# AN ASSESSMENT OF THE RESPONSE OF TREE BARK AND EPIPHYTIC LICHENS TO ELEMENTAL AVAILABILITY AT GROUND LEVEL THROUGH NUCLEAR TECHNIQUES

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Biological monitoring has made quite an impressive way since the early, rather scattered observations of environmentally-induced stress on native plants in urban-industrial areas (Nylander, 1866; Arnold, 1901). The heyday really came after World War II though, and, through the following decades, biomonitoring with plants has grown into a serious alternative – or, at least, an useful complement – to traditional (instrumental) methods of assessing contaminants from natural or anthropogenic sources (Burton, 1986; Nimis, 1990). In what concerns air contamination only, such an expansive growth has been sustained mainly by work with lower species – lichens, bryophytes and, to a much lesser extent, non-lichenised fungi. For the last decade, and according to Garty (2000), the number of new references dealing only with lichens in major literature sources has just approached 150. The contribution from higher, vascular plants appears much less relevant. And yet, several genera of those arguably underrated higher plants feature an ubiquity, availability and easiness of sampling that remains unmatched by lower epiphytes. But then, one might ask, how come they are not used more often…?

While not restricted to, answers to the question will most likely refer to some possibility of biased indication due to an interference from soil uptake and/or systemic control. It is true that an additional complexity may arise from interpreting their analytical data due to the former aspects and maybe a few others as well, *eg* an identity between some notorious air-pollution factors and common plant-body constituents. Nevertheless, there is also a wide range of advantages in using parts of higher plants for biomonitoring purposes that should not be overlooked, from greater availability and simpler, harmless sampling (Poikolainen, 1997), to the possibility of putting together larger sets of data that may prove beneficial for multivariate analysis (Kuik and Wolterbeek, 1994), to mention just a few.

In the realm of vascular plants, bark stands far behind leaves – or needles, for that matter – in what concerns atmospheric assessment. Relatively speaking, tree-bark studies have been scarce and mostly related to environmental acidification (Staxang, 1969; O'Hare, 1974; Grodzinska, 1978, 1982; Härtel, 1982; Takala *et al.*, 1990), although that situation has been going through changes lately – for example, see Schulz *et al.* (2000a, 2000b) and pertinent references therein, or a recent, general review on biomonitoring with vegetable organisms (Mulgrew and Williams, 2000). Lichens and bark have been sampled in Portugal since the early 90s, though the work with the former has been much greater. It is perhaps now time to look into the true ability of bark as an air-pollution monitor and, should it be the case, to start bridging some gaps between the use of bark and epiphytes in atmospheric studies.

As a contribution to that purpose, bark from olive trees (*Olea europaea* Linn.) has been collected throughout mainland Portugal and searched for its elemental contents by means of two nuclear-analytical techniques: instrumental neutron activation analysis (INAA) and proton-induced X-ray emission (PIXE). Both techniques are intrinsically accurate and may be seen to complement each other in the way that, as a whole, they yield some 46 elements, with 16 elements in common (Freitas *et al.*, 2000). This presentation will be focused on an illustrative selection of elements from major sources, on their tentative assignment to them, and also on the advantage of multi-elemental techniques in environmental research at large.

After an appropriate reconciliation and exploratory analysis, results from both techniques have been compared with an extensive database on concentration patterns of trace elements in *Parmelia* spp. thalli from the same locations *and* mostly from the same bark substrates. Nonparametric (distribution-free), robust statistics were then used for assessing the degree of association between elemental concentrations in barks and lichens, as well as between source-related elements in bark samples. Bark results were also put through factor analysis for emission-source identification. Major findings in trend significance and factorial loads will be presented and discussed. Last yet by no means least, an emphasis should be placed on an additional asset that comes from using multi-elemental, analytical techniques, such as the present ones. Without giving too much away, it could be said that the determination of a broad spectrum of elements may really enhance the possibilities of data interpretation and greatly facilitate the search for source patterns, therefore helping to disclose unanticipated effects and/or data relationships (Bode and Wolterbeek, 1990; Wolterbeek *et al.*, 1996).

As mentioned, there is now an incredible amount of biomonitoring work that spans a whole lot of pollution inputs to about every ecosystem on Earth, which has been mostly done with lower plants. Despite an arguably superior ability to accumulate elements and indicate them without an interference from soil – attributes that seem vastly overstated, the first, and may actually be valid only for epiphytic species, the second – the truth is, lichens are known for slow regeneration, so an intensive sampling may put them in short supply or in the very threshold of extinction, while mosses seem hardly an option in dry areas. This presentation will show that, as far as the our investigation goes, there is no reason for discarding olive-tree bark as an alternative to epiphytes, inasmuch as *Olea europaea* is an ubiquitous species in mainland Portugal, let alone southern Europe and the Mediterranean Basin at large.

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