

**An abstract of the PhD thesis of Dr. Tommaso Sitzia for the
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*The role of hedgerows as corridors for plant species:
determinants analysis and efficiency evaluation*

The Po plain landscape has been characterized for centuries by agriculture and urbanized areas. Over the last century the rationalisation of agricultural practices has reduced the diversity of landscape structures and has led to the standardisation of agricultural landscapes. Biotopes, especially woodlots and hedgerows, have either disappeared or have been isolated. This situation endangers animal and plant species, if they have not already disappeared.

Ecological corridors can be functionally defined to indicate connectivity and as physical structures to indicate connectedness. They can be defined as functional connections enabling dispersal and migration of species that could be subject to local extinction. As physical structures they also can be defined as various landscape structures, other than core areas, in size and shape varying from wide to narrow and from meandering to straight structures, which represent links that permeate the landscape, maintaining or re-establishing natural connectivity.

Both animal and plant species could benefit from an ecological network approach, which can lead not only to the conservation of isolate biotopes, but also to their functional linkage.

Hedgerows play an important role as habitat for tree and shrub species and as locations from which they colonise new areas. Moreover, they function as habitat corridors for relict forest herb populations.

First, I studied the frequency of occurrence of woody species in four structural hedgerows types. In the same time I applied field protocol to quantify their physical, biometrical and biodiversity parameters and indicators and classified their structural diversity in four types: multi-storied, two-storied, high single-storied and short single-storied, based on physiognomy of shrub, coppice, pollard and high tree coverages. Second, at a larger scale, I studied the effects of functional connectivity on woody

species distribution in the landscape and how the connectivity affected the species composition. Third, I examined the robustness of the proposed typology and whether the recorded differences in species occurrences and richness in the above investigations were related to their mode of dispersal or to the attributes of the sampled hedgerows.

A total of 500 hedgerows were examined in five study areas (Provinces of Venice, Treviso, Rovigo and Verona). To test for significant differences between the four structural types, I randomly sub-sampled the total sample and excluding those hedgerows which did not conform to some dimensional criteria.

The second part of the dissertation is devoted to the investigations of the determinants of the presence of forest species in hedgerows, in particular origin (i.e. remnant vs. regenerated), proximity to forest and width. As Corbit *et al.* (1999) did in the New York State, I focused on the following questions.

- i. How common are forest herbs in hedgerows?
- ii. What factors correlate with the presence of forest species in hedgerows (origin, attachment vs. isolation, distance from source, width)?
- iii. Are hedgerows corridors for forest species?

To address these questions I sampled three functional types of hedgerows: remnant attached to nearest relict woodlot (n=14), regenerated attached (n=4), isolated, with respect to the nearest woodlot, remnants (n=6), recognised by a comparison of historical aerial-photos. I sampled hedgerows and woodlots for the presence and abundance of forest herbs. There were significant differences in cover between three types but not in abundance of forest species. The species composition of forest species in hedgerows attached to forest stands showed a strong affinity with that of the adjacent stand, based on a complete permutation test.

At the analysed scale (0-90 m), a distance effect on cover was found only in species dispersed by ants, while those dispersed by vertebrates did not show any significant trend with distance from woodlots. The dispersal process, although it appeared very slow, was found as follows:

- i. similarity with adjacent woodlots significantly lower in isolated (even if remnant) vs. attached hedgerows (even if regenerated).

- ii. The results of Corbit et al. (cit.) in part confirmed. The reduction with distance from woodlots along the 90 m transect was confirmed only for species dispersed by ants or by gravity.

It is quite surprising that, in a highly fragmented and disturbed landscape, even 3-16 m wide hedgerows can support forest species population. One potential reason for the relative richness in forest species was the low distance from remnant woodlots. Most of the hedgerows (14) were themselves remnant and thus likely to contain relict populations of forest species. Overall, in remnant and regenerated hedgerows, habitat suitability for forest herbs was affected by width, especially in hedge wider than 12 m. This confirms the observations of Forman & Godron (1986) who suggest a minimum of 8-12 m width to support stable forest species populations.

The most frequent species were *Anemone nemorosa*, *Viola reichenbachiana* and *Polygonatum multiflorum*. The first and the second were ants dispersed, while the last ingested. *Allium ursinum*, *Circaea lutetiana*, *Hepatica nobilis*, *Melica nutans* and *Thelypteris palustris* were absent in hedgerows, but also very rare in woodlots.

Self and wind dispersed species (short distance of dispersal) were less frequent in isolated remnants, thus suggesting the importance to maintain a functional linkage between corridors and their source of propagules (woodlots).

Eight species were present only in woodlots: Zanetti (1997) considers four out of them important for conservation purposes. Seven species were present only in hedgerows: Zanetti (1997) considers one out of them important. This is noteworthy because hedgerows, beside woodlots, can be relict habitats and sources.

The research has requested the survey of a 80 x 40 km area. Nevertheless, only four regenerated attached hedgerows were found. More efforts are needed to concentrate planting activities near existing sources of forest species, to maintain forest species within an ecological network framework.

With regard to the structural types, the results showed that they differed in the surveyed attributes. The mean cover height and the mean dendrometric diameter were higher in high single-storied. The short single-storied, mainly composed of shrubs or coppices, had a higher number of stems per hectare. Finally, the multi-storied had the

highest values of Shannon indexes, measured as diameters and heights, herbaceous strata width, species richness, both total and relative to length, and dead fallen trees.

The isolation index (based on the mean distance from the four nearest neighbours) led to the following evidences. I noted a progressive reduction in single hedgerows woody species richness up to the threshold of 400 m was reached. At longer distances, the overall richness decreased too. The seed dispersal mode did not seem influent as both animal and ants dispersed showed various behaviours; *Frangula alnus*, *Euonymus europaeus*, *Hedera helix* and *Rubus* spp., all dispersed by vertebrates, showed significantly higher occurrence in less isolated hedgerows.

As reported in the scientific literature, several factors can be used to estimate the value of hedgerows as bird, mammal and bat habitat. The most important are hedge size (height, width, volume) and the presence/abundance of trees. Given that the proposed typology showed a strong quantitative separation between types in some of those attributes, I suggest its use to provide a background against which decisions concerning hedgerow management might be evaluated.

Further researches could deal with a deeper statistical treatment of the surveyed data. For example, a niche analysis could help with the knowledge of the role of competitive species to the forest species, as I surveyed all plant species. Moreover, the survey could embrace also regenerated isolated hedgerows, which is often planted thanks to the European Community funding. Finally, the monitoring of the composition and frequency of forest herbs could give other insights into the diachronic existence of ecological networks.