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The accidental release of exotic species from breeding colonies and zoological collections

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Summary

Exotic species have often been introduced into a new country in zoological or botanical gardens or on game and fur farms. When accidentally or deliberately released, these alien species can become invasive and have negative impacts on native plant and animal communities and human activities. This article focuses on a selection of such invasive species: principally the American mink (*Neovison vison*), but also the coypu (*Myocastor coypus*), muskrat (*Ondatra zibethicus*), raccoon dog (*Nyctereutes procyonoides*), raccoon (*Procyon lotor*) and African sacred ibis (*Threskiornis aethiopicus*). In each of these cases, the authors describe the biological characteristics and life history of the species, in relation to its invasive capacity, the origins and establishment of non-native populations, the environmental consequences and possible control measures. The main negative impacts observed are the destruction of habitat, the introduction and/or spread of pathogens and changes in the composition of native communities with consequent effects on biodiversity.

Keywords

Control measure – Environmental impact – Exotic animal – Invasive species – *Myocastor coypus – Neovison vison – Nyctereutes procyonoides – Ondatra zybethica – Procyon lotor – Threskiornis aethiopicus.*

Introduction

Human activities have always been accompanied by vegetal and animal movements, either unintentionally or deliberately. Non-indigenous species can be introduced into a country for the purpose of breeding or for ornamental reasons. But fences to contain animals are not always completely effective. Moreover, even fences regarded as secure are not immune to accidental or deliberate damage by humans (for example, careless farmers, animal rights activists) or natural events, such as trees falling on the fence or tornadoes destroying the enclosure. These events often result in the animal escaping to the wild and can lead to the establishment of alien and invasive species.

Accidental releases of captive animals from farms or zoological gardens are frequent and have caused serious problems in many parts of the world, particularly in island habitats; for instance, the brush-tailed possum (*Trichosurus vulpeca*) in New Zealand, Reeve's muntjac (*Muntiacus reevesi*) and the Canadian goose (*Branta canadensis*) in the United Kingdom (UK). An exhaustive review of all these invasive species would be a tedious work. Instead, this article focuses on a selection of invasive species accidentally released from breeding colonies or zoological collections, principally the:

- American mink (*Neovison vison*)
- coypu (*Myocastor coypus*)
- muskrat (*Ondatra zibethicus*)
- raccoon dog (*Nyctereutes procyonoides*)
- raccoon (*Procyon lotor*)
- African sacred ibis (*Threskiornis aethiopicus*).

For each of these, the authors describe the biological characteristics and life history of the species, in relation to its invasive capacity, the origins and establishment of non-native populations, the environmental consequences and possible control measures.

The American mink

The American mink (*Neovison vison*) is a semi-aquatic mustelid from North America, inhabiting marine coasts, flowing waters and banks, with a general diet including both aquatic and terrestrial prey (17). Originally included in the genus *Mustela*, the American mink has recently been moved into the new genus, *Neovison*, with its extinct relative, the sea mink (*N. macrodon*) (58).

The diet of American mink reveals opportunistic behaviour which is easily adapted to the local environment. Small mammals constitute an important part of the diet and the preferential species depend upon the studied area (muskrats, rats, small rodents, rabbits). Fish and birds (waterfowl, mainly of the Rallideae family) are also often consumed. Crayfish often constitute the main part of the invertebrate portion of the diet (33).

Mink are valued for their dense winter fur. The fur farming industry developed in Europe in the 1920s and reached a peak in the 1960s and 1970s, after a decline due to the 1929 financial crisis (29, 30). From the 1980s, the number of fur farms declined rapidly in most European countries and some, such as Austria and the UK, even banned such farms (9). Escaped and voluntarily released mink are now closely adapted to their new environment in Europe (8), as well as in South America, where feral populations have been identified in Argentina and Chile (39, 46). Feral populations of American mink are now present in most European countries (53), especially the Nordic countries (9). In Denmark, the first producer of mink fur in Europe (29), it has been found that most free-ranging mink (79%, n = 213) were born on a farm and subsequently escaped, indicating that farms can act as a true source for wild populations, maintaining high levels of mink abundance (24).

