

## European Beaver and its Return

One of few species that have been successfully returned to the places of their original habitation particularly thanks to a strong preservation effort is European beaver (*Castor fiber*). Until the 17<sup>th</sup> century it was a common species of European fauna of river floodplains, low forests and wetlands. It could also be found in most territories of the present Czech Republic, especially in the river basins of the Labe (Elbe) and the Morava Rivers and in South Bohemia. With continuing deforestation, dewatering of wetlands and their conversion to fields and meadows, the area of biotopes occupied by beavers dropped as well as the number of their individuals. Beaver was also intensively hunted for its valuable fur, for meat (due to its scaly tail its meat was claimed to be fish and therefore it could be eaten also during the period of fasting) and for castoreum (the castor sacs secretion used as a medicine or perfume base). Beaver fat was considered a universal medicine, as well as testicles, blood, bones and teeth. These circumstances caused beaver to be extinct in the wild in our country as well as in many other European countries in the middle of the 18<sup>th</sup> century. At the turn of the 18<sup>th</sup> and 19<sup>th</sup> century attempts to breed beavers in so called "beaveries" or half-natural breeds appeared at several places in South Bohemia, but their numbers began to increase fast and it was not possible to prevent them from escaping to the wild. It evoked worries about possible erosion of dams of ponds and soon beavers began to be intensively hunted again until 1882, when they completely disappeared



European beaver

Photo: Aleš Vorel

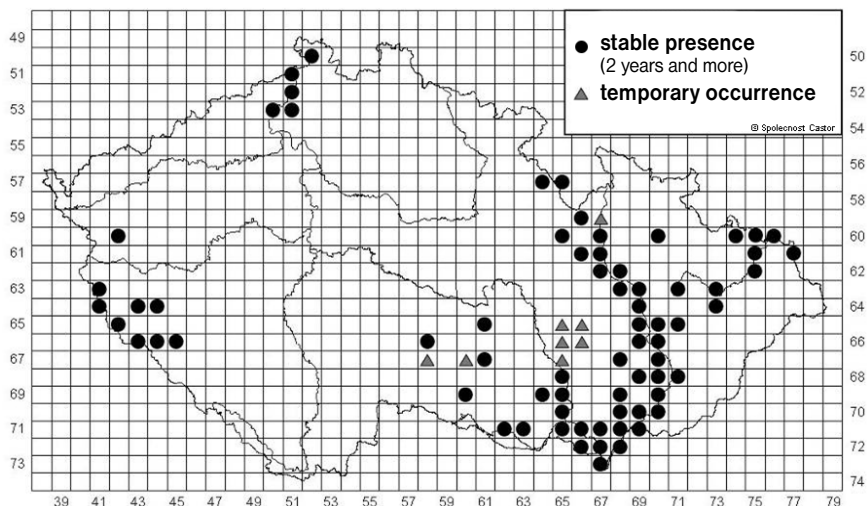


Fig. 1 - Distribution of European beaver in the Czech Republic (2005).

from our fauna. Beaver experienced similar fate also in other European countries and at the end of the 19<sup>th</sup> century there were only about 1.200 individuals in isolated populations on the lower Rhone River in France, on the Elbe River middle course in the German Saxony-Anhalt, in southern Norway, in Poland, Belarus and Russia.

In the 20<sup>th</sup> century, the implementation of strict protection of European beaver and its reintroductions followed by natural spreading led to successful renewal of its original population at many locations. The first mention of beavers' repeated presence in our territory is from 1967, when a migrating beaver was killed by ferrymen on the Kamenice River in north Bohemia. Our only genetically original population has later spread in this direction, i.e. from Saxony-Anhalt upstream the Elbe River up to the lock in Střekov. It is a *Castor fiber albicus* subspecies. The other populations in the Czech Republic come from reintroductions. Since 1986, beavers from Austria have been migrating to us upstream the Morava and the Dyje Rivers. Since the beginning of the 90s, and at some places since even before, beavers from Bavaria have been coming to west and south Bohemia. Beavers settling in the river basin of the Odra and the Divoká Orlice Rivers are of Polish origin. The reintroduction to the protected landscape area Litovelské Pomoraví carried out by the workers of the Department of Ecology of the Faculty of Science, the Palacký University and the basic organisation of the Czech Union for Nature Conservation "Beaver" in Olomouc was important for the river basin of the Morava River. In November 1991 they released six and in May 1992 another fourteen European beavers, subspecies *Castor fiber vistulanus*, originating from the Suwalki lake district in north-east Poland. In November 1996, one adult pair from Lithuania was added and another two pairs from Lithuania were released on the Odra River near Libavá in the same year.

