Global Routes to Local Miracles

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The world of immigrant plants tends to be painted in black and white: "good" native plants versus "evil" alien plants. In general terms, this is understandable because of a fair number of well-known cases of harmful invasions. But in fact, the phenomenon of immigrant plants shines in shades of gray. As such, we must look closer at how plants disperse to new areas, by themselves or helped by humans, and ponder more deeply the consequences. Maria Thereza Alves's project *Seeds of Change* brings this into focus using the example of plants that have spread via the ballast of sail ships.

The question is most concrete when looked at through the lens of a specific place. In this case, Reposaari: an island outside the estuary of the River Kokemäenjoki on the west coast of southern Finland, one of the locations where Alves collected material.

Reposaari used to be an important harbor in the era of sailing ships, approximately from the late eighteenth century until the first decades of the twentieth. For a short time in the 1870s, it was the liveliest export harbor in Finland. The key to its importance is Kokemäenjoki, a major channel draining the big lakes in central Finland into the Baltic Sea and thus a natural waterway to drive timber from the inland to the coast. In earlier times, the river served as a major channel for human settlers to move from the coast to the inland.

The Gulf of Bothnia's expanse opens up on the western side of Reposaari and offers seaways to other parts of the Baltic. On the other hand, the eastern side is well sheltered against storms and has provided a favorable location to load sailing ships with timber sawed from logs that were driven down the river.

However, every place is dependent on a larger sphere of influence. The significant connections from Reposaari extend, on the one hand, toward the inland along the river Kokemäenjoki, and on the other hand, out to the Baltic Sea. This position as a joint is fairly typical of coastal cities anywhere, but local histories are, of course,

variable. Local specificities are best laid out by comparing regions that are similar in some ways but differ in others, like the Baltic and the Mediterranean.

Plants, too, have the ability to colonize new lands. Geographer Jonathan Sauer formulated a simple rule on what factors influence the migration of plants.[1] The interplay of two opposing forces is decisive here: centrifugal or spreading outwards, driven by seed dispersal, and centripetal or withdrawing, caused by various factors of environmental control. When environmental conditions change, the balance between these forces also changes in a complex and nonlinear fashion; identifying unambiguously the causal factors leading to such change can rarely be done; more often, it's a combination of factors.

Different parts of the world have their peculiar features. At one extreme are regions that have undergone drastic disruptions in environmental conditions over large areas. In northwestern Europe, a geological process of cardinal importance has been the Pleistocene ice age over the last two and a half million years or so. The advance and retreat of enormous ice sheets a few miles thick have dominated the ecological conditions all across Europe during this era. The stages of extended glaciations number, perhaps, twenty. These glacial fluctuations have moved plants around. When an ice sheet expands, it causes flora to "withdraw" to the south by going extinct in regions covered by ice. During melting, the flora will root in suitable spots in newly exposed lands. The pattern includes both slow, step-by-step movements and so-called "jump dispersal" over long distances due to various contingent factors.

The Baltic coastline where Reposaari is located has gone through such fluctuations. During the peak of the latest glaciation 22,000 years ago—hardly a blink of an eye on a geological time scale—the whole of northwestern Europe was covered by a continent-wide glacial sheet down to northern Germany and south-central England. Everything alive in this vast region today has arrived from someplace else.

What was there in the region of Reposaari and elsewhere in northwestern Europe before these glaciations? Plant remains—mainly pollen found in soils—offer more or less convincing evidence that conditions have varied a lot from one warm period to the next. The geography of continental Europe has made it difficult for plants to carry through the movements required for survival during the Pleistocene: from north to south and then back north. Major mountain ranges run east to west in central and southern Europe,

which is a major factor explaining the relative impoverishment of forests in western Eurasia compared with the eastern flank of the continent and North America.

The environmental changes have been very rapid. Trees provide most reliable data on plant movements as their pollen can be identified to the species, and data points telling about presence or absence of trees at different sites are numerous enough to allow estimates of rates of dispersal after the onset of the present warm period.[2] Findings vary from a few hundred yards per year (for beech, ash, and lime tree, for instance) to more than two thousand yards per year (for birch). These are coarse average estimates, but they generally indicate amazingly high rates of dispersal.

