

A comprehensive analysis of Morales Agacino entomological expeditions in Spanish Sahara 1941-1946, with an updated checklist of collection sites and collected insect species (Insecta Polyneoptera, Hymenoptera, Coleoptera Carabidae and Tenebrionidae)

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# A comprehensive analysis of Morales Agacino entomological expeditions in Spanish Sahara 1941-1946, with an updated checklist of collection sites and collected insect species (Insecta Polyneoptera, Hymenoptera, Coleoptera Carabidae and Tenebrionidae)

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## ABSTRACT

From 1941 to 1946, E. Morales Agacino (Estación Fitopatológica del INIA, Almería), accompanied by J. Mateu Sanpere (naturalist, seconded to the Spanish Sahara), J. Giner Marí (Instituto Español de Entomología, Madrid) and F. Español Coll (Museo de Zoología, Barcelona), explored the ex-Spanish Sahara (from Cap Juby to Cap Blanc) according to a standardised protocol. Collected specimens and types of newly described taxa were deposited in the museums of Madrid and Barcelona and the results of the surveys published in the journal EOS. In total, 356 species and subspecies of Polyneoptera, Coleoptera and Hymenoptera have been collected. This large-scale entomological survey is presently little considered, mainly because the published locality names are no more in use and difficult to georeference. We have reconstructed the routes of the eight missions carried out by Morales Agacino, Giner Marí and Mateu Sanpere using old maps of the Spanish Sahara (1949) and recent maps of southern Morocco. 134 collection sites have been identified, listed with old and actual toponyms, geographical coordinates and elements of topographical descriptions. Lists of the species collected during these expeditions for the Insecta Orthoptera, Blattodea, Mantodea, Dermaptera, Phasmatoidea, Coleoptera (Carabidae Latreille, 1802 and Tenebrionidae Latreille, 1802), and Hymenoptera (Sphecidae Latreille, 1802, Crabronidae Latreille, 1802, Pompilidae Latreille, 1805, Bradynobaenidae Saussure, 1892 and Mutillidae Latreille, 1802) are given. The scientific value of these data for taxonomy and conservation is illustrated for the Orthoptera Acridomorpha: within the Dericorythidae Jacobson & Bianchi, 1905, the type locality of *Bolivaremia domenechi* Morales Agacino, 1949 is identified and described; and the synonymy of *Pamphagulus mateui* Morales Agacino, 1949 and *Pamphagulus vicinus* Ramme, 1931 is reanalysed using distributional data. Examples of acridomorph Saharan and Mediterranean indicator species are given, using their separate distributions in the local west-east climate continuum. The coherence of the surveys carried out by Morales Agacino and his collaborators provide a most valuable reference inventory for the characterization of the Sahara fauna and its transformations since 1950; its use will be facilitated by the proposed up-date of geographical data.

**KEY WORDS**  
Northwest Africa,  
geographical coordinates,  
biodiversity survey.

## RÉSUMÉ

*Analyse approfondie des expéditions entomologiques de Morales Agacino dans le Sahara espagnol 1941-1946, avec une liste actualisée des sites de collecte et des espèces d'insectes collectées (Insecta Polyneoptera, Hymenoptera, Coleoptera Carabidae et Tenebrionidae).*