Beaver thus has returned to our territory and it has shown the change of its original habitats was an important, but not the decisive factor for its extinction. It has almost no natural predators and competitors in our conditions, and if protected, it is able to quickly renew the numbers of its populations. European beaver has a status of a Severely Threatened species in the Czech Republic under Act No. 114/1992 Sb. on the Protection of Nature and the Landscape (Decree for implementation, No. 395/1992 Sb., No. 175/2006 Sb.). Bern Convention of the Council of Europe from 1979 on the Conservation of European Wildlife and Natural Habitats beaver is included in Appendix III (protected fauna species). In European Community Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora is listed in Annex II (animal and plant species of community interest whose conservation requires the designation of special areas of conservation) and Annex IV (animal and plant species of community interest in need of strict protection).

Presently is the increase of our beaver population of almost an exponential character because it is in the initial stage of colonisation of a new territory. Due to the strong territoriality, the young migrate to new, still non-settled areas. With the growing number of beavers there are more and more cases, when this animal comes in urbanized areas into conflicts with human interests (water works and constructions, forest and agricultural cultures etc.). To minimize them, it is very important to study biology and ecology of this species and monitor the development of its population.

### Species Description

European beaver is the biggest European rodent and together with its close relative Canadian beaver (*Castor canadensis*) it is the second biggest rodent in the world – after South American capybara (*Hydrochoerus hydrochaeris*). An adult weighs up to 30 kg

with the body length (LC) of 75–102 cm. Its body is adapted to semi-aquatic way of life. It is covered with a thick (up to 30.000 hairs per cm<sup>2</sup>) brown or black animal hair impregnated with greasy secretions of pair anal glands. Eyes, when submerged protected by a transparent membrane, are situated on the upper side of the head, as well as nostrils and ears that can be closed by special muscles. Lip muscles may close behind the front gnawing teeth, which enable beaver to gnaw at branches even under water. Beaver manages to stay there for approximately 15 minutes per one breathe. Back legs with nearly 20 cm long toes are equipped with webs. A doubled claw on the second toe serves for fur treatment. Smaller front legs modified for burrowing have only outlined webs and thanks to partly counter-positioned fifth toe, they have a good grasping ability. A striking mark is a 25–34 cm long strongly dorsoventrally flattened tail, which is nearly bare, covered with hexagonal corneous scales. It fulfils many important functions for beaver. It serves not only for moving and manoeuvring under water, but also as a support in upright posture on back legs (e.g. when it cuts woody plants). It is used for thermoregulation and as a fat deposit. By noisy flapping of tail on water surface beaver warns other members of the colony or threatens enemies. Another adaptation to life in water is a joint opening of the digestive and genital-urinary tracts, which minimizes the risk of infection.

Both genders have two pair glands situated in back parts of the body between pelvis and the tail root. The bigger pair, called scent glands, secretes castoreum – a half-liquid yellow-brown substance of characteristic scent formerly used in folk medicine (it contains e.g. salicylic acid) and in perfumery (for its ability to maintain odour). Smaller pair of glands secretes a greasy substance, greyish with females, and yellowish with males, which especially serves for fur impregnation and has also characteristic odour. The secretion of both glands serves as an olfactory signal of age, sex and social status of an individual in the colony and is used for the territory marking. Smell is the leading sense; hearing and touch are also important.

