Why are underground flowering and fruiting more common in Israel than anywhere else in the world?

Recently, Kaul *et al.*[1] reviewed the phenomenon of amphicarpy – a common type of underground flowering and fruiting. Amphicarpy describes a phenomenon in which a plant produces aerial as well as subterranean fruits. A related phenomenon is geocarpy, in which all the fruits in an individual plant develop below the soil surface and remain there until germination. Kaul *et al.*[1] listed 36 amphicarpic species that bear cleistogamous flowers on subterranean shoots, and four geocarpic species. Van der Piji[2] listed 16 geocarpic species and several additional amphicarpic species. Altogether, about 50 amphicarpic species and 20 geocarpic species are known worldwide[1–4]. Thus, out of the ca. 250,000 flowering plant species, one in ca. 5000 species is known to be amphicarpic, and in ca. 12,500 geocarpic.

In the flora of Israel with its ca. 2500 flowering plant species, there are eight amphicarpic species (*Emex spinosa, Lathyrus ciliolatus, L. hierosolymitanus* var. *amphicarpus, L. hirticarpus, Pisum fulvum, Vicia sativa* ssp. *amphicarpa* = *V. angustifolila, Catananche lutea* and *Gymnarrhena micrantha*) – one in ca. 310 species, and eight geocarpic species (*Biarum angustatum, B. bovei, B. olivieri, B. pyrami, Faktorovskya aschersoniana, Trifolium subterraneum, T. israëliticum* and *Callitriche pedunculata*) – one in ca. 310 species. The ratio of species with underground seed production is ca. one in 155 species[3,5–9]. This very high ratio of underground fruiting (over 20% of the global number of known species with underground fruit) raises the question of why this phenomenon is so common in the flora of Israel. Underground fruiting is believed to be more common in annuals[1] which occur often in the Israeli flora (53.1% of the species)[10]; It has also been selected because of advantages like (a) keeping a proven site in a patchy environment; (b) to overcome uncertainity for survival throughout the growth season because of disturbance (drought, fire, grazing); (c) protecting seeds from extreme fluctuations of microclimate at the soil surface[1,11–13]. In Israel, drought, fire and grazing are very common. Fire and grazing became more intensive since the beginning of agriculture in the Near East (some 10,000 years ago). However this period is not long enough to establish so many new species with this rare syndrome. I propose that this might be an indication of a long history of disturbances in the eastern Mediterranean region, longer than the considerable human impact in the last several millennia. However, in addition to the ecological setting which seems to select for amphicarpic and geocarpic types, it is likely that the high number of botanists who have studied such a small flora (in an arid region) have discovered all or most of the local amphicarpic and geocarpic repertoire. If this is the case, then globally several hundred amphicarpic and geocarpic species still await discovery.

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