Globetrotters
New Fauna and Flora among us
**Glossary**

**Archaeobiota**  
Microorganisms, fungi, plants and animals, not native to a certain area and who arrived there before the year 1492, with direct or indirect human help; they are able to reproduce on their own in that area.

**Neobiota**  
Microorganisms, fungi, plants and animals, not native to a certain area and who arrived there after the year 1492, with direct or indirect human help; they are able to reproduce on their own in that area.

**Neophytes**  
Plants, not native to a certain area and who arrived there after the year 1492, with direct or indirect human help; they are able to reproduce on their own in that area.

**Neomycetes**  
Fungi, not native to a certain area and who arrived there after the year 1492, with direct or indirect human help; they are able to reproduce on their own in that area.

**Invasive Alien Species (= Neozoa)**  
Animals, not native to a certain area and who arrived there after the year 1492, with direct or indirect human help; they are able to reproduce on their own in that area.

---

**Changing Nature**

The worldwide network of trading, together with global warming, is the precondition for the current enhanced migration of species around the globe. Geographical barriers, such as oceans and mountains, are no insurmountable barriers any more. Ships, planes and international road haulage by lorry and train, as well as tourism, enable some ‘globetrotters’ to enter new countries and continents. Global warming enhances this process, as it enables additional species to reproduce and overwinter. This is how fungi, plants, animals, as well as microorganisms, colonise new areas—worldwide.

Climate changes happened also in the past. Today we are in a warm interval within an ice age, which had its climax about 21,000 years ago, when glaciers covered the Enns and further south into the Palten river valley, as well as the upper Mur river valley as far as Judenburg. Subsequently, warmer and colder periods often alternated rapidly. Thus, within a period of just 50 years, between 11,535 and 11,487 years ago, temperatures increased rapidly to those of today after a cold phase (Younger Dryas). Cold periods were drier phases, as most water was bound in the polar ice caps—afflicting the composition of plant and animal species.

Since the New Stone Age, man has also affected species composition. Since Columbus—his discovery of America gave rise to further discoveries and conquests—the number of non-native species is rising constantly. Also, most of our fruit and vegetable species have been imported; ornamental plants from all continents are growing in our gardens and in our houses. About one third of all plants in Austria are not native. Furthermore, hunting, fishing, animal breeding for fur, forestry, as well as trade, has brought new animals and plants. Globalisation causes an intercontinental transfer of species on a scale never before seen.

This exhibition deals with those organisms which came to us after 1492—called Neobiota—as well as their impacts, on ecology, the economy and public health.
More than 4,000 species of vascular plants—which excludes mosses and algae—occur in Austria. One third of these are neophytes; many introduced deliberately by man. Many have been planted in botanical gardens or in gardens of stately homes several hundred years ago, and later in private gardens. Some were cultivated as vegetables, others as food for bees or for their timber. Around 10 out of 100 species manage to escape human custody and to 'go native'. They manage to proliferate on their own, to spread and colonise new areas permanently. These 'new inhabitants' usually do not affect existing animal and plant communities. Approximately one per cent of all Neobiota cause problems and becomes invasive. The map shows that ratio: of 100 species of plants, 32 are neophytes, who survive without human help. Three are invasive with negative impacts on native species and their habitats, e.g. by displacing rare species.

With a comparably small area, Austria offers organisms a large variety of different habitats: the Alps, their foothills, the planes, hills and plateaus of the Bohemian Massif. The climatic setting between the damper, oceanic influenced zones in the North and West, drier Pannonian continental conditions in the East, and Mediterranean influences in the South lead to an abundance of species. About 67,000 species are currently known from Austria. This exhibition covers about three per cent of these species, for which man eased the way to colonise the country. A variety of different biotopes offers these globetrotters many possibilities to establish themselves—sometimes with profound and troublesome influences on native communities that can be harmful to health or to the economy. In the following rooms we show which factors are crucial for new animals and plants which have already colonised or may colonise Austria in the future—and what consequences these have. Through hunting, agriculture, fisheries, breeding of animals for fur, beekeeping, as well as pleasure taken in beautiful plants and birds, man has partly influenced the native variety of species for hundreds of years. However, presently, this trend is increasing; today, mostly inadvertently, by air, land or water, and via global trading.

