DISTRIBUTION AND HABITS OF THE ORTHOPTERA *(SENS. LAT.)* OF THE BALEARIC ISLANDS (SPAIN)

S. K. Gangwere* and V. Llorente**

ABSTRACT

There has been little concerted study of the Balearic Island Orthoptera (*sens. lat.*) and their allies, hence the present investigation analyzing personal data, specimens of the Museo Nacional de Ciencias Naturales and the Universidad Complutense of Madrid, and pertinent literature. Based on this analysis, the Balearic fauna of these insects now numbers 85 species and subspecies of xerophilic, mesophilic, hydrophilic, and domestic/semidomestic habitat selectivity. About 60 % of these taxa are common to northwest Africa, Iberia, and meridional Europe. The remainder are more restricted in distribution, 12 % being essentially northwest African, 12 % western Mediterranean island, 11 % meridional European (Palearctic), and 5 % Iberian in origin. Factors which may have acted to produce their current Balearic distribution include glaciation, past land bridges, and passive transport via air currents, human vehicles, and probably rafting. The winglessness or reduced wings of some species have apparently not inhibited their island colonization inasmuch as no significant positive correlation is demonstrated between flight and dispersal. A regression analysis of the 85 Balearic representatives shows that island distance from the nearest mainland does *not* have a significant influence on species numbers but island size does, a result inconsistent with current island biogeographic theory. Most Balearic Orthoptera are active during two or more seasons per year except winter, and some are active either all or almost all year long. There are two overall population peaks, the greater in June and the lesser in September.

Key words: *Orthoptera, Balearic Islands, western Mediterranean islands, biogeography, ecology, habits, behavior.*

RESUMEN

Distribución y hábitos de los Orthoptera *(sens. lat.)* de las Islas Baleares (España).

Basándose principalmente en la bibliografía consultada y en nuestros propios datos, así como en el estudio del material perteneciente al Museo Nacional de Ciencias Naturales y a la Universidad Complutense de Madrid, se conocen hoy día 85 especies y subespecies pertenecientes a la fauna ortopterológica de las Baleares. Estos insectos son de hábitos xerófilos, mesófilos, hidrófilos o domésticos/semidomésticos. Alrededor de un 60 % de estos Orthopteroidea es común con el Noroeste de Africa, Península Ibérica y Europa meridional. El resto está más restringido en su distribución, siendo el 12 % esencialmente norteafricano, el otro 12 % común con las islas mediterráneas occidentales, el 11 % esencialmente europeo (paleártico) y el 5 % de origen ibérico. Los principales factores que han influido en la distribución balear son las glaciaciones, los «puentes» o enlaces terrestres del pasado y el transporte pasivo mediante corrientes de aire, de agua (a la deriva) y vehículos humanos. El apterismo o el micropterismo en algunas especies no ha detenido aparentemente su colonización insular, puesto que no se ha demostrado que exista una considerable correlación positiva entre la capacidad de vuelo y la dispersión de las especies. Un análisis de regresión de los 85 representantes de las Baleares demuestra que la distancia insular al punto más cercano de tierra firme no tiene una influencia significativa sobre el número de especies, mientras que el tamaño de la isla sí la tiene, un resultado un tanto sorprendente si lo comparamos con la teoría de la biogeografía insular conocida. La mayoría de los Or-

* Department of Biological Sciences, Wayne State University, Detroit, MI 48202, USA
** Entomología, Museo Nacional de Ciencias Naturales, J. Gutiérrez Abascal, 2, 28006 Madrid, Spain

thoptera de las Baleares se encuentran activos durante dos o más estaciones del año, excepto el invierno, y algunos incluso casi todo el año. Hay dos máximos de población, el mayor en junio y el menor en septiembre.

Palabras clave: *Orthoptera, Islas Baleares, islas mediterráneas occidentales, biogeografía, ecología, hábitos, comportamiento.*

INTRODUCTION

Studies of Balearic orthopteroid faunistics since the end of the last century are limited. Chronologically listed, they include only MORAGUES (1894), BOLÍVAR (1876-1878, 1897-1900), NAVÁS (1909, 1910), JORDANS (1925), EIDMANN (1927), KRAUSS (1928), EBNER (1931), ESPAÑOL (1935), FERNANDES (1962), COMPTE (1968), GANGWERE (1975), and EHRMANN (1988). The BOLÍVAR reports are Iberian catalogs that, for the sake of completeness, included a few Balearic species. Except for the MORAGUES, COMPTE, FERNANDES, and GANGWERE reports that focused, respectively, on the overall Balearic fauna, on the Menorcan fauna, on ectobiid cockroaches, and on feeding in Ibizan and Menorcan grasshoppers rather than the islands' Orthoptera as a whole, these citations consist of accounts of species collected incidentally by Balearic vacationers. They stem primarily from Mallorca, the largest, touristically most important island. Some lack specific locality data; others cite only 1 or 2 localities from a single island; and virtually all ignore the smaller islands. Consequently, today's literature includes neither an up-to-date, comprehensive list of the Balearic orthopteran fauna, nor a treatment of their distribution and habits, nor a discussion of their relationships with the faunas of adjacent Iberia, France, Corsica, Italy, Sardinia, Sicily, and northwest Africa. The present study based in part on an American Philosophical Society grant-in-aid to S. K. Gangwere and on a later Wayne State University sabbatical award, also to Gangwere, addresses these gaps.

The author and year of description of the Balearic taxa discussed may be found, not upon the species' first mention, but later in the section entitled «Biological Notes». Except where indicated, information concerning the islands' geographic and physical features, climate, and vegetation are adapted from pertinent literature as interpreted by personal field experience in the Balearics. This literature, which goes uncited in the section that follows, includes: ATLAS DE LES ILLES BALEARS (1979), COLOM (1978), FACAROS & PAULS (1981), HOUSTON (1964), LINES (1971), RIVAS & COSTA (1987), and WAY (1962).

GEOGRAPHIC FEATURES, PHYSICAL FEATURES, AND CLIMATE

The Balearic Archipelago consists of certain subtropical islands located off the Mediterranean coast of Spain. The easternmost, Menorca, is almost equidistant between Spain's Cabo de la Nao and Sardinia, and the westernmost, Ibiza, is located close to Cabo de la Nao. Between them lies Mallorca (figs. 1 and 2).

The Balearic Islands are located near the horse latitudes, hence are exposed to a climate characterized by hot, dry summers and mild, rainy winters. These subtropical conditions result both from the Mediterranean sun which tempers the seas bathing the islands and from the combined influence of the trade winds and the subtropical highs that moderate the sea breezes. During summer, the sea comes under the influence of the trade winds which generally blow off the mainland toward the Atlantic, bringing little moisture. Summer conditions in the Balearics approximate those of southeastern coastal Spain but are occasionally disturbed by a hot, dry, dust-laden wind, the «sirocco», from the Sahara. There is a pronounced diurnal fluctuation, evening temperatures drop-

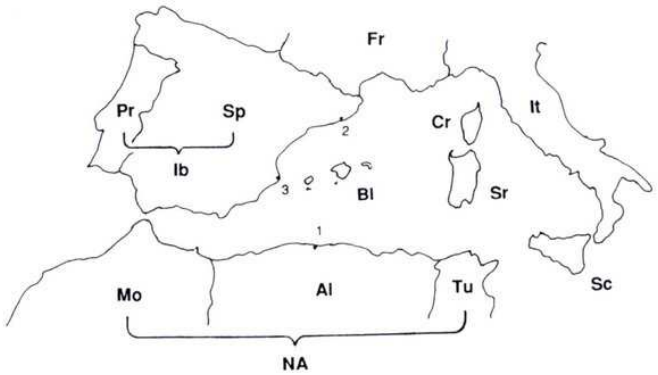

Fig. 1.—Spatial relationships among the islands of the Balearic Archipelago, other major western Mediterranean islands, and the adjacent mainlads. Code: B1 = Balearics; Cr = Corsica; Fr = France; Ib = Iberia including Pr = Portugal and Sp = Spain; It = Italy; NA = Northwest Africa including Al = Algeria, Mo = Morocco, and Tu = Tunisia; Sr = Sardinia; Sc = Sicily; 1 = Algiers; 2 = Barcelona; 3 = Cabo de la Nao.

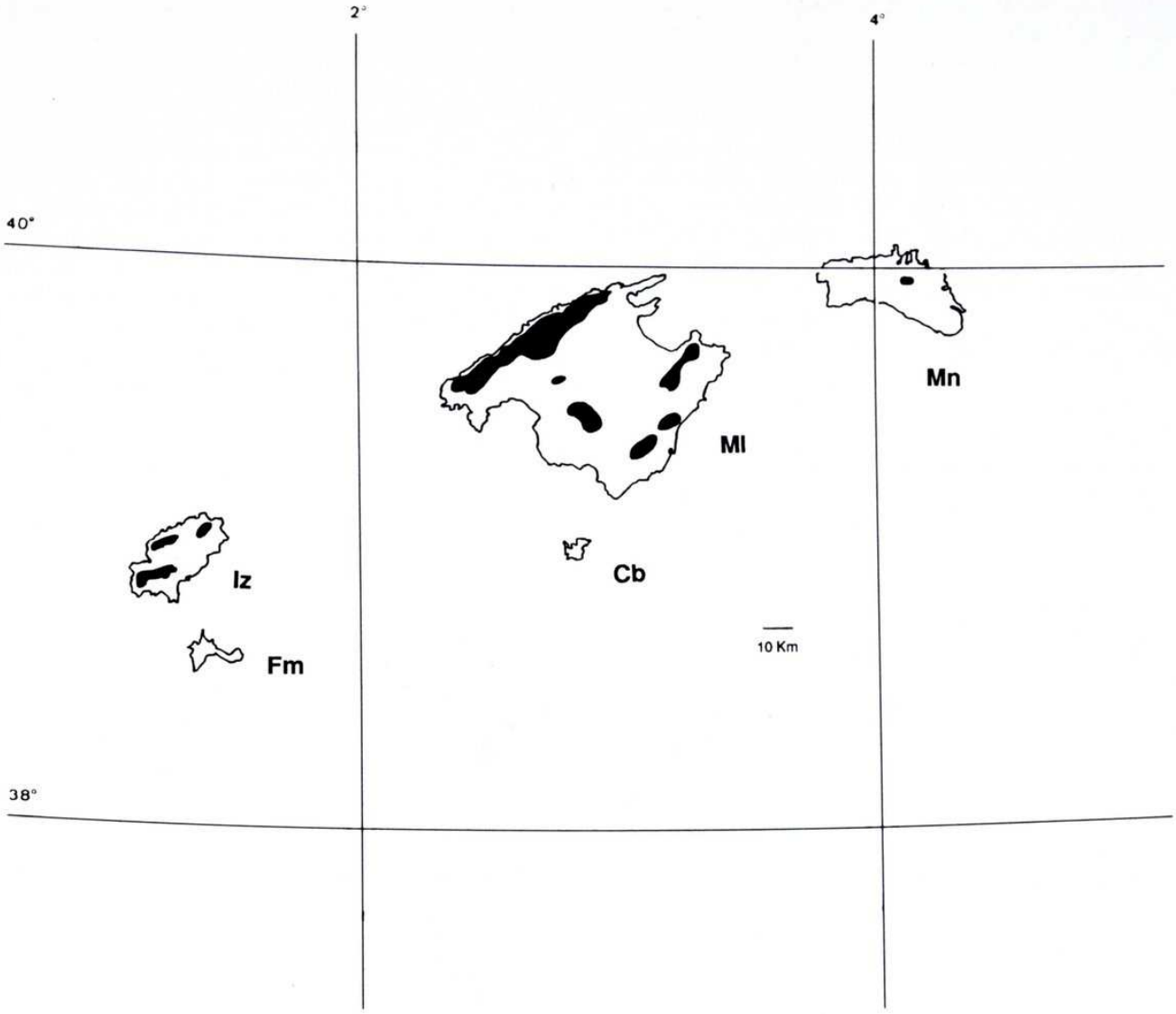

Fig. 2.—Balearic Islands' spatial relationships to each other and places exceeding 200 m above sea level, suggestive of relief, in black. Scale, indicated at the lower right. Cb = Cabrera; Fm = Formentera; Iz = Ibiza; Ml = Mallorca; Mn = Menorca.

ping sharply. In winter, the trade winds and the high pressure zone shift toward the equator, so the Balearics come increasingly under the influence of the cyclonic westerlies and their rains blowing off the Atlantic. The result is a mild, rainy winter subject only occasionally to brief periods of dry cold. The latter stem from the «mistral», the cold Siberian wind emanating from the continent primarily via the Gulfs of Lyon and Genoa. The Prevailing sea breezes blow radially from the periphery toward the center of all the major islands except Formentera, which is dominated by easterlies. December and January are the most windy and May the least windy months of the year.

Subrectangular Mallorca (=Majorca), the largest, most varied island of the chain, has an approximate area of 3,640 km^2 (fig. 4). About two-thirds of it consists of Tertiary plains and basins. Its coastline is irregular, with sandy coves in the south and the rocky cliffs of the Sierra de Alfabia in the north, at places dropping almost vertically into the sea. Puig Major, the sierra's highest peak, reaches 1,445 m above sea level. Immediately south of the sierra is an extensive central plain extending to the sea at the bays of Palma in the southwest and Alcudia and Pollensa in the northeast. Elsewhere the plain is interrupted by low mountains seldom exceeding 200 m (fig. 2). The island's drainage is by «torrentes», usually dry stream beds carved by the elements out of the terrain. In places, these empty into deep, picturesque canyons. Several streams near the northeastern coast drain into

a marshy coastal lagoon, the Albufera, immediately south of Alcudia.

Mallorca has a mean annual precipitation ranging from over 1,300 mm in the northern mountains to 300-400 mm along the southern coast, with intermediate values (400-600+ mm) in the central plain. The rainfall is seasonal. Almost half arrives in fall when the sea is warmer than the land. Most of the remainder, over warmer land, is during spring. Temperature data from Palma, Mallorca, indicate the presence of winter from December into March, with January the coldest month (mean temperature 9.5° C), and summer from June through September, with August the warmest month (mean temperature 24.4° C). The sea temperature is mild throughout the year, varying from 13° C (January-February) to 26° C (August). Relative humidity is high, the average annual value approximating 73 %. Insolation, with values of 2,800 hours of sunshine per annum, is among Europe's highest. The island is less windswept than are the other Balearics owing to the Sierra de Alfabia which affords the lee partial protection from the winter «mistral».

Subcrescentic Menorca (=Minorca), the second largest island of the archipelago, has an approximate area of 702 km^2. Its northern coast is indented into numerous «barrancos» and deep coves. Its southern coast consists of an almost straight line of rocky cliffs cut at intervals by «arroyos» dropping into the sea at sandy beaches. It is relatively flat and wind swept. Its highest point, Mont Toro, reaches only 358 m above sea level.

Menorca consists of a Tertiary southern and a Devonian northern formation. The southern enjoys a Baetic origin common with that of Ibiza and Mallorca and the northern a «Tyrrhenian origin», presumably being part of the now-submerged continent to which Corsica and Sardinia belong. The two formations collided along the center of the island forming a visible fault extending from Ciudadela to Mahon (fig. 4). The thin reddish soil is interspersed with boulders and rocky terraces, the latter mostly porous limestone.

Menorca has a pronounced wind chill factor in winter. The mean temperature at Mahon ranges from 10.3° C (January) to 24.4° C (August). The mean annual precipitation runs approximately 500-600 mm along the northern and southern coasts and 600-700 mm along the Ciudadela-Mahon central belt. The land is flat, affording little climatic protection, and the porous limestone substrate absorbs rain almost as fast as it falls.

Ovoid-shaped Ibiza (=Iviza or Eivissa), the third largest island, has an area of 521 km^2. Its topography is hilly to mountainous, with lines of relief radiating several directions. The highest peak, Atalaya, reaches 475 m above sea level. Ibiza's folded limestone terrain, like that of Mallorca, is a geological continuation of the mainland's Baetic Cordillera. This mountain chain descends into the sea at Cabo de la Nao, reappears as Ibiza, disappears again, and then rises as Mallorca. The Ibizan coastline consists of an irregular succession of coves and small bays ringed by often precipitous cliffs. The Balearic Islands' only river of consequence, the Rio Santa Eulalia, courses eastward over Ibiza and discharges into the Mediterranean at Santa Eulalia. Elsewhere in Ibiza and in the other islands, drainage is by «torrentes.»

By its more southerly location and greater proximity to the Iberian mainland, Ibiza enjoys a warmer summer (26° C mean August temperature) than do the foregoing. Its relatively reduced rainfall consists of sudden showers. Mean annual precipitation ranges from 300-400 mm at the island's periphery to 450+ mm near its center. Despite the reduced rainfall and the porous limestone substrate, the clay soil helps keep the vegetation green well into summer, in contrast to the parched summer vegetation of Menorca.

Boot-shaped Formentera, the fourth largest island of the Balearics, has an area of 72 km^2. It is a windswept island located just south of Ibiza, of whose limestone plain it is essentially a continuation. It consists of little more than two low hills, western Guillem (107 m) and eastern La Mola (202 m), joined by a sandy isthmus. The coastline is flat sandy beach except for cliffs near northeastern Es Calo. The western and central parts of the island have a mean annual precipitation of approximately 300-400 mm, the eastern part about 400-450 mm, and the southern cape less than 300 mm.

Rocky Cabrera, with an approximate area of 16 km^2, is the fifth largest island of the archipelago. It lies just south of Cabo de Salinas, the southernmost point of Mallorca. It has an excellent natural port supporting a modest village in the shadow of Puig de Cabrera which, at 173 m above sea level, is the island's highest peak. To the east is another peak, Puig de Picamosques, and to the north a vast limestone cavern, the Cova Azul, carved out of the island's northwest corner. The island is undeveloped touristically, most of it being given over to a military base from which civilians are excluded.

PLANT COMMUNITIES AND AGRICULTURE

The following information on Balearic plant communities is adapted from pertinent literature as interpreted by personal field experience in the archipelago. This literature, which goes uncited in the section that follows, includes: ATLAS DE LES ILLES BA-

LEARS (1979), COLOM (1978), FACAROS & PAULS (1981), HOUSTON (1964), RIVAS & COSTA (1987), UVAROV (1977), and WAY (1962).

The present-day vegetation of the islands is secondary, owing to deforestation, overgrazing, fire, and subsequent erosion to the point where the slopes are almost bare.

Over half of the total land area is cultivated (fig. 3). Elsewhere throughout the islands may be found «maqui», a typical Mediterranean scrub community consisting of low evergreen shrubs, chiefly of the plant families Cistaceae, Labiatae, Ericaceae, and Leguminosae. Common representatives include rock-rose (*Cistus salviaefolius* L.), lavender (*Lavandula dentata* L.), thyme (*Thymus* spp.), rosemary (*Rosmarinus officinalis* L.), heath (*Erica* spp.), mastic tree (*Pistacia lentiscus* L.), box (*Buxus sempervirens* L.), strawberry tree (*Arbutus unedo* L.), and broom (*Spartium junceum* L.). Under wetter conditions, «maqui» may give way to a dense, sclerophyllous woodland called «carrascal» or «ensinar», dominated by holm oak (*Quercus ilex* L.), and on slopes to coniferous forest, chiefly Aleppo pine (*Pinus halepensis* Mill.). A distinct littoral zone either of flat, sandy beach with a scant xeric vegetation or of marshy land supporting a lush growth of sedges, rushes, and grasses completes the Balearic landscape.

Mallorca's diverse landscape varies from rolling hills and mountains, to cliffs and gorges, to lakes and marshes, to cultivated, terraced plains, to orchards and forests, and to sandy beaches. The vegetation reflects this diversity as well as human influence. Relatively little natural vegetation remains except for the stands of pine, juniper (*Juniperus phoenicea* L. and *Juniperus oxycedrus* L.), and oak that still cover the slopes of the Sierra de Alfabia and places along the southeast coast. Aleppo pine is the chief woodland species. Dwarf palm (*Chamaerops humilis* L.), juniper, rock-rose, and rosemary are common in the northeast and southwest of the island, and oleander (*Nerium oleander* L.) and myrtle (*Myrtus communis* L.) course along the dry river beds. Asphodels (*Asphodelus microcarpus* Viv.) are virtually ubiquitous. Elsewhere, the island has been transformed into semicontinuous garden. At lower elevations, carefully maintained terraces support potatoes, tomatoes, artichokes, and other vegetables and fruit and olive trees, many of the latter centuries old. Citrus trees grow in sheltered valleys, particularly in the north. The central plain is largely given over to individual, carefully walled fields supporting vegetables and fig, peach, apricot, and almond trees. Here and there may be found vineyards. The swampy land near northeastern Albufera supports rice and wheat cultivation.

Menorca's thin, rocky soil supports drought-resistant Mediterranean scrub or groves of Aleppo pine, oak, juniper, and wild olive (*Olea europaea* var. *oleaster* Hoff. & Lk.) in places where not cultivated. The unprotected northern half of the island is wooded and relatively unpopulated, and the central and southern zones are more densely populated and cultivated. Peach and almond trees and vines are planted in sheltered places, along with prickly pear for fruit and hedging. Wheat, oats, barley, potatoes, beans, and other short-rooted crops are grown in small fields bounded by low, meticulously constructed stone walls. Trees and shrubs tend to grow vertically to the top of these structures before branching out horizontally.

Ibiza is more protected by its topography than is Menorca, and its landscape is less austere. Along hillsides, it supports the Aleppo pine responsible for the Greek name of the island, as well as junipers, dwarf palm, wild olive, and holm oak. Almond, fig, and orange trees and well-tended vegetable gardens grow in sheltered valleys. Oleander and myrtle are found along river beds and drought-resistant Mediterranean scrub elsewhere.

