

# IMPACT OF TOURIST RESORTS ON RARE PHYTOCOENOSIS

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## Summary

Seaside tourism is a worldwide phenomenon. It seriously affects natural ecosystems, precisely in the sites where the most peculiar phytocoenosis thrive. The coast between Nice (France) and Isola d’Elba (Italy) underwent a very early tourist exploitation. Two centuries of tourism allow a historical examination of the phenomenon, a proper analysis of the effects, and prediction of trends. This study may be useful to plan a better and environmentally aware future for those same localities and for newly born ones.

## 1. Introduction

Some ecosystems are rather uniform over large areas of Earth’s surface. Steep environmental gradients place different ecosystems against one another in a small space. Water–land corridors, such as coastlines and rivers, are typical examples of this. Where environmental gradients are very steep, most ecosystems are small and highly specialized, often being composed of endemic and rare species that do not live elsewhere. Both rivers and coastlines have been used by humankind since prehistoric

times and have been intensively transformed during the development of civilization. Many natural ecosystems have been converted to agriculture, artificially forested, used for industrial or civil settlements, used for human infrastructure, and so forth. The very last kind of conversion, occurring relatively recently, is from natural ecosystems to tourist resorts. Nowadays, tourism affects natural ecosystems in the whole world, but Europe has been affected from the earliest stages of tourist development. The northern Mediterranean coast has been transformed in an exceptionally intensive way. The phenomenon developed in about two centuries, so that different stages and a series of consequences are rather clearly recognizable. The present article therefore deals with general principles concerning the typical impact of tourist resorts on rare phytocoenosis, but mainly refers to the coast between Nice (France) and Isola d'Elba (Italy), that is, the north Tyrrhenian and Ligurian coast, where seaside resorts have a long history. Moreover, seaside holidays are sharply preferred by tourists and seaside resorts near not far from industrial cities underwent heavy development.

## **2. Rare Coastal and Riparian Phytocoenosis**

Steep environmental gradients occur everywhere land rises from water. Ecosystems that are permanently underwater are composed of beings adapted to live in water which do not survive in the open air longer than a few minutes or, occasionally, hours. The same thing occurs with beings adapted to live in the open air which do not survive underwater longer than few minutes, hours or, exceptionally, days. Water level is not constant and is dependent on tides and waves in the sea and in large lakes, and on alternating floods and droughts in riparian areas. In a relatively short distance, different ecosystems face different degrees of underwater immersion and exposure to open air. Single species are adapted to a relatively small range of tolerance, so that their spatial distribution is limited to narrow, although sometimes long, strips. Special environmental gradients are related to salt-concentration tolerance. In those cases specialized beings are adapted to a relatively small range of tolerance. One of the most complex arrangements of natural ecosystems occurs where a river flows into the sea close to sandy dunes and rocky cliffs. In this case at least three gradients of vegetation types can be observed: the gradient from salt-tolerant to salt-intolerant phytocoenosis rooted on the rocky coast, the gradient from salt-tolerant to salt-intolerant phytocoenosis in coastal wetlands, and the gradient from flood-tolerant to drought-tolerant phytocoenosis related to the length of seasonal flooding. There are also combined gradients and special supplementary ones related to the exposure to sand abrasion or to the light intensity. Coastal and/or riparian vegetation therefore forms one of the most complex living systems. It is extremely rich in biodiversity, not in terms of simple absolute number of species (some very specialized ecosystems are composed of few species), but in terms of rare, endemic, and phytogeographically uncommon species. Moreover, a chronological succession of vegetation towards a more uniform, climactic ecosystem is impeded by active geomorphological factors that are dominant in the environment. On the contrary, the spatial succession of vegetation is maintained by those geomorphological factors that impede the natural evolution of vegetation.

In the northernmost Mediterranean area the situation is even more complex. The Mediterranean climate proper meets the temperate one and therefore two phytogeographical regions meet each other: the Central European Region and the

Mediterranean Region. Central European species often reach very low altitudes following the ecological corridors of streams and rivers, and Mediterranean species reach relatively high altitudes on steep, sunny, and dry slopes facing south.