This history also includes interesting seemingly anomalous cases. For instance, the hazelnut apparently spread to the British Isles via the Irish Sea, not directly across what nowadays is known as the English Channel. Presumably nuts were carried by water currents from the west European coast. Another anomaly is a sudden appearance of the pine in the Scottish Highlands quite early after the retreat of the glazier. Perhaps a flock of crossbills got thrown northwards in a storm and dropped in their feces seeds that luckily germinated.

Another important feature documented in Europe and North America is that different species of trees have traveled independently of each other. A forest is not a unified "plant community" that can travel back and forth as an entity, another factor explaining why forest profiles have varied greatly from one warm period to the next. Of the dozen or so dominant trees forming northern forests around the Baltic today, the spruce is the latest colonizer. It arrived from the east to Finland soon after the retreat of the ice, but expanded to different parts of the Scandinavian mountains as recently as two thousand years ago.

The effects of human-induced change on plant distributions resemble patterns of natural environmental change. Somewhat schematically, permanent settlement and land cultivation prepare the ground for step-by-step dispersal, while communication and transport over long distances increase chances of jump dispersal. Historically, these processes have acted together. Early localized traces of human presence are quite similar everywhere: habitations, yards, paths, latrines, waste disposal sites, and so forth, as well as clearance of areas for cultivation and domesticated animals. No wonder a similar set of species has thrived in human-modified environments worldwide, in

areas where similar "western Eurasian" livelihood practices have been adopted. Historian Alfred Crosby famously dubbed this "ecological imperialism."[3]

Permanent agriculture originated less than ten thousand years ago at several centers on different continents. Permanent settlements spread to Central Europe from the southeast some six thousand years ago and reached Denmark and southern Scandinavia some four thousand years later. It took another millennium or two before agricultural settlements showed up along the northern shores of the Baltic, including the Kokemäenjoki river basin.

Which plants were favored by the spread of human culture has been well-known since old. Cultivated plants were, of course, a major element, and quite a few of them colonized natural and semi-natural habitats in the vicinity of permanent settlements. They were followed by weeds that thrive in fields and gardens, several of them being similar to cultivars and therefore very difficult to keep in check. In addition, a whole range of other plants thrives in environments that typically take shape around human habitation.

In the millennia following what has been called the "original colonization" of northern Europe (often called by the Danish term "landnam"), landscapes were thoroughly domesticated, too.[4] Forests gave way to cultivated lands, and patchworks of land plots with different vegetation changed shape; the profile of landscapes became more "fine-grained" and presented more small-scale variation than was the case in the original prehuman situation. Overall, everything has been molded by historical human influence; there is nothing "primeval" left in any literal sense.

Long-distance trade, particularly maritime, has provided plants with major opportunities for jump dispersal. The global influence that Alves's *Seeds of Change* project is tracing is from the recent centuries, but the historical background has deep roots. A comparison between the Mediterranean and the Baltic is instructive. They both are landlocked seas; i.e., surrounded by land masses except for narrow straits that provide connection to the world ocean; a landlocked sea does not isolate people living along its shores but connects them, provided people learn the skills of seafaring, which is precisely what happened in both regions. Until recent centuries, movement across land was much more difficult and time consuming than moving across water.

Maritime historian Lionel Casson has collected a wealth of evidence on the development of seafaring skills in the ancient world.[5]

To travel across waters, people originally used anything that floats. Reed craft was an early device adopted on the relatively benign waters of the Nile. Early in the third millennium BCE, ancient Egyptians took the important step of making their boats entirely of planks; they needed sturdy boats to transport blocks of stone used for building the pyramids. In the beginning, the boats were replicas of reed crafts in wood, but they gradually acquired novel "woody" shapes.