Cultivation of cereals, figs, almonds, and vines is common in the western and central sectors of Formentera despite the arid climate and flat, unprotected topography. Elsewhere the island supports scrub except for discontinuous groves of Aleppo pine.

COLLECTION LOCALITIES: THEIR GEOGRAPHY, TOPOGRAHY, AND FLORA

Fig. 1 shows the spatial relationships among the islands of the Balearic Archipelago, other major western Mediterranean islands, and adjacent mainlands.

Fig. 2 shows the Balearic Islands' spatial relationships to each other and indicates in black those places that exceed 200 m of elevation, suggestive of relief.

Fig. 3, as modified and redrawn from the ATLAS DE LES ILLES BALEARS (1979), shows today's Balearic vegetation, mostly a result of human influence. The islands' spatial relationships are distorted for purposes of illustration.

Fig. 4 shows the location of all collection localities cited for the archipelago. The islands' spatial relationships and size are distorted for purposes of illustration.

RESULTS

The «Biological Notes», tables I-III and figs. 5-7 summarize the results of the study. The data on which they are based are from personal collections and observations, specimens from the collections of the Museo Nacional de Ciencias Naturales and the

Universidad Complutense, Madrid, and pertinent literature.

The «Biological Notes» provide an annotated provisional list of the 85 Balearic species and subspecies and a brief discussion of their distribution and habits. Author names and species description dates are included, along with new island records (indicated as «NEW RECORD»).

Table I lists the world distribution of the 61 Balearic genera and the world, western Mediterranean, and Balearic distributions of the 85 Balearic species and subspecies. The collection localities are alphabetized, numbered, and shown in fig. 4. Some localities listed in table I are based on literature records (regular print) and some either on specimens that the authors collected in nature or on museum materials that they analyzed personally in the laboratory (**bold print**).

Table II summarizes the Balearic species' habitat selection, perching habits, food habits, diel periodicity, presumed phenology or seasonal distribution, and wing development (suggestive of vagility).

Table III classifies the 61 Balearic genera of Orthoptera according to their characteristic xerophilic, mesophilic, hydrophilic, or domestic/semidomestic habitat occupancy.

Fig. 5 is a regression analysis of the numbers of orthopteran species found in the Balearic and other major western Mediterranean islands compared with distance (in kms) from the nearest mainland.

Fig. 6 is a regression analysis of the numbers of orthopteran species found in the Balearics, other major western Mediterranean islands, and adjacent mainlands compared with the natural log of land area.

Fig. 7 compares the percentage inter-island composition of the Orthoptera of the Balearic and other major western Mediterranean islands.

ORTHOPTERAN FAUNISTICS

Collecting effort and fortuity

Most citations of Balearic Orthoptera stem from places where Balearic travelers stayed. The species recorded by MORAGUES (1894), who was an inhabitant of Mallorca, and those by NAVÁS (1909) are important exceptions. Mallorca, the largest, most important island, naturally dominates the faunal list, with Menorca and Ibiza following in order. The other islands have largely been neglected. A complete list of all collection records, past and present, is provided in fig. 4 and table I.

Specimens of 41 of the 85 species cited for the fauna as a whole were collected in the field and verified personally in the laboratory, as indicated by **bold**-type locality designation. The remaining citations, all shown in regular type, are based on the literature. A total of 18 new island records, each shown as «NEW RECORD», is cited for the first time.

Geological context

Many former dispersal routes have been interrupted during geological time denying populations passage into the separated regions. This accounts for the tendency of older taxa such as Blattoptera to have a more widespread or cosmopolitan distribution, than do newer taxa.

The first Blattoptera, Phasmoptera, and Dermaptera arose prior to the Tertiary when the earth was experiencing marked change by continental drift. The remaining modern groups including Mantodea, Rhaphidophoridae, Tettigoniidae, Gryllidae, Tetrigoidea, and Acridoidea evolved during the Tertiary or Quaternary (GANGWERE, 1967). This chronology eliminates geological drift as a major determinant of Balearic orthopteran distribution except indirectly through the continuing physiographic changes produced by drift. The late Tertiary (Miocene and Pliocene) was a period of continental uplift and increasing aridity during which herbaceous monocots and dicots became abundant and open grassland replaced the widespread forests of earlier times. It was followed by the Quaternary during which the world took on its present-day configuration (GANGWERE, *l. c.*).

The continents have repeatedly been subjected to uplift, and increasing amounts of water have been locked into the continental ice sheets during periods of glaciation. These processes have caused the seas to stand at lower levels increasingly exposing the land, affecting its size and shape, and uncovering land bridges permitting dispersal of insects between otherwise isolated places. A number of bridges discussed below are relevant to western Mediterranean faunistics.

The Balearic fauna stems from a «Tyrrhenian plate» from which, during the Oligocene and Miocene, several microplates separated by geological drift giving origin to the archipelago, to the other western Mediterranean islands, and to the mainlands (LA GRECA, 1983, 1990, 1990a). Specifically, the northern section of the plate broke into an Ibero-Provencal block which remained attached to the mainland, a Sardo-Corsican block, and a Balearic block which separated tardily from the Iberian Peninsula to form the archipelago. The southern section of the «Tyrrhenian plate» broke into Calabro-Sicilian and other fragments of less direct interest to this study than those mentioned above (LA GRECA, 1990a).

The explorations of the Glomar Challenger (HSÜ,

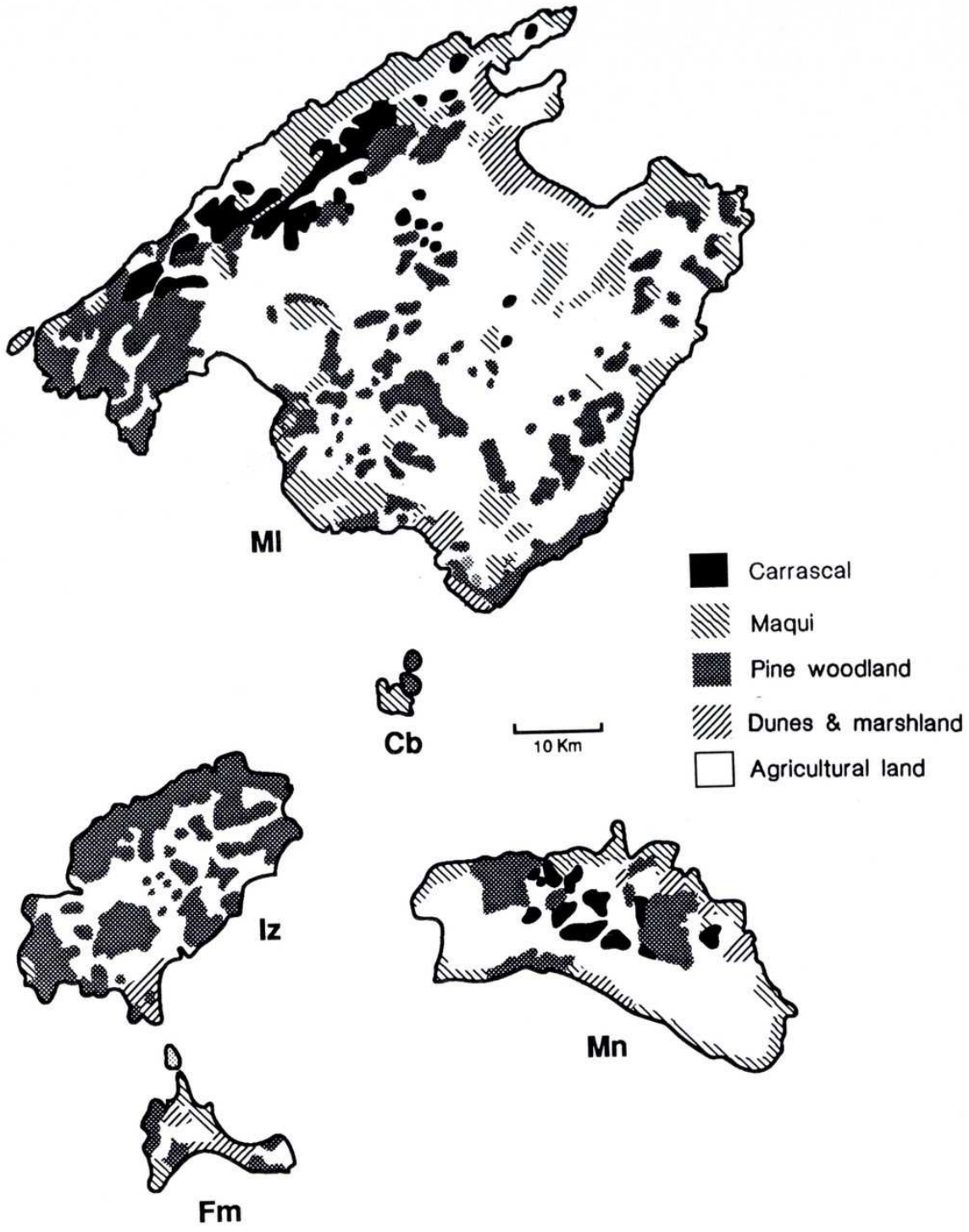

Fig. 3.—Distribution of today's Balearic vegetation, mostly a result of human influence, as modified from the ATLAS DE LES ILLES BALEARS (1979). Islands' spatial relationships distorted for purposes of illustration. Scale indicated in the center. Code: Cb = Cabrera; Fm = Formentera; Iz = Ibiza; Ml = Mallorca; Mn = Menorca. Plan communities: «carrascal» or broad-leaved native evergreen forest; «maqui» or Mediterranean scrub; mixed pine woodland; dune- & marshland; and agricultural land.

1972) indicate that, as late as the early Miocene, about 5.5 million years ago, the Mediterranean basin was a great interior desert lying over 3,000 m below sea level. During this time, the Balearic coastal plains must have been high plateaus and the islands themselves lofty peaks. This assured at least limited faunal access to the Balearics from the Iberian mainland though some authors (LA GRECA, 1990a) question the ability of insects other than a few halophilous marsh dwellers to have extended their range during this period. Then, at the end of the Miocene, an opening was breached at the Ceuta-Gibraltar arc, and the inrushing waters of the Atlantic Ocean helped refill the desiccated Mediterranean (HSÜ, *l. c.*).

Even after restoration of the Mediterranean passageway, occasional land access continued across a Levantine land bridge that permitted dispersal of terrestrial insects from the peninsula to the islands. During the late Pliocene, some 3 million years ago, the bridge connecting Mallorca-Menorca to Iberia-Ibiza-Formentera was severed, and during the Quaternary, some 2 million years ago, the bridge to the Balearics disappeared altogether. For a time, Formentera remained attached to Ibiza and Mallorca to Menorca (COMPTE, 1968). These now-vanished connections assured the modern Mediterranean orthopteran fauna fairly recent access to the Balearics. Their sequence of disappearance suggests closer affinities between the Ibizan-Formenteran faunas than between them and the Mallorcan-Menorcan faunas (COMPTE, *l. c.*; COLOM, 1978). It also suggests closer affinities between the mainland-Ibizan-Formenteran faunas than between them and the Mallorcan-Menorcan faunas (COMPTE, *l. c.*; COLOM, *l. c.*).

During the Pleistocene, from 2 million to perhaps 10,000 years ago, the earth experienced several glacial episodes that alternated with milder interglacial intervals. During each, the existing glaciers enlarged and advanced from more polar areas into more temperate ones. Animal and plant life presumably retreated before the onslaught, lowland forms being displaced toward the equator and montane forms toward the lowlands. The process then reversed itself during the succeeding interglacials (HOUSTON, 1964; TWEEDIE, 1974; LA GRECA, 1983, 1990, 1990a). Glaciation probably resulted in the wholesale extinction of some orthopteran taxa and the proliferation of other, more cold-adapted ones.

The Würm episode took place perhaps 90,000 years ago. It seems well established with regard to the Mediterranean (HOUSTON, 1964). By the Würm, the Balearics had already detached from the Levantine land bridge. The Würn apparently produced an equatorial transposition of each life zone in succession from tundra to tropics. Mixed deciduous forest grew throughout the Mediterranean basin, and forest tundra occurred on the lower mountain ranges. The Mediterranean evergreen forests were displaced southwardly into the Sahara (HOUSTON, *l. c.*). Then the mixed forest was supplanted by scrub upon the northward retreat of the glaciers. This explains the occurrence of the endemic cockroaches of the genera *Ectobius* and *Phyllodromica* and certain other relict forms that retreated into Mallorca's woodlands and mountains.

Vagility and wingedness/winglessness

Vagility, the measure of individuals' mobility and ability to cross barriers such as the expanse of sea separating the Balearics from the mainland, varies with the species. In Orthoptera, it varies from those forms with negligible ability to disperse to those with considerable. Many Orthoptera are long winged or macropterous. Their well-developed organs of flight may, in some cases, enable them to negotiate the relatively short distance from Europe or North Africa to the Balearics. Others are flightless, being either short winged (brachypterous) or wingless (apterous).

A simple analysis of the 85 Balearic taxa indicates that 30 % are either short winged or wingless, and 70 % are long winged. Of the 5 Balearic endemic species, 3 (60 %) are either short winged or wingless. Other wingless Balearic forms include the cockroach *Loboptera decipiens,* the several recorded walkingsticks, and certain crickets. Among the short-winged Orthoptera are the ectobiid cockroaches and amelíne mantises, the katydid *Steropleurus balearicus,* etc. Sometimes the brachyptery is more pronounced in females than in males. In this event, as in amelines, the apparent reduction in vagility is the same in both sexes, reflecting oviposition; populations are maintained only in areas that the females can reach.

Certain long-winged representatives of the Balearic fauna such as the tree cricket *Oecanthus pellucens* and the katydid *Phaneroptera nana nana* are weak fliers. Others are strong fliers. Flight in the grasshopper *Eyprepocnemis plorans* and in the several species of the genera *Oedipoda, Sphingonotus,* and *Aiolopus* is strong. That of the locusts *Anacridium aegyptium, Locusta migratoria,* and *Schistocerca gregaria* is renowned. The two latter species are known for flights of thousands of miles to islands far removed from the outbreak areas and may land on ships at sea.

A summary of the incidence of flightlessness in the major taxonomic groups follows: Blattoptera (6 of 8 spp.) 75 %, Mantodea (5 of 8 spp.) 63 %, Phasmoptera (3 of 3 spp.) 100 %, Tettigoniidae (2 of 16 spp.) 13 %, Gryllidae (8 of 14 spp.) 57 %, Tetrigoidea (0 of 1 sp.) 0 %, Tridactyloidea (0 of 1 sp.) 0 %, and Acridoidea (1 of 33 spp.) 3 %.

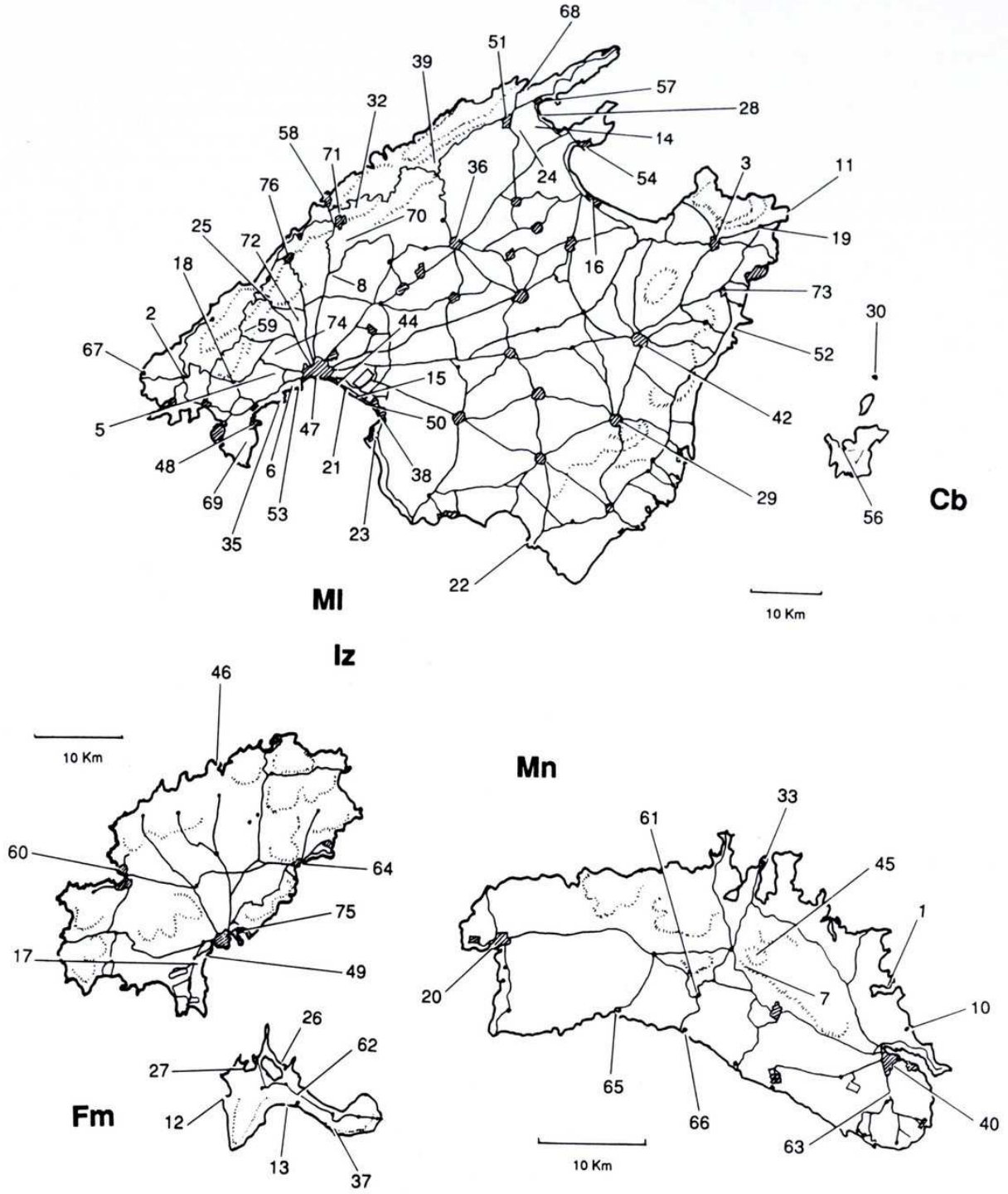

Fig. 4.—Seventy six cited collection localities of the Balearic Archipelago, alphabetized, numbered, and located, with island spatial arrangement and size distorted for purposes of illustration. Scale indicated for each island except Cabrera (see Mallorcan scale) and Formentera (see Ibizan scale). Roads and selected topographic features indicated. General code: Cb = Cabrera; Fm = Formentera; Iz = Ibiza; Ml = Mallorca; Mn = Menorca. Specific locality code: 1) Albufera de Mahon, Mn; 2) Andraitx, Ml; 3) Artá, Ml; 4) Balearics, Bl; 5) Bellver, Ml; 6) Bendinat, Ml; 7) Binillobet, Mn; 8) Buñola Orient, Ml; 9) Cabrera, Cb; 10) Cala Mesquida; Mn; 11) Cala Ratjada, Ml; 12) Cala Sahona, Fm; 13) C'an Marti, Fm; 14) C'an Pascuala, Ml; 15) C'an Pastilla, Ml; 16) C'an Picafort, Ml; 17) Canteras, Iz; 18) Capdella, Ml; 19) Capdepera, Ml; 20) Ciudadela, Mn; 21) Coll d'en Rabassa, Ml; 22) Colonia de Sant Jordi, Ml; 23) El Arenal, Ml; 24) El Puig, Ml; 25) Esporlas, Ml; 26) Es Pujols, Fm; 27) Estanq del Peix, Fm; 28) Estany de la Gola, Ml; 29) Felanitx, Ml; 30) Foradada; 31) Formentera, Fm; 32) Fornalutx, Ml; 33) Fornells, Mn; 34) Ibiza, Iz; 35) Illetas, Ml; 36) Inca, Ml; 37) La Mola, Fm; 38) Las Maravillas, Ml; 39) Lluch, Ml; 40) Mahón, Mn; 41) Mallorca, Ml; 42) Manacor, Ml; 43) Menorca, Mn; 44) Molinar Levante, Ml; 45) Mont Toro, Mn; 46) Na Xamena, Iz; 47) Palma and environs, Ml; 48) Palma Nova, Ml; 49) Playa d'en Bossa, Iz; 50) Playa de Palma, Ml; 51) Pollensa, Ml; 52) Porto Cristo, Ml; 53) Porto Pi, Ml; 54) Puerto de Alcudia, Ml; 55) Puerto de Alcudia to C'an Picafort, Ml; 56) Puerto de Cabrera, Cb; 57) Puerto de Pollensa, Ml; 58) Puerto de Soller, Ml; 59) Puigpuñent, Ml; 60) San Antonio, Iz; 61) San Cristóbal, Mn; 62) San Fernando to Es Calo, Fm; 63) San Luis, Mn; 64) Santa Eulalia del Río, Iz; 65) Santa Galdana, Mn; 66) Santo Tomás, Mn; 67) Sant Telm, Ml; 68) San Vicente, Ml; 69) Sa Porrasa, Ml; 70) Sierra de Alfabia, Ml; 71) Sóller, Ml; 72) Son Españolet, Ml; 73) Son Servera, Ml; 74) Son Vida, Ml; 75) Talamanca, Iz; 76) Valldemosa, Ml.