Moreover, the Mediterranean sea covers more longitude than latitude. As a consequence of migration towards the south due to glaciations, many temperate species of the Tertiary Age became extinct when they met the obstacle of a large sea, or were reduced to relics strictly related to special micro-environments. In a milder period after the last glacial age, many species needing warmth conquered the northern shore of the Mediterranean sea once again, but later colder periods again insulated the neosubtropical populations into scattered relics strictly bound to special micro-environments. Genetically insulated populations helped the creation and selection of endemic species in both cases.

### 2.1. Natural Vegetation of Sand Beaches and Adjacent Land

A littoral zone is a narrow strip of land extending from the high water mark up to a few tens of meters inland. The plants growing in this zone directly depend on the salinity, the strength of the wind which moves the sand and powerfully polishes everything, and the humidity of the air, each to a greater or lesser degree. On sandy shores, the first thing one encounters, coming from the sea, is the *Cakiletum maritimae*, which are short-living and very specialized plants. On weak, mobile dunes, one finds perennial herbs, *Agropyretum mediterraneum*, while the first permanent vegetation that stops most of the flying sand, thereby building steady dunes, is the *Echinophoro–Ammophiletum* or the *Ammophiletum arundinaceae*, tall grass which shields smaller, but precious, species such as *Pancratium maritimum* from wind and salt. Only where beaches are increasing their width does littoral vegetation follow a gradual succession with distinguished *Sporoboletum arenariae* and *Crucianelletum maritimae*; otherwise a steeper environmental gradient places the different ecosystems against one another in a small space, blends them together, or even places the *Ammophiletum* directly against the littoral forest or matorral.

A few meters off the beach, at the point where the sand, fixed in steady dunes, is enriched by more and more organic matter, a littoral matorral occurs, for instance the *Pistacio*—or the *Rhamno—Juniperetum macrocarpae*, composed both of conifers and sclerophylles. If not degraded, the associations grouped in the *Juneperion liciae* can grow as tall as a proper forest, over five meters.

The dune system is a strong obstacle to the flow of freshwater towards the sea. Very often, immediately inland of the dunes is a salty wetland occupied by herbaceous associations grouped in the *Juncetalia maritimi*, rich in specialized grass belonging to the genera *Salicornia*, *Aster*, *Limonium*, and so forth. Where the stagnant water is less salty, *Juncetalia acuti* can grow, and where water is stagnant year-round *Scirpetum maritimum* can grow. The climactic vegetation of the plains behind the dunes and the marshes is a forest, rich in evergreen Mediterranean species as well as in deciduous temperate species, depending on how close the water-bearing stratum is to the soil surface. Where water is easily available year-round, temperate species like *Quercus robur*, *Fraxinus oxycarpa*, *Ulmus minor*, *Populus alba*, and even *Carpinus betulus*

thrive along with the Mediterranean species *Quercus ilex* and *Laurus nobilis* in the *Viburno tini-Quercetum ilicis quercetosum robori*. The climactic forest of littoral plains is also rich in evergreen climbers, such as *Hedera helix*, *Rubia peregrina*, *Smilax aspera*, and *Rosa semprevirens*. This association could potentially occupy the large plain between the Leghorn Province and the mouth of the Magra River, where the phytogeographically rare climber *Periploca graeca* also thrives.

## 2.2. Natural Vegetation of Sea Cliffs

Where hills and mountains directly emerge from the sea, the coastline is often a cliff. The phytosociological order *Crithmo-Limonietalia* is found there. Along the bow coastline from Provence-Côte d'Azur to Tuscany, this pioneer vegetation tolerates salt spray well. This habitat is also hospitable to rare, endemic plants, such as species and subspecies of the genera *Limonium*, *Centaurea*, *Brassica*, and so forth. A few meters inland, some other species enrich local vegetation, such as the tallest grass of the northwestern Mediterranean, *Ampelodesmos mauritanicus*. Immediately inland, the matorral thrives, composed of many sclerophylles, forming various associations rich in different and sometimes rare species. Where this rocky and severe environment faces south and is sheltered from cold winds, heliophylous and thermophilous species thrive free from competition with climactic species. Inland hills and low mountains are have high rainfall and are therefore covered with evergreen forest that is so dark underneath that species typical of the southernmost Mediterranean cannot survive.

