce their numbers (Danell 1996).

In Estonia *O. zibethicus* is a hunting object, which can be also considered as a controlling method. According to the Hunting Law in Poland, *O. zibethicus* occurring in fish ponds can be shot throughout the year. Outside fish ponds, the species can be hunted between 11.04 and 15.04 ([Polish Alien Species Database](#)). In Latvia, according to Hunting Law, *O. zibethicus* can be shot from October 1<sup>st</sup> – March 31<sup>st</sup> and in unlimited numbers. In the open season of year 2004/2005, 69 *O. zibethicus* were caught in Latvia.

According to Burghause (1996), the "most successful, but also the most expensive" form of *O. zibethicus* indirect control is fortification of the embankments. The banks of water bodies are protected against *O. zibethicus* essentially by inserting a layer of plastic foil. These sections are additionally reinforced with a strong layer of large stones.

### **Information and awareness**

In Estonia two booklets introducing invasive species of local importance have been published (Kukk et al 2001, [Kull et al. 2005](#)). The purpose of those booklets is to make the wider range of people aware of the problems going hand-in-hand with the spread of invasive species. The booklet also aims to show how the species look and to explain how the spread of species could be controlled.

### **Knowledge and research**

In Denmark registration of the *O. zibethicus* distribution has taken place with the use of *O. zibethicus* rafts (Ramsgaard 2005, Ramsgaard and Christensen 2006). In Norway, there are no recent mappings of the *O. zibethicus* distribution and no analyses of the dispersal rate during different periods (Danell 1996).

### **Recommendations or comments from experts and local communities**

A monitoring program for *O. zibethicus* is recommended. It should focus on the maximum population density attained in the absence of control measures, and on the efficacy of predation by mink (*Mustela vison*). Lauenstein (pers. comm.) expects that some government agencies may reassess their position in the next few years, because the widespread lack of control activities could result in

a serious aggravation of the *O. zibethicus* problem. Furthermore a better co-operation between the implicated countries is needed to collect better knowledge of the species (Nanna R. Ramsgaard, pers. comm.).

## References and other resources

### Contact persons

Nikolai Laanetu (EE) Centre of Forest Protection and Silviculture, Iva 12, 12618 Tallinn, Tel: +372 6 771 301, Fax: +372 6 771 300, E-mail: [nlaanetu@hotmail.com](mailto:nlaanetu@hotmail.com)

Frank Klingenstein (DE) Bundesamt für Naturschutz (Federal Agency for Nature Conservation) Konstantinstraße 110 53179 Bonn -- [www.bfn.de](http://www.bfn.de) Tel.: ++49(0)228/8491-264, Fax: -119, E-mail: [frank.klingenstein@bfn.de](mailto:frank.klingenstein@bfn.de)

Pall Hersteinsson (IS) PhD, Professor of Mammalogy, Institute of Biology, University of Iceland, Sturlugata 7, IS-101 Reykjavik, Iceland, Tel.: +354-535 4608, E-mail: [pher@hi.is](mailto:pher@hi.is)

Petri Nummi (FI) Lecturer in wildlife ecology and management, Department of applied biology FIN-00014, University of Helsinki, Tel: +358 9 191 58366, E-mail: [petri.nummi@helsinki.fi](mailto:petri.nummi@helsinki.fi)

Wojciech Solarz (PL) Institute of Nature Conservation, Polish Academy of Sciences Mickiewicza 33, 31-120 Krakow, Poland, Tel. +48 609 440 104 E-mail: [solarz@iop.krakow.pl](mailto:solarz@iop.krakow.pl)

Thomas Secher Jensen (DK) Aarhus Universitet, Naturhistorisk Museum, Universitetsparken, Bygning 210, DK-8000 århus C, Tel.: +45 86 12 97 77, E-mail: [Thomas.Secher.Jensen@nathist.au.dk](mailto:Thomas.Secher.Jensen@nathist.au.dk)

Nanna R. Ramsgaard (DK) Tordenskjoldsgade 29 st th. 8200 Århus N Tel.: Tel. 87390069, E-mail: [bisam@somewhere.dk](mailto:bisam@somewhere.dk)

Steinar Wikan (NO) Svanhovd Environmental Centr, N-9925 Svanvik, Tel. (+47) 78 97 36 00, E-mail: [svanhovd@svanhovd.no](mailto:svanhovd@svanhovd.no)

Jānis Ozoliņš (LV) State forest service, Department of hunting, Rīga, 13 janvāra Str. – 15, LV-1932, Tel: +371 7212776, E-mail: [janis.ozolins@vmd.gov.lv](mailto:janis.ozolins@vmd.gov.lv)

Kjell Danell (SE) Swedish University of Agricultural Sciences, Department of Animal Ecology, Tel: +46 70 3747974, E-mail: [Kjell.Danell@szoock.slu.se](mailto:Kjell.Danell@szoock.slu.se)

