Testing the environmental prediction hypothesis for mast-seeding in California oaks

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Abstract: We analyzed 29 years of acorn production by five species of California oaks (genus *Quercus*) to test the hypothesis that trees produce large seed crops prior to wet years, conditions facilitating seedling germination and survival. The mean crop of three of the species correlated positively and nontrivially with the following year's rainfall, but none was statistically significant. Including the acorn crop 1 and 2 years earlier yielded several significant relationships between the acorn crop and future rainfall, but none held up when applied to a second, independent site. Across individuals, acorn production by 7% of trees correlated significantly with subsequent rainfall. Although these trees differed from other trees in several characters, differences were not sufficient to discriminate between trees that correlated significantly with subsequent rainfall from those that did not. We conclude that acorn production by California oaks does not forecast wet years and does not support the environmental prediction hypothesis.

Résumé : Nous avons analysé la production de glands durant 29 années chez cinq espèces de chêne de la Californie (genre *Quercus*) pour tester l'hypothèse selon laquelle les arbres produisent de grandes quantités de glands en prévision des années de forte pluviosité qui favorise la germination et la survie des semis. La production moyenne de trois des espèces était positivement et sans équivoque corrélée avec la pluviosité de l'année suivante mais aucune corrélation n'était statistiquement significative. Le fait d'inclure la production de glands durant les 2 années précédentes a produit plusieurs relations significatives entre la production de glands et la pluviosité future mais aucune de ces relations ne tenait lorsqu'elles étaient appliquées à un deuxième site indépendant. Sur une base individuelle, la production de glands de 7 % des arbres était significativement corrélée avec la pluviosité subséquente. Bien que ces arbres fussent différents des autres sur la base de plusieurs caractères, ces différences n'étaient pas suffisantes pour distinguer les arbres dont la production de glands était significativement corrélée avec la pluviosité subséquente de ceux dont la production de glands ne l'était pas. Nous concluons que la production de glands des chênes de la Californie ne permet pas de prévoir les années de forte pluviosité et ne supporte donc pas l'hypothèse de la prévision environnementale.

[Traduit par la Rédaction]

Introduction

Masting or mast-fruiting — the intermittent, synchronous production of seeds by a population of plants — is a well-documented phenomenon among a variety of plant taxa, although it appears to be particularly prevalent among wind-pollinated Northern Hemisphere trees (Kelly 1994; Koenig and Knops 2000; Kelly and Sork 2002). There are at least three reasons why this phenomenon is of ecological and evolutionary interest. First, masting can produce large resource pulses of great significance to terrestrial ecosystems, acting "bottom-up" to initiate cascades of ecosystem effects (Ostfeld and Keesing 2000). Second, the mechanisms producing reproductive synchronization, which may be evident over large geographic areas of thousands of square kilometres (Koenig and Knops 1998; Koenig et al. 1999*a*, 1999*b*), remain controversial, the two main hypotheses being that spatial synchrony is driven by (*i*) environmental synchrony (the Moran effect: Ranta et al. 1997; Koenig 2002) and (*ii*) reproductive efficiencies related to the dependence of trees on the availability of outcrossed pollen, or pollen coupling (Satake and Iwasa 2000, 2002). Third, the selective factors favoring the evolution of masting behavior are unresolved. Currently, the two most commonly considered hypotheses are predator satiation (Janzen 1971) and enhanced pollination efficiency (Smith et al. 1990; Kelly et al. 2001). However, several other hypotheses have been proposed, most of which are rarely tested because they are thought to be applicable only to specific systems (Kelly 1994).

Here, we consider one of these frequently overlooked explanations for mast-fruiting, the environmental prediction hypothesis. This hypothesis, which proposes that weather cues are used to predict optimum future conditions for seed germination, is well established in some Australian monocots where fire is a trigger for high seed production and si-

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