

Seed dispersal in W Mediterranean *Euphorbia* species*

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Abstract

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Several morphological types of seed coat, related to dispersal mechanisms, were found in W Mediterranean *Euphorbia* species (*Euphorbiaceae*), through scanning electron microscopy. Two main steps in dispersal mechanisms are presented: a, primary dispersion, by explosive aperture of cocci; and, b, secondary dispersion, by myrmecochory, ornithochory or anemochory.

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1. Introduction

Since SERNANDER's (1906) monograph, the seeds of *Euphorbia* L., having a caruncle with elaiosome function, have been considered as typically dispersed by myrmecochory.

However, as preliminary results from a wider research project on W Mediterranean *Euphorbiae*, we can assert that dispersal mechanisms are far more complex and diverse, including distinct seed surface patterns and distinct ant responses to different *Euphorbia* species.

2. Seed morphology

From more detailed investigations on seed morphology (BAIGES & BLANCHÉ in press), six major types of seeds can be recognized, as it is shown in Fig. 1 and Table 1. Some particular features are obviously correlated with dispersal syndromes, such as presence/absence of caruncle, seed size, mode of capsule dehiscence and, specially, presence/absence of mucilage.

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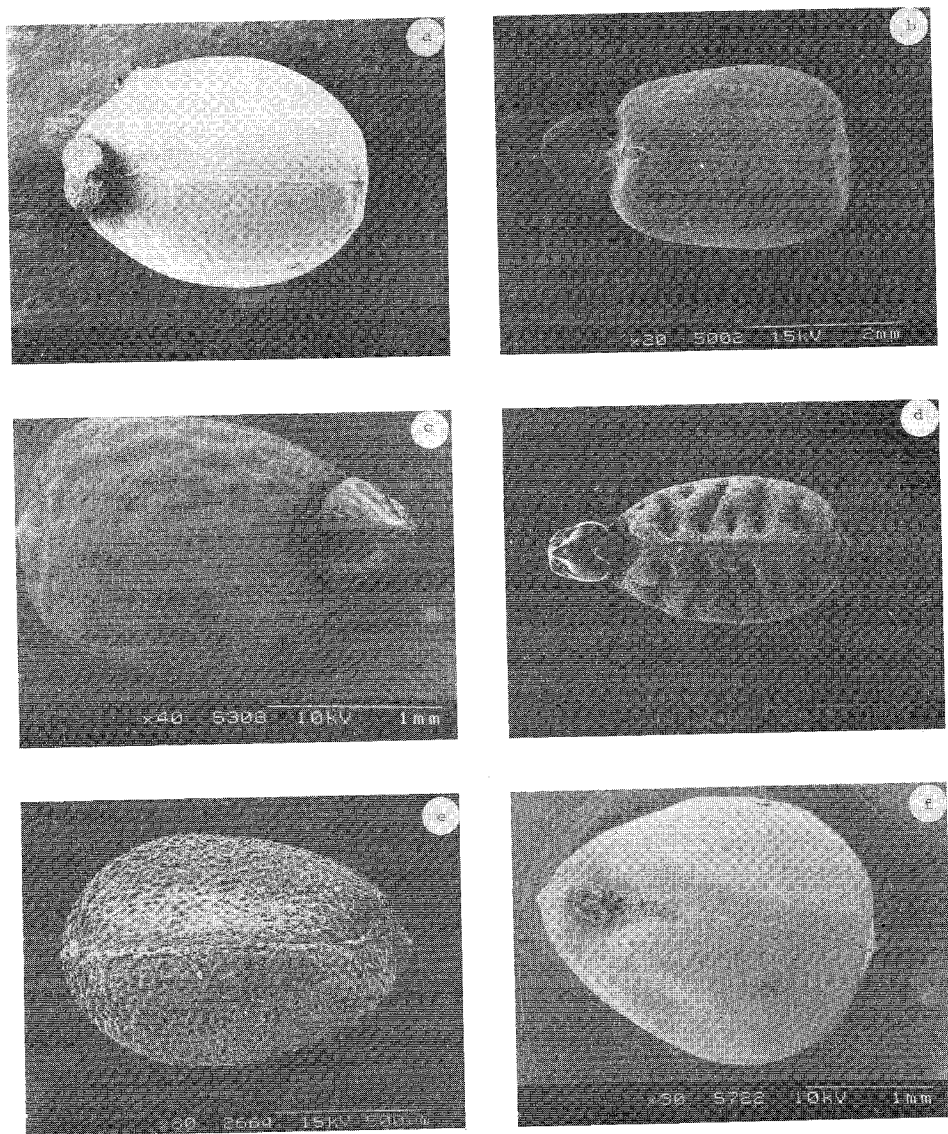


Fig. 1. Morphological seed types recognized: a, *Euphorbia akenocarpa* (Type I); b, *E. serrata* (Type II); c, *E. segetalis* (Type III); d, *E. falcata* (Type IV); e, *E. serpens* (Type V); f, *E. paralias* (Type VI).