Why are these globetrotters so successful? What do they cause? Can we stop them becoming established here? Can we do something when they are already established and cause detrimental effects on nature, man or our economy? This exhibition will get to the bottom of these questions.
Developmental Cycle of the Harlequin Ladybird

Creation of a Model with Micro-CT Imaging and 3D Printing

In traditional model making, models are formed based on sectional drawings, first by hand and in plasticine, and then cast in plastic. Surface structures as well as proportions are replicated as naturally as possible. This laborious process often takes several months. Modern technology cannot only reduce the time spent on producing a model to a few weeks, but can also improve the quality of the result. By using Micro-CT Imaging of a preserved larva, a pupa and a beetle, it was possible to produce the very detailed 3D prints shown here, in the scale 50:1. Details of the surface were then re-worked. Subsequently, the 3D prints were taken apart and negative silicone casts created. Based on these silicone moulds, transparent, coloured plastic casts were produced, which then could be mounted. Their final colouring was applied using Airbrush and paint brushes. Finally, manually produced fine bristles and hairs were attached. The compound eyes of the ladybird consist of numerous single eyes, which are arranged in many rows. They were imitated by using 1.5 mm balls, formed from a negative cast and filled with epoxy resin. The colourful background enhances the 3D effect. The wings of the ladybird are too thin to be printed in 3D. A digital microscope was used for measuring the cross-section, and then a 50:1 plaster mould created, so that they could be deep-drawn in transparent plastic foil.

Area Expansion

Under natural conditions—without human intervention—plant and animal populations spread due to an excess of migrating offspring. When there is no free space in the original area, offspring is forced to colonise new, usually immediately adjacent, regions. The purpose of transportation of plant seeds by wind, water or animals, as well as the mostly undirected dispersal of young animals is the occupation of new, previously un-colonised areas. Geographical, climatic and ecological boundaries for dispersal, such as insurmountable mountain ranges, marine areas or unfavourable climate conditions, often hinder area expansion. Therefore, natural shifts of the range of animal and plant species are often rather slow. Large natural area shifts are often connected with long-standing tectonic and climatic changes. Thus, many of our well-known, native plant and animal species colonised Europe following to climate warming after the end of the last Ice Age and the resulting spread of deciduous and mixed forests in Central and Northern Europe.
Travelling with Human Assistance

Since the origin of life on our planet, climate changes affected the composition and distribution of organisms. Over the last 3 million years humans assisted the dispersal of species through migration and wars. When people became sedentary with the start of agriculture and food storage in the New Stone Age, humans changed the landscape, the environment and started to affect natural cycles for the first time. In Europe the Neolithic started about 7,700 years ago. The first non-native plants appeared: with grains associated agricultural weeds were introduced, but also some of our meadow plants like cornflowers, common plantain, henbane and red poppies. Rye, apricots and sweet chestnuts were introduced in Austria no later than during Roman times. Animals, like rats, house mice and house crickets arrived. All that species are called Archaeobiota: microorganisms, fungi, plants and animals which arrived in new areas with humans before the discovery of America, which marks the transition from the Middle Ages into the Modern Times.

Cane Toad

Bufo marinus

In 1935, 100 Cane Toads were imported to Queensland, Australia, for biological pest control in sugar cane fields. What worked in parts of South and Central America—their homeland—failed here, with incalculable consequences: The toads didn’t eat the Greyback Beetle (Lepidoderma albohirtum), and has proliferated quickly as natural enemies are lacking. Female toads lay 36,000 eggs per year. Today, the population is estimated at 92 million animals, in the Northern Territory alone. The species is nocturnal and eats anything it can get hold on. The speed of expansion towards the South and West is about 30 km per year. Since the Cane Toad has a poisonous skin secretion, and local animals were unable to develop resistance due to separate evolution, the species is fatal for most indigenous predators. This has already caused the extinction of several species of snakes and monitor lizards. Ingested by dogs or birds the toad’s secretions have deadly consequences. Many campaigns have called on people to catch and kill them. Science is looking for disease agents to stop the further spread of the Cane Toad.
What Makes Introduced Species Successful?

About three per cent of all organisms in Austria are Neobiota. Their population depends on different principles from that of native species. This is because, particularly, the mutual relationships with their living spaces (biotopes) and other species (biocoenosis), established over long periods of time, follow different rules. Introduced species didn’t need any energy to get here. If the climate in their country of origin is similar to ours, then there is a good chance that they can reproduce here as well. Habitat change following to habitat destruction and intensive farming makes for an easier spread. For example, one can find many invasive, quickly growing plants in high densities in cleared areas in monocultures, or alongside rivers, which, due to flooding, have permanently changing riverbanks. There they experience little competition. Because of their ground-covering growth habit, which overshadows the soil and changes the microclimate, the seeds of other species cannot germinate. Since the original diversity makes way for monotony, the number of organisms in the soil is reduced, as is that of insects and other animals, which are the basis for the diet and reproduction of a broad range of species. Often, introduced species have shorter reproductive cycles and higher reproductive rates. The many thousand larvae of the Chinese Pond Mussel (*Sinanodonta woodiana*) complete their development in only seven days. The species proves to be highly competitive with the native Duck Mussel. Presently, one can only find about 20 per cent of native Duck Mussels (*Anodonta anatina*) in the backwater of the Raab river between Feldbach and Hohenbrugg, compared to 80 per cent Chinese Pond Mussels. A wide range of food, a higher tolerance of changing temperatures, as well as the lack of natural predators and parasites, which are limiting most species in their original location, may increase the competitiveness of introduced species. Only a small percentage of globetrotters are invasive, i.e. a threat to the native fauna and flora, changing the function of ecosystems.