Johan Danielsen (NO) Directorate for Nature Management, Tungasletta 2, N-7485 Trondheim, Norway, Tel.: + 47 73580 949, E-mail: [Johan.Danielsen@dirnat.no](mailto:Johan.Danielsen@dirnat.no)

Andrey Warshavsky (RU) Severtsov Institute of Ecology and Evolution, Russian Academy of Sciences, Moskow, Leninskij pros., 33, Russia. Tel.:495 1247932. E-mail: [Warsh@yandex.ru](mailto:Warsh@yandex.ru)

### Links

[A review of European mink \(\*Mustela lutreola\*\)](#)

[Polish Alien Species database](#)

[Bisamrotte – Registreringer i Pasvik Naturreservat 1994-2000](#)

## References

- Artimo, A. 1960. The dispersal and acclimatization of the *Ondatra zibethica* (L.), in Finland. Papers on Game Res. 21: 1-101. Helsinki.
- Banfield, A. W. F. 1974. The mammals of Canada. – University of Toronto Press, Toronto, Canada, 438 pp.
- Barthelmes, D. 1991. Schwere Fraßschäden durch Bisamratten (*Ondatra zibethica* L.) als Ursache für den Gelegerückgang in mitteleuropäischen Seen. – Arch. Natursch. Landschaftsforsch. 31(1): 3-18.
- Baumann, A. and R. Everding .1986. Schädling in Naturschutzgebieten. – Der Bisamjäger 21: 9.
- Bernhardt, K. G., Schröpfer, R.1992. Einfluß des Bisams auf die Vegetation - Untersuchungen im Ersatzbiotop Geeste im Emsland. Naturschutz und Landschafts-planung 1/92: 20-26
- Bothe, C. 1993. Über die Wirksamkeit, Zuverlässigkeit, Norwendigkeit und Tierschutzgerechtigkeit von Bisamfallen und Fangmethoden. Unveröff. Diplomarbeit, Braunschweig.
- Brander, T. 1955. Über die Bisamratte, *Ondatra z. zibethica* (L.) als Vernichter von Najaden. – Arch. f. Hydrobiol. 50(1): 92-103.
- Burghause, F. 1988. Der Bisam – vom Pelztier zum Schädling. – In: Naturhistorisches Museum Mainz (ed.), „Einwanderer“ – Zur Geschichte und Biologie eingeschleppter und eingewanderter Arten in Rheinland-Pfalz. I.: Säugetiere, 27-37. Mainz (=Mainzer Naturwissenschaftliches Archiv, Beiheft 10).
- Burghause, F. 1996. 40 Jahre Bisam in Rheinland-Pfalz. Die Bedeutung eines eingewanderten Nagers und die Bemühungen, seinen Schaden einzudämmen. – Mainzer naturwiss. Archiv 34: 119-138.
- Böhmer, H.J., Heger, T., Trepl, L. 2001. Fallstudien zu gebietsfremden Arten in Deutschland - Case studies on Aliens Species in Germany. – Texte des Umweltbundesamtes 2001 (13), 126pp.
- Danell, K. 1977. Short-term plant succession for following the colonization of a northern Swedish lake by *O. zibethica*, - J. APPL. ECOL. 14: 933-947.
- Danell, K. 1979. Reduction of aquatic vegetation following the colonization of a northern Swedish lake by the *O. zibethica*, – OECOLOGIA 38: 101-106.
- Danell, 1996 – introduction of aquatic rodents: lessons of the *Ondatra zibethicus* invasion, Wildlife biology 2: 213-220.
- Diemer, B. 1996. Der Bisam (*Ondatra zibethicus*) in Baden-Württemberg. - In: Verein der Freunde und Förderer der Akademie für Natur- und Umweltschutz (Umweltakademie) beim Ministerium für Umwelt und Verkehr Baden-Württemberg (Hrsg.), Neophyten, Neozoen – Gefahr für die heimische Natur?, 182-186. Stuttgart (= Beiträge der Akademie für Natur- und Umweltschutz Baden-Württemberg 22).
- Heidecke, D. and Seide, P. ca. 1986. Bisamratte *Ondatra zibethicus* (L.). In: Buch der Hege, 640-666.
- Hochwald, S. 1990. Bestandsgefährdung seltener Muschelarten durch den Bisam (*Ondatra zibethica*). – Schriftenr. Bayer. Landesamt für Umweltschutz 97: 113-114.
- Hoffmann, M. 1958. Die Bisamratte – ihre Lebensgewohnheiten, Verbreitung, Bekämpfung und wirtschaftliche Bedeutung. – Leipzig 1958.
- Kintzel, W. 1985. Die Besiedlung des Kreises Lübz durch die Bisamratte (*Ondatra zibethica*). – Säugetierkd. Inf. Jena 2(9): 277-281.
- Kirchner, H.-A. 1954. Das Vordringen der Bisamratte nach Mecklenburg. – In: Archiv der Freunde der Naturgeschichte in Mecklenburg, Bd. 1, 118-124.
- Krauss, M. 1990. Die Nahrung des Bisams (*Ondatra zibethicus*) an der Havel in Berlin-West und der schädigende Einfluß auf das Röhricht. – Landschaftsentw. u. Umweltforschung 71: 141-181.
- Kukk, T., Kull, T., Lilleleht, V., Ojaveer, H. 2001. Võõrliigid Eestis. Keskkonnaministeerium. Tallinn. Estonia.
- Kull, T., Kukk, T., Kangur, M. et al. 2005. [Invasiivsed võõrliigid Eestis](#). Keskkonnaministeerium. Tallinn. Estonia. (In Estonian)
- [Landelijk Jaarverslag 2002 Muskusrattenbestrijding](#) – Web-version
- Lavrov, N.P. 1957. Akklimatizatsija ondatrö v SSSR. Izdatelstvo Tsentrosojuz, Moskva. 531 s.
- Liljeström, G. 1954: Bisam I Norrbotten. – Svensk Jakt 92: 341. (In Swedish).
- Lund, E. and S. Wikan 1995: The *Ondatra zibethica* L. established in Norway. *Fauna* 48: 114-122.
- Meinert, G. and Diemer, B. 1977. Die Vermehrung des Bisams in Abhängigkeit von der Wassertemperatur. – Gesunde Pflanze 28 (9): 200-202.
- Ramsgaard, Nanna R. (2005): Bisamrotten (*Ondatra zibethicus*) i Danmark - Status og konsekvensanalyse af bisamrottens udbredelse i Danmark. Unpubl. M.Sc. thesis. Univ. Aarhus, Denmark.
- Nummi, P., Väänänen, V-M. and Malinen, J. 2005. Alien grazing: Indirect effects of muskrats on invertebrates. – Biol. Invasions. In press.
- Ozols G. 1997. Ondatra, bizamžurka (*Ondatra zibethica*). Enciklopēdija Latvijas daba. 4. Rīga, Preses nams, 55 - 56