Table I.—**World distributions of the Balearic genera of Orthoptera and the world, western Mediterranean, and Balearic distributions of the Balearic species/subespecies. Collection localities are indicated by numbers explained in fig. 4. Localities shown in bold-faced type are based on specimens seen personally; those in regular print are based on literature records. Code: Al = Algeria; Bl = Balearics; Cb = Cabrera; Cn Md = Central Mediterranean; Cr = Corsica; Cs = cosmopolitan; Ed = endemic; Et = Ethopian/Afrotropical; Fm = Formentera; Fr = France; Ib = Iberia; It = Italy; Iz = Ibiza; Md = Mediterranean; Ml = Mallorca; Mn = Menorca; Mo = Morocco; NA = North Africa; Nr = Nearctic; Or = Oriental; Pl = Paleartic; Pr = Portugal; Sc = Sicily; Sp = Spain; Sr = Sardinia; Tr = tropicopolitan; Tu = Tunisia; W Md = western Mediterranean.**

Taxa	World	W Md	Bl
Ectobius	Et/Pl		
Ectobius p. punctulatus	W Md	Pr, Sp, Fr	Ml: 41, Mn: 33
Ectobius panzeri	Pl	Pr, Sp, Fr	Iz?, Ml: 19, 47, 51, Mn: 33, 65
Phyllodromica	Md		
Phyllodromica adspersa	Bl Ed	Bl Ed	Ml: **21, 47, 72,** 55, Mn: 33 **43**
Phyllodromica llorenteae	Bl Ed	Bl Ed	Ml: **11, 47,** Mn: **43, 45**
Blattella	Cs		
Blattella germanica	Cs	Pr, Sp, Fr, Cr, Sr, It, Sc, Tu, Al, Mo	Fm: 31, Iz: 34, Ml: 19, 47, Mn: 40, 61
Loboptera	Cs		
Loboptera decipiens	Md	Pr, Sp, Fr, Cr, Sr, It, Sc, Tu, Al, Mo	Cb: 9, Ml: **5, 6, 8,** 19, **21, 41, 47,** 51, **70, 73,** Mn: **33, 40,** 43
Blatta	Cs		
Blatta orientalis	Cs	Pr, Sp, Fr, Cr, Sr, It, Sc, Tu, Al, Mo	Fm: 31, Iz: 34, M.: 47, 51, 71 **72,** Mn: 40
Periplaneta	Cs		
Periplaneta americana	Cs	Pr, Sp, Fr, Cr?, Sr, It, Sc, Tu, Al, Mo	Fm: 31, Iz: 34, Ml: 5, **25, 47**
Perlamantis	Md		
Perlamantis alliberti	W Md	Sp, Fr, Tu, Al, Mo	Ml: 19
Ameles	Md		
Ameles africana	W & Cn Md	Pr, Sp?, Cr, Sr, Sc, Al, Mo	Ml: **36,** 38, **47, 67,** Mn: **43**
Ameles decolor	W & Cn Md	Pr, Sp, Fr, Cr, Sr?, It, Sc, Al	Ml: **8,** 47, 51, Mn: **66**
Ameles picteti	W Md	Sp, Sc, Al	Ml: 38
Ameles spallanzania	Md	Pr, Sp, Fr, Cr, Sr, It, Sc, Tu, Al, Mo	Ml: **36, 47,** 51, **67, 73, 74,** Mn: **43**
Iris	Md		
Iris oratoria	Md	Pr, Sp, Fr, Sr, It, Sc, Tu, Al, Mo	Ml: **14,** 19, **47, 50, 67, 72,** Mn: 43
Mantis	Cs		
Mantis religiosa	Cs	Pr, Sp, Fr, Cr, Sr, It, Sc, Tu, Al, Mo	Bl: **4,** Iz: 34, Ml: 19, 38, **47,** 51, **72, 73,** Mn: **33,** 43, 61, 65
Empusa	Et/Md		
Empusa pennata	Md	Pr, Sp, Fr, Cr, Sr, It, Sc, Tu, Al, Mo	Ml: 51
Bacillus	Md		
Bacillus rossius	Md	Pr?, Sp, Fr, Cr, Sr, It, Sc, Tu, Al	Ml: 38, 47, 51
Clonopsis	Md		
Clonopsis gallica	W Md	Pr, Sp, Fr, Cr, Sr, It, Sc, Tu, Al, Mo	Ml: 41
Leptynia	W Md less Na		
Leptynia hispanica	Few places W Md	Sp, Fr	Ml: 51

Odontura	W Md		
Odontura stenoxipha	W Md	Sr, Sc, Tu	Ml: **44**
Phaneroptera	Et/Pl		
Phaneroptera n. nana	Md	Pr, Sp, Fr, Cr, Sr, It, Sc, Tu, Al, Mo	Cb: 9, Iz: 34, **46,** Ml: 19, 38 **41, 47,** 51, **74,** Mn: **7,** 40
Phaneroptera sparsa	Et/few places Md	Sp, Al	Ml: 38
Tylopsis	Et/Md		
Tylopsis lilifolia	Et/Md	Pr, Sp, Fr, Cr, It, Sc, Tu, Al	Ml: 51
Conocephalus	Cs		
Conocephalus conocephalus	Et/Md	Sp, Fr, Cr, It, Sc, Al, Mo	Ml: 38
Ruspolia	Tr		
Ruspolia n. nitidula	Et/Pl	Pr, Sp, Fr, Cr, It, Sc, Al, Mo	Ml: 51, 55
Tettigonia	Pl		
Tettigonia viridissima	Pl	Pr, Sp, Fr, Cr, It, Sc, Tu, Al, Mo	Ml: 24, 47, Mn: 43
Decticus	Pl		
Decticus albifrons	Md	Pr, Sp, Fr, Cr, Sr, It, Sc, Tu, Al, Mo	Ml: 47, 51
Decticus verrucivorus	Pl	Pr, Sp, Fr, It	Mn: 43
Platycleis	Pl		
Platycleis affinis	Pl	Pr, Sp, Fr, Cr, It, Sc, Al, Mo	Ml: 38
Platycleis falx laticauda	W Md	Pr, Sp, Fr, Sr, It, Sc, Tu, Al, Mo	Ml: **47,** Mn: **66**
Platycleis grisea	Pl	Sp, Fr, Cr, It, Sc, Tu, Al, Mo	Iz: **46,** Ml: **5,** 19, 47, 51
Platycleis intermedia	Pl	Pr, Sp, Fr, Cr, Sr, It, Sc, Tu, Al, Mo	Bl: 4, Ml: 19, Mn: 40
Platycleis sabulosa	W Md	Pr, Sp, Fr, Cr, It, Sc, Al, Mo	Ml: 38
Tessellana tessellata	Pl	Pr, Sp, Fr, Cr, Sr, It, Sc, Tu, Al, Mo	Ml: 38, 47, 51, Mn: **66**
Steropleurus	Md		
Steropleurus balearicus	Bl Ed	Bl Ed	Ml: **5,** 19, **41, 44, 47,** 52, **59, 69, 74,** 76, Mn: **20,** 65
Acheta	Cs		
Acheta domesticus	Cs	Pr, Sp, Fr, It, Sc, Tu, Al, Mo	Ml: 47, Mn: 43
Gryllomorpha	Md		
Gryllomorpha dalmatina	Md	Pr?, Sp, Fr, Cr, Sr, It, Sc, Tu, Al, Mo	Ml: **47,** 51
Gryllus	Cs		
Gryllus bimaculatus	Pl, mostly Md	Pr, Sp, Fr, Cr, It, Sc, Tu, Al, Mo	Bl: 4, Cb: 9, Iz: **75,** Ml: 19, **21, 36, 44, 47,** Mn: 40
Gryllus campestris	Pl	Pr, Sp, Fr, Cr, It, Sc, Al, Mo	Cb: 9, Iz: 34, Ml: 51, Mn: 33
Melanogryllus	Et/Pl		
Melanogryllus desertus	Pl	Sp, Fr, Cr, It, Sc, Tu, Al, Mo	Ml: 47
Tartarogryllus	Pl		
Tartarogryllus burdigalensis	Md	Pr, Sp, Fr, It, Sc, Tu, Al, Mo	Ml: 19, **23, 36, 47,** 51, 55, Mn: 43
Nemobius	Cs		
Nemobius sylvestris	Pl	Pr, Sp, Fr, It, Al, Mo	Ml: 55
Arachnocephalus	Tr		

Arachnocephalus vestitus	Md	Pr, Sp, Fr, Cr, Sr, It, Sc, Al, Mo	Ml: 47, 51
Mogoplistes	Md		
Mogoplistes brunneus	Md	Sp, Fr, Cr, Sr, It, Sc, Tu, Al, Mo	Ml: 51
Myrmecophilus	Cs		
Myrmecophilus acervorum	Pl	Sp, Fr, It, Al	Ml: 53, Mn: 33
Myrmecophilus ochraceus	Md	Sp, It, Sc, Tu, Al	Ml: **25,** 47
Trigonidium	Tr		
Trigonidium cicindeloides	Md	Pr, Sp, Fr, Cr, Sr, It, Sc, Tu, Al, Mo	Ml: **47,** Mn: 33
Oecanthus	Cs		
Oecanthus pellucens	Pl	Pr, Sp, Fr, Cr, It, Sc, Tu, Al, Mo	Iz: **46,** Ml: 19, **32,** 38, **47,** 51, Mn: 43
Gryllotalpa	Cs		
Gryllotalpa gryllotalpa	Pl	Pr, Sp, Fr, Cr, It, Sc, Tu, Al, Mo	Ml: 19, 47, **72,** Mn: 43
Paratettix	Tr		
Paratettix meridionalis	Et/Pl	Pr, Sp, Fr, Cr, Sr, It, Sc, Tu, Al, Mo	Ml: 19, **29, 36, 41, 47,** 51, Mn: 40
Tetrix	Cs		Ml: 51
Tridactylus	Cs		
Tridactylus variegatus	Md/Or	Pr, Sp, Fr, It, Tu, Al, Mo	Bl: 4, Ml: 41
Pyrgomorpha	Et/Pl		
Pyrgomorpha conica	Md	Pr, Sp, Fr, Cr, Sr, It, Sc, Tu, Al, Mo	Ml: 19, **21, 47, 50,** 51, **73**
Tropidopola	Et/Pl		
Tropidopola c. cylindrica	Md	Pr?, Sp, Cr, Sr, It, Sc, Tu, Al, Mo	Ml: **15,** 19, 28, Mn: 1, 43
Anacridium	Et/Md		
Anacridium aegyptium	Md	Pr, Sp, Fr, Cr, Sr, It, Sc, Tu, Al, Mo	Iz: **46,** Ml: **5,** 19, **25, 44, 47,** 51, **72, 73,** Mn: **33, 40,** 63, **66**
Schistocerca	Cs		
Schistocerca gregaria	Et/Md	Pr, Sp, Tu, Al, Mo	Bl: 4
Pezotettix	Md		
Pezotettix giornae	Md	Pr, Sp, Fr, Cr, Sr, It, Sc, Tu, Al, Mo	Ml: 51, 68
Calliptamus	Pl		
Calliptamus b. barbarus	Md	Pr, Sp, Fr, Cr, Sr, It, Sc, Tu, Al, Mo	Fm: **12, 26, 27, 37,** Iz: **46, 60,** Ml: **3, 8, 16,** 19, **21, 25, 32, 41, 42, 47, 50,** 51, **58,** 69, 71, 72, **73, 74,** Mn: **33, 40,** 63, **66**
Eyprepocnemis	Et/Pl		
Eyprepocnemis plorans	Et/Md	Pr?, Sp, Cr, Sr, Sc, Tu, Al, Mo	Iz: 34, Ml: **3,** 16, 19, **21, 25, 32, 41, 42, 47,** 51, **67, 72, 73,** Mn: **10,** 20, **33**
Acrotylus	Et/Pl		
Acrotylus i. insubricus	Md	Pr, Sp, Fr, Sr, It, Sc, Tu, Al, Mo	Ml: 41
Acrotylus patruelis	Et/Md	Pr, Sp, Cr, It, Sc, Tu, Al, Mo	Ml: 19, **41, 47,** 51, **72**
Aiolopus	Et/Pl		
Aiolopus simulatrix	Et/Md	Sr, Al	Ml: 41
Aiolopus strepens	Et/Md	Pr, Sp, Fr, Cr, It, Sc, Tu, Al, Mo	Iz: **46,** Ml: **2, 3, 8, 16,** 19, **21, 25, 36, 42, 47,** 51, **72, 73,** Mn: **33, 40, 66**

Aiolopus thalassinus	Et/Pl	Pr, Sp, Fr, Cr, It, Sc, Tu, Al, Mo	Iz: **46, 49,** Ml: **3, 8, 21, 25, 36, 47,** 51, **72, 73,** Mn: **33,** 40, 43
Calephorus	Md		
Calephorus compressicornis	W Md	Pr, Sp, Fr, Al, Mo	Ml: 19
Locusta	Et/Pl/Or		
Locusta migratoria	Et/Pl/Or	Pr, Sp, Fr, Cr, It, Sc, Tu, Al, Mo	Ml: 19, **21,** 38, **41, 47, 51, 74,** Mn: 43
Oedaleus	Et/Pl/Or		
Oedaleus decorus	Pl	Pr, Sp, Fr, Cr, It, Sc, Tu, Al, Mo	Bl: 4, Ml: 47
Oedipoda	Pl		
Oedipoda charpentieri	Md	Pr, Sp, Fr, It, Al	Ml: 38
Oedipoda caerulescens	Pl	Pr, Sp, Fr, Cr, Sr, It, Sc, Tu, Al, Mo	Ml: 41, Mn: 20
Oedipoda fuscocincta	W Md	Pr, Sp, Fr, Cr, Sr, Sc, Tu, Al, Mo	Ml: 38
Oedipoda miniata	Md	Sr, Sc, Tu, Al, Mo	Cb: 9, 30, Fm: **26, 27, 37, 62,** Iz: **49,** Ml: **3, 16** 19, **21,** 35, **41, 47, 50, 51,** 52, **58, 72, 73,** Mn: **33,** 40, **43, 66**
Paracinema	Et/Md		
Paracinema t. bisignata	Md	Pr, Sp, Fr, Cr, Sr, It, Sc, Al, Mo	Ml: **36**
Psophus	Pl		
Psophus stridulus	Pl	Sp, Fr, Sr, It	Mn: 43
Sphingonotus	Et/Pl		
Sphingonotus azurescens	Md	Pr, Sp, It, Tu, Al, Mo	Ml: 47, 69
Sphingonotus c. corsicus	W Md	Pr, Sp, Cr, Sr	Cb: **9,** Fm: **12, 26,** Iz: **46,** Ml: **6, 8,** 35, **41, 44, 47, 50, 51, 67, 69,** Mn: **10, 33,** 40, **66**
Sphingonotus rubescens	Md	Pr, Sp, Cr, Sr, Al, Mo	Fm: **26, 37,** Iz: **17,** Ml: **41, 47, 50, 58, 67**
Sphingonotus uvarovi	Bl, Cr, Sr Ed	Bl, Cr, Sr Ed	Fm: 31, Ml: 41
Acrida	Et/Pl/Or		
Acrida u. mediterranea	Md	Pr?, Sp, Fr, Cr, Sr, It, Sc, Tu, Al, Mo	Ml: 38, **47, 50,** 51
Chorthippus	Et/Pl/Nr		
Chorthippus bornhalmi	Yugoslavia	?	Ml: 38
Chorthippus jacobsi	Pl/Or	Pr, Sp	Ml: 16, 19, **21, 36, 41, 47, 50,** 51, 57, 58, 68, 71
Chorthippus dorsatus	Pl	Sp, Fr, It	Ml: 38
Dociostaurus	Md		
Dociostaurus j. occidentalis	W Md	Pr, Sp, Fr, Cr, Sr, It, Sc	Fm: **12, 26, 27, 37, 62,** Iz: **17, 46, 49,** Ml: **2, 16,** 19, **21,** 38, **41, 47, 50,** 51, **57, 73,** Mn: 40, 43, **66**
Euchorthippus	Pl		
Euchorthippus angustulus	Bl Ed	Bl Ed	Fm: 13, Iz: **46, 64, 75,** Ml: **8, 18,** 19, **32, 41, 47, 48,** 51, 54, **57, 58, 71, 76**
Myrmeleotettix	Pl		
Myrmeleotettix maculatus	Pl	Pr?, Sp, Fr, It, Mo?	Ml: 51
Omocestus	Pl		
Omocestus rufipes	Pl	Pr, Sp, Fr, Cr, Sr, It, Sc, Al	Ml: 36, 39, Mn: 40

Generalizations are not readily drawn from the above data except to note the tendency toward flightlessness among cryptic Orthoptera such as stick insects and ameline mantises and among secretive, geophilous forms such as ectobiine cockroaches and certain crickets.

One might logically conclude that flight is positively correlated with dispersal. The relationship does not always hold, however, based on regression analysis of wingedness and dispersal in the 85 Balearic taxa. These surprising results are discussed below («World Distribution of General and Species»). It is sufficient to note here that *no* significant correlation is observed between dispersal in flightless forms (correlation coefficient 0.3790) as opposed to flying forms (0.3428). Thus, the dispersal of Balearic insects must be explained, at least in part, by means other than flight including rafting, wind dissemination, use of land bridges, and «hitchhiking» on human vehicles and products.

The above suggests the possibility of error introduction into those biogeographic analyses of Orthoptera based entirely or largely on flightlessness. This limitation potentially mars a recent, excellent study of the western Mediterranean island Orthoptera (LA GRECA, 1990a). A broad-based analysis of the entire insular or regional fauna appears less likely to introduce bias into the analysis.

Passive transport by rafting, currents, and vehicles

Terrestrial insects seldom survive a journey suspended free in water. They require a floating substrate such as driftwood or matted vegetation on or within which to lodge. This rafting, as it is called, is amply documented in the literature. About 25 % of the Caribbean Sea flotsam examined in one study contained live individuals of at least one terrestrial species, and 6 % had three or more species (HEATWOLE & LEVINS, 1972). Comparable studies have not been conducted with particular reference to Orthoptera, but rafting doubtlessly occurs among them too.

A portion of the Gulf Stream's warm Portuguese Current enters the Mediterranean Sea through the Straits of Gibraltar. Its surface layer then circulates counterclockwise through the western Mediterranean (HOUSTON, 1964). Orthopteran passengers could conceivably cling to floating debris and thereby be carried from the northwest African shores to Europe and *vice versa* and to the Balearics.

Most insects are buoyant owing to their size. Wind currents may waft small individuals hundreds of meters off the ground into a zone of rising air capable of catching, transporting, and depositing them in new places some distances away. Most Orthoptera are relatively large bodied, but they too may be caught and thus transported during flight.

The high-intensity winds of thunderstorms and other strong atmospheric disturbances are more effective dispersal forces than are the low-intensity currents just mentioned. They create violent updrafts capable of carrying twigs, leaves, flowers, seeds, debris, and insects great distances before dropping them on land or at sea. This is the explanation of the «insect rains» recorded in the literature (HESSE *et al.*, 1937).

Lists of insect cosmopolites are dominated by species living in association with man or his dwellings or being disseminated by his ships, trains, automobiles, and airplanes. This is certainly true of the Balearic domiciliary cockroaches *Blattella germanica, Blatta orientalis,* and *Periplaneta americana* and the house cricket *Acheta domesticus*. In historic times, they invaded ships in Mediterranean ports from which they were carried throughout Europe and Asia and eventually the world (TWEEDIE, 1974). Here, they live today in or near man's dwellings under conditions comparable in quality to the dry subtropics (TWEEDIE, *l. c.*). They also frequent southern European and Mediterranean island garbage dumps where decay and slow burning maintain constant warmth even in severe winter (CHOPARD, 1951; TWEEDIE, *l. c.*).