Fisheries Then and Now

Professional fishery has a long tradition in Austria, spanning many centuries. Today it is only practised in a few bodies of water. In the Salzkammergut regional specialities like the Reinanke (a whitefish), Arctic Char and Brown Trout, are caught. In Austria stocking with non-native species has been documented since 1884: this was when the Rainbow Trout and the Brook Trout were first introduced. Increasingly, fishery developed into an economic factor. Apart from stocking of natural water bodies, where sport fishermen catch about 1,900 tons of Rainbow Trouts a year, fish breeding ponds were created and partly stocked with non-native species. Together with deliberately introduced species, some species came in accidentally, such as the Asian False Harlequin which is used as bait. The Styrian Fishery Association—umbrella organisation of all holders of fishery licences, fish farmers and fish breeders—impacts ecological knowledge to its members.
Non-native Fish Species in Austria

There are currently 27 non-native fish species in Austria. This has been established using the fish database as well as data from professional fishermen—in the years 2007 to 2014 129,670 fish were caught for this survey. The majority of fish species are rare; 15 can be found throughout Austria in running water—9 of them in Styria. A quarter of all new arrivals are classified as invasive or potentially invasive. This classification differs from region to region.

Most species arrived in our waters through fishery, less frequently by accidental introduction or via the inland waters of the Danube and Rhine. Their arrival can cause the extinction of native species (e.g. Sea Trout, Grayling). Competition for food and breeding grounds increases, and native species—from egg to adult fish—are on the menu of non-native species, which can also transmit disease agents and parasites (e.g. parasitic nematode in the swimbladder of eels). The occurrence of undesirable hybrids (e.g. Brook Trout and native Sea Trout = Tiger Trout) endangers the genetic integrity of locally adapted populations.

Competitiveness of native species could be improved by the revitalisation of bodies of water, as well as limitations of the deliberate release of non-native species.

Crayfish in Austria

Austria harbours four native species of crayfish: the European Crayfish or Noble Crayfish, the Danube Crayfish, the White-clawed Crayfish and the Stone Crayfish. Mainly for economic reasons, the American species Signal Crayfish, the Eastern Crayfish and the Red Swamp Crayfish were introduced to Europe, and also to Austria. Because of largely identical ecological needs, the Signal Crayfish is a strong competitor with the native Noble Crayfish. The Signal Crayfish occurs in all medium to large flowing bodies of water. The introduced species transmit Crayfish Plague, a disease caused by a water mould (Oomycete Aphanomyces astaci). They are immune to this disease; but fatal to our native species. The mould has already extinguished thousands of crayfish populations and is one of the 100 worst invasive species worldwide. In Austria, the Noble Crayfish occurs in very small, segregated populations; it is highly endangered.

A single American Crayfish can extinguish a whole population of European Crayfish in a body of water. Especially during moulting of the cuticle, or after the death of an infected animal, the fungal spores disperse in large quantities. Since they survive in water for up to three weeks, a flowing body of water can become completely infected.
Hunting Globetrotters

Apart from the species on display—Mouflon, Pheasant and Chukar Partridge—also the Sika Deer (native to East Asia), the Fallow Deer (native to Western Eurasia where the Ice Ages had separated it from Europe) and the Rabbit (native to the Iberian Peninsula, Southern France) were introduced in Austria as game species. A special position is held by Marmots and Ibex, which have been released in many areas for hunting during the 20th century. They are classified as regional Neozoa (= Invasive Alien Species) when man has transferred them to areas where they did not originally occur. So, all of Styria’s Marmots can be traced back to animals of various origin.

In Austria, Ibex became extinct at the beginning of the 18th century due to hunting and poaching, as nearly all parts of their body were supposed to have healing powers. Today’s stock of about 40,000 animals originates from only 100, which had survived in Italy’s Aosta Valley. As only 100 animals are holding the genetic information for all their offspring in Austria, and as there is no link between different colonies, inbreeding can become a danger for the future of these animals. Travelling from Graz, the closest wild colony lives in the Hochlantsch Range.

Each year, 11,000 to 12,000 pheasants are shot in Styria—200,000 throughout Austria. Four weeks before the start of the hunting season (October 1st) they are released for shooting.

In the mid-19th century, Archduke Johann enforced a completely new hunting concept: apart from the right to hunt, an obligation for the protection, game-keeping and careful treatment of game was laid down. Today, hunting is considered an experience of nature and a sustainable use of renewable natural resources.