- Pietsch, M. 1982. *Ondatra zibethicus* (Linnaeus, 1766) – Bisamratte, Bisam. – In: J. Niethammer, F. Krapp, Handbuch der Säugetiere Europas, Bd. 2/I, 177-192. Wiesbaden.
- Ramsgaard N. R. and Christensen, J.T. 2006. Bisamrotten (*Ondatra zibethicus*) I Danmark: Status 2005 (with english summary: Distribution of the muskrat in Denmark: Status 2005). Flora of Fauna 112(1): 20-24.
- Reinhardt, F., Herle, M., Bastiansen, F., Streit, B. 2003. Economic Impact of the Spread of Alien Species in Germany. pp 183
- Rintanen, T. 1976. Lake studies in eastern Finnish Lapland. I. Aquatic flora: Phanerograms and Charles. – Ann. Bot. Fennici 13: 137-148.
- Schröpfer, H. & C. Engstfeld. 1983. Die Ausbreitung des Bisams *Ondatra zibethicus* (Linné 1766, Rodentia Arvicolidae) in der Bundesrepublik Deutschland. – Z. angew. Zool. 70: 13-37.
- Semjonov-Tian-Sjanskij, O. 1987: Pattedyrene på Kola. – Rapport fra Fylkesmannen i Finnmark, (Vadsö, Norway) 25: 1-129. (In Norwegian).
- Stubbe, M. 1993. *Mustela vison* – Mink. – In: J. Niethammer, F. Krapp (ed.), Handbuch der Säugetiere Europas. Band 5: Raubsäuger – Carnivora (Fissipedia). Wiesbaden.
- Ulbrich, J. ca. 1928. Die Bisamratte – Lebensweise, Gang ihrer Ausbreitung in Europa, wirtschaftliche Bedeutung und Bekämpfung. – Dresden.
- Zimmermann, U., Gorlach, J., Ansteeg, O. and U. Bossneck 2000. Bestandsstützungsmaßnahme für die Bachmuschel (*Unio crassus*) in der Milz (Landkreis Hildburghausen). – Landschaftspflege und Naturschutz in Thüringen 37(1): 11-16.
- Корсакова И. Б., Тимофеев В. В., Сафонов В. Г. Акклиматизация охотничье-промысловых зверей и птиц в СССР, ч. 1. – Киров. – 1973. – 536 с. (Acclimatization game animals and birds in the USSR. Kirov, 1973, part 1: 536).
- Соколов В. Е., Лавров Н. П. (Отв. ред.). 1993.. Ондатра. Морфология, систематика, экология. М.: Наука. 542 с. (Sokolov V.E., Lavrov N.P. The muskrat. Morphology, Systematics, Ecology. Nauka Publishers, Moscow 1993. 542 p.

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