Vegetation patterns and primary succession on sea-born volcanic islands (Santorini archipelago, Aegean Sea, Greece)

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with 4 figures and 5 tables

Abstract. Santorini (S Cyclades, Greece) is one of the active volcanoes of the South Aegean volcanic arc, with more than 12 major eruptions during the past 250,000 years. Our research, using a set of 93 phytosociological relevés, focused on the two volcanic islands of Palea Kameni (PK) and Nea Kameni (NK), differing in age and history of vegetation development. Numerical classification techniques were used to define plant communities, and Redundancy Analysis (RDA) was used to investigate the main environmental gradients and identify the explanatory variables with a unique significant contribution to the explanation of the communities’ floristic composition. In RDA environmental factors such as altitude, slope inclination, relief, aspect, age of geological substrate, distance from the shore, and selected Ellenberg Indicator Values (EIVs) were used. In order to test the robustness of the RDA results, principal components analysis was applied to the relevés data set as well. Partial RDAs (variance partitioning) were also applied to investigated the proportion of variance attributed to the age of the lava substrate as compared to the rest of environmental factors. The classification revealed seven plant communities (four on PK and three on NK), described in terms of unique species composition, characteristic ecology, and distribution. Three of the communities were dominated by perennials (all found on PK), while the other communities were built prevalently of therophytes (all communities found on NK and one occurring on PK). The age of lava substrate was found among the most important and statistically significant variables. Furthermore, EIVs for light, nitrogen, reaction, and salinity were found to explain relatively high and statistically significant proportions of species data variance. However, the proportion of variance attributed purely to the age of lava substrate was by far smaller than that attributed to the rest explanatory variables. Conclusively, we suggest that the formation of local pioneer vegetation on the studied volcanic islands is not solely controlled by the age of the substrate (“maturation” of the communities through saturation of their local species pools), but it is also under strong control of factors such as the distribution of ashes after the recent volcanic eruptions, and the chemical and physical properties (e.g. nutrient content) of the soils formed by the deposition of the ashes.

Abbreviations: Comm. – Community, EIVs – Ellenberg Indicator Values, NK – Nea Kameni, PCA – Principal Components Analysis, PK – Palea Kameni, RDA – Redundancy analysis.

Keywords: halo-nitrophilous scrub, Mediterranean vegetation, ordination, tephra, therophytic vegetation, vegetation dynamics, Kameni islands, volcano.


Introduction

Santorini (S Cyclades, Greece) is one of the active volcanoes of the South Aegean Volcanic Arc (known also as Hellenic Volcanic Arc; Albanakis & Styllas 2004); it produced more than 12 major eruptions within the past 250,000 years. The major Santorini (or Thera as it was called in classic Hellenic times) eruption, sometime during a period ranging from 1627 to 1600 B.C. (Friedrich et al. 2006) and associated tsunamis are linked to the demise of Minoan Civilization of the Cyclades and Crete (see Bond & Sparks 1976, Keller 1980, Downey & Tarling 1984, Sparks 2000 etc.). Currently, the Santorini volcano is in a state of intermittent repose, but there is no reason to believe that there will not be any future eruptions (Pyle & Elliott 2006). According to Papazachos (1990) the mean repeat time of the strong eruptions in the Santorini volcanic centre during the last five centuries is 94 (±43) years, resulting in probability of 0.6 for eruption to occur within the next 50 years and probability of 0.95 for the next 110 years (for forecasting the next eruption see Fytikas et al. 1990 and Papadopoulos & Orfanogiannaki 2005). Pyle & Elliott (2006) suggested for instance, that if an eruption should have occurred in 2006 it would have lasted for more than 2.7 years, and eventually produced a dome 115–125 m high. Because of the poten-