Red Lionfish

*Pterois volitans*

Country of Origin: Coastal areas of the Indo-Pacific region, Pacific Ocean: Northwest up to Hawaii, and Southeast down to Polynesia.

The Indo-Pacific Red Lionfish can be found in lagoons and reefs up to 50m deep. The beautiful but dangerous fish is expanding its original range—because of trade in ornamental fish. The Red Lionfish is nocturnal, hiding beneath overhangs during day-time. It can prove dangerous for divers as it doesn’t show any flight behaviour—the spines of the dorsal fin containing strong venom which protects it from predation.

The fish feeds on many species which are of commercial interest. If abundant, its feeding habits can lead to a decline in other fish and thus in income from fishery. As a strong competitor it has a severe impact on native biodiversity, which can lead to the extinction of other species. Especially in small reefs, damage can be vast. Investigations conducted on the Bahamas showed an 80% decline in young fish. Their prey ranges from fish, shrimps, crabs and molluscs to sea lice.

Chukar Partridge | Pheasant | European Mouflon | Chukar Partridge | European Mouflon

Photos: Ursula Stockinger | Wiki/Jörg Hempel

Red Lionfish

Photo: Wolfgang Gessl

Room 02

Room 02
What Turns Introduced Species into a Problem?

Introduced species can alter ecosystems and communities which have evolved over long periods of time. As a result, ecological, economic or health problems can arise. Displacing native species—through competition for food or habitats, as predators, vectors of diseases or parasites – results in a reduced biodiversity. In particular, endemic species (native, or restricted to a certain place) on small islands, have already become extinct. Where there is hybridisation of a newly arriving with an old, established species (e.g. Ruddy Duck and White-headed Duck) this can lead to a reduction in genetic diversity and even the extinction of native species. Monocultures, such as Douglas Firs, compared with beech forests, offer native insects which are often heavily specialised, a greatly reduced diversity of habitats. This often leads to the decrease of native populations. Further, plants influence the soil’s nutrient balance, which affects the plant community and the local fauna. Introduced species are often undesirable in agriculture and forestry, as they arrive here without any means of regulation (predators, parasites). Efforts to stop these species by using chemical, biological or mechanical means are not always successful, but always costly. Around 1840 the Potato Blight, caused by the introduced fungus Phytophthora infestans, destroyed the potato harvest in Ireland. One million people died, and two million more emigrated. Today the Western Corn Rootworm and the Grapevine Phylloxera pose new challenges for maize cultivation and viticulture in Styria. More on this topic can be found in Room 07. Introduced species (Neobiota) can also threaten human health. Some species cause burns (e.g. Giant Hogweed) or allergic reactions (e.g. Common Ragweed), some transmit disease agents or parasites and have economic implications for us and our healthcare system. In Austria, the Common Ragweed alone elicits annual costs of almost 89 million Euros. In the US, introduced species generate annual costs of 137 billion Dollars. Several international conventions—e.g., the Bern Convention on the Conservation of European Wildlife and Natural Habitats—but also national action plans, give guidelines and strategies how to deal with these problems; since 2015, an EU guideline addresses this topic.

Plant-based Energy Generation

Energy plants are agricultural crops planted for energy production. Bio-energy is either gained directly by burning plant material, or indirectly by, e.g., burning of biogas produced by fermentation. Some crops are currently hardly used, but are interesting from an energetic point of view, such as Chinese Silver Grass and Johnson Grass. On good soils they even yield more energy than fast-growing poplar plantations. The main aims are the production of heat, electric energy and bio-fuel. Twenty per cent of Austria’s arable land is planted with energy plants such as maize and rapeseed. In respect to CO₂ balance the cultivation of sustainable energy plants is seen as environmentally friendly. However, adverse side-effects, as fertilisers and pesticides are needed for intensive farming, have to be considered. Increased cultivation has to be seen as disadvantageous if green areas are ploughed, or even marshes, areas close to natural bodies of water, or other natural areas are destroyed. Competition for space between the growing of food plants versus energy plants also has ethical implications.
Forestry—Change of Native Ecosystems

Our forests are a product of century-long management. Primary forests without any human intervention—have become very rare. Forests protect from rockfall, snow and mud avalanches; they are important regulators in the water, oxygen and CO₂ balance. They are habitats for plants and animals as well as recreational areas. Forests are also economic factors; they supply the commodity wood. Therefore, in many places, indigenous trees have been replaced by fast-growing ones. Currently, global warming poses a real challenge for forest management. The spruce, the most common forest tree in Austria, might not be able to tolerate increasing stress from drought in lower areas. This is why new woods are introduced. Some of these introduced species have a tendency to ‘go native’—mainly Robinia (Black Locust) and the Tree of Heaven. These trees mainly occur in warmer locations and have a massive impact on ecosystems, in particular Robinia is highly competitive: on one hand it replaces native species, on the other it increases the nitrogen level in the soil. The Tree of Heaven is one of the 100 most problematic invasive species in Europe. To date, there is little knowledge about the behaviour of the drought-resistant Douglas Fir and Red Oak.