Neovison vison is a very efficient invasive species. For example, Gerell reports that it colonised the whole of Sweden within 35 years (22). Several studies stress the significant impact that the American mink can have on both endemic prey and other riparian carnivores (9, 31). It has had a particularly severe impact upon:
– ground-nesting wetland birds (18)
– seabirds (43)
– rodents (1, 5, 57)
– amphibians (5)
– European mink (*Mustela lutreola*) (53).

This is particularly the case in island ecosystems (13). The decline of the water vole (*Arvicola terrestris*) in the UK is linked to the spread of the American mink as well as to the fragmentation of its habitat. Mink jeopardise the survival of this endangered species, either directly, through predation (50), or indirectly, by creating isolated groups of individuals (1). In Belarus (52) and Estonia, American mink preferentially prey on water vole. Moreover, the impact of American mink on vole populations seems to be more important than the impact (or former impact) of European mink (8, 34, 37). The American mink has also been held responsible for the nesting failure and decline in colonies of black-headed gulls (*Larus ridibunda*), mew gulls (*L. canus*) and common terns (*Sterna hirundo*) in Scotland (14). The impact of the American mink on waterfowl is more difficult to assess (18, 31). Unlike seabirds, Rallidae living in wetlands are not gregarious and attributing predation to the American mink is often impossible.

The American mink is also sometimes described as the cause of the decline of European mink. This is not totally accurate, as European mink have disappeared from areas that are free from feral populations of American mink (19, 35). In fact, remaining populations of European mink are still declining, due to several causes acting synergistically, including human pressure (habitat loss and degradation, historical hunting, accidental trapping, dog predation and vehicle collisions) and infectious disease.

The presence of feral American mink in the range of European mink can have prejudicial effects on several levels.

First, the American and European mink resemble each other in several ways and share the same habitat and diet (36). They can be identified only by size – the former being 60% larger than the latter – and by the presence of white spots on both the chin and upper lip of the European mink. However, these criteria are not absolute (11, 33). When sympatric, the European mink can thus suffer from direct interspecific competition for food or territory. The American mink is more aggressive, has better reproduction rates (38) and a more diversified diet, which explains its higher densities in, for instance, Belarus (51, 52). Moreover, the native species may be mistaken for its exotic rival and destroyed as a pest. Authors such as Macdonald and Thom (32) consider that the competition between the European and American mink illustrates the potentially devastating impact of an introduced carnivore.

The American mink may also be the vector of various diseases. Morbillivirus infections, such as canine distemper, could play a role in the decline of the European mink. In south-western France, 9% of European mink have seroconverted against distemper (41, 45). Parvovirus infections are common in carnivores. The Aleutian disease may be highly pathogenic for both species and the virus has been found in western populations of European mink (20). This parvovirus is very resistant in the environment. It can be transmitted through saliva, faeces, urine and also from the female to the young. In south-western France, serological studies conducted in wild carnivores show higher seroconversion rates in places colonised by the

American mink. Its role is indirectly highlighted by the fact that the seroprevalence of parvovirus decreased from 22% to 12% after destruction campaigns against American mink.

The American mink is also susceptible to various infectious and parasitic diseases, including:
– salmonellosis
– tuberculosis
– botulism
– anthrax
– trichinellosis
– toxoplasmosis
– leptospirosis (41).

To the knowledge of the authors, the risk of transmitting these diseases to farmed species has not been assessed. However, it seems rather low, compared to other diseases with a wildlife species reservoir.

The impact of feral mink on economic activities, such as fish farming, appears relatively small on a national scale but could be locally important (9).

Several measures are taken to control feral populations of American mink, mostly as part of the action plans for the conservation of European mink or water vole. According to the context, these measures aim at preventing the establishment of, controlling or eradicating feral populations. For instance, to prevent the creation of new feral populations, fur farms in Spain may be established in areas where the habitat is not favourable to mink, but are prohibited in the European mink range (9). The early detection of escaped mink in areas where fur farms are present, but where there are no feral mink populations in the wild, is vital, as eradication is easier in the early phase of invasion. Methods such as floating rafts can be used to detect the presence of individuals and trap them in areas where mink are present in low densities, as described by Reynolds (48). In the presence of feral populations, it is first important to improve fences on fur farms and to check for escapes. As Kolar and Lodge point out, reducing both the number of individuals released and the frequency of release reduces the probability of establishment of feral mink populations (28).