External sexual dimorphism is minimal. Males have *os penis* (determination of its presence is the most common way for sex determination). Females have only two pairs of mammary glands.

## Phylogeny

Ancestors of beaver-like mammals evolved in the north hemisphere from the initial stages of primitive rodents of the *Paramys* genus. *Castoridae* family is known from Top Eocene. Its oldest known representative was North American genus *Palaeocastor*, which continued in the blindly ending *Eucastor–Dipoides–Castoroides* line. The oldest genus

in Europe was *Steneofiber*, a small burrowing rodent that became the base for evolution of the *Castor* recent genus in Lower Pliocene. During this transformation adaptation to water occurred. Present species *Castor fiber* (European beaver) originated in Middle Pliocene.

During Tertiary Period there were numerous parallel lines, which gradually ceased to exist. The Pleistocene beaver of *Trogotherium* genus should be mentioned, which used to reach the size of a wolf and also lived in our territory, or the aforementioned *Castoroides* of a bear size and estimated weight of 60–100 kg.

The *Castor* genus colonized nearly whole the Euro-Asia and at the time of interconnection of continents by a land bridge, also the North America. After the land bridge decline (approximately 10 000 years ago) it evolved here in isolation to the present Canadian beaver (*Castor canadensis*). The evidence of common origin is for example an ectoparasitic insect *Platypyllus castoris* found only at both recent beaver species. The main difference between both species is a different number of chromosomes ( $2n = 48$  for *Castor fiber*, but  $2n = 40$  for *Castor canadensis*), which causes their reproductive isolation. Canadian beaver also has averagely more young in the litter and if released in Europe, it is able to competitively drive out the original European beaver. But both species have so similar appearance that without a deeper osteological, biochemical and genetic analysis they cannot be distinguished.

## Species Taxonomy

The *Castoridae* family is represented by two modern species: *Castor fiber* Linnaeus, 1758 – European beaver and *Castor canadensis* Kuhl, 1820 – Canadian beaver. Subspecies of European beaver are distinguished by their relevance to relict populations from the turn of the 19<sup>th</sup> and 20<sup>th</sup> century: south Norway (*C. f. fiber* Linnaeus, 1758), Saxon-Anhalt (*C. f. albicus* Matschie, 1907), France (*C. f. galliae* Geoffroy, 1803), Russia + Belarus + Poland (*C. f. vistulanus* Matschie, 1907), Siberia (*C. f. pohlei* Serebrennikov, 1929) and Mongolia (*C. f. birulai* Serebrennikov, 1929). They also usually correspond with the river basin of big Euro-Asian rivers. However, on the basis of mitochondrial DNA analyses it is currently proposed to distinguish only two forms: “western” (by joining *C. f. fiber*, *C. f. albicus* and *C. f. galliae*) and “eastern” (by joining the other subspecies). Up to 24 subspecies of Canadian beaver are usually distinguished.

## Occurrence

The present areal of the European beaver's occurrence includes Norway, Sweden, Lithuania, Latvia, Estonia, Belarus, north and middle Russia, Ukraine, Poland, Slovakia and Czech Republic. It lives on almost whole the area of German part of the Elbe River, in Mecklenburg and in middle and west parts of

Germany in the Rhine River basin. There is a big population in Bavaria and Austria at the Danube River, Inn River and their tributaries. The beaver gradually expands to the north of France from its original population on the lower Rhone River and from the released population on the Loire River. Reintroductions took place in Switzerland, Denmark, Hungary and Croatia too.

In our country, the beaver inhabits six main areas nowadays: lower Labe River (up to Ústí nad Labem–Střekov), southwest Bohemia, Divoká Orlice River basin, Morava, Dyje and Odra Rivers with their tributaries (Fig. 1). It is estimated that there live about 900–1.100 European beavers in our country nowadays. Thanks to yearly information about their numbers, it can be claimed that the expansion to new territories still proceeds (Českomoravská vysočina, Hrubý Jeseník).