Western Honeybee

The original range of our native honeybee encompasses Europe, Africa and Asia Minor. Cave paintings show that humans looted bees’ nests already during the Stone Age. It was known long ago that bees produce honey, so, over time, the Western Honeybee was spread all around the world. Up until the 18th century, beekeeping was a major economic factor. Once sugar beet was discovered as a means to sweeten dishes, bees lost their status as the main supplier of sweetening agents. Beekeeping is still very popular today. In 2014 about 380,000 beehives were kept in Austria.

Introduced parasites and disease agents threaten honeybees more and more. The Varroa, a mite species originating from Asia, has been decimating our bee colonies since 1983. More disease agents are knocking on the door: the African Small Hive Beetle (Aethina tumida) was found in Calabria in 2014. The Asian Predatory Wasp (Vespa velutina), introduced to France, could also reach Austria soon. Additional Asian mite species, an Asian fungus and the use of Neonicotinoids, insecticides used against the introduced Western Corn Rootworm, all pose threats to our honeybees.
The Long-term Effect of Cuddly Furs

All five species of mammals, shown on the plinth, have been introduced to Europe during the 20th century. Raccoon, Mink and Muskrat are native to North America; the Raccoon Dog to East Asia, and the River Rat (Nutria) to South America. Some managed to escape, some were released deliberately. Having reached freedom, they enlarged their areas and founded viable populations. Newcomers are usually not adapted to native predator–prey relationships, which have evolved over long periods of cohabitation in the same area. That is why population numbers can explode—like those of the Raccoon in Germany at the moment—and can only be limited by human intervention. The Mink, a natural enemy of the Muskrat in America, has Muskrat on their menu also in Europe. Through their digging activities, River Rats and Muskrat destroy dams and riverbanks.

A large-scale control initiative in Great Britain managed to eradicate over 200,000 River Rats. In Italy 220,000 animals were caught over a period of 5 years with costs of 2.6 million Euros. This is compensated by savings on feeding damage to maize and sugar beet of 11 million, and by the repair of dams and riverbanks of 10 million Euros.

Forestry—Change of Ecosystems: Blue Gum

There are over 600 species of Eucalyptus. They are native to Australia, Papua New Guinea and Indonesia. Blue Gums (Eucalyptus globulus) are native to Southeastern Australia and Tasmania, but have been introduced and cultivated in over 100 countries where they often became established in the wild. The areas of Eucalyptus cultivation have seen a vast increase since the 1950’s. Often primeval tropical forests have to make way for it. Eucalyptus grows extremely fast (30 metres in 5 to 10 years); the wood is highly sought after by the cellulose and paper industries.

The ecological impact of Eucalyptus cultivation is manifold: the roots, which can go down to 20 metres, dry the upper layers of soil, thus taking the water away from native plants. Nutrients in the soil are quickly used up, and erosion promoted. The leaves contain eucalyptus oil, which is toxic to most representatives of our native fauna and flora. That is why eucalyptus forests are ecological deserts where other plants and animals can hardly thrive. The largest cultivated areas are in India, followed by Brazil and China. In Europe the largest Eucalyptus plantations exist in Portugal and Spain.
Ornamental Waterfowl

Geese, ducks and swans are amongst the oldest game for man. They were domesticated early, providing meat and eggs, as well as precious downs. First reports of domesticated geese and ducks come from China, South-east Asia and Egypt, and go back to the third century BC. In South America, the Muscovy Duck (Cairina moschata), now also popular as a domestic animal in Europe, was a common poultry even in pre-Columbian times. Other than food, the gorgeous plumage of the males (drakes) of many geese and ducks (Anseriformes) has fascinated humankind since ancient times. Swans, geese and other waterfowl can easily be kept without cages if the chicks’ wings are clipped on one or both sides. For this reason, they were already kept as ornamental fowl in ancient times by the Romans, but also Egyptians and in China. In Western and Central Europe, keeping wild Mute Swans has a long tradition going back to the early Middle Ages. With the emergence of new and faster trade connections between continents by ship, the husbandry and breeding of foreign waterfowl became particularly popular during the 18th and 19th centuries. The parks, aquatic gardens and menageries of the nobility were soon populated with exotic waterfowl from all over the world. The first breeders’ clubs for fancy fowl were founded towards the beginning of the 19th century; they are still engaged in the husbandry of exotic geese and ducks today.

Many ornamental waterfowl imported to Europe from other parts of the world have escaped the care of their owners. Some managed to establish permanent, wild populations outside their areas of origin. Others regularly escape, but cannot establish themselves permanently as yet.