Trapping and culling are the most used methods for local control or eradicating already settled populations. Provided that there are enough resources and personnel, eradication from an area is possible. For instance, in Estonia, American mink were successfully eradicated from Hiiumaa Island (1,000 km²), but at a total cost estimated at approximately €70,000 to €100,000 (56). However, in the UK, the trial aimed at limiting American mink expansion by trapping was unsuccessful, despite yearly trapping of 1,000 animals for 20 years (33). This failure could be due to insufficient trapping pressure or to the fact that trapping the last animals needs more and more effort.

However, even if trapping cannot be used to eradicate the invasive population, it may still be used to control its spread locally, with significant and repeated efforts. Trapping and neutering American mink (either by vasectomy for males or hysterectomy for females, to preserve their sexual behaviour) before releasing them is another method that has been tried in France (P. Fournier, personal communication). This method, even though difficult to implement, theoretically has the advantage of not leaving a free ecological niche for another individual searching for a new territory (mink are territorial individuals), as well as decreasing the fertility rate, since an infertile male mating with a female prevents the female from breeding.

Another indirect way to control mink populations is to act on the habitat, to promote its native competitors, such as the European otter (*Lutra lutra*), or to manage its prey species, especially such introduced species as the rabbit in the UK (9).

The raccoon dog

The raccoon dog (*Nyctereutes procyonoides*) is a canid, originally native to Eastern Asia (eastern China, Korea and Japan). Its favourite habitat is low-altitude forest, with a mix of oak and hornbeam and dense undergrowth, close to water. Raccoon dogs are generally sedentary animals, as reported by Heptner and Naumov (25). During the breeding season, they live in a very small area and then become semi-nomadic. However, changes in their environment can lead to moves of long distances (20 km to 80 km) towards a more favourable environment. Predation on raccoon dogs by stray dogs, red foxes or raptors occurs mainly among the young and juveniles. Populations generally have a yearly turnover of 54% to 60% and, in the wild, life expectancy is less than seven years. In native areas, their diet is mainly composed of vegetal and invertebrate food, varying according to season, year and habitat (16).

However, in colonised areas, another feeding behaviour is observed. For instance, in the former Union of Soviet Socialist Republics (USSR), rodents (mainly voles) constituted the most important part of the diet and in Poland raccoon dogs eat maize given to wild boars. In other areas, necrophagous behaviour is well developed. Basically, raccoon dogs are opportunist animals, eating the food that is easiest to catch and developing adaptive food behaviour. Their mainly nocturnal behaviour makes the species difficult to observe. Moreover, possible confusion with raccoons (*P. lotor*) can lead to mis-identification in areas where the two species cohabit. Both have a mask over their eyes but the raccoon dog is larger, while the raccoon has a longer ringed tail and five fingers on each paw.

The establishment of non-native populations in western Asia and Europe has two sources. First, between 1928 and 1950, various trials were conducted to introduce raccoon dogs into the former USSR, to set up a new free-ranging fur species. Approximately 9,000 animals were released into 76 different locations in Asian and European parts of the USSR. The translocations conducted in eastern and mountainous regions failed, probably due to severe winters and lack of food. In the western USSR, translocations were more successful. Releases were better organised, in that favourable biotopes were selected and artificial dens and food were made available. From there, raccoon dogs began to colonise. In a second 'wave' of translocation, due to an increasing demand for fur, fur farms were created. The accidental release of individuals occurred principally during World War II, when farms were destroyed. Thus, between 1935 and 1984, the expansion of raccoon dogs reached over 1.4 million km². Nowadays, high-density populations are found in Finland, Poland, Romania, the Czech Republic, Germany, the former Yugoslavia and the Baltic states. In addition, raccoon dogs have been observed in Western Europe, as far west as north-eastern France.