## Environmental needs

Beavers live in slowly flowing or still fresh waters of the temperate and cold zone. These mainly include wide floodplains on middle and low courses of bigger rivers, various reservoirs, ponds, flooded sand quarries and wetlands. It also appears in shallow upper courses, in reclamation canals and other artificial drainage canals, if there is suitable composition of woody plants. In such case it settles also in agriculturally used countryside and urbanized areas. Water cleanliness is not a limiting factor. The presence of soft woods, in particular willow (*Salix*), aspen (*Populus*), alder tree (*Alnus*) or birch (*Betula*), is most important. The growth made up only of alder tree makes long-term settlement impossible. In addition to the species composition of bank woods, the size, density and layout of forests are important.

Beaver prefers water habitats with low fluctuations of water level and sufficient water depth. It can regulate these factors by the construction and maintenance of dams. The height of water level must be sufficient to cover entries to beaver refuges under water. It builds them in banks as underground lodges and if

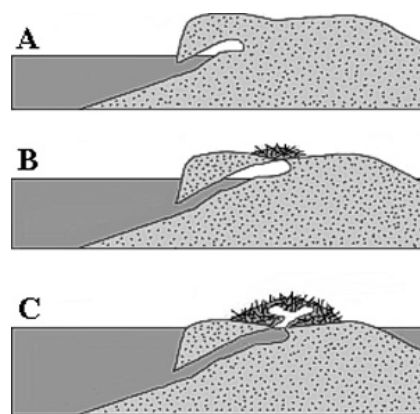


Fig. 2 – Beaver refuges: a lodge (A), a “half-castle” (B) and a “castle” (C).



Photo 1 – Scent mark with footprints

Photo: Jiří Dobiaš



Photo 2 – “Perfect” grazing

Photo: Jiří Dobiaš



Photo 3 – “Imperfect” grazing

Photo: Jiří Dobiaš

the bank substrate is less cohesive and lodges collapse, it builds so-called “castles or half-castles” covered with branches and mud on the top (Fig. 2).

Beavers activate mainly at night. Seasonal activity spreads throughout the year, they do not hibernate in winter but in colder months they often do not leave the lodge for several days and adults decrease their body temperature to 34–35 °C.

### Food

Beaver is exclusively an herbivorous animal. Its range of food is quite wide. More than 150 plant species and about 80 wood species it consumes have been described in Europe. In summer it usually eats soft non-lignified parts of plants and sprouts. It also consumes cultural plants (corn, rape, beet root, potatoes, etc.) in agricultural areas. Unoriginal invasive species such as girasol (*Helianthus tuberosus*) and knotweed (*Reynoutria*) are also mentioned as part of its food.

At the end of vegetation season there is gradually less herbs and beavers change to another type of food. They start cutting trees to get to branches of the top and eat bark, small branches and leaves. In still waters they create winter stock of food under water from leaved branches. Unfortunately, wooden bark contains many substances with adverse effects (salicylic acid, saponins, tanning matters, etc.). Therefore better digestible soft wood is preferred. Beavers have a very long appendix, which contains bacteria supporting digestion and preventing adverse effects of these substances. Despite this fact, the changeover from plants to the bark of trees is a critical period especially for the young. In our country beavers mainly cut willows (*Salix*), aspen (*Populus*), ash tree (*Fraxinus*) and alder tree (*Alnus*). Less cut species include e.g. maple (*Acer*), mazzard cherry (*Prunus avium*), lime-tree (*Tilia*), hazel tree (*Corylus*), birch (*Betula*), oak (*Quercus*), bloody dogwood (*Cornus sanguinea*), hackwood (*Prunus padus*), guelder rose (*Viburnum opulus*), smooth-leaved elm (*Ulmus minor*), black elder (*Sambuccus nigra*) and rarely conifers.

Beavers prefer trees with the stem diameter under 20 cm but they can also cut trees with the diameter exceeding 1 m.