Particularly in the 17th and 18th century, plants were collected in far-away lands and brought back to Europe. Not only scientific interest was high, people also enjoyed the attractiveness of the ‘outlandish’. These plants were first cultivated in botanic gardens, and subsequently reached parks and gardens as ornamental plants. Many of them are now an everyday occurrence and characteristic for our gardens and parks. Some of these ornamental plants escaped cultivation, but only a small percentage managed to establish themselves permanently. Some found themselves in such good environmental conditions that they proliferated, competed with the native flora and changed whole ecosystems. Such invasive ornamental plants—e.g. the Japanese Knotweed—can cause economic damage or—even cause health problems in humans.

Gardening is an increasingly popular hobby. Also in these green oases, a race for beauty and rarity has erupted. Garden centres are selling a variety of plants—also those that can get beyond the barrier of a garden fence, become established in nature and can potentially become invasive. With a view to improving nature, ornamental plants are also planted out to the wild. Biomass coming from domestic gardens and containing parts of plants that can survive, often ends up on river banks and in woodland. By the way, both—planting out and disposing—are illegal.

Responsible garden centres do not sell problematic plants without educating the public about how to deal with those ‘aliens’. Keen gardeners can get brochures about this topic. A very simple recommendation is still to keep gardens as close to nature as possible. This can save oneself many problems with habitats as well as pests.
**Disposable Turtles**

Amongst reptiles, Red-eared Sliders are the most popular pets worldwide. Between 1989 and 1997 the USA exported 52 million of them! Subsequently, because of the Convention on International Trade in Endangered Species of Wild Fauna and Flora restrictions (CITES) were applied. Animal trade has circumvented these restrictions by selling different species or sub-species. In Austria too, sliders are popular terrarium pets, and, once they get too big, are often released into bodies of water. Allegedly they reproduce occasionally, but generally our summers are too cold for the eggs for developing hatchlings.

When they occur together with the European Pond Turtle, there is competition for food and places for sun-bathing. However, recent investigations by Andreas Klewein showed that the smaller European species stays in such places for shorter, as they warm up more quickly, and the Red-eared Sliders are more adaptable in choosing such spots. Therefore competition for sunny places is not a stress factor for the native species. Pets must not be released under any circumstances, owing to their likely affect on native species!

**Ornamental Fish**

Not only Sunfish was imported in Austria as a pet and then released, but also Goldfish (*Carassius auratus*), Jewel Fish (*Hemichromis letourneuxi*) and the Guppy (*Poecilia reticulata*) reached our water bodies through aquarium enthusiasts. The Goldfish arrived in Europe in the 18th century. Swiss investigations confirmed the radical decline of amphibians in a pond as Goldfish eat their larvae. Occasionally they interbreed with the native Crucian Carp (*C. carassius*) and the Prussian Carp (*C. gibelio*). This results in sterile hybrids, but has no further negative impact on the populations of either carp species. Goldfish can mostly be found in urban and park ponds; they are also reported from Lake Constance.

Milder winters may enhance their survival and spread. Guppies and Cichlids can be found in the drain areas of the thermal springs in Warmbad Villach, where the water temperature is always about 24° C. Other tropical species have been released there. Students, under supervision from Jürgen Petutschnig, looked at this section of the river for several weeks. Results: 50 fish species, ten of it Cichlids, and one Signal Crayfish were caught and identified. All these species need higher water temperatures and are unlikely to spread further. This should not serve as justification for getting rid of tropical fish in this manner!
Imminent Danger

In 1948 a pair of American Grey Squirrels escaped from the garden of an embassy in Turin (Northern Italy). Only in 1970 it was discovered that they and their offspring had spread unnoticed. In 1990 it was realised that the population of the European Red Squirrel (Sciurus vulgaris) was halved. Grey Squirrels are more robust, more mobile and more inventive in finding new food resources in new areas. They are bigger and proliferate more quickly. Additionally, they transmit a virus (Parapoxvirus) for which they are immune, but the native species is not. Therefore they pose a severe threat to the survival of the European Squirrel. In 1876 and 1929 the first specimens were introduced to the south of England. In the meantime they have populated woodlands, parks and gardens throughout England, parts of Scotland and in eastern Ireland. On average they spread by 18 km² a year – with fatal consequences. In Great Britain, the population of the European Squirrel has been reduced to 30,000 animals, whereas that of the American Grey Squirrel has increased to over 2.5 million. Thus, it seems only a matter of time before the European Squirrel will become extinct in Great Britain. This development cannot be stopped any more in Great Britain. Animal rights activists stopped early interventions in Italy. Following to statistical models, the Grey Squirrel will, spreading from Italy, reach Switzerland and France within the next few decades. Allegedly, the first specimens have turned up in Northern Germany. Did they come from Great Britain?