The impact of the raccoon dog on an ecosystem is related to its opportunistic feeding behaviour; for instance, predation on birds nesting on the soil in marshes or damage to melon, vine and maize fields. Moreover, various diseases of veterinary and/or public health importance have been reported in raccoon dog populations; the major one being rabies. In Central and Eastern Europe, raccoon dogs are an important reservoir of lyssaviruses (54), maintaining a specific biotype. Since 1990, 9,438 rabies cases have been recorded in raccoon dogs in Europe, mainly in Baltic countries: Poland, Belarus, the Russian Federation and Ukraine (47). Several cases were also reported in Germany, Croatia, the Czech Republic, Romania, Serbia and Montenegro.

However, the Estonian example has shown that oral vaccination campaigns can control raccoon dog rabies (42, 47). Other viral diseases have also been reported; for instance, canine distemper in the Caucasus and parvovirus infection in farmed animals. Among bacterial diseases, leptospirosis and infection by *Yersinia pestis* have been observed. In the Voronez and Khoper reserves, parts of Russia close to Ukraine, a high frequency (58%) of *Trichinella* infections has been reported (49). Various other endoparasites have been described: a total of 32 species of worms have been identified (eight trematodes, seven cestodes and 17 nematodes). Among ectoparasites, six species of fleas and five of lice and ticks have been observed, able to transmit pathogens, such as piroplasms. Mange may also affect raccoon dogs: in 1969 an epidemic of mange killed 900 raccoon dogs in the Danube delta (7).

While some local trapping campaigns are conducted for fur, no real eradication plans for raccoon dogs have been initiated so far, even where the species is exotic. As has been observed for other canids, the raccoon dog tends to increase its litter size when there is increased hunting pressure and also when there is more food available (15).

The raccoon

Another invading carnivore has a similar history: the raccoon (*Procyon lotor*) (16). The raccoon comes from northern America (southern Canada, the United States) and Central America, and its preferred habitat is humid woodlands with rivers and ponds. These animals are active between twilight and dawn, mainly before midnight. Like raccoon dogs, raccoons undergo a winter lethargy, different from true hibernation, and are generally sedentary. However, some individuals may move for long distances (> 200 km) to find an adequate environment, especially after translocation, or sometimes simply to find a temporary source of food far away from their usual territory. Their feeding behaviour is also opportunistic. Vegetal items are more abundant in summertime (fruit, maize, acorns, grasses) and invertebrates (shellfish, crayfish, etc.) are generally more important than vertebrates (amphibians, rats, shrews, eggs, young birds, etc.). In Central and Eastern Europe and in the USSR (3), the first accidental releases came from zoological collections in the 1930s. In some areas, feral raccoons have also been trapped and translocated, explaining the successful colonisation of Azerbaijan, for instance (16). In Belarus, 127 animals were released between 1954 and 1958, and in 1963 the local population reached 700 individuals. In Western Europe, raccoons were imported for fur farms. In Germany, raccoons were introduced in the 1930s in Hesse (central Germany). The population increased during World War II and, during this period, more fur farms were opened and animals escaped.

After the war, raccoons also escaped from US army camps. In the 1960s, the German population of raccoons was estimated at 50,000 to 70,000 animals, distributed over 30,000 km² of the country, extending southwards along rivers. In other European countries, including the Czech Republic, Slovakia, the Netherlands, Luxembourg, Belgium, Austria, Denmark, Switzerland and France, the first sightings of raccoons in nature were reported between the 1960s and the 1980s. Several decades later, reports of wild raccoons in these countries are still rare. Even when there has been no confusion with the raccoon dog, it is difficult to be sure whether these animals are extending their range or have escaped from fur farms. In France, a raccoon dog has been identified approximately 100 km east of Paris, the most western sighting so far.

The most significant impacts of feral raccoons are the damage they cause to maize, melon or peanut fields, vineyards and orchards. They can also have a negative effect on waterfowl and tortoise populations. Various parasites have been reported in raccoons. The most pathogenic are *Gnathostoma procyonis*, a nematode in the stomach, and *Crenosoma globlei*, which infects the lungs. Other infections identified in raccoons include:

– canine distemper
– infectious canine hepatitis (Rubarth's disease)
– St Louis encephalitis
– equine encephalitis
– Chagas disease (American trypanosomiasis).