Niche breadth

The extent of environmental conditions that a population can tolerate varies from wide to narrow, a wide breadth favoring establishment and perpetuation and a narrow one inhibiting this result. Balearic examples with respect to food choice include the several omnivorous domiciliary cockroaches and the house cricket mentioned above. They are widespread at least partly because of their ability to locate suitable food wherever they disperse (GANGWERE *et al.*, 1972). Examples with respect to temperature tolerance include the grasshoppers *Anacridium aegyptium, Acrotylus insubricus insubricus, Acrotylus patruelis, Aiolopus strepens,* and *Ailopus thalassinus*. They are among the species that overwinter as adults in Spain (MORALES AGACINO, 1942). They are found throughout the year in the Balearics and on warm winter days move about actively. Other examples relate to habitat selection. *Calliptamus barbarus barbarus* is among those grasshoppers widely dispersed in all types of terrain from pastures with dense vegetation to stony or sandy hillsides supporting a semidesertic scrub vegetation (see «Biological Notes»). In contrast are the hygrophilous grasshoppers *Calephorus compressicornis, Tropidopola cylindrica cylindrica,* and

Table II.—**Habitat selection, perching habits, food habits, periodicity, phenology or seasonal occurrence, and wing development (suggestive of vagility) in Balearic Orthoptera, as follows.** Habitat selection: **1) Alpine/montane/semimontane; 2) woodland/sylvan; 3) scrub/shrub/woodland ecotonal; 4) lush herbage/swamp/hygrophilous; 5) grassland/prairie/steppe/savanna/campestral; 6) desert/dunes/rock/bare ground; 7) protective leaf litter/stones/debris; 8) caverns/burrows/fossorial; 9) domestic/semidomestic; 10) variable or uncertain.** Customary perch or substrate: **11) Phytophilous/graminicolous; 12) arbusticolous/thamnophilous/arboricolous; 13) geophilous.** Food habits: **14) Forbivorous/herbivorous; 15) florivorous/fructivorous; 16) graminivorous/seminivorous; 17) dendrophagous/arborivorous; 18) predacious/carnivorous; 19) omnivorous; 20) other.** Periodicity: **21) Nocturnal; 22) diurnal; 23) incompletely nocturnal/crepuscular.** Phenology: **24) Winter/hiemal (months xii and i-iii in Balearics); 25) spring/vernal (iii-vi in Balearics); 26) summer/estival (vi-ix in Balearics); 27) fall/autumnal (ix-xii in Balearics); 28) all year/most of year in Balearics.** Wing development: **29) Macropterous; 30) brachypterous/apterous/meipterous.**

Taxon	Habitat	Perch	Food	Period	Season	Wings
Ectobius pallidus punctulatus	2, 3, 5, 6, 7	13	19	21	26	30
Ectobius panzeri	2, 3, 5, 6, 7	13	19	21	26	30
Phyllodromica llorenteae	2, 3, 7	13	19	21	25-26	30
Phyllodromica adspersa	2, 3, 7	13	19	21	25-26	30
Blattella germanica	9	13	19	21	28	29
Loboptera decipiens	7	13	19	21	25-27	30
Blatta orientalis	9	13	19	21	28	30
Periplaneta americana	9	13	19	21	28	29
Perlamantis alliberti	10	11-12	18	22?	26	29
Ameles africana	3, 5, 7	11-13	18	22	28	30
Ameles decolor	3, 5, 7	11-13	18	22	26-27	30
Ameles picteti	3, 5, 7	11-13	18	22	26-27	30
Ameles spallanzania	3, 5, 7	11-13	18	22	25-27	30
Iris oratoria	3	11-12	18	22	26-27	29
Mantis religiosa	3, 5	11-12	18	22	26-27	29
Empusa pennata	3, 5	11-12	18	22	25-26	29
Bacillus rossius	3, 5	11-12	14	21	25-27	30
Clonopsis gallica	3, 5	11-12	14	21	25-27	30
Leptynia hispanica	3	11-12	14, 17	21	25-26	30
Odontura stenoxipha	3	11-12	14-15	21	25-26	30
Phaneroptera n. nana	3, 5	11-12	14-15	21	26-27	29
Phaneroptera sparsa	3, 5	11-12	14-15	21	26-27	29
Tylopsis lilifolia	3	11-12	14-15	21	26-27	29
Conocephalus conocephalus	4, 5	11	14-16, 18?	23	26-27	29
Ruspolia n. nitidula	4	11	16	21	26-27	29
Tettigonia viridissima	1, 3, 5	11-12	18	23	26-27	29
Decticus albifrons	3, 5	13	14, 18	23	26-27	29
Decticus verrucivorus	3, 5	13	14, 18	23	26-27	29
Platycleis affinis	1, 3, 5	11-13	14-16, 18	23	26-27	29
Platycleis falx laticauda	1, 3, 5	11-13	14-16, 18	23	26-27	29
Platycleis grisea	1, 3, 5	11-13	14-16, 18	23	26-27	29
Platycleis intermedia	1, 3, 5	11-13	14-16, 18	23	26-27	29
Platycleis sanbulosa	1, 3, 5	11-13	14-16, 18	23	26-27	29
Tessellana tessellata	1, 3, 5	11-13	14-16, 18	23	26-27	29
Steropleurus balearicus	3	11-13?	14-15?	21?	26-27	30
Acheta domesticus	9	13	19	23	28	29
Gryllomorpha dalmatina	7-9	13	14,19	23	28	30
Gryllus bimaculatus	5, 7	13	14-15, 19	23	25-27	29
Gryllus campestris	5, 7, 8	13	14-15, 19	23	25-27	29
Melanogryllus desertus	5, 7	13	14, 19	23	25-27	30
Tartarogryllus burdigalensis	5, 7	13	14,19	23	25-27	30
Nemobius sylvestris	2, 3, 7	13	14-15, 19	23	26-27	30
Arachnocephalus vestitus	3, 7, 10	11-13	14, 19?	23	26-27	30
Mogoplistes brunneus	2, 7	13	?	?	26-27	30
Myrmecophilus acervorum	8	13	19	?	26-27	30
Myrmecophilus ochraceus	8	13	19	?	?	30
Trigonidium cicindeloides	4	11	?	23	25-27	29

Oecanthus pellucens	3, 5	11-12	14-15, 18	21	26-27	29
Gryllotalpa gryllotalpa	4, 8	13	19	21	28?	29
Paratettix meridionalis	4	13	14, 16, 19	22	25-27	29
Tetrix sp.	3, 4	13	?	22	?	29
Tridactylus variegatus	4, 8	13	14, 19	21	25-27	29
Pyrgomorpha conica	3, 5	11	14	22	25-27	29
Tropidopola c. cylindrica	4, 5	11	16?	22	25-27	29
Anacridium aegyptium	3, 5	12	14,17	22	28	29
Schistocerca gregaria	3, 6	12	14,17	22	26-27	29
Pezotettix giornae	10	11	14	22	28	30
Calliptamus b. barbarus	1, 3, 5, 10	11-12	14-15, 17	22	28?	29
Eyprepocnemis plorans	4, 6	11	14, 16	22	28?	29
Acrotylus i. insubricus	5, 6	13	16	22	28	29
Acrotylus patruelis	5, 6	13	16	22	28	29
Aiolopus simulatrix	5	11	16?	22	28	29
Aiolopus strepens	5	11	16	22	28	29
Aiolopus thalassinus	5	11	16	22	28	29
Calephorus compressicornis	5, 6	11	16?	22	26-27	29
Locusta migratoria	4, 5, 10	11	16	22	25-27	29
Oedaleus decorus	5	13	16	22	26-27	29
Oedipoda charpentieri	5, 6	13	14	22	25-27	29
Oedipoda caerulescens	1, 5, 6	13	14	22	26-27	29
Oedipoda fuscocincta	5, 6	13	14	22	26-27	29
Oedipoda miniata	5, 6	13	14	22	25-27	29
Paracinema t. bisignata	4, 5	11	16?	22	25-27	29
Psophus stridulus	1, 2, 3	11	14	22	26-27	29
Sphingonotus azurescens	6	13	14	22	25-27	29
Sphingonotus caerulans corsicus	6	13	14	22	25-27	29
Sphingonotus rubescens	6	13	14	22	26-27	29
Sphingonotus uvarovi	6	13	14	22	?	29
Acrida ungarica mediterranea	4, 5	11	16	22	26-27	29
Chorthippus bornhalmi	1, 5-6	11	16?	22	26-27	29
Chorthippus jacobsi	1, 5-6	11	16?	22	25-27	29
Chorthippus dorsatus	1, 3-6	11	16	22	26-27	29
Dociostaurus jagoi occidentalis	5	11	14, 16	22	26-27	29
Euchorthippus angustulus	4, 5	11	16	22	26-27	29
Myrmeleotettix maculatus	1, 5	11	16?	22	26-27	29
Omocestus rufipes	1?, 3, 5	11	16?	22	26-27	29

Paracinema tricolor bisignata which, in the Balearics as in Spain (GANGWERE & MORALES, 1970), occur in lush meadows, coastal dunes, and other places near water.

World distribution of genera and species

The Balearic Island Orthoptera belong within 61 genera, of which 32 % are cosmopolitan, essentially cosmopolitan, or tropicopolitan, 28 % are Afrotropical or essentially so, 23 % are Mediterranean or essentially Mediterranean, and 17 % are Palearctic in origin.

The 85 species and subspecies within the 61 genera are distributed as follows: 51 % Mediterranean or essentially Mediterranean, 24 % Palearctic or essentially Palearctic, 13 % Afrotropical or essentially so, 6 % either endemic or highly restricted, and 6 % cosmopolitan, essentially cosmopolitan, or tropicopolitan.

These generalized data may be qualified with respect to taxonomic group. The Mediterranean element proves noteworthy in all groups from Blattoptera to Acridoidea. The Palearctic is pronounced in katydids (38 %) and crickets (46 %). The cosmopolitan is strong in cockroaches (38 %).

Virtually all of the 85 orthopteroid taxa mentioned above may be found elsewhere in addition to the Balearics, mostly in the Iberian Peninsula and adjacent Mediterranean lands. A little over half (51 %) of the Balearic species have a Mediterranean distribution. Some such as the cockroach *Loboptera decipiens,* the walkingstick *Bacillus rossius,* the mantises *Iris orato-*

Table III.—**Classification of the genera of Balearic Orthoptera according to their customary habitat selection, as follows:** xerophilic **or campestral habits including occupancy of open fields, cultivated land, roadsides, sandy or stony bare ground, wasteland, and scrub;** mesophilic **or sylvan habits including occupancy of broad-leaved or coniferous woodland;** hydrophilic **habits including occupancy of lush grassland, swamps, and marshland; and** domestic/semidomestic **habits.**

Balearic genera	Xerophilic	Mesophilic	Hydrophilic	Domestic
Ectobius		x		
Phyllodromica		x		
Blattella				x
Loboptera				x
Blatta				x
Periplaneta				x
Perlamantis	x			
Ameles	x			
Iris	x			
Mantis	x			
Empusa	x			
Bacillus	x			
Clonopsis	x			
Leptynia	x			
Odontura	x			
Phaneroptera	x			
Tylopsis	x			
Conocephalus			x	
Ruspolia			x	
Tettigonia	x			
Decticus	x			
Platycleis	x			
Tessellana	x			
Steropleurus	x			
Acheta				x
Gryllomorpha				x
Gryllus	x			
Melanogryllus	x			
Tartarogryllus	x			
Nemobius		x		
Arachnocephalus	x			
Mogoplistes		x		
Myrmecophilus	x			
Trigonidium				x
Oecanthus	x			
Gryllotalpa				x
Paratettix				x
Tetrix				x
Tridactylus				x
Pyrgomorpha	x			
Tropidopola				x
Anacridium	x			
Schistocerca	x			
Pezotettix	x			
Calliptamus	x			
Eyprepocnemis				x
Acrotylus	x			
Aiolopus	x			
Calephorus				x
Locusta	x			
Oedaleus	x			
Oedipoda	x			
Paracinema				x
Psophus		x		
Sphingonotus	x			
Acrida				x
Chorthippus	x			
Dociostaurus	x			
Euchorthippus	x			
Myrmeleotettix	x			
Omocestus	x			

ria and *Empusa pennata,* the katydid *Decticus albifrons,* the crickets *Arachnocephalus vestitus, Gryllomorpha dalmatina, Tartarogryllus burdigalensis, Mogoplistes brunneus,* and *Myrmecophilus ochraceus,* and the grasshoppers *Pyrgomorpha conica, Pezotettix giornae, Anacridium aegyptium, Oedipoda miniata,* and *Acrida ungarica mediterranea* are holomediterranean.

Other Mediterranean taxa are more restricted. The grasshopper *Aiolopus simulatrix,* for example, is northwest African, and the grasshoppers *Sphingonotus caerulans corsicus* and *Dociostaurus jagoi occidentalis* are found in meridional Europe (the latter in the western sector). The walkingstick *Leptynia hispanica,* found in northern Iberia just into southern France, and the katydid *Odontura stenoxipha,* found in Sardinia, Sicily, and Tunisia, are even more restricted in distribution than are the preceding. A few taxa to be mentioned below are endemic to the Balearic Islands.

Recent research indicates that there is no North African fauna *per se.* The fauna of western Mediterranean Morocco, Algeria, and Tunisia seems to have a different origin from that of the eastern Mediterranean countries of North Africa (LA GRECA, 1990a). The northwest African fauna is also not to be confused with Afrotropical. Though part of continental Africa, northwest Africa resembles the other places bordering the Mediterranean Sea in terms of climate and soil and is unlike the vast lands south of the Sahara Desert, the natural barrier separating the Palearctic and Ethiopian realms.

Northwest Africa has been separated from the Iberian Peninsula since the late Miocene, almost the

same length of time that the Balearics have been isolated from the Peninsula (COMPTE, 1968). With the disappearance of the Ceuta-Gibraltar and Levantine land bridges, Balearic isolation was perfected. Prior to that time, faunal interchange was easy. Even today, the distances do not pose an insuperable barrier for insects with the vagility of most Orthoptera. The Ceuta-Gibraltar separation is narrow, only about 14 km. The Levantine separation is likewise not insuperable. Even the most isolated island of the Balearics, Menorca, is located but a few hundred kilometers off the European and North African shores.

About 24 % of the Balearic Orthoptera have a Palearctic or essentially Palearctic distribution. Representatives include the katydids *Tettigonia viridissima, Platycleis grisea,* and *Platycleis intermedia,* the cricket *Nemobius sylvestris,* and the grasshopper *Oedaleus decorus*. These insects are a mixed lot including ecologically widespread species as well as restricted ones found in central and meridional Europe, North Africa, and sometimes temperate Asia.

An Afrotropical influence is reflected in approximately 13 % of the Balearic Orthoptera. The katydid *Conocephalus conocephalus,* the pygmy grasshopper *Paratettix meridionalis,* and the grasshoppers *Eyprepocnemis plorans, Acrotylus patruelis,* and *Aiolopus strepens* are representative. They too are a mixed lot including tropical, savanna, desert, and other elements.

About 6 % of the Balearic fauna consists of cosmopolitan, essentially cosmopolitan, or tropicopolitan species. The familiar *Mantis religiosa* is a representative cosmopolite. Others include the domiciliary cockroaches and the house cricket *Acheta domesticus*. Their presence in the Balearics is no accident. Cockroaches are among the most ancient of insects, and both the house cricket and they live in close association with mankind and are disseminated by his vehicles.

A regression analysis of 729 species from the western Mediterranean region including North Africa (data based on CHOPARD, 1943), Iberia (GANGWERE & MORALES, 1970), France (CHOPARD, 1951), and the Balearic Islands (present data) provides R-square values that document increased species numbers with the natural log of land area. This species-area relationship is strong, as indicated by a .92 correlation coefficient, but is insufficient for statistical determination of significance by its degrees of freedom. No further use is made of these data.

A regression analysis restricted to the 85 Balearic species and subspecies is more useful. The output of island distance from nearest mainland provides R-square values of 0.21 (a correlation coefficient of 0.46) which is *not* statistically significant (fig. 5). However, the island size output produces R-square values of 0.58 (a correlation coefficient of 0.76) $P<0.01$ level (fig. 6).

These regression data are thus partly inconsistent with the Island Biogeographic Theory hypothesized by MAC ARTHUR & WILSON (1967) to explain quantitatively certain long-appreciated relationships. This theory correlates numbers of species per island with island size, habitat diversity, and distance from the colonizing source. It involves two main components, immigration and extinction, interacting to produce an equilibrium number of species as follows: the larger the island, the closer it is to its colonizing source, the greater its niche breadth and overall carrying capacity, and the lesser its extinction rate, the more colonists on it per unit of time and *vice versa.* It follows that near, ecologically diversified, large islands support more species than do far, relatively undiversified, small islands.

Fig. 5, which demonstrates a lack of correlation between the numbers of Balearic species and their distance from the nearest colonizing source, is inconsistent with the Theory of Island Biogeography. Fig. 6, in contrast, demonstrates a direct correlation between the numbers of species and the size of the island/s or mainland that they occupy. More will be said of this later.

Endemism

There are no known orthopteran genera and only 5 species (about 6 % of the total 85 species) that are endemic or at least closely restricted to the Balearic Islands. Among the few endemic species are the cockroaches *Phyllodromica llorenteae* and *Phyllodromica adspersa* and the katydid *Steropleurus balearicus,* endemic to Mallorca and Menorca, and the grasshoppers *Sphingonotus uvarovi,* endemic to Formentera, Mallorca, Corsica, and Sardinia, and *Euchorthippus angustulus,* endemic to Formentera, Ibiza, and Mallorca. The first 3 species are flightless, and the last 2 are fliers. However, even flightless Orthoptera appear capable of passive transport the hundred or so kilometers from the mainland to the islands, and strong fliers easily negotiate this distance by wing.

The 5 Balearic endemics compare with the 24 endemic species and 6 endemic genera (27 % and 10 %, respectively, of the Tenerifean fauna) noted during earlier research on Tenerife, one of the major islands of the Canarian Archipelago (GANGWERE *et al.,* 1972). Tenerife is small, about half the size of Mallorca, yet it alone has 88 orthopteran taxa, a total exceeding the 85 taxa shared by the Balearic Archipelago as a whole. Moreover, Tenerife is oceanic in origin having arisen from the sea volcanically some

time during the Miocene. The Balearics, in contrast, are continental islands that once enjoyed a land connection with the adjacent mainland. These facts suggest, incorrectly, that Tenerife should have a smaller, more depauperate fauna than do the Balearics. A plausible explanation of the relatively high faunal richness and incidence of endemism in Tenerife as opposed to the Balearics is that Tenerife has greater niche breadth than do the Balearics. Certain Balearic islands are almost flat and support little more than Mediterranean scrub, grassland, pine forests, and sandy beaches. It is also possible that a more continuous immmigration flow into the Balearics as opposed to the Canaries favored more adaptable species and inhibited less adaptable ones.

Balearic and western Mediterranean inter-island distribution

Turning again to the regression study of the 85 Balearic taxa (fig. 6), a correlation is noted between the numbers of species and the log area of the western Mediterranean islands and mainland occupied. There is agreement with the regression line except for Formentera (Fm), Mallorca (Ml), and possibly Ibiza (Iz). Their departure from the line may be explicable by, among other variables, the sampling methods used, the transporting air and water currents, habitat diversity, differential predation, relict pattern, and ease of access to sea ports or airports. It is impossible to determine precisely which factors are operative here.

One might guess, however, that the recorded orthopteran fauna of Formentera is reduced over what might be expected because of the island's habitat uniformity and undersampling. It is a small, ecologically monotonous place. Relatively little grows on it except pine woodland, Mediterranean scrub, and cultivated fields. Few Orthoptera dwell in woodland, especially pine woodland. Most species frequent scrub, cultivated fields, and the other open situations that dominate the Formenteran landscape. In such places the insects are probably exposed to enhanced levels of predation by birds, lizards, and other predators, with potential for selective influence on species representation. Formentera is also an island without well-developed tourist facilities; it lacks a reliable water supply; it is distant from the normal shipping lanes; its harbor is small; and it has no airport. Places of this nature are seldom visited and collected, so undersampling is inevitable. Not surprisingly, the island's previous literature citations are limited to 2 species, *viz.*, *Sphingonotus uvarovi* and *Euchorthippus angustulus*, both of which are Balearic endemics.

Mallorca, the most obvious departure from expected in fig. 6, has a comparatively extensive recorded fauna. It is the largest, most varied island of the archipelago and one of the world's most scenic places. It has an important mountain range and other physiographic features responsible, in part, for pronounced niche breadth. It straddles the shipping lanes and, at Palma, has one of the great sea ports of the world. In summer, its airport is among the busiest in Europe. Its tourist facilities are outstanding. Numerous visitors, including many biologists, annually vacation on the island and in the process make incidental in-

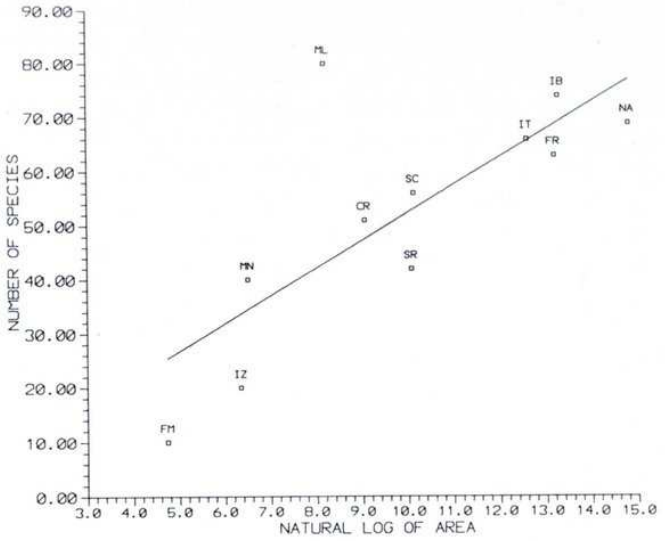

Fig. 5.—Regression analysis of the numbers of orthopteran species found in the Balearics and in other major western Mediterranean islands compared with distance (in kms) from the nearest mainland. The indicated relationship is *not* statistically significant. Code: Cr = Corsica; Fm = Formentera; Iz = Ibiza; Ml = Mallorca; Mn = Menorca; Sr = Sardinia; Sc = Sicily.

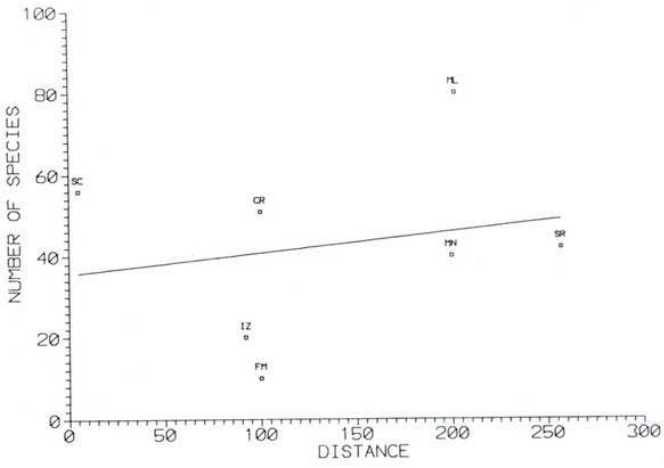

Fig. 6.—Regression analysis of the numbers of orthopteran species found in the Balearics, other major western Mediterranean islands, and adjacent mainlands compared with the natural log of land area. The indicated relationship *is* statistically significant $P<0.01$. Code: Cr = Corsica; Fm = Formentera; Fr = France; Ib = Iberia; It = Italy Iz = Ibiza; Ml = Mallorca; Mn = Menorca; NA = Nort Africa; Sr = Sardinia; Sc = Sicily.

sect collections. Not surprisingly, Mallorca is oversampled with respect to the rest of the Balearics and the other major western Mediterranean islands.