Unintended Introductions

It has never been easier to cover long distances by water, air or on land. Introduced species use all these as ‘blind passengers’. They are mainly found in harbours, in waterways and canals used by ships, around airports and alongside train tracks and roads. Wood-destroying insects travel with bonsai trees and imported wood, but also with woodcarvings from Africa. Plant pests are hidden in ornamental and agricultural plants; soil organisms are imported with compost, and mosquitoes, with their drought-resistant eggs, come to Europe in used car tires. Green coffee, raw cocoa, peanuts and apricot kernels are also vectors for insects. In the case of plants, it is seed contamination or bird feed, which distributes species worldwide. Seeds also use the coats of animals to change location. Other organisms use our luggage to arrive without being initially noticed—be it in shoe profiles, on clothes, with souvenirs or as disease agents. If the destination provides habitats and suitable living conditions, new species reproduce. Secondary ways of distributions support less-mobile globetrotters in their quest to enlarge their territory. Such means of distribution are also the unintentional spread with machinery—mowers spread ragweed seeds over large distances—or with soil excavations, compost and garden waste, containing rhizomes or seeds. Parasites, like the Varroa mite, are spread by shipping or exchanging honeybees, which are their hosts. And there are also detours: Potatoes, a South American species, had to travel via Europe to North America, to take the Colorado Beetle with them back to Europe.
Traffic and Wind Aiding Transport

The mass occurrence of Horse Chestnuts at Lake Ohrid in the 1980s led to the scientific discovery of a new species of moth, the Horse-chestnut Leaf Miner. Genetic data have shown that the moth is native to Macedonia and has not been introduced there, which had been assumed for a while. By 1989 first individuals were discovered in Upper Austria. Despite its limited capability for active flight, the species inhabits today most of Europe. Air currents created by traffic aid their dispersal along main transport routes. Their wings with tassel-like hairs support passive transportation by wind currents and the expansion of the species’ range. High reproduction rate is a precondition for the species’ success: with the flowering of Horse Chestnuts the first generation of moths hatches, which had over-wintered as pupae in the leaf litter. A few days later first-generation moths lay eggs on the upper side of leaves in the lower crowns of Horse Chestnuts. The larvae mine in leaves. Depending on weather conditions, two to three generations can be produced till autumn. The mining activity leads to an early falling of the affected leaves. With the removal of leaf litter in autumn many pupae are removed, and thus helps to lower the degree of infestation. When using pesticides impeding insect development, all other insects are equally affected.

Lucky Bamboo and Vehicle Tires as Transport Aids

Over the last decades, the Tiger Mosquito, native to Southeast Asia, has been transported all over the world by freight traffic as well as human travel. The Lucky Bamboo belongs to the genus Dracaena and, immersed in water to keep it fresh, is shipped from Asia all over the world. It has been proved that the Tiger Mosquito (Aedes albopictus) which develops, like all mosquitoes, in water was thus able to increase its range of distribution as a ‘stowaway’. The diurnal mosquito also travels in second-hand car tires. These are transported around the world for recycling. Small aggregations of water in the tires create ideal conditions for the eggs, larvae and pupae to survive. It is known that the animals used this means of transport to travel to North America (1985), Brazil (1986), Albania (1989), Italy and Southern France (1990), and Nigeria (1994). With them they brought disease agents such as a number of viruses, e.g. Dengue, Yellow, Chikungunya and West Nile Fever as well as encephalitis. The Tiger Mosquito was first reported in Austria in 2012 in the provinces of Burgenland and Tyrol. Apparently, the animals have not yet become established. However, global warming could help them in that quest. Their recipe for success is that they have a high temperature tolerance and can complete their whole development cycle, from egg to adult mosquitoes, in tiny aggregations of water.
Ballast Water—Transporting Species Worldwide

90 per cent of worldwide trade is done by ship. When empty, the ships need ballast water for stability: on departure it is pumped aboard and contains millions of usually microscopically small animals. Around 40,000 ships are cruising worldwide at any time—and in them about five million tons of ballast water as well as tens of thousands of species. These blind passengers are set free in ports and coastal areas. In the 1980s, a species of comb jelly, the Sea Walnut (Mnemiopsis leidyi) which inhabits the Atlantic Ocean’s coast of America, first arrived in the Black Sea and from there, via ballast water in oil tankers, in the Caspian Sea. A population explosion—250 animals per cubic meter of water—caused the subsequent breakdown of the caviar industry, as the comb jelly feeds on fish eggs, fish larvae and zooplankton.