In the southeastern United States, raccoons are a reservoir for leptospirosis and tularemia. However, the most important role played by the raccoon is as a disease reservoir for rabies. Since the disappearance of canine rabies in the United States, the urban infection has been maintained within raccoon populations. In Europe, between 1990 and 2009, the World Health Organization of the United Nations (WHO) *Rabies Bulletin Europe* mentions 129 cases of rabies in raccoons in its database. These have occurred mainly since the year 2000, in Ukraine, but also in Estonia, Lithuania and Germany (47).

In Europe, the natural regulation of raccoons through predation seems to have no effect (16). In addition, controlling raccoon populations is difficult because of the high adaptability and opportunistic behaviour of the species, which gains advantages from the presence of humans, especially through scavenging.

The coypu or nutria

The coypu or nutria (*Myocastor coypus*) is a large, semi-aquatic rodent, between 5 and 9 kg in weight, which is uniformly brown with a cylindrical tail and characteristic, prominent orange incisors. Its habitat is wetlands, close to permanent water or marshes. This herbivore eats wetland plants and crops. Some reports indicate that it feeds on freshwater mussels (23). The species is prolific with no specific season for reproduction. Sexual maturity occurs between three and ten months and it has a mean litter size of five to six young. The size of the litter depends on winter conditions, which influence the health status of the female, and possible embryo losses during the early stages of gestation.

Originally native to South America, large feral populations of coypu are nowadays present in North America, Africa, Europe and Asia (12). In Europe, the coypu was introduced principally for meat and fur production, but was also brought in for zoological collections. Colonisation began when individual animals escaped from fur farms. The Invasive Species Specialist Group (23) from the International Union for Conservation of Nature reports feral populations of coypu in 22 countries throughout the world. In France, coypu were first introduced at the end of the 19th Century, in a private zoo, and then in fur farms in the 1920s. The first escapes from fur farms were reported in 1939, and the feral population dramatically increased between 1974 and 1985 (2).

The main impact of *M. coypus* in colonised areas is habitat destruction and changes in the composition of local plant communities. Its burrowing behaviour undermines the banks of rivers, canals and dykes. Its preferential feeding on rhizomes or reeds reduces vegetal biodiversity and plant cover, leading to changes in the flow speed of the river, erosion and flood. Moreover, this damage to habitat and plant cover can also have a negative effect on the reproduction of birds, fish and invertebrates (23). *Myocastor coypus* can also cause agricultural damage by feeding on crops. All this damage can be very costly. For example, during one five-year period in Italy, damage to river banks was estimated at €10,000,000 and losses to agriculture at €935,000 (44).

The coypu may also carry pathogens shared with other mammals and humans. For instance, Ménard *et al.* (40) highlight the fact that up to 40% of coypu are infected by the liver fluke, *Fasciola hepatica*, when infected cattle and the intermediate host of the fluke, the mollusc *Limnea truncatula*, are also present. The coypu is also described as a reservoir for leptospirosis (4) and a host for *Francisela tularensis* and *Toxoplasma gondii*.

Management and control measures to reduce the impact of coypu are generally based on trapping and shooting. Anticoagulants are also used but the risk of poisoning non-target species is always present. Even when the poisoned baits are distributed in a 'selective' manner, i.e. on floating platforms, their direct or indirect consumption (through the ingestion of bait or predation on poisoned animals, respectively) can have major consequences on other species, including endangered ones, such as the European mink (21), polecats (*M. putorius*), otters and water vole (10). Although attempts at eradication have generally proved unsuccessful on large populations, the elimination of coypu populations has been achieved in Denmark, Finland, Norway, Sweden and the UK (15). In all cases, control measures were very expensive. For instance, in Italy, 220,000 coypu were trapped between 1995 and 2000, for a cost of €2,614,000.