The earliest evidence of Egyptian seagoing ships dates back to the middle of the third millennium BCE. Also, other Mediterranean peoples learned and adopted Egyptian ship craft skills, building different types of boats for different purposes. These vessels' demand for a skilled crew also grew over time. It is no coincidence that many ancient thinkers used the command of a ship as a metaphor for statecraft.

In French historian Fernand Braudel's words, "The Mediterranean is not so much a single entity as a 'complex of seas.'"[6] Skills needed to move across waters were refined in regions where the rewards were best, like the Aegean archipelago and the Venetian Lagoon. River connections inland were also important; the Nile steered them toward the south and the Po and the Rhône toward the north. However, in general, navigable rivers were of no prime importance in the Mediterranean because of her geography characterized by steep mountains and a hot and dry summer climate.

When comparing the Baltic with the Mediterranean, the first point to note is the enormous difference in the harshness of the conditions. The Baltic is covered by ice for more than half a year in the north and for several months in the south. Also, tilling the lands surrounding the Baltic required new methods, and the productivity of cultivation is lower than in the Mediterranean lands.

But similar to the Mediterranean, the Baltic is a "complex of seas." Original colonists to its shores sustained themselves by hunting and fishing. They must have moved on the waters, too, but the early stages of seafaring have vanished without a trace (while ancient Egyptians, Greeks and Romans left behind inscriptions on wall paintings, vases, coins and so on). The first Baltic era of intensive sailing began with the Vikings, who dominated the northern seas for some two and a half centuries, starting in the late eighth century. Their plundering and trading journeys reached the Mediterranean via a western route along the Atlantic coast, and the Black and Caspian Seas via an eastern route along the big rivers that flow to the Baltic.

The German Hanseatic League took over as the next maritime

power in the Baltic; its heyday lasted from the early thirteenth century to the late sixteenth century, by and large. During this period, the histories of the Baltic and the Mediterranean became closely aligned through a trading network of relatively autonomous cities all over Europe. As historian Robert Bartlett writes:[7]

> *Just like Muslim sea power in the Mediterranean, pagan sea power in the north was checked and rolled back. The dominance of Christian navies was a distinctive feature of the High Middle Ages. [...] The trading cities of Germany and Italy simultaneously expanded and integrated the economy of the west.*

In the Baltic, major cities were established at the deltas of big rivers that offered routes toward the inland. The river Kokemäenjoki belongs in this category, but its physical geography is determined by land uplift, a dominant phenomenon in northwestern Europe. The weight of the glacial ice sheet pressed down the crust of the earth during the last glaciation, and the crust has been slowly pushing up. At the latitude of Reposaari, the rate of uplift has been a bit over a foot and a half per century in recent times. This means that the most suitable location for a harbor moved toward the west—outward—as the sea retreated; the city of Pori, to which Reposaari administratively belongs, is located along the river some twelve and a half miles to the inland.

Overall, it is the nature of landlocked seas such as the Mediterranean and the Baltic that seafaring has created strong ties between the regions and cities along their shores. Human communication has created dense contact networks and whatever can make use of such a network has done so. Plants and other living beings moving about with the help of humans are no exception. Every location in such a network has acquired its own *distributed nature*, maintained by continuous exchange of elements of nature and culture.

Used in sail ships to improve balance when the freight is light, ballast is a fascinating, if not miraculous means for plants to achieve jump dispersal. Since ancient times, ballast has been a necessary device used in ships. Lionel Casson notes that in antiquity, sand and stone were standard materials used as ballast. Some ancient sources note that sand stored in the hold of a ship was occasionally used to keep water or wine fresh, shaded from direct sunshine.

Extra ballast was dumped at ports where bulk materials were loaded on the ship for export. At lively ports the volume of dumped ballast grew prohibitively big; archaeologist Mats Burström reports that the earliest written note on ballast in northern sources was by

Haakon Magnusson in 1313, forbidding dumping at the harbor of what is now Trondheim, Norway.[8] Some of the materials were also reused. A famous example is in King's Lynn, England, where a wall was built of ballast stones over a century, beginning in 1266. In the wall, about three thousand of its fifty-five thousand stones are of Baltic origin.