Starting at the Rio de la Plata, the Golden Mussel (Limpnoperna fortunei), began its rapid spread throughout South America. It has its origin in the deltas of the large Chinese rivers. The golden mussel attaches itself to aquatic plants and harbour walls and blocks drinking water and cooling water pipelines of hydroelectric power stations, thus causing high cleaning costs. In the Big Lakes region of North America, equally large populations of Zebra (Dreissena polymorpha) and Quagga Mussels (D. rostriformis bugensis) have been established since the 1980s. A ballast-water management convention, adopting special rules, is designed to get this method of alien introductions under control.

Introduced Species—What Now?

In 1994 Austria joined the United Nations Convention on Biological Diversity. The convention aims to prevent the introduction of non-native species, which can potentially threaten indigenous species, ecosystems and habitats and at the control and, if necessary, at the removal of populations of invasive species. Preservation and sustainable use of global biodiversity are aims of nature conservation that are acknowledged worldwide. The Austrian Federal Ministry for Agriculture, Forestry, Environment and Water Management has prepared an action plan based on the study ‘Neobiota in Austria’ by F Essl and W Rabitsch. It incorporates aims and procedures how to deal with Neobiota in regard to ecological, economic and health implications. It further includes instructions for institutions and organizations for managing Neobiota and stresses the need of education and sensitisation of the public. However, further research and monitoring is needed as well, as there is still little knowledge of possible interactions of new arrivals with native species. For the control of invasive species both, federal state laws (laws on nature conservation, hunting and fishing) as well as the jurisdiction of the Republic of Austria (laws on forestry and environmental control) are responsible. A common, regulated approach is desirable, but collaboration and synchronization on the international level is also necessary—Neobiota do not stick to national borders.

This room presents some examples for the control of invasive Neobiota by Styrian institutions and organisations. But, besides public institutions, anybody of us can help to protect natural diversity and natural habitats! Since most foreign species often start spreading years after their first appearance, it is urgently recommended not to introduce non-native plants and animals to your own environment or to stop their propagation—i.e. in your garden as well as adjoin lands. This can be afforded by the eradication of shoots, installation of rhizome barriers, the removal of flowers before they produce seed, and the disposal of viable plant parts. In addition, the release of animals from aquaria or terraria and of any other non-native species should be avoided.
Invasive Neophytes—Dispersal Biology and Problems

Invasive Neophytes colonise mainly disturbed, but also natural habitats. They disperse rapidly and displace native, and in many cases endangered species. Most invasive plants have amazing means of dispersal, e.g. by catapulting thousands of seeds a long distance from the stock plant or the colonization of adjacent areas with underground shoots. Starting from a small, introduced part of a plant, new dominant stands will grow, which do not have natural enemies in our country. Some invasive species are not just dangerous for native biodiversity, but may affect economic interests by heavy damage or gradual impairment of buildings, roads, dams and river banks. Therefore, control measures are indicated by conservation as well as economic interest. Interventions should be adequate in respect to the actual problem and adapted to the location without causing further damage to the environment. Otherwise—as seen from previous experience—well-meant interventions in ecosystems can have unexpected consequences and result in the need for future interventions.

As a preventive measure, invasive species should no longer be planted and garden waste not (illegally) deposited along brooks or in woodlands. Already infected sites should be controlled immediately.

Globetrotters Leaving Europe

Species are migrating all around the globe, with and without direct human assistance. Hence, it is not surprising that also European species move between continents and are not always welcome at their destination. Particularly serious problems with non-native species exist in Australia, as its early isolation from other continents allowed the evolution of a unique fauna and flora. Introduced organisms, like mice, rats, cats and foxes, usually out-compete native Australian species as their flight behaviour is not adapted to alien species. They are further defenceless against disease agents introduced by foreign species. Currently, 20 non-native species of birds and 25 species of mammals are well established in Australia; 23 million wild boars, five million donkeys, 300,000 domestic horses and as many dromedaries live there in the wild. In recent years snipers have killed 160,000 dromedaries which devastate water holes and tear down fences.

Also other continents have problems with introduced species: originating in Europe, the Purple Loosestrife (*Lythrum salicaria*) was introduced to North America at the beginning of the 20th century. There, unlike to its habit in its original range, the plant, which is often used as bee pasture, spreads rapidly. In North America the species currently covers many wetlands and seems to cope better with man-made habitats than native species. Hence, purple loostrife is much more successful in its new than in its original range in Europe. A species can behave differently in a new area. It is assumed that in the future flora and fauna, especially in those countries that have a similar climate and intensive trade links, will become more uniform. This scenario is called ‘biotic homogenisation’.
Globetrotters
New Fauna and Flora among us
06.11.2015–08.01.2017

Naturkundemuseum,
Universalmuseum Joanneum
Joanneumsviertel, 8010 Graz

Texts:
Ulrike Hausl-Hofstätter, Renate Höllriegl,
Peter Sackl, Ursula Stockinger

Translation:
Brigitte Grimm

Layout:
Karin Buol-Wischenau