The muskrat

The muskrat (*Ondatra zibethicus*) is a large aquatic rodent native to the swamps, marshes and wetlands of North America. Imported for fur farming into various parts of the world, it successfully colonised Ukraine, Russia, parts of the People's Republic of China and Mongolia, Japan (Honshu Island), Argentina and Chile. In Europe, it was first introduced into Czechoslovakia in 1905, and then into many other countries. Nowadays, feral muskrat populations are present in northern and Central Europe. In France, breeding started in 1928 and the first feral animals were observed in 1933 (15).

As with coypu, the main impact of the muskrat is due to grazing, which affects vegetation dynamics and consequently can have serious effects on fish, shellfish and populations of ground-nesting birds. Muskrats can even threaten endangered species, as in the case of the semi-aquatic mammal, the Russian desman (*Desmana moschata*) (15). Damage to crops, weakened river banks, railroads and dams can be very costly. In Germany, for instance, this annual cost is estimated at €12.4 million which includes the costs of disease control. Indeed, muskrats may act as both vectors and reservoirs of various pathogens of human and veterinary importance, such as the liver fluke, leptospirosis or alveolar echinococcosis (as the intermediate host of *Echinococcus multilocularis*) (26).

Control measures are mainly based on trapping and hunting. In France, the hunting tally between 1998 and 1999 reached 88,000 muskrats. Poisoning campaigns with anticoagulants or zinc phosphide are sometimes conducted but, as in the case of the coypu, this method can lead to poisoning non-target species, especially predators, which eat dead or dying muskrats. The cost of eradication efforts in Germany was estimated at over €30 million per year.

The African sacred ibis

The African sacred ibis (*Threskiornis aethiopicus*) is a sturdy wading bird, naturally present in sub-Saharan Africa, western Madagascar and south-western Iraq. In its original area, its habitat was mainly fields and wetlands but also dumps and dunghills, illustrating the strong adaptive ability of this species. The sacred ibis breeds and feeds in groups. Its diet is varied: invertebrates, earthworms, molluscs, fish, amphibians, reptiles, young birds and carrion or slaughterhouse offal. Predation on other birds may be carried out by individual birds or by a group of ibis, which has become accustomed to this type of prey.

Easy to maintain in captivity, African sacred ibis were introduced into many zoos around the world. In France, in the 1980s, some birds escaped from a zoo in Brittany. A feral population became established and spread along the Atlantic coast. In 2006, the overall population in western France was estimated at 1,700 pairs and 5,000 birds (59). In southeastern France, some individuals were released from a zoo in Languedoc-Roussillon and sacred ibis are now present on the Mediterranean coast (27).

The main fear about the sacred ibis becoming established is its potential impact on ecosystems, especially on indigenous avian species, and thus on biodiversity. Competition with other birds in a feeding area is not easy to assess. However, competition on breeding and nocturnal resting sites has already been proven. Moreover, the sacred ibis is reported to predate on colonies of the sandwich tern (*Thalasseus sandvicensis*), black tern (*Chlidonias niger*) and cattle egret (*Bubulcus ibis*).

In line with the precautionary principle, scientists warn of the invasive characteristics of this exotic bird because of its predation on sensitive species and scavenger behaviour, which can lead to the spread of pathogens (60). Thus, they recommend the eradication of the species. Efforts to do so continue in France.

Conclusion

Accidental and voluntary releases of non-indigenous species may have different kinds of negative impacts. Some are easy to point out: the destruction of habitat due to digging, changes in the composition of local plant communities related to the feeding habits of introduced species, with serious consequences for biodiversity and autochthonous animal communities. The introduction of shared pathogens is also an important risk affecting the indigenous fauna, including people. Effects on animal communities due to predation are sometimes more difficult to detect, as is competition for a specific ecological niche. When the original indigenous species is already threatened, any risk of releasing a potential competitor should be avoided by strict control of breeding facilities.