What was ballast and what was cargo?—a confounding question. Large copper sheets that have been rescued from shipwrecks along the shores of various distant lands provide a partial answer, but it remains ambiguous, too. We simply do not know.

The weight of freight or ballast required for safe passage is estimated to be about a quarter the weight of the whole ship, depending on the height of its reel and mast. The total amount of ballast freighted across the world seas and oceans is in the millions of tons. With steamships gradually overcoming sailing ships after the mid-nineteenth century, water tanks took the place of sand and gravel in balancing the ships.

In most harbors that are located within major cities, ballast dumping sites have largely vanished, built over for other use as port facilities, industrial and storage buildings, traffic arteries, and so on. Reposaari is a rare exception: a considerable proportion of its ballast dumping sites have remained undeveloped. This is because the main harbor was transferred to another location in the Kokemäenjoki estuary when the age of sailing—and trade in Reposaari—came to an end. Consequently, exotic plants are left, both growing in the gardens of local people as a proudly cherished heritage, and occasionally appearing at sites at which the soil is suitably disturbed.[9]

In a quantitative sense, ballast plants are a minor element in local floras of old harbor cities. The situation is, in fact, similar in the case of colonizing plants such as weeds; this fact contradicts the impression produced by the scare of "alien colonists." Botanist Richard Mabey, a specialist on the weed flora of Britain, posits:[10]

> *The serious lesson that I've learned from three decades of stalking alien weeds in Britain is that for most of them life is sweet, but short. For the hundreds of new species that arrive each year, the available niches are small, the climate hostile, the pace of environmental change often faster than even their rapid life cycles, and most of the non-cultivated land surface already occupied by ancient and determined natives.*

Ultimately, however, there is no "correct" solution to how to relate to plants that colonize new areas. My view is that the appearance of new immigrant plants in human-modified environments is an encouraging sign that not everything in nature avoids places modified

by us humans. Plants transported via old trade contacts give fodder for historical imagination. Who else was traveling on the same ships? Some of the shades evoked by such questions are pitch dark as with slave trade, some are deliciously light as with spices and herbs. As Maria Thereza Alves says, *borderless histories* invite us to understand and cherish global interdependence and coexistence, provided we want to learn. Besides, it is good to be reminded that thanks to human influence, the collection of plant species in the whole of modern Europe is considerably richer than it was immediately after the glacial ice cover melted away.[11]

(1) Jonathan D. Sauer, *Plant Migration: The Dynamics of Geographic Patterning in Seed Plant Species* (Berkeley: University of California Press, 1988).

(2) H. J. B. Birks, "Holocene Isochrone Maps and Patterns of Tree-Spreading in the British Isles," *Journal of Biogeography* 16, no. 6 (1989): 503–40.

(3) Alfred W. Crosby, *Ecological Imperialism: The Biological Expansion of Europe, 900–1900* (Cambridge: Cambridge University Press, 1986).

(4) Hilary H. Birks et al., *The Cultural Landscape: Past, Present and Future* (Cambridge: Cambridge University Press, 1988).

(5) Lionel Casson, *Ships and Seamanship in the Ancient World* (Baltimore, MD: Johns Hopkins University Press, 1995).

(6) Fernand Braudel, *The Mediterranean and the Mediterranean World in the Age of Philip II* (London: Fontana Paperbacks, 1975), 23.

(7) Robert Bartlett, *The Making of Europe: Conquest, Colonization and Cultural Change 950–1350* (London: Allen Lane, 1993), 293.

(8) Mats Burström, *Ballast: Laden with History* (Lund, Sweden: Nordic Academic Press, 2018).

(9) Heli M. Jutila, "Seed Bank and Emergent Vascular Flora of Ballast Areas in Reposaari, Finland," in *Annales Botanici Fennici* 33 (1996): 165–82.

(10) Richard Mabey, Weeds: *The Story of Outlaw Plants* (London: Profile Books, 2010), 257.

(11) The Finnish flora includes two thousand five hundred species; depending on the time frame adopted, six hundred to one thousand species are classified as immigrants.