### Reproduction and Life Strategy

Beaver is monogamous and lives in families of 2–10 individuals. Family colonies made up of parents’ couple, the young of the year and sexually immature young of past years settle differently long section of the riverbank or water area. In summer they may use several lodges or castles, but they spend winters usually in one refuge with common stock of food. Sexually matured individuals at the age of 3–4 years are not tolerated any more and leave the family. They consequently migrate sometimes tens of kilometres to find a sexual partner and a place for the establishment of their own colony. Migration is usually realized through watercourses but beavers can also cross borders of water divide by land. Mating usually incurs in water in winter periods. After 105–109 days of pregnancy 2–5 young (rarely 6–7) are born from April to August. They are born with sighted and with fur and after several weeks they start accept softer plant food and learn swimming. They are breast-fed for the period of three months. Common period of life of freely living animals is approximately 7–8 years; individuals bred in captivity may live to the age about 35 years.

Beaver families are strongly territorial and they actively defend the occupied territory. The size of their territory differs according to conditions of the environment (particularly its productivity). If the colony is not completely isolated and contacts with strange individuals occur, they mark territorial borders by means of scent marks usually situated on piled-up heaps of mud and vegetation (Photo 1). Marks shall inform the intruder on owners of the territory (all members of the colony take part in marking) and the entry to a foreign territory. In this way they prevent unnecessary fights. Marking intensity increases in the spring, when young migrating beavers are looking for new territories. Reactions to unknown individuals are stronger than to individuals from neighbouring colonies. Territoriality is one of mechanisms of

the beaver population size auto-regulation. If optimal territories are occupied, young individuals do not find places for the establishment of new colonies and during their migration they often get to fights with owners of territories. Mortality is high and remaining beavers must occupy sub-optimal locations, where they can support fewer young. Owners of territories are also under permanent pressure from their surrounding, if there is too dense population. Due to this stress and gradual decrease of food base, body weight of individuals’ and the number of survived young decreases and the rate of illnesses and mortality increases. It results in the population size reduction.

### Environmental Impacts and Conflicts with Humans

In addition to man, only few animals are able to actively influence their environment to such great extent as beaver. It is able to change geomorphology, hydrology and biota of the occupied territory by its activity. Therefore it is called “ecosystem engineer” because it is able to positively and negatively change the character of an ecosystem. This effect is often highly positive in the countryside depleted by human activity because ecological value and biodiversity of the territory provably increases in most territories modified by beavers. Unfortunately, in cultural countryside its activity often comes to conflicts with human interests. Beaver influences its environment especially by building refuges, cutting woods and building dams.

Burrowing of underground refuges and water canals in river banks impairs their integrity, decreases their pitch and widens a riverbed. Beaver thus revitalizes watercourses straightened and drained by humans. An adverse effect of this activity rests in impairment of strength of dams of ponds, reservoirs and flood-preventing barriers.

By cutting trees and bushes and flooding localities beavers change species and age composition of bank vegetation. Continuous removal of wooden biomass causes opening of the area, lightening of growth and a change character of the locality. The cut trees conse-

quently sprout from stump, root and other parts. Aspen and willow groves are formed in such places with high initial density of individuals, which are even more productive source of food. But this activity comes to conflict with human interests, if it interferes with forest and agricultural cultures, parks and preserved growths.

By building dams parts of watercourses are changed to slowly flowing or still waters. This is connected with erosion and sedimentation changes (the creation of floodplain soils), chemical composition and temperature proportions of water and soil. New communities of still waters are formed. The underground water level and thus water retention in the countryside is higher, flow is stabilized and during floods, flood wave is smaller and slower. Thus ideal conditions for life and nesting of water birds incur. But in urbanized countryside there are often problems with flooding of infrastructure objects (railways, roads, etc.), wastewater purification plants, potable water resources and agricultural or forest soil. Potential changes in the location of a riverbed may be source of disputes with owners of adjacent plots.