The consequences of species introduction may also be insidious, as in the case of genetic pollution. This has happened with the ruddy duck (*Oxyura jamaicensis*). Bred since 1948 at the Wildfowl and Wetlands Trust in Slimbridge (UK), the ruddy duck is native to America. In 1960, it escaped from Slimbridge and colonised continental Europe. Fifteen years later, this alien species threatens the indigenous white-headed duck (*O. leucocephala*) with extinction, through direct competition but also, above all, through hybridisation and genetic pollution. Hybridisation can also occur between native domestic and wild animals, e.g. between domestic swine and wild boar, which are interfertile. Crossings can occur because of breaks in fences, the voluntary release of domestic animals to improve the size of game animals or when pigs are bred in free-ranging environments. This genetic pollution could have led to the presumed disappearance of the original Mediterranean wild boar (*Sus scrofa meridionalis*) on Corsica, a French Mediterranean island.

Thus, strict controls by veterinary and environmental authorities on the introduction and installation of alien species onto farms or into zoological gardens is one of the first and most vital measures to prevent severe negative impacts on the autochthonous environment.

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Lâcher accidentel d'espèces exotiques à partir de colonies d'élevage et de collections zoologiques

J. Barrat, C. Richomme & M. Moinet

Résumé

Des espèces exotiques ont souvent été introduites dans un nouveau pays, dans des jardins zoologiques ou botaniques, pour l'ornement, ou bien dans des fermes d'élevage, pour la fourrure ou comme gibier. Lorsqu'ils sont accidentellement voire volontairement relâchés, les individus de ces espèces exotiques fondent parfois des populations qui peuvent alors devenir envahissantes et avoir un impact négatif sur les communautés végétales et animales ou sur les activités humaines. Cet article se concentre sur une sélection d'exemples de ces espèces envahissantes : en premier lieu le vison d'Amérique (*Neovison vison*) puis le ragondin (*Myocastor coypus*), le rat musqué (*Ondatra zibethicus*), le chien viverrin (*Nyctereutes procyonoides*), le raton laveur (*Procyon lotor*) et l'ibis sacré africain (*Threskiornis aethiopicus*). Pour chacun de ces exemples, les auteurs décrivent les caractéristiques biologiques de l'espèce en relation avec ses capacités invasives puis l'origine et l'historique d'implantation de la population introduite, ses conséquences environnementales ainsi que les éventuelles mesures de contrôle. Les principaux impacts négatifs concernent la destruction de l'habitat, l'introduction et/ou la diffusion d'agents pathogènes et des changements dans la composition des communautés écologiques initiales avec des conséquences sur la biodiversité.

Mots-clés

Animal exotique – Impact environnemental – Mesure de contrôle – *Myocastor coypus* – *Neovison vison* – *Nyctereutes procyonoides* – *Ondatra zybethica* – *Procyon lotor* – *Threskiornis aethiopicus*.

■

Liberación accidental de especies exóticas de colonias reproductoras y colecciones zoológicas

J. Barrat, C. Richomme & M. Moinet

Resumen

A menudo las especies exóticas son introducidas en un nuevo país al llegar a parques zoológicos, jardines botánicos o criaderos de animales con fines de caza o peletería. Cuando son liberadas al medio, ya sea voluntaria o accidentalmente, esas especies foráneas pueden adquirir un carácter invasor y resultar dañinas para la flora y fauna autóctonas y las actividades humanas. Los autores se concentran en unas pocas de esas especies invasoras, sobre todo el visón americano (*Neovison vison*), pero también la nutria (*Myocastor coypus*), la rata almizclera (*Ondatra zibethicus*), el perro mapache (*Nyctereutes procyonoides*), el mapache boreal (*Procyon lotor*) y el ibis sagrado africano (*Threskiornis aethiopicus*). En cada caso los autores exponen las características biológicas y la historia de la especie en relación con su capacidad de invasión, los orígenes y el asentamiento de poblaciones foráneas, las consecuencias ambientales de la invasión y posibles medidas de control. Los principales perjuicios observados son la destrucción del hábitat, la introducción y/o propagación de patógenos y la alteración de la composición de las comunidades autóctonas, con su cortejo de efectos sobre la diversidad biológica.

Palabras clave

Animales exóticos – Especie invasora – Impacto ambiental – Medidas de control – *Myocastor coypus* – *Neovison vison* – *Nyctereutes procyonoides* – *Ondatra zybethica* – *Procyon lotor* – *Threskiornis aethiopicus.*

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