Recent geological history may also partly account for Mallorca's enhanced species numbers. As noted, mixed deciduous forest grew throughout the Mediterranean basin during the Pleistocene, later to be supplanted by scrub as the glaciers retreated northward. This could explain the island's specialized cockroaches, katydids, and crickets, some of which are assuredly relicts.

The relatively reduced fauna of Ibiza is best explained by undersampling.

The distribution of the 85 Balearic taxa may be listed in order of decreasing levels of importance, as follows. The Mallorcan fauna is the largest (consisting of 48 % of the 85 species); then the Mallorcan-Menorcan (28 %); the Mallorcan-Menorcan-Ibizan and sometimes Formenteran (18 %); the Menorcan (3 %); and finally all other combinations (4 %). These data support the closer faunal relationship postulated between Mallorca and Menorca than between them and the other Balearic Islands (COMPTE, 1968; COLOM, 1978).

Fig. 7 provides a more detailed analysis of the 85 Balearic taxa. It describes the faunal composition of all the major western Mediterranean islands including the Balearics, Corsica, Sardinia, and Sicily. A mean faunal profile of the overall Balearic orthopteran fauna (B1) shows that it consists of 60 % species common to northwest Africa, Iberia, and France, 12 % essentially northwest African species, 12 % species with a western Mediterranean insular distribution, 11 % essentially meridional European species, and 5 % Iberian species. A similar mean profile of the Orthoptera of Corsica, Sardinia, and Sicily (non-B1) differs from the Balearic pattern, as follows: 80 % common (northwest African, Iberian, and French) species, 13 % essentially northwest African species, 5 % essentially meridional European species, 1 % Iberian species, and 1 % insular forms.

Balearic habitat occupancy

Most of today's Balearic land surface is given over to agriculture (fig. 3). That which is not consists largely of scrub («maqui») or pine forest, leaving only a little land for development of coastal dunes and marshland and broad-leaved native evergreen forest («carrascal»). This profoundly altered distribution of plant communities from climax has important implications with respect to the occurrence of today's Orthoptera, most species of which have responded predictably.

Table III recognizes for the 61 orthopteran genera the following patterns of habitat selectivity within the Balearic Islands:

Xerophilic or campestral. This includes occupancy of all types of dry, open habitat, either cultivated or wild.

Mesophilic or sylvan. This includes occupancy of woodland, chiefly broad-leaved evergreen or pine.

Hydrophilic. This includes occupancy of wetlands such as the islands' coastal swamps and marshland.

Domestic/semidomestic.

All Balearic mantises and walkingsticks, virtually all katydids, and most crickets and grasshoppers may be classified as *xerophilic,* either plant-frequenting phytophiles or ground-dwelling geophiles. These insects run the gamut from widespread to restricted and from frequent to infrequent in their occurrence in open grassy fields, along roadsides, in cultivated land, in scrub and wasteland, and on stony or sandy bare ground or dunes. Some occur in most of these situations, and others are restricted to only one or two of them.

Specifically, representatives of the mantis genera *Iris, Perlamantis, Mantis,* and *Empusa* perch on the xeric vegetation of open, sunny fields and scrub and those of the genus *Ameles* either there or on the ground beneath. The walkingstick genera *Bacillus, Clonopsis,* and *Leptynia* are likewise phytophilous on the low vegetation of open fields and scrub, as are the katydid genera *Odontura, Phaneroptera, Tylopsis,* and *Tettigonia.* The katydid genera *Decticus, Platycleis,* and *Steropleurus* either perch there or live on the ground beneath, as do all of the grasshopper genera except the several hydrophilic ones listed in table III and the mesophilic genus *Psophus.*

Among representatives of the Balearic orthopteroid *mesophiles* are the cockroaches of the non-domiciliary genera *Ectobius* and *Phyllodromica* and the cricket genera *Nemobius* and *Mogoplistes.* All are found beneath leaf litter and debris in wooded situations. All are geophiles, and all stand in contrast to the phytophilous woodland grasshopper *Psophus stridulus,* doubtfully recorded from the Balearics.

Among representatives of the Balearic *hydrophiles* are the katydid genera *Conocephalus* and *Ruspolia,* the cricket genera *Trigonidium* and *Gryllotalpa,* the pygmy grasshopper genera *Paratettix* and *Tetrix,* the tridactyloid genus *Tridactylus,* and the grasshopper genera *Eyprepocnemis, Calephorus, Paracinema,* and *Tropidopola.* All inhabit lush herbage within or near water. All are phytophiles except *Gryllotalpa, Paratettix, Tetrix,* and *Tridactylus,* which are geophiles.

Representatives of the *domiciliary* Balearic Orthoptera are found within the cockroach genera *Blattella, Loboptera, Blatta,* and *Periplaneta* and the cricket genera *Acheta* and *Gryllomorpha.* They live in

nooks and crannies within or about the dwellings and other structures of mankind.

The herein-proposed system (table III) departs from the more complex system advanced by COLOM (1978) in his comprehensive 2-volume treatise on Balearic biogeography in which the following insect habitats and examples (nomenclature updated herein) are recognized from among the Orthoptera:

Littoral. The grasshopper *Oedipoda miniata* cited by COLOM *(l. c.)* from coastal dunes is hardly exclusive to dunes. A number of other littoral forms that escape mention are common in bare rocky or sandy situations throughout the islands.

Montane woodland. The cockroaches *Ectobius panzeri* and probably *Ectobius pallidus punctulatus* are correctly cited, but other representatives of this assemblage are missing from COLOM's list.

Scrub. The grasshopper *Dociostaurus jagoi occidentalis* and the katydid *Steropleurus balearicus* are cited, as is the grasshopper *Calliptamus barbarus barbarus.* However, the latter enjoys an extraordinarily wide habitat selection, occupying places running the gamut from densely vegetated pasture to arid scrub. COLOM fails to mention numerous other scrub species.

Cultivated lowlands. Pyrgomorpha conica, Anacridium aegyptium, Acrotylus patruelis, Aiolopus strepens, Aiolopus thalassinus, Calephorus compressicornis, Locusta migratoria, Acrida ungarica mediterranea, Chorthippus jacobsi, Euchorthippus angustulus, and *Myrmeleotettix maculatus* are cited. None of those grasshoppers is exclusive to cultivated land, and some are more appropriate to other non-cultivated situations.

Marshland. The pygmy grasshopper *Paratettix meridionalis* and the grasshopper *Eyprepocnemis plorans* are correctly listed, but COLOM fails to mention a number of other important hygrophiles.

Therefore, COLOM's (1978) classification of insects according to their habitat occupancy seems inconsistent with today's orthopteran distributions. Perhaps the explanation may be found in habitat destruction, the Balearic plant communities having been altered to the point of severely reducing the habitats open to selection. COLOM's orthopteran distributions (*l. c.*) are based on data from MORAGUES (1894), NAVÁS (1909), and other turn-of-the-century authors, not on more modern, heretofore unavailable information.

Phenology

Table II lists the known phenology of adult Balearic Orthoptera according to the following categories: winter or the months xii and i-iii, spring iii-vi, summer vi-ix, fall ix-xii, and an inclusive all year/most-or-year category.

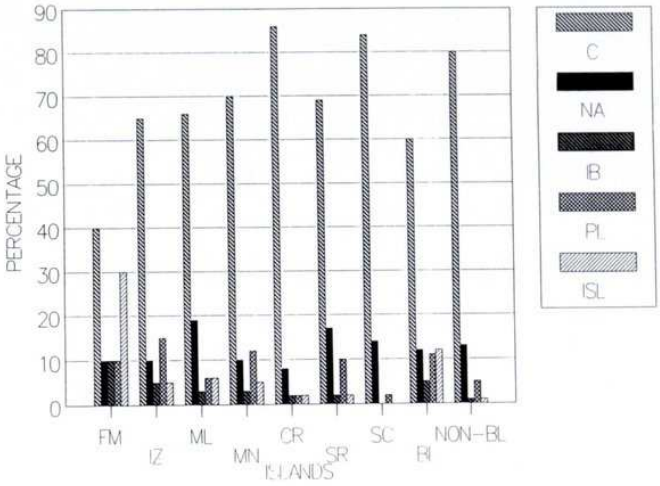

Fig. 7.—Comparison of the percentage orthopteran composition of the Balearics and other major western Mediterranean islands. Code: C = common Old World Orthoptera shared among northwest Africa, Iberia, France,and the Balearics; NA = essentially northwest African forms shared with the Balearics or with Iberia and the Balearics; Ib = Iberian Orthoptera shared with the Balearics; Pl = Palearctic, essentially meridional European Orthoptera shared among Iberia, France, and the Balearics or between the Balearics and France, sometimes over into Italy; Isl = insular forms shared among the Balearics and other major western Mediterranean islands; Fm = Formentera; Iz = Ibiza, Ml = Mallorca; Mn = Menorca; Cr = Corsica; Sr = Sardinia; Sc = Sicily; Bl = Balearic Orthoptera as a whole, Non-Bl = Corsican, Sardinian, and Sicilian Orthoptera as a whole.

Balearic Orthoptera tend to be active most the year. Nymphs are encountered within their preferred habitat earlier in the collecting season and adults later, and the two are found together toward mid season. Unfortunately, data on nymphal occurrence are sparse, hence, the necessity of concentrating on adults in this brief account.

Most species have a pronounced population fluctuation that is only in part taken into account in table II which indicates merely that one or more individuals of a species were collected during a particular season. No further discrimination is attempted though the species may have been either common or so reduced in number as to be negligible.

About 16 % of the Balearic orthopteran taxa are adult all year long, about 7 % only during summer or fall, none during winter only, and none during spring only. About 77 % of them are adult for more than one season per year, usually summer-fall (vi-xii) but sometimes spring-summer-fall (iii-xii). Overall, there are two population peaks, the greater in June and the lesser in September.

BIOLOGICAL NOTES

The system of classification and much of the nomenclature adopted for the following discussion are

after HARZ (1969, 1975) and HARZ & KALTENBACH (1976). The notes on feeding and overall behavior are from personal information. The phenological data are based on specimens seen personally except as indicated otherwise. Distributional and other data from the literature are cited appropriately.

BLATTOPTERA

ECTOBIIDAE

ECTOBIINAE

The genera *Ectobius* Stephens, 1835, and *Phyllodromica* Fieber, 1853, include certain non-domiciliary cockroaches of western Mediterranean forest, mountain, and grassland. They are geophilous insects that hide under vegetation, stones, and litter during the day but wander about over the substrate and low vegetation at night. They are omnivorous in all stages and adult usually from early summer into fall.

Ectobius pallidus punctulatus Fieber, 1858

This cockroach inhabits coastal locations in Portugal, Spain, Mediterranean France (HARZ & KALTENBACH, 1976) and the Balearic Islands of Mallorca (BOLÍVAR, 1897-1900, FERNANDES, 1962) and Menorca (BOLÍVAR, 1876-1878; FERNANDES, *l. c.*; COMPTE, 1968).

Ectobius panzeri Stephens, 1835

This delicate cockroach is widespread in sandy coastal areas of the Iberian Peninsula and southern France (GANGWERE & MORALES, 1970; HARZ & KALTENBACH, 1976), Madeira (FERNANDES, 1972), and possibly Italy. The Balearic form, recorded from Mallorca (NAVÁS, 1909) and Menorca (COMPTE, 1968) and perhaps found in Ibiza, could be distinct. Some past records attributed to the insect may pertain to the similar *E. haeckeli* (Bolívar, 1876).

Phyllodromica adspersa (Bolívar, 1897)

This small endemic cockroach occupies wooded locations in the Balearics (HARZ & KALTENBACH, 1976; FAILLA & MESSINA, 1981, 1983), being found in Mallorca (MORAGUES, 1894; EBNER, 1931; EHRMANN, 1988; present data) and Menorca (MORAGUES, *l. c.*; BOLÍVAR, 1897-1900; FERNANDES, 1962; COMPTE, 1968; present data).

Phyllodromica llorenteae Harz, 1971

This cockroach, also endemic, is found under stones near the type locality Mont Toro, Menorca and in Mallorca (HARZ 1971a; HARZ & KALTENBACH, 1976; FAILLA & MESSINA, 1983; present data).

BLATTELLIDAE

BLATTELLINAE

The genus *Blattella* Caudell, 1903, includes one species in Europe, the well-known ***Blattella germanica*** (Linnaeus, 1767). This domiciliary cosmopolite is ubiquitous throughout the western Mediterranean. Based on available records (MORAGUES, 1894; NAVÁS, 1909; COMPTE, 1968), it occurs on each of the four main Balearic islands. It is a nocturnally active omnivore found indoors in houses, hotels, restaurants, bakeries, and similar establishments throughout its range (GANGWERE, 1961). It may be found in southern European garbage dumps during winter (CHOPARD, 1951). Adults may be collected throughout the year.

The genus *Loboptera* Brunner, 1865, includes a number of European species, of which the Balearic one, ***Loboptera decipiens*** (Germar, 1817), is holomediterranean (HARZ & KALTENBACH, 1976). It is also found in Madeira (FERNANDES, 1972) and the Canaries (GANGWERE *et al.*, 1972) and is common throughout the Iberian Peninsula (BURR, 1910; GANGWERE & MORALES, 1970). Its Balearic occurrences include Mallorca (MORAGUES, 1894; BOLÍVAR, 1876-1878; NAVÁS, 1909; KRAUSS, 1928; EBNER, 1931; EHRMANN, 1988; present data), Menorca (BOLÍVAR, *l. c.*; COMPTE, 1968; present data), and Cabrera (ESPAÑOL, 1935). A geophile, this cockroach hides during the day under stones, litter, and low vegetation and emerges at night to forage. It is adult at least from spring into fall.

BLATTIDAE

BLATTINAE

The well-known cockroach genera *Blatta* Linnaeus, 1758, and *Periplaneta* Burmeister, 1838, include certain domiciliary cosmopolites that are well developed in the western Mediterranean region.They are omnivores that scavenge nocturnally in and about the dwellings of mankind where they may be found adult throughout the year.

Blatta orientalis Linnaeus, 1758

This cockroach is ubiquitous throughout the western Mediterranean and is also found in Madeira (FERNANDES, 1972) and the Canaries (GANGWERE *et al.*, 1972). Based on available records (MORAGUES, 1894; BOLÍVAR, 1897-1900; NAVÁS, 1909; EIDMANN, 1927; KRAUSS, 1928; COMPTE, 1968; EHRMANN, 1988; present data), it occurs at least on the four main islands of the Balearic Archipelago. Its habits are similar to those of *Blattella germanica* (above). Though usually found indoors even in warmer regions, it may survive the European winter out-of-doors in garbage dumps (CHOPARD, 1951).

Periplaneta americana (Linnaeus, 1758)

This domiciliary cosmopolite is practically ubiquitous throughout western Mediterranean port cities where it inhabits houses, restaurants, hotels, bakeries, warehouses, sewers, and ships (CHOPARD, 1951). It is seldom found out-of-doors though in summer it flies with facility (CHOPARD, *l. c.*) Adults may be found throughout the year. Based on available records (MORAGUES, 1894; NAVÁS, 1909; COMPTE, 1968; present data), it occurs on each of the four main Balearic islands.

MANTODEA

AMORPHOSCELIDIDAE

AMORPHOSCELIDINAE

The genus *Perlamantis* Guérin Méneville, 1843, includes the distinctive ***Perlamantis alliberti*** Guérin Méneville, 1843, a mantis restricted to the western Mediterranean. It lives in southeastern Spain, southern France, and northwest Africa (HARZ & KALTENBACH, 1976) as well as Mallorca (NAVÁS, 1909). It is adult from summer to fall. Like other mantises, it is a staunch predator. It is probably diurnally active notwithstanding the crepuscular behavior noted for it in the literature (GANGWERE & MORALES, 1970).

MANTIDAE

AMELINAE

Genus *Ameles* Burmeister, 1838, includes a number of essentially Mediterranean mantises found on or under tall herbs, shrubs, and low trees in dry, sunny, uncultivated pastures and scrub. They are diurnally active insects adult from summer into fall. They are predacious on small insects but differ from other mantises which typically lie in wait for prey to be caught by stealth; *Ameles* actively run over the vegetation in pursuit of their quarry (MORALES AGACINO, 1947). Flushed males fly weakly before climbing to the top of an adjacent plant to rest, head uppermost. The brachypterous females hop and run when flushed.

Ameles africana Bolívar, 1914

This small mantis is recorded from uncultivated places in southern Portugal, Corsica, Sardinia, Sicily, and North Africa (HARZ & KALTENBACH, 1976) and is probably found in Spain. It frequents dry fields in Las Maravillas, Mallorca (EHRMANN, 1988), and specimens are here noted from several other Mallorcan localities and from Menorca (NEW RECORD). Some past records attributed to the insect may pertain to the similar *Ameles spallanzania* (Rossi, 1792).

Ameles decolor (Charpentier, 1825)

This scrub-dwelling mantis is common in meridional Europe, northwest Africa, and on many Mediterranean islands (HARZ & KALTENBACH, 1976) including Mallorca (NAVÁS, 1909; EBNER, 1931; present data) and Menorca (NEW RECORD).

Ameles picteti (Saussure, 1869)

Found in southern Spain, Sicily, and Algeria (HARZ & KALTENBACH, 1976), this mantis was recently recorded from Mallorca (EHRMANN, 1988).

Ameles spallanzania (Rossi, 1792)

This common Mediterranean mantis is found in meridional Europe from Portugal to Italy eastward, in North Africa, and on many Mediterranean islands (HARZ & KALTENBACH, 1976) including Mallorca (MORAGUES, 1894; NAVÁS, 1909; present data) and Menorca (NEW RECORD).

MANTINAE

The well-known genera *Iris* Saussure, 1869, and *Mantis* Linnaeus, 1758, are phytophilous mantises widespread on the herbage and scrub of dry, sunny hillsides, pastures, and clearings (MORALES AGACINO, 1947). Their representatives are diurnally active pre-

dators of habit typical of their group; unlike *Ameles* (above), they lie in wait for prey to be caught by stealth. They are adult from summer through fall.

Iris oratoria (Linnaeus, 1758)

This handsome mantis has a circummediterranean distribution (LLORENTE, 1980). Its Balearic records include Mallorca (NAVÁS, 1909; EBNER, 1931; present data) and Menorca (RAMIS, 1814; BOLÍVAR, 1876-1878; COMPTE, 1968).

Mantis religiosa Linnaeus, 1758

This essentially cosmopolitan mantis is known from central and meridional Europe, North Africa, and Asia, as well as Madeira (FERNANDES, 1972) and the Canaries (GANGWERE *et al.*, 1972). It is an adventive in the United States and Australia (HARZ & KALTENBACH, 1976; LLORENTE, 1980). The insect is ubiquitous in Iberian Peninsula grassland and scrub (GANGWERE & MORALES, 1970) and abundant in the cultivated regions of North Africa (CHOPARD, 1943). It frequents low vegetation in Mallorca (MORAGUES, 1984; NAVÁS, 1909; EBNER, 1931; present data), Ibiza (COMPTE, 1968), and Menorca (RAMIS, 1814; BOLÍVAR, 1876-1878; COMPTE, *l. c.;* present data).

EMPUSIDAE

EMPUSINAE

The genus *Empusa* Illiger, 1798, includes several Mediterranean species of which the distinctive ***Empusa pennata*** (Thunberg, 1815) is recorded from the Balearics. This holomediterranean mantis (HARZ & KALTENBACH, 1976) is ubiquitous in France's Midi (CHOPARD, 1951) and in the Iberian Peninsula (GANGWERE & MORALES, 1970). It is recorded from Mallorca (NAVÁS, 1909). A phytophile that flies with facility, its males are attracted to light (CHOPARD, *l. c.*). Like other Mediterranean mantises, it eats small beetles, moths, etc., but rejects dead insects (GANGWERE & MORALES, 1973). It is adult during spring and summer and hibernates in the nymphal stage.

PHASMOPTERA

PHYLLIDAE

BACILLINAE

The wingless, nocturnally active stick insects of the genera *Bacillus* Latreille, 1825, and *Clonopsis* Pantel, 1915, occupy hot, dry fields and other open places where they perch on and eat different dicots with which they prove well camouflaged. They move sluggishly, sometimes staying on the same individual plant for a week or more. They are adult during much of the growing season, from spring through fall.

Bacillus rossius (Rossi, 1790)

This holomediterranean species (HARZ & KALTENBACH, 1976) is known from several localities in Mallorca (BOLÍVAR, 1876-1878; MORAGUES, 1894; NAVÁS, 1909; EHRMAN, 1988).

Clonopsis gallica (Charpentier, 1825)

This holomediterranean stick insect is even more widespread than the preceding (HARZ & KALTENBACH, 1976). It occurs throughout the western Mediterranean basin including Mallorca (KRAUSS, 1928), but confirmation of the latter is needed. The insect's reproduction is assumed to be parthenogenetic in the Iberian Peninsula (GANGWERE & MORALES, 1970).

