The German Tamarisk (*Myricaria germanica*, in front) can survive even when covered by metres of sand and gravel.

Photo: Sabine Fink, WSL

HABITATS **Uncomfortable places to live preferred.** Whether buried in gravel, frozen to the core, or constantly windblown, some living organisms can colonise the most extreme habitats. How do they cope – and why is this interesting for research?

Sabine Fink keeps an eye out for her study objects while standing in fishing boots by the Moesa river, which is gushing noisily through the Misox Valley in the Grisons. She checks her location on a map. She puts on a life jacket, stomps into the water and starts searching along the riverbank. "The current is okay until the water is knee-deep. Then it gets tricky." On the map, a blue triangle marks the spot where a German Tamarisk *(Myricaria germanica)* used to grow.

But during the flood of the century in October 2019, the Moesa's riverbed shifted, sweeping the plant along with it. "The water used to be shallow here, but now it has become the main channel," says Sabine. The German Tamarisk is typically found on gravel banks, which are characteristic features of 'untamed' rivers. "Since the construction of watercourses, gravel banks have become rare, and the German Tamarisk has disappeared in many places – especially on the Swiss Central Plateau."

In the 'Hydraulic Engineering and Ecology' research programme, the biologist is investigating, together with hydraulic engineers from ETH Zurich and fish specialists from EAWAG, how sediment transport and water discharge function; how hydropower production affects them and what river revitalization measures can achieve. Their findings help to indicate how well the Moesa is functioning as a habitat. Sabine measures the location and size of the tamarisk and collects a few leaf samples for genetic analysis. "Their genetic diversity and the information we collect on the habitat show how suitable the site is for the survival of the German Tamarisk."

Where life becomes too hard for others

Those animals, plants and fungi that can cope with extreme conditions usually pursue two of three ecological strategies. Pioneer species are quickly on the scene in the new spaces created through floods, avalanches or fires. There they grow and multiply rapidly before other species can gain a foothold. In contrast, stress-tolerant organisms do not rely on speed, but on longevity and toughness. The species associated with each strategy can endure very adverse conditions in which others cannot survive: icy cold, drought or lack of nutrients. What they also have in common is that, in less extreme locations, they are both at a disadvantage against species that pursue the third survival strategy, namely competing strongly for space, light and nutrients.

Pioneers often create conditions that make other life possible. WSL microbiologist Beat Frey is studying microorganisms that thrive on the debris of melting glaciers and even in the ice itself. There they defy extreme UV radiation and temperature fluctuations of up to 40 degrees. At the foot of the Damma Gla-

cier in Canton Uri, WSL researchers have recorded no fewer than 1000 species of bacteria and 200 species of fungi. "They turn apparently dead stone desert into soil," says Beat.

Stress-tolerant species, in contrast, colonise extreme locations and persist in these habitats in the long-term. In 2011, botanists found a flowering purple mountain saxifrage *(Saxifraga oppositifolia)* on the Dom mountain (4545 m above sea level), whose age they estimated at 30 years. "For specialised species, the conditions may not be so inhospitable," says Christian Rixen from the SLF Group 'Mountain Ecosystems', who researches flora on mountain summits. Snow acts like a protective blanket in winter. The cushion or rosette growth of the plants stores warmth close to the roots. While the saxifrage can survive being frozen through completely at night, several other plant species store antifreeze.

The survival artists are interesting for research for several reasons. For example, the influence of climate change is particularly evident at extreme locations. "In the high mountains changes in vegetation are mostly due to climate change," says Christian. At extreme locations, moreover, the number of species threatened with extinction is often above average. With global warming, summit dwellers, for example, are being displaced by competitors from lower altitudes. Very nutrient-poor habitats such as bogs and their highly adapted inhabitants have also become rare.

The German Tamarisk is typical of gravel bank and floodplain landscapes, which have become rare in Switzerland, but which other threatened species also depend on. It is a true pioneer, but it also shows signs of stress tolerance. The seedlings survive on recently exposed and dried out gravel banks where other young plants have already died. The adult plant tolerates 'wet feet' and can even sprout again if buried up to one metre deep. New shoots sprout directly from buried plant parts. The long network of roots not only anchors the plant itself, but also the river banks. In France, tamarisks are planted on artificial embankments to stabilise them.

Moving boundaries

Which conditions are extreme depends on the life form. For a tall-growing plant, such as a tree, the timberline at an altitude of 1800 to 2000 metres is where it becomes critical. "Its upright growth makes it difficult for it to make optimal use of the soil heat and exposes it to wind and snow," says Peter Bebi, head of the SLF Group 'Mountain Ecosystems'. Trees need a growing period of at least three months with a mean temperature of about 6 °C. Single trees can survive in sheltered places at altitudes of up to 3000 metres, but are usually very old and small.

"As a result of climate change, we expect the timberline to shift upwards in many areas and northwards in the Arctic," says Peter. A higher timberline also has repercussions for the climate, in particular because forests radiate less heat back into space than snow. Biodiversity could also change since plants above the timberline receive, for example, much more light but have to withstand greater temperature extremes. Moreover, animals find less cover there. That is why Peter and his team are researching the factors that influence tree growth at high altitudes.

Sabine Fink demonstrates a survival strategy of willows on sandy and gravel banks: extremely long roots, which have here been exposed by erosion.

Extreme habitats are not only fascinating. They also deserve special attention and protection. The research into how well the inconspicuous German Tamarisk can spread along the Moesa provides some indications of this threatened shrub's prospective future. But it also shows how near-natural – or not – the entire river system is. This is why WSL researchers will continue to explore wild waters like the Moesa in fishing boots and life jackets. *(bki)*

Photo: Beate Kittl, WSL