Table 1. Morphological features of W Mediterranean *Euphorbia* seeds.

Type	Dehiscence	Size	Surface	Caruncle	Mucilage
<i>Euphorbia akenocarpa</i> (I)	no	medium	smooth	+	-
<i>E. esula</i> (II)	explosive	big	smooth	+	-
<i>E. segetalis</i> (III)	explosive	var.	rough	+	-
<i>E. peplus</i> (IV)	explosive	med/sm.	rough	easily lost	+
<i>E. chamaesyce</i> (V)	explosive	small	rough	-	+
<i>E. paralias</i> (VI)	explosive	med/big	rough	sometimes lost	traces

The mucilaginous projections, when present, arise from the outer cell layer of the testa. They are of mixed composition, containing pectose-cellulose- and callose-filaments as showed by histochemical tests (schedule in SERRANO 1946).

3. Primary dispersion

In the *Euphorbiaceae*, the explosive dehiscence of the capsule is well known, with the record of 45 m of distance reached by seeds of *Hura crepitans* (VAN DER PIJL 1982). But, how far can the *Euphorbia* seeds be dispersed?

Experiences carried out in our laboratory with *E. medicaginea* Boiss. show that the most important part of the seed set falls near the mother plant, within a radius of about 10-40 cm from the stem axis (Fig. 2). Only few seeds reach distances from 100 to 200 cm. Assuming that wind force, seed size and other specific peculiarities, can modify these results, no more than 5 m are expected to be reached by this general primary mechanism in the W Mediterranean species.

4. Secondary dispersion

However, this ballistic dispersion is not the only mechanism available to the diaspores of *Euphorbia*. When the seeds are firstly dispersed, they remain exposed to the ecological factors, and some other dispersal types can be used by seeds.

4.1. Myrmecochory

In order to confirm the general idea that the seeds of *Euphorbia* are dispersed by myrmecochory, some field observations have been done in Catalonia (Ports de Tortosa Mountains, Cubelles beach and Garraf Mountains).

Experiences were planned as proposed by SERNANDER (1906) and used by several authors as BERG (1975), and PEMBERTON (1988). Groups of 10 seeds were

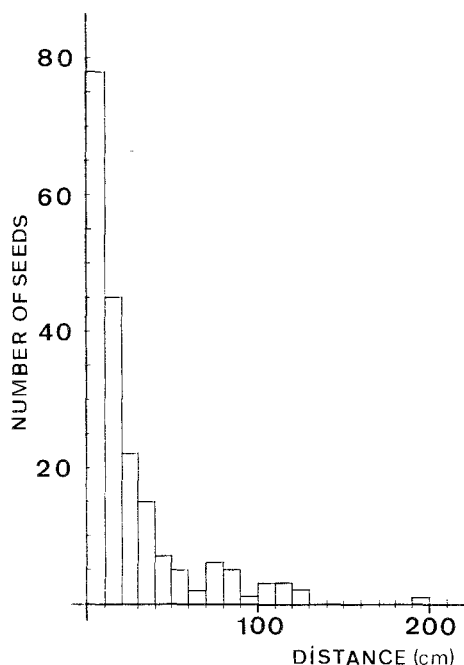


Fig. 2. Experience on seed ballistic dispersal on *Euphorbia medicagineae*.

placed on the corners of a square of 2 x 2 cm near the ants nest and the *Euphorbia* population, but not on the main way of ant columns. Four sets of seeds were presented to ant activity: a) normal carunculate seeds; b) normal ecarunculate seeds; c) artificially ecarunculate seeds; and d) free caruncles artificially removed from carunculate seeds. Ant species were collected and their activity was recorded. The results of these experiences are shown in Fig. 3.

The parameter measured was the number of seeds that remain in situ during a given period of time. Normal carunculate seeds were effectively removed by ants in 5-11 hours after exposition. However, seeds without caruncle (Type V, i.e., *Euphorbia prostrata* Aiton) remain in place until the end of the experience, and only occasionally were removed for a few centimetres and, finally, rejected by ants. Thus, we can conclude that carunculate seeds are dispersed by myrmecochory whereas seeds without caruncle are not.

We also observed that free caruncles are quickly removed (30 min after exposition to ants) and that seeds artificially ecarunculated remain much more time than the normal ones (Fig. 3). Then, the attractiveness of the normal carunculate seeds is located in the caruncle presenting, then, the function of elaiosome. This character is reinforced by the presence of lipid droplets and starch grains in the elaiosome cells (Fig. 4). Our results are in agreement with those of BERG (1975) and PEMBERTON (1988).