Thermophilous species survive along the Ligurian and north Tyrrhenian coast, but only along the sunniest littorals, limited towards the sea by heavy salt spray and inland by competition with climactic species. Very peculiar phytocoenosis, scattered in the most suitable sites, characterize the northwestern Mediterranean coast: *Oleo-Euphorbietum dendroidis*, with the tertiary relic *Euphorbia dendroides* (summer deciduous), *Teucri-Juniperetum phoeniceae*, and *Anthyllidion barba-jovis*. In places, these warm stations give hospitality to another relic, *Chamaerops humilis*, the only spontaneous palm of the northern Mediterranean. Even where those peculiar species are absent, the littoral matorral is rich in plant biodiversity, because, being rather free from the competition of climactic species, it allows the growth of many species that do not tolerate shade. Those phytocoenosis are grouped in the classes *Cisto-Lavanduletea*, *Pistacio-Rhamnetea alaterni* and in the alliances *Rosmarino-Ericion* and *Ericion arboreae*, whose associations are often very responsive to soil conditions. In fact, along sea cliffs, erosion is a major factor and a zonal, climactic soil does not develop; therefore the roots of local vegetation are directly exposed to the mineral matrix. The most thermophilous matorral is the alliance *Oleo-Ceratonion*, a relic along the northwestern Mediterranean littoral that can have the features of a proper forest. Another littoral feature is the forest *Pino halepensis-Quercetum ilicis*, composed of conifers and broadleaf together, spontaneous in many stations along the coast from Côte d'Azur to the Leghorn Province, but limited to a narrow strip between the pioneer matorral and the climactic forest, that is, the association *Viburno tini-Quercetum ilicis* almost everywhere. Inland, other peculiar associations survive, such as the *Viburno-Quercetum ilicis suberetosum*, where *Quercus suber* thrives, in small populations, often reduced to relics spread in a large territory, that is, seriously threatened of being extinct.

### 2.3. Natural Riparian Vegetation

Many rivers and streams flow into the Ligurian and Tyrrhenian seas. Some of them come from the maritime Alps or the northern Apennine, which are mountains in the Mediterranean climate with snow covered ridges for long periods each winter. Their regimen is therefore sub-Alpine and sub-Mediterranean, with floods in autumn due to heavy rainfall and in spring due to snow melting, and drought in the summer. These rivers have a permanently visible flow and their riparian vegetation is typical of central European rivers; especially where they cross large plains (e.g., the Var, the Magra, the Serchio, and the Arno). The forest of riparian deciduous broadleaf is also composed of sub-Mediterranean species, forming the alliance *Populion albae*. In the parts of the Ligurian gulf with the most rainfall (e.g., its easternmost side), even short streams springing at a low altitude can have a permanent flow under an arboreal gallery of deciduous broadleaf included in the alliance *Alno-Ulmion*, which reaches sites incredibly close to the sea, even when exposed to salty spray.

On the contrary, streams whose basins are wholly in the coastal hills have a typical Mediterranean regimen. They are dry each summer and undergo few, short, tremendous floods due to extremely intense and concentrated rainfall in autumn and to long periods of uninterrupted rainfall in winter. When no water flows on the surface, the water-bearing stratum underneath ensures water availability to the roots of riparian vegetation. This kind of river is called *fiumara* and its northernmost limit is along the western Ligurian coast, both in France and in Italy. *Fiumare* can also be found in the Tuscan archipelago (north Tyrrhenian sea). A specialized vegetation, similar to a matorral, grows along these streams. It is composed of deciduous and evergreen shrubs, classed as *Nerio-Tamaricetea*; having as characteristic species *Nerium oleander*, *Tamarix* spp., and *Vitex agnus-castus*. A village in the Riviera dei Fiori is named Camporosso just because of its red field of blooming oleanders.

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### **Biographical Sketch**

**Paolo Degli Antoni** was born in Florence, Italy, in 1958. He studied Forestry at the University of Florence and graduated with a thesis concerning secondary successions (forest ecology). He is an officer of the Italian National Forest Service, and has published articles and made contributions mainly concerning landscape ecology.