### Beaver activity marks

Direct observation of beavers is quite difficult due to their mostly night activity. Fortunately, their food, movement and building activity leaves many marks in the environment, which are not only clear evidence of their presence, but also reflect the level of their activity in the given territory. With regard to the fact that we can mostly estimate the time of their origin, results gained by their use are often comparable with the telemetric method. We can usually notice following beaver activity marks:

**Grazing:** It occurs due to cutting and food activity of beaver and it is the most frequently found activity mark. It is led from one side on thin branches (an oblique feed mark incurs) and on thicker branches it is equal around the whole perimeter (a typical feed mark is created in the form of sandglass). Traces after big beaver gnawing teeth can be seen on browsed areas. We can find them especially on wood, but experienced observer is able to note it also on plants. According to the level of browsing we distinguish three types of them:

if the bite off part is fully separated, it is so called "perfect" grazing (Photo 2). If a branch or trees are eaten into, but they have not been separated, we call such grazing "imperfect grazing" (Photo 3). The third type of grazing is so called "mirror" (Photo 4), when only bark on a small area is eaten. It is likely to incur during tasting the woods, but there is also a theory that beavers use it for orientation.

**"Food chairs":** They appear where beavers consume food at certain safer places (e.g. in undergrowths, shallow waters or boundaries of land and water). There are feeding traces (freely lying branches without bark and inner bark), wood chippings and bark remains.

**Traces:** Impressions of legs or tail in mud, wet sand or snow. They are of a very short lifetime unlike all other activity marks and they are therefore the evidence of a fresh beaver presence in the locality (Photo 1).

**Slides:** Places, where beavers come ashore. They are often recessed and smoothed by beaver's body and branches drawn to water (Photo 5).

**Trails:** Beaten paths on land usually leading to sources of food (Photo 6).

**Canals:** Long narrow flooded canals dug in banks that assure beavers' access to more remote growths.

**Scent marks:** They usually have the form of a perfumed pile from mud, sand or vegetation (Photo 1). These activity marks can be found only rarely in the main period of monitoring (November - February). They are found more often from March until the end of summer, when the marking intensity is higher.

**Excrements:** Very rare activity mark. They contain undigested remains of food.

**Refuges:** The most frequent are lodges. It is a very important category but with regard to the fact that they are all under ground and their entrances open under water level, it is very difficult to find them. Entrances may temporarily appear above water level during water level fluctuations. Then they can be seen in summer e.g. from a boat. In winter we can notice warm air rising from breathing openings. When walking along the bank, lodges with collapsing ceiling parts are more visible. These collapsed lodges are usually abandoned. Another type of

refuge is so called "half-castles", i.e. lodges with the upper part covered with branches and soil and so called "castles", which are all made up of a pile of branches sealed with soil. Difference between a lodge, a half-castle and a castle can be seen in Fig. 2

**Dams:** Diagonal and longitudinal constructions in watercourses able to retain water. They are built on shallow courses with low flow rate and where water level fluctuations often incur. Increasing the water level enables permanent hiding of entrances to refuges under water level and better availability of surrounding woods from water. They are mostly built from stems and branches sealed with pieces of turf, soil and mud but they can contain found anthropogenous materials, such as PVC foils etc.

### Future

The European beaver was a part of our nature and it has successfully returned. Although it is not possible to avoid its conflicts with human interests in present urbanized countryside, its influence is surely not just negative. For example, beavers carry out the otherwise very expensive revitalization of the reclaimed land with artificially straightened rivers for free. Methodology of prevention from undesirable beavers' influence is gradually established and innovated (vegetation adaptation, fences, underground foils, dam drainage and others). A management plan for beaver has been made for the Czech Republic. It will determine areas with higher and lower level of beavers' protection and critical areas where its occurrence is undesirable. Let's hope these remarkable animals, which belong to our nature, will become a permanent part of our fauna already.

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Photo 4 – "Mirror" grazing

Photo: Jiří Dobiaš



Photo 5 – Beaver slide

Photo: Jiří Dobiaš



Photo 6 – Beaver trails

Photo: Jiří Dobiaš