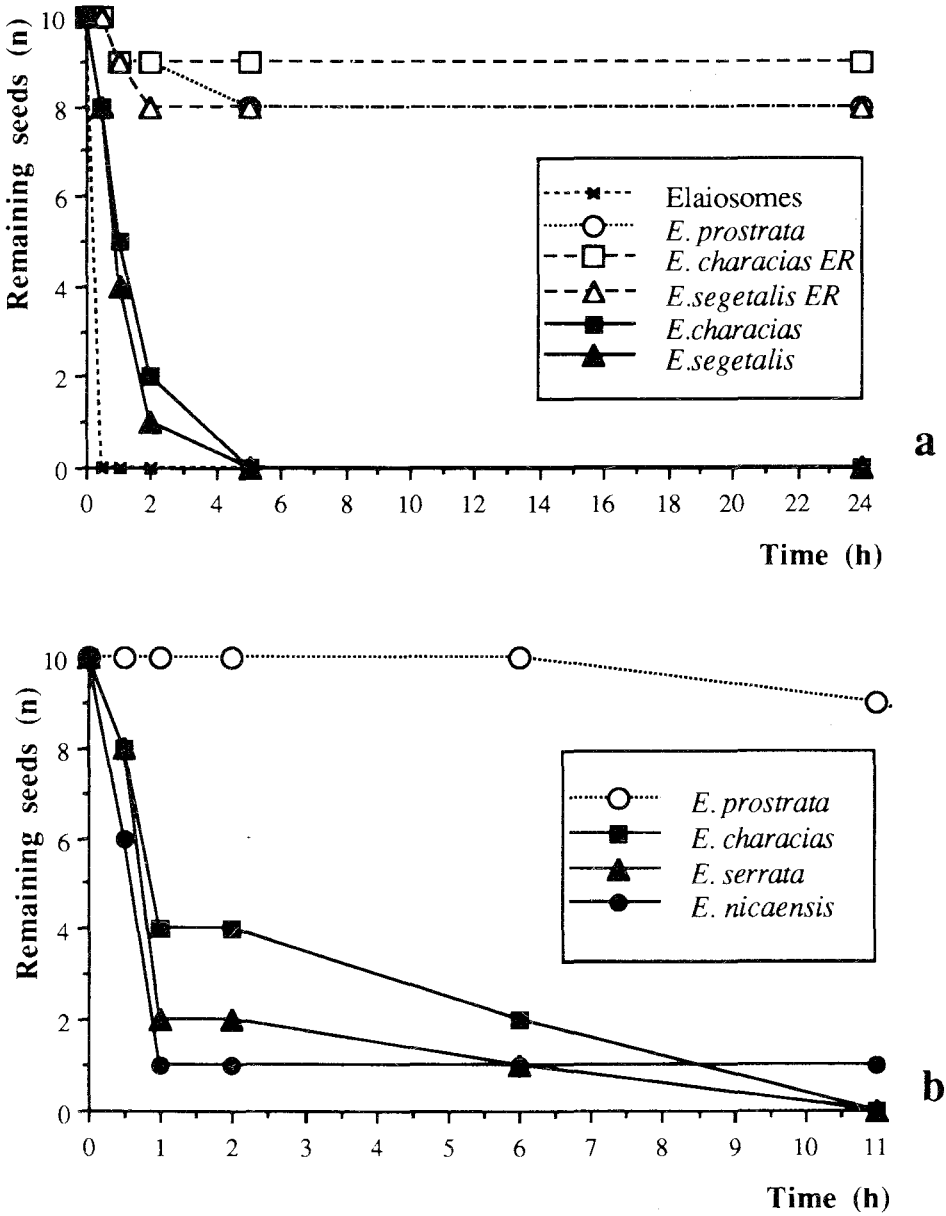


Fig. 3. Experiences on myrmecochory (Ports de Tortosa, Tarragona): a, No. 002 (09.08.1989; time of beginning: 13 h; ant species involved: *Tetramorium caespitum* (L.), *Myrmica scabrinodis* (Nyl.), *Formica rufibarbis* (non active); b, No. 007 (18.08.1989; time of beginning: 10 h, ant species involved: *Aphaenogaster gibbosa* (Latr.) mainly. Elaiosomes: free elaiosomes artificially removed from mature seeds. ER: artificially ecarunculated seeds. See details in text.

