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Old-field succession along a precipitation gradient in the semi-arid coastal region of Tenerife

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Abstract

Secondary succession on abandoned fields was studied in the semi-arid region of Tenerife (Canary Islands). At four different sites along a precipitation gradient four chronosequences were sampled. On the whole, 11 fields, abandoned for eight to 70 years, and adjacent near-to-natural stands were studied, with regard to species richness, species composition, vegetation structure, life form distribution and the importance of endemic/exotic species, using uni- and multivariate statistical methods.

In the three drier chronosequences species richness increased significantly during succession whereas in the wettest sequence it peaked very early with a subsequent decline towards the mature stand. Temporal changes in floristic composition were significant and revealed clear directional trends. We could distinguish two pathways of succession: one for the northern coast under more humid conditions and one for the southern coast under arid conditions. Therophytes were generally substituted by nanophanerophytes, while hemicryptophytes and chamaephytes showed low abundances with peaks in late successional stages. At all sites, endemic species replaced exotic species, with regard to both relative number and cover. The relative importance of exotic species in early succession increased with increasing precipitation. Cover of perennials, stand height and stand biomass increased with time since abandonment and water availability. Floristic composition recovered faster than stand structure and, in particular, stand biomass.

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We have the following conclusions (i) The absence of disturbance and in presence of near-to-natural stands in the surroundings, coastal scrub on Tenerife has the capacity to regenerate completely albeit slowly after traditional agricultural use. (ii) The rate and pathway of succession are influenced by site productivity, i.e. mean annual precipitation. (iii) Life form distribution changed in the second phase of succession in relation with the precipitation gradient. (iv) The initially dominant exotic annual plant species seem to be a temporary problem only since, in the course of succession, they are substituted by native perennials.

Keywords: Secondary succession; Succulent scrub; Canary islands; Chronosequence; Species richness; Biomass; Canonical Correspondence Analysis (CCA)

1. Introduction

Old-field succession is a special case of secondary succession on abandoned, usually arable fields (Glenn-Lewin and Van Der Maarel, 1992). It has been studied extensively in temperate climates (Nicholson and Monk, 1974; Bazzaz, 1975; Bornkamm, 1981; Inouye et al., 1987; Huston and Smith, 1987; Tilman, 1987; Osbornová et al., 1990; Myster and Pickett, 1994; Meiners et al., 2002) as well as under Mediterranean conditions (Houssard et al., 1980; Tatoni et al., 1994). In semi-arid to arid regions, however, studies on secondary succession are rather scarce (Cox and Madrigal, 1988; McLendon and Redente, 1992; Stylinski and Allen, 1999; Wezel and Böcker, 1999; Bolling and Walker, 2000, Bonet 2004), possibly because succession proceeds very slowly under these harsh conditions (Dean and Milton, 1995; Cody, 2000).

Most of the studies focused on successional changes in one region, analysing a single chronosequence or data from permanent plots. Often, only the chronosequence approach (space-for-time substitution, Pickett, 1989) is possible, since data from long-term permanent plots are extremely rare. Although space-for-time substitution has some disadvantages such as possible small differences between the plots with regard to site history, edaphic and microclimatic conditions or availability of propagules (Pickett, 1989; Bakker et al., 1996), it has been shown, however, that the approach is basically sound (Debussche et al., 1996; Foster and Tilman, 2000).

As already mentioned by Prach (1993), there is a considerable lack of knowledge concerning the relationship between the dynamics of secondary succession and environmental factors. This relationship can be studied by comparing successional series from habitats with different site conditions, which can be established experimentally, for instance by adding nutrients (Tilman, 1987; McLendon and Redente, 1992). Alternatively, larger geographical regions have to be taken into account which, however, makes comparisons more difficult (Prach, 1993; Prach et al., 2001).

In this context, site productivity has been found to influence the rate of succession as well as changes in species richness and structural parameters (Tilman, 1987; Prach, 1993). Models predict an asymptotical increase in species richness during