PHASMATIDAE

PACHYMORPHINAE

There are two species within the genus *Leptynia* Pantel, 1890, of which one, ***Leptynia hispanica*** (Bolívar, 1878), is relevant here. This stick insect, essentially an Iberian endemic, lives in the mountains of Spain over the Pyrenees just into southern France (GANGWERE & MORALES, 1970). It is said to occur in Mallorca (NAVÁS, 1909), but the record awaits confirmation. The insect is nocturnal, phytophilous, and dendrophagous is central Spain, showing especial preference for the foliage of legume shrubs (GANGWERE & MORALES, 1973).

ORTHOPTERA OR SALTATORIA

TETTIGONIIDAE

PHANEROPTERINAE

The delicate, nocturnally active katydids of the genera *Odontura* Rambur, 1839, *Phaneroptera* Serville, 1831, and *Tylopsis* Fieber, 1853, are phytophilous on coarse, high vegetation growing in wood openings, fields, and other dry, often hilly places. They feed on

certain dicots on which they perch and are adult from early summer into fall.

Odontura stenoxipha Fieber, 1853

This western Mediterranean genus includes species endemic to Sardinia and Sicily and, subject to karyological analysis, possibly to Mallorca and Tunisia (MESSINA, 1981; LA GRECA, 1990a). The Iberian form, as presently recognized, occurs in Sicily, Sardinia, Tunisia, and Mallorca (HARZ, 1969; GANGWERE & MORALES, 1970). Confirmation of the species' Mallorcan occurrence is afforded by specimens from Molinar Levante (MORALES AGACINO, 1943; LLORENTE & PINEDO, 1990).

Phaneroptera nana nana Fieber, 1853

This Old World katydid is known from meridional Europe to Asia Minor and throughout North Africa (HARZ, 1969; KRUSEMAN, 1988). It occurs throughout the western Mediterranean. It is ubiquitous in the Iberian Peninsula, frequenting vineyards, shrubs, and sometimes low trees (GANGWERE & MORALES, 1970). It occurs in Ibiza (COMPTE, 1968; present data), Mallorca (MORAGUES, 1894; NAVÁS, 1909; EBNER, 1931; EHRMANN, 1988; present data), Menorca (COMPTE, *l. c.*; present data), and Cabrera (ESPAÑOL, 1935).

Phaneroptera sparsa (Stål, 1857)

This katydid inhabits parts of Africa, Asia Minor, Madeira (FERNANDES, 1972), and the Canary Islands (HARZ, 1969; GANGWERE *et al.*, 1972). It also occurs along coastal southeastern Spain (RAGGE, 1965) and in Mallorca (EHRMANN, 1988). In Spain, it rejects grass as food but accepts the leaves and flowers of a number of forbs and shrubs (GANGWERE & MORALES, 1973).

Tylopsis lilifolia (Fabricius, 1793)

This insect is characterized by habits similar to those of *Phaneroptera* spp. (GANGWERE & MORALES, 1973). It is common in central and meridional Europe, southwest Asia, and North Africa (HARZ, 1969). It is widespread in Spain (GANGWERE & MORALES, 1970), Mediterranean France (CHOPARD, 1951; KRUSEMAN, 1988), Italy (BURR, 1910), and Sicily, and it is known from Mallorca (NAVÁS, 1909).

CONOCEPHALINAE

The meadow katydid genus *Conocephalus* Thunberg, 1815, includes a species ***Conocephalus conocephalus*** (Linnaeus, 1767), known from meridional Europe to Asia Minor and Africa (HARZ, 1969). This insect is essentially an Afrotropical form with a relict distribution in western Mediterranean coastal locations (FAILLA *et al.*, 1973). In Spain, it is taken both in dry, grassy places and in marshland (GANGWERE & MORALES, 1970). It was recently taken in Mallorca (EHRMANN, 1988). Like other *Conocephalus*, it is presumably incompletely nocturnal, being active and stridulating both during the day and at night. Its probable diet includes flowers, fruits, and leaves, both dicot and grass, as well as insect prey (GANGWERE & MORALES, 1973). It is adult in late summer and fall.

The genus *Ruspolia* Schulthess-Schindler, 1898, includes the well-known cone-headed katydid ***Ruspolia nitidula nitidula*** (Scopoli, 1786) of central and meridional Europe, Asia, Africa, and the Canaries (HARZ, 1969; HERRERA, 1982; KRUSEMAN, 1988) and Madeira (FERNANDES, 1972). It is found throughout most of the western Mediterranean including Mallorca (NAVÁS, 1909; EHRMANN, 1988). In Spain, it is a nocturnally active feeder on grass florets found growing in humid places (GANGWERE & MORALES, 1970) and is adult from summer through fall.

TETTIGONIINAE

The katydid genus *Tettigonia* Linnaeus, 1758, includes only a few Palearctic species, one of which is the familiar ***Tettigonia viridissima*** (Linnaeus, 1758). This insect is common throughout the western Mediterranean (HARZ, 1969; KRUSEMAN, 1988). Its Balearic records include Mallorca (MORAGUES, 1894; NAVÁS, 1909; EHRMANN, 1988) and Menorca (BOLÍVAR, 1876-1878; HERRERA, 1982). It perches on trees, shrubs, and the tall, coarse herbage of upland meadows and other mesic places in the Iberian Peninsula (GANGWERE & MORALES, 1970). It is incompletely nocturnal, being active during late afternoon through evening. Appropriate to its powerful body, it is a voracious hunter-predator capable of only limited phytophagy but able to scavenge under starvation pressure (GANGWERE & MORALES, 1973). It is adult from summer into fall.

DECTICINAE

The genus *Decticus* Serville, 1831, contains certain powerful shield-backed katydids that, in the western

Mediterranean region, occupy cultivated fields, clearings, and other dry, hot, grassy places. They are incompletely nocturnal dicot feeders-predators (GANGWERE & MORALES, 1973). Essentially geophilous, they nonetheless ascend the vegetation nightly to feed. They are adult from summer through fall.

Decticus albifrons (Fabricius, 1775)

This strong flier is known from the Mediterranean basin, the Near East, southwest Asia, and the Canaries and Madeira (HARZ, 1969; FERNANDES, 1972; GANGWERE *et al.*, 1972; KRUSEMAN, 1988), occurring especially in parched lowland areas (SAMWAYS & HARZ, 1982). It is found throughout the western Mediterranean including Mallorca (MORAGUES, 1894; NAVÁS, 1909).

Decticus verrucivorus (Linnaeus, 1758)

This shield-backed katydid is similar to its congener (above) except for a smaller body size, a more northerly distribution, and a preference for lush grassy montane situations (SAMWAYS & HARZ, 1982). It occurs in central and meridional Europe and southwest Asia (HARZ, 1969) but fails to reach southern Spain and northwest Africa (GANGWERE & MORALES, 1970). Its recorded presence in Menorca (RAMIS, 1814; BOLÍVAR, 1876-1878; KRAUSS, 1928) needs confirmation.

Platycleis Fieber, 1852, is a genus of European, Asian, and African shield-back katydids consisting of variable, poorly understood, difficult taxa differing in habitat selection and behavior (GANGWERE *et al.*, 1972; SAMWAYS, 1976). Their determination based on structural characters alone requires unusual care and competence and yields only tentative records. The species occupy meadows, wood clearings, and other dry, well vegetated communities, cultivated or uncultivated (GANGWERE & MORALES, 1970). They are incompletely nocturnal, being almost equally active during the day and at night, but ascend the vegetation and feed largely at night. They eat a wide range of foods including dicots, grass, and small prey (GANGWERE & MORALES, 1973). They are adult from summer through fall.

Platycleis affinis Fieber, 1853

This insect is known from central and meridional Europe, North Africa, Asia Minor, and central Asia (HARZ, 1969; KRUSEMAN, 1988) as well as most of the western Mediterranean. Its recorded presence in Mallorca (EHRMANN, 1988) awaits confirmation.

Platycleis falx laticauda Brunner, 1882

This subspecies occurs throughout the western Mediterranean (HARZ, 1969) including Mallorca (MORAGUES, 1894; KRAUSS, 1928; present data) and Menorca (NEW RECORD). In Menorca, it frequents dry, open fields in which it flies like a bird, making a low flight up to 7-10 m before landing.

Platycleis grisea (Fabricius, 1781)

An inhabitant of central and meridional Europe and North Africa (HARZ, 1969; KRUSEMAN, 1988) and the Canaries (GANGWERE *et al.*, 1972), this katydid is common throughout the western Mediterranean. It is widespread on patches of grass in Spain's mountain meadows (GANGWERE & MORALES, 1970). Its Balearic records include Mallorca (MORAGUES, 1894; NAVÁS, 1909; present data) and Ibiza (NEW RECORD).

Platycleis intermedia (Serville, 1839)

This holopalearctic shield-back (HARZ, 1969; KRUSEMAN, 1988) inhabits the entire western Mediterranean over to the Canaries (GANGWERE *et al.*, 1972). Its Balearic records include Mallorca (NAVÁS, 1909; EBNER, 1931) and Menorca (COMPTE, 1968).

Platycleis sabulosa (Azam, 1901)

This shield-back is listed from the Canaries (GANGWERE *et al.*, 1972) and most of the western Mediterranean including North Africa (HARZ, 1969). It is localized along the sandy borders of the Mediterranean Sea in France (CHOPARD, 1951) and is almost ubiquitous in the Iberian Peninsula (GANGWERE & MORALES, 1970). It is known from Mallorca (EHRMANN, 1988).

Tessellana tessellata (Charpentier, 1825)

This shield-back, once lumped within genus *Platycleis*, is placed in its own genus. It may be distinguished from the species of *Platycleis* by its smaller size and different tegminal coloration. It occurs in central and meridional Europe, North Africa, Asia Minor, and the Canaries (HARZ, 1969; GANGWERE *et al.*, 1972; HERRERA, 1982; KRUSEMAN, 1988). It is com-

mon throughout the western Mediterranean. Its Balearic records include Mallorca (MORAGUES, 1894; NAVÁS, 1910; EHRMANN, 1988) and Menorca (NEW RECORD).

EPHIPPIGERINAE

The genus *Steropleurus* Bolívar, 1878, includes only one species, ***Steropleurus balearicus*** (Bolívar, 1884), from the Balearic Islands. This insect, a lubberly endemic, is infrequently encountered in Mallorcan (MORAGUES, 1894; NAVÁS, 1909; BURR, 1910; JORDANS, 1925; EBNER, 1931; present data) and Menorcan (COMPTE, 1968; present data) vineyards, scrub, and wasteland. It is adult from summer through fall. Its habits are presumed similar to those of other *Steropleurus* spp. If so, it spends the day hiding in underbrush and ascends the vegetation nightly to stridulate, mate, and feed on wild scrub and occasionally crop plants and fruit trees (GANGWERE & MORALES, 1973). Both sexes stridulate.

GRYLLIDAE

GRYLLINAE

Field crickets are found on cultivated or fallow, dry or humid ground or in clearings open to the sun. They are incompletely nocturnal, walking about over the vegetation from late afternoon through evening but hiding the rest of the time under stones, clumps of earth, or leaf litter. A few species are domiciliary or at least live in close association with humans. Like cockroaches, they eat many different foods, especially flowers and fruits, and scavenge on weakened or newly dead insects but are not aggressively predacious (GANGWERE, 1961). Their adult periodism extends from spring into fall except for the domiciliary species, which may be collected throughout the year.

The cosmopolitan genus *Acheta* Fabricius, 1775, includes the familiar ***Acheta domesticus*** (Linnaeus, 1758). This domiciliary insect, the house cricket or «cricket of the hearth», has a range embracing all of Europe, North Africa, Asia, many islands, and the New World (HARZ, 1969). It occurs throughout the western Mediterranean including Spain (GANGWERE & MORALES, 1970). Its Balearic records include Mallorca (MORAGUES, 1894) and Menorca (RAMIS, 1814; BOLÍVAR, 1876-1878; KRAUSS, 1928).

Gryllomorpha Fieber, 1853, is a Mediterranean genus that includes a Balearic species, ***Gryllomorpha dalmatina*** (Ocskay, 1832). This circummediterranean insect is a wingless semidomestic geophile common throughout the western Mediterranean region (HARZ, 1969; HERRERA, 1982; KRUSEMAN, 1988) including Mallorca (NAVÁS, 1909; EBNER, 1931; present data). In Spain, it occurs along the northeastern coast living a scavenger's existence in damp places under rocks, in and about the foundations of country houses, and in cellars, caves, and grottos (GANGWERE & MORALES, 1970).

The genus *Gryllus* Linnaeus, 1758, includes two important Mediterranean species. The first, ***Gryllus bimaculatus*** De Geer, 1773, is a large, handsome field cricket characteristic of the whole of Africa, meridional Europe, parts of Asia, and the entire western Mediterranean (HARZ, 1969; KRUSEMAN, 1988) as well as Madeira (FERNANDES, 1972) and the Canaries (GANGWERE *et al.*, 1972). It has an essentially coastal distribution in Spain (GANGWERE & MORALES, 1970). In the Balearics it occurs in Mallorca (MORAGUES, 1894; NAVÁS, 1909; JORDANS, 1925; EIDMANN, 1927; KRAUSS, 1928; EBNER, 1931; present data), Ibiza (NEW RECORD), Menorca (COMPTE, 1968), and Cabrera (ESPAÑOL, 1935). ***Gryllus campestris*** Linnaeus, 1758, is the second important European representative of genus *Gryllus*. It occurs in Europe, Palearctic Asia, and North Africa including most of the western Mediterranean (GANGWERE & MORALES, 1970). It is ubiquitous in France (CHOPARD, 1951; KRUSEMAN, 1988) and Iberia (GANGWERE & MORALES, *l. c.*). Its Balearic distribution includes Mallorca (NAVÁS, 1909), Ibiza and Menorca (COMPTE, 1968), and Cabrera (ESPAÑOL, 1935). Unlike its closely similar congener, *Gryllus bimaculatus* (above), it digs a burrow at the entry of which the male «sings» (CHOPARD, *l. c.*).

Melanogryllus Chopard, 1961, includes a single Balearic species, ***Melanogryllus desertus*** (Pallas, 1771). This cricket, known from central and meridional Europe, Palearctic Asia, and North Africa (HARZ, 1969; HERRERA, 1982; KRUSEMAN, 1988), occurs throughout the western Mediterranean including Mallorca (MORAGUES, 1894; EBNER, 1931). It hides under stones along humid stream banks and at the edge of cultivated fields in Spain (GANGWERE & MORALES, 1970).

The genus *Tartarogryllus* Tarbinsky, 1940, includes the well-known ***Tartarogryllus burdigalensis*** (Latreille, 1804), a circummediterranean cricket (HARZ, 1969) also found in Madeira (FERNANDES, 1972) and the Canaries (GANGWERE *et al.*, 1972). It is ubiquitous in Iberia (GANGWERE & MORALES, 1970) and in southern and western France (CHOPARD, 1951;

KRUSEMAN, 1988). It occurs in Mallorca (NAVÁS, 1909; JORDANS, 1925; KRAUSS, 1928; EHRMANN, 1988; present data) and Menorca (BOLÍVAR, 1876-1878; KRAUSS, *l. c.*; COMPTE, 1968).

NEMOBIINAE

Nemobius Serville, 1839, is a widespread, important cricket genus best known in the Old World for ***Nemobius sylvestris*** (Bosc, 1792). This essentially Palearctic species (HARZ, 1969) is ubiquitous in France (CHOPARD, 1951; KRUSEMAN, 1988), common in northern Italy (BURR, 1910) and Iberia (GANGWERE & MORALES, 1970), and recorded from Mallorca (EHRMANN, 1988). It frequents woodland, hiding under leaf litter, within moss, etc. (GANGWERE & MORALES, *l. c.*). It is an omnivore-herbivore, consuming such foods as molds and mildew, dead or dying insects, and dicot foliage (RICHARDS, 1952). It is incompletely nocturnal in periodicity, and its adult periodism extends from summer into fall.

MOGOPLISTINAE

This subfamily includes the wingless genera *Arachnocephalus* Costa, 1855 and *Mogoplistes* Serville, 1839, both with Balearic representatives.

Arachnocephalus vestitus Costa, 1855

This cricket, to which the *A. yersini* Saussure, 1877, of the Balearics literature (BOLÍVAR, 1927) is probably referable, is essentially a holomediterranean coastal form (CHOPARD, 1951; GANGWERE & MORALES, 1970; KRUSEMAN, 1988). It is known from Mallorca (NAVÁS, 1909; EBNER, 1931). A shrub-dweller, particularly on *Cistus* (CHOPARD, 1943), it also lives under leaf litter (GANGWERE & MORALES, *l. c.*). It is adult from summer into fall.

Mogoplistes brunneus Serville, 1839

This holomediterranean cricket (HARZ, 1969) occurs under dry leaves in woodlands bordering the western Mediterranean Sea including those of Mallorca (NAVÁS, 1909). It is adult from summer into fall. Little is known of its biology.

MYRMECOPHILINAE

The curious, diminutive crickets of the genus *Myrmecophilus* Berthold, 1827, live beneath stones and bark, taking sustenance from certain ant species with which they share a commensalistic relationship. Their biology is poorly known.

Myrmecophilus acervorum (Panzer, 1799)

This Palearctic species, known from most of the western Mediterranean (CHOPARD, 1951; HERRERA, 1982), has been noted to occur in Mallorca (EIDMANN, 1927) and Menorca (COMPTE, 1968). However, these records await confirmation. It is adult from summer into fall (CHOPARD, *l. c.*).

Myrmecophilus ochraceus Fischer, 1853

This holomediterranean cricket has a more southerly distribution than does its congener (above). It occupies much of the western Mediterranean basin (HARZ, 1969) and occurs in Mallorca (EIDMANN, 1927; BOLÍVAR, 1927; KRAUSS, 1928; present data).

TRIGONIDIINAE

The genus *Trigonidium* Rambur, 1839, includes the distinctive Afro-Asian cricket ***Trigonidium cicindeloides*** Rambur, 1839. It occurs in meridional Europe from Portugal to Greece and beyond including everywhere within the western Mediterranean (HARZ, 1969) and Canaries (GANGWERE *et al.*, 1972). In the Balearics, it lives in Mallorca (MORAGUES, 1894; BOLÍVAR, 1897-1900; present data) and Menorca (BOLÍVAR, 1876-1878; BURR, 1910; KRAUSS, 1928; COMPTE, 1968). It frequents moist hillsides and other lush, sunny places in the south and east of the Iberian Peninsula (GANGWERE & MORALES, 1970; LLORENTE, 1980) where, as in France (CHOPARD, 1951), it perches on reeds and herbage. It is adult from spring through fall.

OECANTHINAE

Oecanthus Serville, 1831, is a genus of tree cricket that includes the familiar ***Oecanthus pellucens*** (Scopoli, 1763). This insect occurs in central and meridional Europe, Asia Minor, central Asia, North Africa, Madeira, and the Canaries (HARZ, 1969; FERNANDES, 1972; GANGWERE *et al.*, 1972; HERRERA, 1982; KRUSEMAN, 1988). It lives throughout the western Mediterranean and is ubiquitous in the Iberian Peninsula (GANGWERE & MORALES, 1970). Its Balearic records include Mallorca (MORAGUES, 1894; NAVÁS, 1909; EHRMANN, 1988; present data), Me-

norca (LLORENTE, 1980), and Ibiza (NEW RECORD). Throughout its range, it is phytophilous on herbs and shrubs from which the males «call» at night. Despite a delicate appearance, it is a voracious predator of small, soft-bodied insects. It also eats dicot flowers and sometimes fruits and leaves (GANGWERE, 1961; GANGWERE & MORALES, 1973) and is adult from summer into fall.

GRYLLOTALPIDAE

GRYLLOTALPINAE

The mole cricket genus *Gryllotalpa* Latreille, 1802 includes a Balearic species, ***Gryllotalpa gryllotalpa*** (Linnaeus, 1758). This fossorial insect is found in central and meridional Europe, North Africa, the Near East, and Asia over to the Philippines (HERRERA, 1982; KRUSEMAN, 1988). It occurs throughout the western Mediterranean (LLORENTE, 1980) including Mallorca (MORAGUES, 1894; NAVÁS, 1909; KRAUSS, 1928; present data) and Menorca (RAMIS, 1814; LLORENTE, *l. c.*). Like other mole crickets, it frequents cultivated fields or moist meadows near rivers where it may be found under stones or in subterranean galleries of its own construction (GANGWERE & MORALES, 1970). It is an omnivore, eating plant roots, living and dead insects, and earthworms (GANGWERE, 1961). It is probably adult throughout the year despite its more limited recorded periodism.

TETRIGIDAE

TETRIGINAE

The pygmy grasshopper genus *Paratettix* Bolívar, 1887, includes the widespread Old World species ***Paratettix meridionalis*** (Rambur, 1838). This small insect occurs in meridional Europe, North Africa, Madagascar, Asia Minor, and is also found on various Atlantic islands including the Canaries (GANGWERE *et al.*, 1972; HARZ, 1975; HERRERA, 1982). It is common throughout the western Mediterranean including Mallorca (MORAGUES, 1894; NAVÁS, 1909; EBNER, 1931; LLORENTE & PRESA, 1981; EHRMANN, 1988; present data) and Menorca (COMPTE, 1968). It is a good swimmer that frequents sandy beaches and swampy land near the banks of rivers and ponds (MORALES AGACINO, 1942). Like other tetrigids, it is a diurnal omnivore-herbivore (GANGWERE, 1961). It is probably adult throughout the year in the Balearics.