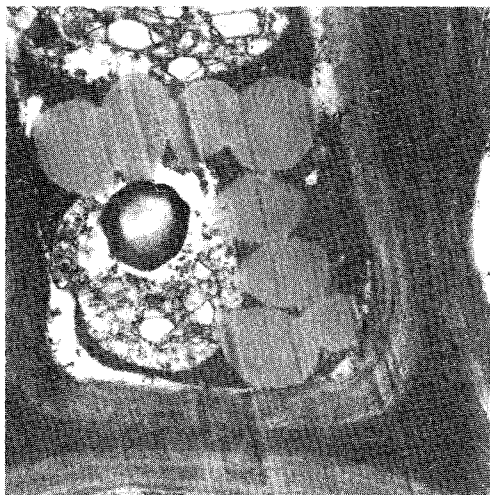


Fig. 4. Transmission electron micrograph of elaiosome cell of *Euphorbia flavicoma*.

Finally, concerning the ant species that act as dispersal agents, we did not observe any evident correlation between ant species - plant species. In general, ant species investigated are active on any *Euphorbia* seed presented, when they are active. This is important, because it means that in *Euphorbia*, myrmecochory is an inspecific mechanism. This fact implies that any carunculate species can conquest new territories even if no previous contact with their ant species have been existed. PEMBERTON (1988) recorded normal myrmecochory on *E. esula* L. in the U.S.A., this species being recently introduced from Europe.

In Table 2, we show the activity of all the ant species observed in the field observations. Among the most active species that carry seeds, there are some granivorous species that short-circuit the dispersal mechanism because the seeds will probably be eaten by ants. This is a very complicated question, in relation to the benefits obtained by plants and ants in this mutualism, extensively discussed by BERG (1975), CULVER & BEATTIE (1980, 1983), DAVIDSON & MORTON (1981), WESTOBY et al. (1982), and RICE & WESTOBY (1986).

4.2. Ornithochory

Seeds of type V (*Euphorbia chamaesyce*-type) are not dispersed by ants (Fig. 3). Their small size, the absence of caruncle and the presence of mucilages inflated in contact with water, are features of a very distinct dispersal syndrome. CARLQUIST (1966) reports the presence of a mucilaginous coat in seeds of several species of subgenus *Chamaesyce* Rafin., belonging to our type V. This author places these seeds under the ornithochory syndrome, as seeds fixed in birds wings and body, reach by this way long distances between the Hawaiian Islands. If this is true —we did not collect data on this type of dispersion— ornithochory can explain (together with anthropochory) the general distribution of the subgenus *Chamaesyce* (sub-

cosmopolitan, see NORTON 1900, SMITH & TUTIN 1968), which arrived in W Mediterranean from America or Asia by means of long distance dispersal mechanisms as ornithochory.

4.3. Anemochory

Seeds of type VI (*Euphorbia paralias* L.) may use also a secondary dispersion mechanism, not by ants. During our observations in their natural habitats (littoral dunes along the Mediterranean coast), only the ant species *Iridomyrmex humilis* (introduced from America) was found, without any activity on *E. paralias* seeds. As in dunal areas ant species are rare, alternative mechanisms have to be adopted to reach longer distances. Wind is strong in beaches and in normal days the globose seeds of *E. paralias* have been seen rolling over the sand surface for over 50-100 m in few minutes.

5. Conclusions

— Seeds of types I, II, III and IV are dispersed by ants and usually nests can be seen under *Euphorbia* populations.

— As caruncles may have other functions than elaiosome ones (i.e., seed disjunctors into the coccae before explosion cf. BERG 1975), their reduction or absence (seed types IV and V) may be replaced by new structures. Mucilagues have been reported as seed disjunctors, too. These new features can be useful to adaptation to new dispersal syndromes, as ornithochory.

— Additional and alternative mechanisms (indehiscent fruits, anemochory, etc.) can be developed under particular ecological conditions.

Table 2. Ant activity on *Euphorbia* L. seeds and feeding habits.

Active ants on dispersal

Ports de Tortosa

Tetramorium sp. (O/G)

Formica gerardi Bondr. (?)

Leptothorax racovitziae (?)

Tapinoma erraticum (Latr.) (N)

Lasius niger (L.) (N/A)

Lasius alienus (Föster) (N/A)

Camponotus piceus (Leach.) (N)

Aphaenogaster gibbosa (Latr.) (O/G)

Table 2 (cont.)

Garraf, Cubelles
Messor capitatus L. (G)

Non active / active ants (active in some cases, not in others)

Ports de Tortosa
Myrmica scabrinodis (Nyl.) (O)
Myrmica sabuleti (Meinert) (O)
Plagiolepis pygmaea (Latr.) (N)
Camponotus aethiops (Latr.) (N/A)

Non active ants

Ports de Tortosa
Formica rufibarbis Fab. (O)
Camponotus lateralis (Olivier) (W)

Garraf, Cubelles
Iridomyrmex humilis (Mayr.) (N,A)
Pheidole pallidula (Nyl.) (O)
Crematogaster auberti Emery (A,N)

O = Omnivorous

G = Granivorous

N = Nectarivorous

A = Aphids

W = Association to wood

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