DUNG BEETLE DISTRIBUTION PATTERNS IN THE IBERIAN PENINSULA

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A canonical variate analysis was used to summarize the distribution pattern of 30 species of dung beetles (Scarabaeinae) from 162 sites in the Iberian peninsula (Spain and Portugal) in relation to 4 site variables. The best separation of beetle species, obtained using a xerothermic climatic index, was into 3 groups called "mediterranean", "unrestricted" and "temperate". Little further separation was achieved using altitude, dung type or soil type. These data are used to select dung beetles for introduction to south-western Australia for bush fly control.

KEY-WORDS: Scarabaeinae, Spain, Portugal, climate, soil, dung.

Dung beetles (Coleoptera: Scarabaeidae, subfamily Scarabaeinae) fly to fresh dung which they feed on as adults and bury as food for their larvae. Beetles are being introduced to south-western Australia to improve the rate of breakdown of cattle dung in pastures, and thus to reduce populations of the dung-breeding bush fly Musca vetustissima Walker. The beetles selected for introduction should be adapted to feed on and bury dung in the spring (Ridsdill-Smith & Kirk, 1985), at a time when bush fly populations in SW Australia increase rapidly (Matthiessen, 1983), and when there is little dung beetle activity (Ridsdill-Smith & Hall, 1984).

SW Australia has a mediterranean climate with cool moist winters and warm dry summers. The Iberian peninsula (Spain and Portugal) has regions with a similar climate (Anon, 1963) and annual pastures grazed by cattle where dung beetles are abundant (Ridsdill-Smith & Kirk, 1982, 1985). The species which contributed most to dung dispersal in the spring at 1 pasture site in SW Spain were identified by Ridsdill-Smith & Kirk (1985).

Distribution of dung beetles has been related to temperature and rainfall (Matthews, 1972, 1974; Tyndale-Biscoe, Wallace & Walker, 1981), altitude (Dzhambazishvili, 1973; Lumaret, 1979; Martin, 1982; Hanski, 1983), dung type (Lumaret, 1979; Oppenheimer & Begum, 1978; Walter, 1978; Ricou, 1981; Martin, 1982), and soil texture (Nealis, 1977; Doube, 1983). In this paper we consider the extent to which these site variables appear to limit the distribution of dung beetle species in pastures on the Iberian peninsula.

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METHODS

Surveys in the Iberian peninsula were made between 1976 and 1983, mainly in spring when the greatest number of dung beetle species were active (Lumaret, 1977; Ridsdill-Smith & Kirk, 1985). Some areas in each type of climate were surveyed every season, and some sites were visited in different seasons. Surveys occurred in nearly all provinces in Spain and Portugal (figure 2a).

Sites selected were pastures with grazing animals or with dung less than a week old. Beetles in moist dung and the soil beneath were collected for at least 10-15 minutes at each site and identified. Soils were classified as light (high proportion of sand), heavy (high proportion of clay) or gravel and the dung identified from cattle, sheep, goats, horses, mules, pigs, dogs or human sources.

The bioclimatic index, and the altitude of each site were determined according to Anon (1963). The index represents the number of dry days (i.e. without rain corrected for humidity) during the dry season, and has been used by Kirk (1974) and Spradbery & Kirk (1978) to study the distribution of siricid woodwasps in Europe. The following groupings were used: mediterranean - 40 to 200 dry days, transitional - up to 40 dry days, and temperate - no dry period. A transitional climate may be mediterranean in some years and temperate in others (Kirk, 1974). The data did not justify more detailed separation of climate types.

ANALYSIS OF DATA

All data from sites with positive records for at least 1 species of dung beetle were analysed. Species at < 5 sites were excluded. The site variables were given numerical values as follows: Climate; mediterranean = 1, transitional = 2, temperate = 3. Altitude; 1-100 m = 1, 101-800 m = 2, 801-2000 m = 3. Soil; light = 1, heavy = 2, gravel = 3. Dung was grouped; Cattle = 1, sheep and goat = 2, horse and mule = 3, omnivore = 4. A group variable mean was calculated for each species for each variable. A species found at 10 sites of which 3 had light soil, 6 had heavy soil and 1 gravel, had a group variable mean for soil of \((3 \times 1) + (6 \times 2) + (1 \times 3) / 10 = 1.8\). Canonical variate analysis provided a way of summarizing these data and showing patterns of beetle distributions in relation to the combined effects of site variables (Reyment et al., 1984; Chapter 7). The separation between groups of species was maximized as to the variation within groups for a linear combination of the variables. A canonical variate mean was calculated for each species and variable.

The number of records for each species was expressed as a percentage of all sites surveyed for that variable. For instance a species was present at \(3/77 = 4\%\) of sites on light soil and \(6/75 = 8\%\) of sites on heavy soil and \(1/10 = 10\%\) of sites on gravel.

RESULTS

The climatic index gave the best separation of species (table 1). The standardized canonical vector for climate was far greater than that for altitude, dung or soil in the 1st canonical variate. The additional contribution of altitude, dung and soil respectively, was slight as judged by the relative magnitudes of their canonical roots (table 1).

Plots of the first 2 canonical variates are shown in figure 1. Lines were drawn to separate apparent groupings. Most species occurred mainly in mediterranean climates, like Copris hispanus (L.) (figure 2b); they are called “mediterranean” species. Species found in mediterranean, transitional and temperature sites, like Onthophagus taurus (Schreb.) (figure 2c) are called “unrestricted”. Species like Copris lunaris (L.) (figure 2d) were found mainly in temperate sites and are called “temperate”. A canonical variate analysis using altitude, dung and