Tetrix Latreille, 1802, is another genus of pygmy grasshopper listed from the Balearics. Unfortunately, the identity of the insect recorded from Pollensa, Mallorca, as ***Tettix bipunctatus*** Linnaeus, 1758 (NAVÁS, 1909) is uncertain. In absence of the specimen/s on which the record is based, more precise citation is impossible though one might guess it to be *Tetrix undulata* (Sowerby, 1806).

TRIDACTYLIDAE

TRIDACTYLINAE

The curious genus *Tridactylus* Olivier, 1789, includes the widespread ***Tridactylus variegatus*** (Latreille, 1809). It occurs throughout the Mediterranean basin, southwest Asia, and eastward into the Oriental Realm (HARZ, 1975). It is common within the western Mediterranean region including Mallorca (LLORENTE, 1980). It is a good swimmer that uses both the mandibles and the fore legs to dig galleries along the sandy or muddy banks of rivers (CHOPARD, 1951; HARZ, *l. c.;* KRUSEMAN, 1988). Its biology is poorly known (MESSNER, 1964), but it presumably eats algae and other aquatic plants. It is adult from spring through summer (CHOPARD, *l. c.*).

PYRGOMORPHIDAE

PYRGOMORPHINAE

The widespread Old World grasshopper genus *Pyrgomorpha* Audinet-Serville, 1838, includes ***Pyrgomorpha conica*** (Olivier, 1791), a species found in meridional Europe, North Africa, and Asia Minor including throughout the western Mediterranean (HARZ, 1975) and Canaries (GANGWERE *et al.*, 1972). Its known Balearic occurrence is in Mallorca (MORAGUES, 1894; NAVÁS, 1909; EBNER, 1931; present data). It is practically ubiquitous in the Iberian Peninsula in dry, sunny meadows, uncultivated fields, and scrubby hillsides and mountainsides (MORALES AGACINO, 1942; GANGWERE & MORALES, 1970), and it frequents dunes and similar habitats in the Balearics. It eats the foliage of various dicots (GANGWERE & MORALES, 1973). It hibernates in the nymphal stage and is adult from early spring well into fall.

CATANTOPIDAE

TROPIDOPOLINAE

Tropidopola Stål, 1873, is an Old World genus that includes the Mediterranean subspecies ***Tropidopola***

cylindrica cylindrica (Marschall, 1836). It is known from North Africa, eastern Spain, southern Italy, the western Mediterranean islands, and Asia Minor (HARZ, 1975; HERRERA, 1982). Its Balearic records include Mallorca (NAVÁS, 1909; JORDANS, 1925; KRAUSS, 1928; present data) and Menorca (BOLÍVAR, 1876-1878; BURR, 1910; KRAUSS, *l. c.;* COMPTE, 1968). In Spain as in the Balearics, it is infrequently encountered on *Carex* and tall grass, invariably in humid, uncultivated coastal communities (MORALES, 1942; GANGWERE & MORALES, 1970). Its food-habits are graminivorous, and it is adult from spring into fall. Little else is known of its biology.

CYRTACANTHACRIDINAE

The genus *Anacridium* Uvarov, 1923, includes the well-known Old World locust ***Anacridium aegyptium*** (Linnaeus, 1764). This holomediterranean species (HARZ, 1975) is known from Mallorca (MORAGUES, 1894; NAVÁS, 1909; EBNER, 1931; present data), Menorca (BOLÍVAR, 1897-1900; COMPTE, 1968; GANGWERE, 1975), and Ibiza (COMPTE, *l. c.;* GANGWERE, *l. c.*). It is practically ubiquitous in dry places in Spain, in towns as well as in the countryside, adults being found throughout the year (MORALES AGACINO, 1942; GANGWERE & MORALES AGACINO, 1970). It is a strong-flying, diurnally active thamnophile difficult to collect because of its mobility. It feeds on the foliage of many dicots, both forbs and woody plants, but is not economically important (GANGWERE & MORALES, 1973). It eats the tall composite weed, *Dittrichia viscosa* (L.) Greuter, on which it habitually perches along Ibizan roadsides (GANGWERE, *l. c.*).

The genus *Schistocerca* Stål, 1873, is infamous for its species ***Schistocerca gregaria*** (Forskål, 1775), the desert locust, one of mankind's foremost plague species. This insect is characteristic of Africa and southwest Asia. Occasional swarms migrate westward from this area to Madeira (FERNANDES, 1972), the Canaries (GANGWERE *et al.*, 1972), certain other Atlantic islands, and northward to the Iberian Peninsula. Some individuals stray as far northward as England and Ireland (HARZ, 1975). Swarms are also recorded from the Balearics (BOLÍVAR, 1897-1900; BURR, 1910; KRAUSS, 1928; MORALES AGACINO, 1942), presumably Mallorca, though the literature does not specify. The diurnally active insect is adult from summer through fall. Though essentially a dicot feeder, it exhibits unusual catholicity, taking a wide range of herbs, woody plants, garden crops, grains, native grasses, etc. Despite its proverbial voracity, its Balearic and Spanish populations stemming from invasion are not economically important.

CATANTOPINAE

The genus *Pezotettix* Burmeister, 1840, includes the well-known holomediterranean species ***Pezotettix giornae*** (Rossi, 1794). This brachypterous grasshopper is ubiquitous in moderately dry terrain of all types in the Iberian Peninsula (MORALES AGACINO, 1942; GANGWERE & MORALES, 1970), southern France and Corsica (CHOPARD, 1951), Italy, Sardinia, and Sicily (LA GRECA, personal communication), and North Africa (CHOPARD, 1943), and it is known from Mallorca (NAVÁS, 1909). It perches on herbs, shrubs, and other low vegetation and may be found on leaf litter. It eats dicots but rejects grass and animal materials (GANGWERE & MORALES, 1973). It is diurnally active and adult throughout the year.

CALLIPTAMINAE

Calliptamus Serville, 1831, contains a number of important Old World species and subspecies including ***Calliptamus barbarus barbarus*** (Costa, 1836). This insect, to which the Balearic records formerly listed under the name *Calliptamus italicus* (Linnaeus) probably pertain, is the most widely distributed of its genus. It is known from central and meridional Europe, North Africa, and southwestern and central Asia (HARZ, 1975). It occurs throughout the western Mediterranean and is ubiquitous in the Iberian Peninsula (GANGWERE & MORALES, 1970). It is also ubiquitous in the Balearics including Ibiza (COMPTE, 1968; GANGWERE, 1975; LLORENTE, 1982), Mallorca (MORAGUES, 1984; NAVÁS, 1909; EBNER, 1931; LLORENTE, *l. c.;* EHRMANN, 1988; present data), Menorca (COMPTE, *l. c.;* GANGWERE, *l. c.*), and Formentera (NEW RECORD). It occupies terrain ranging from densely vegetated humid pastures, to cultivated fields, and to dry stony or sandy semidesert. The Balearic individuals are forbivorous phytophiles that eat different forbs and shrubs on which they move about diurnally (GANGWERE, *l. c.*). Adults are found virtually throughout the year.

EYPREPOCNEMIDINAE

The grasshopper genus *Eyprepocnemis* Fieber, 1853, contains only a single species in Europe, ***Eyprepocnemis plorans*** (Charpentier, 1825). This Afrotropical/Mediterranean grasshopper is known from meridional Europe, North Africa except the Sahara,

Asia Minor, and Central Asia (HARZ, 1975). It does not occur in France (CHOPARD , 1951; KRUSEMAN, 1982), but it is found in southern Italy (BURR, 1910), southern and eastern Spain (GANGWERE & MORALES, 1970), and probably southern Portugal. Its Balearic records include Ibiza (COMPTE, 1968), Mallorca (MORAGUES, 1894; NAVÁS, 1909; BURR, 1910; EBNER, 1931; present data), and Menorca (BOLÍVAR, 1897-1900; COMPTE, *l. c.;* present data). In the Balearics, as in Spain (MORALES, 1942; GANGWERE & MORALES, *l. c.*), this strong flier inhabits the lush, tall vegetation of sandy, sunny areas, often near water. It is diurnal, phytophilous, and herbivorous, consuming mixed forbs and grass (GANGWERE & MORALES, 1973). It is probably adult all year in the Balearics.

LOCUSTINAE (= OEDIPODINAE)

The band-winged grasshoppers are diurnally active occupants of hot, dry, sparsely vegetated fields, meadows, hillsides, rocky slopes, roadsides, or dunes exposed to full sun. Certain of them are strongly geophilous «bare-ground species», but others are phytophilous. Some are graminivores and others either forbivores or herbivores (mixed feeders). They tend to be adult all year long.

The strongly xerothermic species of the genus *Acrotylus* Fieber, 1853, frequent patches of grass in sandy, sunny places, especially dunes alongside rivers and seas. They are geophilous, graminivorous, and adult throughout the year.

Acrotylus insubricus insubricus (Scopoli, 1786)

This subspecies is know from meridional Europe, North Africa, Asia Minor, central Asia, the Canaries, Madeira, and throughout the western Mediterranean (GANGWERE *et al.*, 1972; FERNANDES, 1972; HARZ, 1975; HERRERA, 1982). It is ubiquitous in France's Midi (CHOPARD, 1951; KRUSEMAN, 1982) and in the Iberian Peninsula where, throughout the year, it is characteristic of dunes and other sandy, xerothermic places (MORALES AGACINO, 1942; GANGWERE & MORALES, 1970; LLORENTE, 1980). Its Mallorcan record (KRAUSS, 1928) needs confirmation.

Acrotylus patruelis (Herrich-Schaeffer, 1838)

Sometimes confused with its congener (above), this grasshopper is distributed throughout the whole of Africa (DIRSH, 1965) and also occurs in meridional Europe, the Canaries GANGWERE *et al.*, 1972), the Near East, and on Mediterranean islands including Corsica and Sicily (HARZ, 1975). It apparently does not live in France (CHOPARD, 1951), but it is present in Italy (BURR, 1910). It is almost ubiquitous throughout the year in the Iberian Peninsula (MORALES AGACINO, 1942; GANGWERE & MORALES, 1970). Its Balearic records include Mallorca (MORAGUES, 1894; NAVÁS, 1909; BURR, *l. c.;* EBNER, 1931; PRESA & LLORENTE, 1979; present data).

Aiolopus Fieber, 1853, is a genus of phytophilous, diurnally active, graminivorous grasshoppers that occupy meadows, cultivated fields, and other sunny places. They are adult all year long.

Aiolopus simulatrix (Walker, 1870)

This grasshopper is found in Africa, southwest Asia, and on certain Mediterranean islands (HARZ, 1975). It was recently recorded from Mallorca (EHRMANN, 1988), but the record needs confirmation.

Aiolopus strepens (Latreille, 1804)

Known from meridional Europe, septentrional Africa, Madeira (FERNANDES, 1972), the Canaries (GANGWERE *et al.*, 1972), and southwest Asia (DIRSH, 1965; HARZ, 1975), this familiar grasshopper occurs throughout the western Mediterranean. It is common in southern France (CHOPARD, 1951; KRUSEMAN, 1982) and Italy (BURR, 1910), and it is ubiquitous in the Iberian Peninsula (MORALES AGACINO, 1942; GANGWERE & MORALES, 1970). Its Balearic distribution includes Ibiza (COMPTE, 1968; GANGWERE, 1975), Mallorca (MORAGUES, 1894; BOLÍVAR, 1897-1900; NAVÁS, 1909; EIDMANN, 1927; EBNER, 1931; present data), and Menorca (COMPTE, *l. c.;* GANGWERE, *l. c.*). Like its congener *Aiolopus thalassinus* (below), it takes to flight readily, making it difficult to capture (BURR, *l. c.).*

Aiolopus thalassinus (Fabricius, 1781)

This grasshopper is widespread throughout central and meridional Europe, Asia, Madeira, Cape Verde, and the Canaries, Africa, and Australia (FERNANDES, 1972; GANGWERE *et al.*, 1972; HARZ, 1975; HERRERA, 1982). It occurs throughout the western Mediterranean, being ubiquitous in Mediterranean France (CHOPARD, 1951; KRUSEMAN, 1982), southern Italy (BURR, 1910), and the Iberian Peninsula (MORALES AGACINO, 1942; GANGWERE & MORA-

LES, 1970). Its Balearic records include Mallorca (MORAGUES, 1894; NAVÁS, 1909; EIDMANN, 1927; EBNER, 1931; present data), Menorca (BOLÍVAR, 1897-1900; COMPTE, 1968; present data), and Ibiza (NEW RECORD). It may be collected together in the same place with its congener *Aiolopus strepens* and has similar habits. This suggests the desirability of investigating their possible interspecific competition.

The genus *Calephorus* Fieber, 1853, includes the Mediterranean species ***Calephorus compressicornis*** (Latreille, 1804). This handsome insect occurs throughout septentrional Africa, the Iberian Peninsula, the Mediterranean provinces of France (HARZ, 1975), and Mallorca (NAVÁS, 1909) but does not reach the eastern Mediterranean (HARZ, *l. c.*). It is a phytophile in sandy, sunny places, especially dunes, meadows, and other communities near water (MORALES AGACINO, 1942). Its food-habits are graminivorous. Its adult periodism in southern climes extends from summer well into winter. Little else is known of its biology.

The plague locust genus *Locusta* Linnaeus, 1758, is infamous for its species ***Locusta migratoria*** Linnaeus, 1758, consisting of several subspecies. This insect has an extraordinarily wide distribution throughout Africa and much of Europe and Asia (CHOPARD, 1951). It is virtually ubiquitous in southern France (CHOPARD, *l. c.;* KRUSEMAN, 1982) and in the Iberian Peninsula (MORALES AGACINO, 1942; GANGWERE & MORALES, 1970). It also invades Madeira (FERNANDES, 1972), the Canaries (GANGWERE *et al.,* 1972), and various Mediterranean islands including Mallorca (MORAGUES, 1894; NAVÁS, 1909; KRAUSS, 1928; EBNER, 1931; HARZ, 1971; EHRMANN, 1988; present data) and Menorca (BOLÍVAR, 1897-1900; COMPTE, 1968). Throughout its range, it is phytophilous on dense vegetation growing in cultivated fields, fallow land, and meadows. It is a graminivore renowned for its voracious consumption of grasses and sedges but is never noxious in the Iberian Peninsula and the Balearics. Its adult periodism extends from spring into fall.

Oedaleus Fieber, 1853, is an Old World grasshopper genus with a single European species, ***Oedaleus decorus*** (Germar, 1826). This graminivorous geophile is holopalearctic (HARZ, 1975). It is common in France (CHOPARD, 1951; KRUSEMAN, 1982) and Italy (BURR, 1910), and it is ubiquitous in the Iberian Peninsula (GANGWERE & MORALES, 1970). It is also known from Madeira (FERNANDES, 1972), the Canaries (GANGWERE *et al.,* 1972), and Mallorca (MORAGUES, 1894; HERRERA, 1982). It is usually found in meadows and hot, dry, sparsely vegetated places with grass but may also occur in more humid places (MORALES AGACINO, 1942; GANGWERE & MORALES, 1973). It is adult from summer into fall.

The genus *Oedipoda* Serville, 1831, contains certain strongly xerophilous geophiles that pose a taxonomic problem. They are in need of revision in the absence of which it may not be possible to separate them accurately. They are completely diurnal «bareground grasshoppers» characteristic of bare or sparsely vegetated fields, rocky slopes, dry hillsides, roadsides, dunes, and other arid places exposed to full sun. They may become inactive without exposure to direct sunlight. They are, in general, dicot feeders that eat the low plants that grow in sparsely vegetated habitats. They also scavenge on dead plant and animal materials encountered in their wanderings but eat grass sparingly (GANGWERE & MORALES, 1973). Most are adult from late spring through into fall.

Oedipoda charpentieri Fieber, 1853

This circummediterranean band-wing of Algeria, Portugal, and Spain over to the Near East and southeast Asia (DIRSH, 1965; HARZ, 1975) was recently taken in Mallorca (EHRMANN, 1988).

Oedipoda caerulescens (Linnaeus, 1758)

This band-wing occurs in central and meridional Europe, North Africa, Asia Minor, central Asia, and the Canaries and Azores (GANGWERE *et al.,* 1972; HARZ, 1975). It is found throughout the western Mediterranean, being ubiquitous in France (CHOPARD, 1951; KRUSEMAN, 1982), in the Iberian Peninsula (MORALES AGACINO, 1942; GANGWERE & MORALES, 1970), and from plains to mountains in Italy (HARZ, *l. c.*). Its Balearic records include Mallorca (COMPTE, 1968; LLORENTE, 1980) and Menorca (BOLÍVAR, 1876-1878; COMPTE, *l. c.*).

Oedipoda fuscocincta Lucas, 1849

This band-wing occurs in the Azores and Canaries and throughout the western Mediterranean (HARZ, 1975). It is ubiquitous in the Iberian Peninsula (MORALES AGACINO, 1942; GANGWERE & MORALES, 1970). It has been taken in Mallorca (EHRMANN, 1988).

Oedipoda miniata (Pallas, 1771)

This species, to which the Balearic records listed as *O. salina* (Pallas, 1771) probably pertain, lives in

southwest and central Asia, in North Africa, and on the western Mediterranean islands of Sardinia, Sicily, and the Balearics (HARZ, 1975; HERRERA, 1982). In the latter, it is found in Mallorca (MORAGUES, 1894; NAVÁS, 1909; JORDANS, 1925; EIDMANN, 1927; EBNER, 1931; EHRMANN, 1988; present data), Menorca (BOLÍVAR, 1897-1900; COMPTE, 1968; GANGWERE, 1975), Cabrera and the nearby islet of Foradada (ESPAÑOL, 1935), Ibiza (NEW RECORD), and Formentera (NEW RECORD). It eats the sparse dicot growth of dusty roadsides and other bare, arid places in Menorca (GANGWERE, *l. c.)*.

The genus *Paracinema* Fischer, 1853, includes the holomediterranean ***Paracinema tricolor bisignata*** (Charpentier, 1825) (HARZ, 1975). This subspecies is widespread but never common in the western Mediterranean. Previously unknown from the Balearics, it is now recorded from Inca, Mallorca (NEW RECORD). Elsewhere in its range, the insect is a graminicole characteristic of meadows, marshes, and other humid places (MORALES AGACINO, 1942; HARZ, *l. c.*). Based on its herbivorous-type mandibles, it probably eats grasses as well as forbs. Aside from the little that is known of its habitat selection, food-habits, and probable spring-fall seasonal occurrence, its biology is poorly understood.

The band-winged genus *Psophus* Fieber, 1853, includes a single European species, ***Psophus stridulus*** (Linnaeus, 1758). This grasshopper is a central and meridional European and central and eastern Asian mountain form (HARZ, 1975) recorded from the Alps, Central Massif, and Pyrenees of France (CHOPARD, 1951; KRUSEMAN, 1982) and the Pyrenees and Cantabrians of Spain (MORALES AGACINO, 1942; GANGWERE & MORALES, 1970) where it frequents dry, sunny woodland, forest edge, or steppe. Based on a single specimen, possibly mislabeled, it is recorded from Menorca (RAMIS, 1814; BOLÍVAR, 1876-1878). This possible relict occurrence in the Balearics is questionable in view of the insect's predilection for montane woodland. It is a dicot feeder in Spain (GANGWERE & MORALES, 1973) where it is adult from summer into fall.

Sphingonotus Fieber, 1852, like *Oedipoda* Serville, 1831, is a taxonomically difficult genus of «bare-ground grasshopper» with many species characteristic of Mediterranean desert and subdesert. The Balearic specimens of *Sphingonotus* within the collections of the Museo Nacional de Ciencias Naturales belong within either *Sphingonotus caerulans corsicus* Chopard, 1923, or *Sphingonotus rubescens* (Walker, 1870) (see below). These insects are strongflying dicot feeders that frequent arid, sandy biotopes, especially sunny fields, hillsides, and rocky slopes (GANGWERE & MORALES, 1970). They are adult from spring or summer into fall.

Sphingonotus azurescens (Rambur, 1838)

This band-wing of meridional Europe, North Africa, the Near East, central Asia, and the Cape Verde Islands (DIRSH, 1965; HARZ, 1975) is found throughout the western Mediterranean. It is ubiquitous in the Iberian Peninsula (MORALES AGACINO, 1942; GANGWERE & MORALES, 1970) and also occurs in Mallorca (EBNER, 1931; MORALES AGACINO, *l. c.;* HARZ, 1975).

Sphingonotus caerulans corsicus Chopard, 1923

This subspecies is known from Portugal and southern Spain, Corsica, Sardinia, and the Balearics (HARZ, 1975). In the Balearics it lives in Mallorca (MORAGUES, 1894; NAVÁS, 1909; JORDANS, 1925; EIDMANN, 1927; KRAUSS, 1928; present data), Menorca (COMPTE, 1968; present data), Ibiza (EIDMANN, *l. c.;* COMPTE, *l. c.;* present data), Cabrera (ESPAÑOL, 1935; present data), and Formentera (NEW RECORD).

Sphingonotus rubescens (Walker, 1870)

This xerophile is found in North Africa, meridional Europe, southwest and central Asia, Madeira, the Canaries, and the Balearics (DIRSH, 1965; FERNANDES, 1972; GANGWERE *et al.*, 1972; HARZ, 1975; HERRERA 1982). It frequents subdesert and steppe in Portugal and central and eastern Spain (MORALES AGACINO, 1942; GANGWERE & MORALES, 1970) and sandy or stony, sunny places in Mallorca (EBNER, 1931; present data). It occupies similar habitats in Ibiza (NEW RECORD) and Formentera (NEW RECORD).

Sphingonotus uvarovi Chopard, 1923

This band-wing is endemic to Corsica, Sardinia, and the Balearics (KRUSEMAN, 1982) including Formentera and Mallorca (HARZ, 1975; KRUSEMAN, *l. c.*).

ACRIDINAE

The distinctive grasshopper genus *Acrida* Linnaeus, 1758, includes a large number of Old World

species and subspecies, one of which, ***Acrida ungarica mediterranea*** Dirsh, 1949, has a Mediterranean distribution from the Iberian Peninsula to southeastern USSR (HARZ, 1975). It is common in coastal locations throughout the western Mediterranean (CHOPARD, 1951) including Mallorca (EHRMANN, 1988; present data). It frequents both cultivated and uncultivated places with tall grass for food and perching. It is adult from summer into fall and hibernates in the nymphal stage. Based on the specimens seen to date, it is assumed that the closely similar *Truxalis nasuta* (Linnaeus, 1758), also recorded from Mallorca (MORAGUES, 1894; NAVÁS, 1909), is confused with this species. If *Truxalis nasuta* is eventually recognized for the Balearics, this will elevate the species total from 85 to 86.

GOMPHOCERINAE

These graminicolous slant-faced grasshoppers are characteristic either of dry, sparsely vegetated scrub or of lush open meadows, wood openings, and other grassy places. Most species are graminivores, but a few are herbivores, eating both grasses and forbs. They are diurnally active insects usually adult from summer into fall.

The genus *Chorthippus* Fieber, 1852, consists of species with color and structural differences parallel to those found within related genera; hence, they may be difficult to separate.

Chorthippus bornhalmi (Harz, 1971)

This species described from Yugoslavia is surely more widespread (HARZ, 1975). It could also occur in the Balearics, based on a recent citation from Las Maravillas, Mallorca (EHRMANN, 1988), but the record needs confirmation.

Chorthippus jacobsi Harz, 1975

This slant-face, to which the so-called *Chorthippus brunneus* (Thunberg, 1815), *Chorthippus biguttulus biguttulus* (Linnaeus, 1758), *Stenobothrus bicolor* (Charpentier, 1825) and *Stauroderus bicolor* Azam, 1901, said to occur in Mallorca (MORAGUES, 1894; NAVÁS, 1909; EBNER, 1931; CLEMENTE *et al.*, 1987) are probably referable (RAGGE, 1987), is virtually ubiquitous in Mallorca. It frequents dry meadows in the Balearics and Spain (GANGWERE & MORALES AGACINO, 1973; present data) where it eats grass. It is adult from spring into fall.

Chorthippus dorsatus (Zetterstedt, 1821)

Found throughout much of Europe into Palearctic Asia, this slant-face is ubiquitous in France (CHOPARD, 1951; KRUSEMAN, 1982) and in the north and east of Spain (GANGWERE & MORALES, 1970). It was recently taken in Mallorca (EHRMANN, 1988). In Spain, it occupies somewhat damper places than does its congener, *Chorthippus jacobsi* (above) and, like it, is a graminivorous summer-fall species.

The Iberian Peninsula *Dociostaurus* Fieber, 1853, formerly called *D. genei* (Ocskay, 1832), belong to two subspecies now, *Dociostaurus genei genei* (Ocskay, 1832) and *Dociostaurus jagoi occidentalis* Soltani, 1978 (see below). Based on comparative study of personal collections, specimens from the Museo Nacional de Ciencias Naturales, and those of the Universidad Complutense, Madrid, it is concluded that all Balearic records pertain to the latter, *Dociostaurus jagoi occidentalis*.

Dociostaurus jagoi occidentalis Soltani, 1978

This familiar slant-face, to which the so-called *Dociostaurus hispanicus* (Bolívar, 1898) and *Dociostaurus genei* (Ocskay, 1832) said to occur in Mallorca (EHRMANN, 1988) are probably referable, has a western Mediterranean distribution. It occurs in Portugal, Spain, France, Corsica, Sardinia, Sicily, Italy, and the Balearics (SOLTANI, 1978; HERRERA, 1982). Its Balearic records include Mallorca (MORAGUES, 1894; NAVÁS, 1909; EBNER, 1931; EHRMANN, 1988; present data), Menorca (BOLÍVAR, 1897-1900; COMPTE, 1968; GANGWERE, 1975), Ibiza (GANGWERE, *l. c.*), and Formentera (NEW RECORD). The insect frequents dry, sandy places along the coasts of Menorca and Ibiza and is an herbivore, taking both grasses and forbs (GANGWERE, *l. c.*). It is adult from summer into fall.

The genus *Euchorthippus* Tarbinsky, 1926, includes the Balearic grasshopper ***Euchorthippus angustulus*** Ramme, 1931. This slant-face to which the so-called *Stenobothrus pulvinatus* (Fischer, 1846) and *Chorthippus pulvinatus* (Fischer, 1846) said to occur in Mallorca (MORAGUES, 1894; NAVÁS, 1909) are probably referable, is endemic to the Balearics (MORALES AGACINO, 1942; GANGWERE & MORALES, 1970). It lives in Formentera (HARZ, 1975), Ibiza (GANGWERE, 1975; RAGGE & REYNOLDS, 1984), and Mallorca (MORAGUES, 1894; NAVÁS, 1909; BURR, 1910; EBNER, 1931; RAGGE & REYNOLDS, *l. c.*; RAGGE, 1987; presenta data). It probably also occurs in Menorca, but confirmation is needed. It is a diurnally active, obligatory graminivore of lush,

grassy places in Ibiza (GANGWERE, *l c.*) Adults are found from summer into fall.

The genus *Myrmeleotettix* Bolívar, 1914, includes several Old World species, one of which, ***Myrmeleotettix maculatus*** (Thunberg, 1815), is of interest here. This grasshopper characteristic of the mountains of central Europe has a western Mediterranean distribution that includes central and northern Spain (MORALES AGACINO, 1942; GANGWERE & MORALES, 1970), France (CHOPARD, 1951; KRUSEMAN, 1982), northern Italy (HARZ, 1975; LA GRECA, 1985), and possibly Morocco (CHOPARD, 1943) and Mallorca (NAVÁS, 1909). The latter two citations need confirmation. This graminivorous insect has a summer-fall phenology.

Closely related to *Myrmeleotettix* (above) is the difficult genus *Omocestus* Bolívar, 1878, one species of which, ***Omocestus rufipes*** (Zetterstedt, 1821), is relevant to this study. Probably referable to it are the so-called *Omocestus ventralis* (Zetterstedt, 1821) recorded from Mallorca (NAVÁS, 1909) and the *Stenobothrus* sp. said to occur in Menorca (COMPTE, 1968). *Omocestus rufipes* is a Palearctic graminivore that inhabits arid fields, scrub, and other open places from Portugal to Siberia (HARZ, 1975). It is known from throughout the western Mediterranean including two places in Mallorca (NAVÁS, 1909), but the Balearic records await confirmation.

ACKNOWLEDGMENTS

Drs. R. G. Bland, of Central Michigan University, Mt. Pleasant, Michigan, USA, A. Compte Sart, of the Museo Nacional de Ciencias Naturales, Madrid, Spain, A. B. Ewen, of Agriculture Canada, Saskatoon, Saskatchewan, Canada, and D. C. Freeman, of Wayne State University, Detroit, Michigan, USA, read the report and offered suggestions of value in its improvement. Drs. Freeman and Compte, as well as Drs. F. H. Sanders, of Wayne State University, and E. Morales Agacino, of Madrid, Spain, gave invaluable technical information and assistance. Sr. Compte graciously provided heretofore unrecorded locality records based on his years of professional experience in the Balearics. Wayne State University, the Museo Nacional de Ciencias Naturales, and the Universidad Complutense de Madrid provided facilities. The American Philosophical Society, of Philadelphia, Pennsylvania, USA, and the Department of Biological Sciences of Wayne State University gave financial assistance. To the above individuals, institutions, and organizations, the authors are indebted.

REFERENCES

ATLAS DE LES ILLES BALEARS: GEOGRAFIC, ECONOMIC, HISTORIC. 1979. Diafora, Barcelona; 88 pp.

BOLÍVAR, I. 1876-1878. *Sinópsis de los Ortópteros de España y Portugal.* Imprenta T. Fortanet, Madrid; 333 pp.

BOLÍVAR, I. 1897-1900. *Catálogo Sinóptico de los Ortópteros de la Fauna Ibérica.* Impr. Univ., Coimbra; 168 pp.

BOLÍVAR, I. 1927. Datos complementarios sobre los Ortópteros de la Península Ibérica, II: Grílidos. *Bol. R. Soc. esp. Hist. Nat.,* 27: 96-110.

BURR, M. 1910. *A Synopsis of the Orthoptera of Western Europe.* Oliver Janson Publ., London; i + 160 pp.

CHOPARD, L. 1943. Orthoptéroïdes de l'Afrique du Nord. *Faune de l'Empire français,* 1. Lib. Larose, Paris; 450 pp.

CHOPARD, L. 1951. Orthoptéroïdes. *Faune de France,* 56: P. Lechevalier, Paris: 359 pp.

CLEMENTE, M. E., GARCÍA, M. D. & PRESA, J. J. 1987. *Clave de los Géneros de Saltamontes Ibéricos.* Univ. Murcia; 64 pp.

COLOM, G. 1978. *Biogeografía de las Baleares.* Vols. 1-2. Inst. Estudios Baleáricos, CSIC, Palma; 515 pp.

COMPTE, A. 1968. *La Fauna de Menorca y Su Origen.* Rev. Menorca número extraord., Mahón; 212 pp.

DIRSH, V. M. 1965. *The African Genera of Acridoidea.* Cambridge Univ. Press, London; xiii + 579 pp.

EBNER, R. 1931. Einige Orthopteren von Mallorca. *Bol. R. Soc. esp. Hist. Nat.,* 31: 497-503.

EHRMANN, R. 1985. Standorttreue von *Mantis religiosa* (L.). *Articulata,* 2 (7): 179-180.

EHRMANN, R. 1988. Neue Orthopteren-Funde für die Balearen-Insel Mallorca. *Articulata,* 3 (4): 147-150.

EIDMANN, H. 1927. Zur Kenntnis der Insektenfauna der balearischen Inseln. *Entomol. Mitteil.,* 16 (1): 24-37.

ESPAÑOL, F. 1935. De re entomologica: contribució a l'entomologia de les illes de Cabrera i Foradada. *Butll. Inst. Catalana Hist. Nat.,* 35: 251-253.

FACAROS, D. & PAULS, M. 1981. *Mediterranean Island Hopping.* Hippocrene Books, N.Y.; 264 pp.

FAILLA, M. C. & MESSINA, A. 1981. Sulle specie di *Phyllodromica* del grupo *sardea* (Serv.). *Animalia,* 8: 95-103.

FAILLA, M. C. & MESSINA, A., 1983. Blattari di Sardegna. *Lav. Soc. It. BIogeogr.,* 8 (N.S.): 545-555.

FAILLA, M. C.; MESSINA A. & NOBILE, V. 1973. Blattodei, Mantodei, Fasmodei, Ortotteri e Dermatteri delle isole Eolie e dell'isola di Ustica. *Lav. Soc. It. Biogeogr.,* 3 (N.S.): 3-16.

FERNANDES, J. DE A. 1962. Revisão dos Ectobiinae da Peninsula Iberica e Ilhas Baleares. *Rev. Port. Zool. Biol. Geral,* 3: 149-246.

FERNANDES, J. DE A. 1972. Notas sobre ortopteroides do arquipelago da Madeira. *Arq. Mus. Bocage,* 3 (9): 305-318.

GANGWERE, S. K. 1961. A monograph on food selection in Orthoptera. *Trans. Am. Entomol. Soc.,* 87: 67-230.

GANGWERE, S. K. 1967. The phylogenetic development of food selection in certain orthopteroids. *Eos,* 42: 383-392.

GANGWERE, S. K. 1975. The faunistics, ecology, and feeding of Balearic orthopteroids. *Yearbook Am. Phil. Soc.,* 1974: 321-322.

GANGWERE, S. K. & MORALES, E. 1970. The biogeography of Iberian orthopteroids. *Misc. Zool.,* 2 (5): 1-67.

GANGWERE, S. K. & MORALES, E. 1973. Food selection and feeding behavior in Iberian Orthopteroidea. *Anales INIA, Ser. Prot. Veg.,* Madrid, 3: 251-337.

GANGWERE, S. K., MORALES, M. & MORALES, E. 1972. The distribution of the Orthopteroidea in Tenerife, Canary Islands, Spain. *Contr. Am. Entomol. Inst.,* 8 (1): 1-40.

HARZ, K. 1969. Die Orthopteren Europas, Vol. 1. *Ser. Entomol.,* 5. Dr. W. Junk Publ., The Hague; xx + 749 pp.

HARZ, K. 1971. Die Wanderheuschrecke in Spanien. *Atalanta* (B), 3: 338.

HARZ, K. 1971a. Zwei neue Schabenarten aus Spanien. *Atalanta* (B), 3: 343-348.

HARZ, K. 1975. Die Orthopteren Europas vol. 2. *Ser. Entomol.*, 11. Dr. W. Junk Publ., The Hague; iii + 939 pp.

HARZ, K. & KALTENBACH, A. 1976. Die Orthopteren Europas vol. 3. *Ser. Entomol.*, 12. Dr. W. Junk Publ., The Hague; iii + 434 pp.

HEATWOLE, H. & LEVINS, R. 1972. Biogeography of the Puerto Rican bank: flotsam transport of terrestrial animals. *Ecol.*, 53: 112-117.

HERRERA, L. 1982. Catalogue of the Orthoptera of Spain. *Ser. Entomol.*, 22. Dr. W. Junk Publ., The Hague; viii + 162 pp.

HESSE, R., ALLEE, W. C. & SCHMIDT, K. P. 1937. *Ecological Animal Geography*. John Wiley & Sons, New York; iv + 597 pp.

HOUSTON, J. M. 1964. *The Western Mediterranean World, and Introduction to the Regional Landscapes*. Longmans, London; xxxii + 800 pp.

HSÜ, K. J. 1972. When the Mediterranean dried up. *Sci. Am.*, 227: 27-36.

JORDANS, A. von. 1925. Die Ergebnisse meiner 2. Reise nach Mallorca. *J. für Ornithol.*, 73: 194-207.

KRAUSS, H. A. 1928. Die Dermapteren und Orthopteren der balearischen Inseln. *Entomol. Mitteil.*, 17 (2): 140-146.

KRUSEMAN, G. 1982. Materiaux pour la faunistique des Orthoptères de France, Fasc. II: Les acridiens des Musées de Paris et d'Amsterdam. *Verslagen en Technische Gegevens Inst. Taxonomische Zool.*, 36. Univ. Amsterdam, Amsterdam; 134 pp.

KRUSEMAN, G. 1988. Materiaux pour la faunistique des Orthoptères de France, Fasc. III: Les Ensifères et des caelifères: les tridactyloides et les tétrigoides des Musées de Paris et d'Amsterdam. *Verslagen en Technische Gegevens Inst. Taxonomische Zool.*, 51. Univ. Amsterdam, Amsterdam; 164 pp.

LA GRECA, M. 1983. Il contributo degli Ortotteri e dei Mantodei alla conoscenza della biogeografia di Sardegna. *Lav. Soc. It. Biogeograf.* (n.s.), 8: 557-575.

LA GRECA, M. 1985. Contributo alla conoscenza degli Ortotteri delle Alpi Occidentali piemontesi con descrizione di una nuova specie di *Stenobothrus*. *Animalia*, 12: 215-244.

LA GRECA, M. 1990. La zoogeografia e la tettonica a placche. *Scienza & Tecnica* (Annuario EST), 1989-1990: 122-134.

LA GRECA, M. 1990a. The insect biogeography of west Mediterranean islands. *Atti Convegni Lincei*, 85: 469-491.

LINES, A. 1971. Climates of Northern and Western Europe. *In* WALLON, C. C., ed.: *World Survey of Climatology*, 5, Elsevier, Amsterdam & N.Y.; 195-227.

LLORENTE, V. 1980. Los Ortopteroides del Coto Doñana. *Eos*, 54: 117-165.

LLORENTE, V. 1982. La subfamilia Calliptaminae en España (Orthoptera, Catantopidae). *Eos*, 58: 171-192.

LLORENTE, V. & PINEDO, M. C. 1990. Los Tettigoniidae de la Peninsula Ibérica, Islas Baleares y Norte de Africa. Género *Odontura* Rambur, 1838 (Orthoptera). *Bol. Asoc. esp. Entomol.*, 14: 153-174.

LLORENTE, V. & PRESA, J. J. 1981. Los Tetrigidae de la Península Ibérica (Orthoptera). *Eos*, 57: 127-152.

MAC ARTHUR, R. H. & WILSON, E. O. 1967. *The Theory of Island Biogeography*. Monogr. Population Biol., Princeton Univ.; xi + 203 pp.

MESSINA, A. 1981. Sulle specie di *Odontura* del gruppo *stenoxypha* (Fieb.). (Orthoptera: Acrididae) *Animalia*, 8: 15-26.

MESSNER, B. 1964. Beobachtungen zum Weidefrass und Galeriebau von *Tridactylus variegatus* Latr. in Bulgaria. *Zool. Anz.*, 173: 274-278.

MORAGUES, F. 1894. Insectos de Mallorca. *An. Soc. esp. Hist. Nat.*, Madrid, 23: 73-87.

MORALES AGACINO, E. 1942. Langostas y saltamontes. *Publ. Serv. Lucha contra Langosta*, 10. Estación Central de Fitopatología Agrícola, Madrid; 66 pp.

MORALES AGACINO, E. 1943. Estudios sobre Ortópteros del Mediterráneo Occidental. II. Notas críticas sobre las *Odonturas* de la Península Ibérica. *Eos*, 19: 267-280.

MORALES AGACINO, E. 1947. Mántidos de la fauna ibérica. *Bol. Pat. Veg. Entomol. Agr.*, 15: 131-164.

NAVÁS, L. 1909. Notas zoológicas: Ortópteros de Mallorca. *Bol. Soc. Arag. Cienc. Nat.*, 8: 197-201.

NAVÁS, L. 1910. Notas entomológicas: excursiones por Cataluña y Mallorca. *Bol. Soc. Arag. Cienc. Nat.*, 9: 240-248.

PRESA, J. J. & LLORENTE, V. 1979. Sobre el género *Acrotylus* Fieb. (Orthoptera: Acrididae) en la Península Ibérica. *Acrida*, 8: 133-150.

RAGGE, D. R. 1965. Ortópteros y Dermápteros colectados en la Península Ibérica durante los años 1962 y 1963 por misiones del British Museum (Nat. Hist.). *Graellsia*, 21: 95-119.

RAGGE, D. R. 1986. The songs of the western European grasshoppers of the genus *Omocestus* in relation to their taxonomy. *Bull. Br. Mus. nat. Hist.* (Entomol.), 53 (4): 213-249.

RAGGE, D. R. 1987. Speciation and biogeography of some southern European Orthoptera, as revealed by their songs. *In* BACCETTI, B., ed.: *Evolutionary Biology of Orthopteroid Insects*. Ellis Horwood Ltd., London; 418-426.

RAGGE, D. R. & REYNOLDS, W. J. 1984. The taxonomy of the western European grasshoppers of the genus *Euchorthippus*, with special reference to their songs. *Bull. Br. Mus. nat. Hist. (Entomol.)*, 49 (2): 103-151.

RAGGE, D. R. & REYNOLDS, W. J. 1988. The songs and taxonomy of the *Chorthippus biguttulus* group in the Iberian Peninsula. *J. Nat. Hist.*, 22: 897-929.

RAMIS, J. 1814. *Specimen animalium, vegetabilium et mineralium in insula Minorica frequentiorum ad normam Linneani sistematis*. Mahon; 60 pp.

RICHARDS, T. J., 1952. *Nemobius sylvestris* in S. E. Devon. *Entomologist*, 85: 83-87, 108-111, 161-166.

RIVAS, S. & COSTA, M. 1987. España Insular: las Baleares. *In* PEINADO, M. & RIVAS, S., eds.: *La Vegetación de España*. Col. Aula Abierta, 3. Serv. Publ., Univ. Alcalá; 544 pp.

SAMWAYS, M. J. 1976. Habitats and habits of *Platycleis* spp. in southern France. *J. Nat. Hist.*, 10: 643-667.

SAMWAYS, M. J. & HARZ, K. 1982. Biogeography of intraspecific morphological variation in the bush crickets *Decticus verrucivorus* (L.) and *D. albifrons* (F.). *J. Biogeogr.*, 9: 243-254.

SOLTANI, A. A. 1978. Preliminary synonymy and descrip-

tion of new species in the genus *Dociostaurus* Fieber, 1853, with a key to the species in the genus. *J. Entomol. Soc. Iran,* suppl. 2: 1-93.

TWEEDIE, M. 1974. *Atlas of Insects*. John Day Co., New York; 128 pp.

UVAROV, B. P. 1977. *Grasshoppers and Locusts*. Vol. 2. Centre Overseas Pest Res., London; ix + 613 pp.

WAY, R. 1962. *A Geography of Spain and Portugal*. Methuen, London; xi + 362 pp.

WORLD WEATHER RECORDS. 1951-1960. Vol. 2: Europe. US Dept. Commerce; 372-375.

Recibido el 14 de junio de 1991
Aceptado el 27 de enero de 1992