De 1941 à 1946, E. Morales Agacino (Estación Fitopatológica del INIA, Almería), accompagné de J. Mateu Sanpere (naturaliste, détaché au Sahara espagnol), J. Giner Marí (Instituto Español de Entomología, Madrid) et F. Español Coll (Museo de Zoología, Barcelona), ont exploré l'ex-Sahara espagnol (de Cap Juby à Cap Blanc) selon un protocole standardisé. Les spécimens collectés et les types des taxons nouvellement décrits ont été déposés dans les musées de Madrid et de Barcelone, et les résultats publiés dans la revue *EOS*. Au total, 356 espèces et sous-espèces d'insectes Polyneoptera, Coleoptera et Hymenoptera ont été collectées. Cet énorme travail de suivi entomologique est actuellement peu considéré, notamment parce que les noms de lieux publiés ne sont plus utilisés comme tels et sont difficiles à géolocaliser. Nous avons reconstitué l'itinéraire des huit missions effectuées par Morales Agacino, Giner Marí et Mateu Sanpere à partir de cartes anciennes du Sahara espagnol (1949) et de cartes récentes du sud du Maroc. 134 sites de collecte ont été identifiés, répertoriés avec leurs toponymes anciens et actuels, leurs coordonnées géographiques et des éléments de description topographique. Une liste des espèces collectées lors de ces expéditions pour les Insecta Orthoptera, Blattodea, Mantodea, Dermaptera, Phasmatodea, Coleoptera (Carabidae Latreille, 1802 et Tenebrionidae Latreille, 1802), et Hymenoptera (Sphecidae Latreille, 1802, Crabronidae Latreille, 1802, Pompilidae Latreille, 1805, Bradynobaenidae Saussure, 1892 et Mutillidae Latreille, 1802) est proposée. La portée scientifique de ces données pour la taxonomie et la conservation est illustrée pour les Orthoptera Acridomorpha : au sein des Dericorythidae Jacobson & Bianchi, 1905, la localité type de *Bolivaremia domenechi* Morales Agacino, 1949 est localisée et décrite; et la synonymie de *Pamphagulus mateui* Morales Agacino, 1949 et *Pamphagulus vicinus* Ramme, 1931 est discutée sur la base de données de distribution. Nous proposons d'autre part des exemples d'espèces acridomorphes indicatrices, d'origine saharienne et méditerranéenne, avec des aires de distribution séparées sur le gradient climatique local ouest-est. La cohérence des collectes réalisées par Morales Agacino et ses collaborateurs fournit un précieux inventaire de référence pour la caractérisation de la faune saharienne et de ses transformations depuis 1950; son utilisation sera grandement facilitée par l'actualisation des données géographiques présentées ici.

## MOTS CLÉS

Afrique du Nord-Ouest, coordonnées géographiques, inventaire de biodiversité.

## INTRODUCTION

The study of insects in Atlantic Sahara is tightly bound with the history of the desert locust (*Schistocerca gregaria* (Forskål, 1775)) outbreaks and its international control (Chatelin & Bonneuil 1995). During the years 1926-1934 and 1941-1947, the repeated plagues in North Africa led Paul Vaysiere, Boris Zolotarevsky and Roger Pasquier at the 'École d'Agriculture', Algiers, to found in 1929-1932 the 'Comité d'Étude de la Biologie des Acridiens' (CEBA), which will become the 'Office National Anti-Acridien' (Maurel & Defaut 2012). In October 1941, the 'Alto Comisario de España en Marruecos' assigned Eugenio Morales Agacino to study the locust problems in the south of Morocco (Viejo Montesinos & Gomis Blanco 2006). Despite a permanent state of insecurity in the Spanish Sahara, the Franco-Spanish cooperation took form in 1942 with a joint mission in the Tiris Zemmour, from Bir Moghrein to Smara. Morales Agacino organised this expedition, with the participation of Boris Zolotarevsky (France) and Charles Rungs (Morocco). A desert locust outbreak in February-May of 1943 occurred in the Saquia Al Hamra region and Rio de Oro (Giner Marí 1944): a survey of this spot by Morales Agacino and Joaquín

Mateu Sanpere brought about the urgency of organising preventive controls at the borders of Algeria, Morocco and Mauritania (Morales Agacino 1943, 1945a).

In this general context, the study of the plant communities was undertaken in the winter-spring breeding areas of the solitary locust in the north of Mauritania and along the coastline of the Spanish Sahara (Zolotarevsky & Murat 1938); Marc Murat, Charles Rungs, Charles Sauvage and Théodore Monod then proposed the first biogeographical units of southern Morocco and Mauritania in the first issue of the 'Mémoires de l'Office national Anti-Acridien' (Murat 1944; Guinea 1945). Guinea (1945) also published a 152-page treatise on the vegetation of the Spanish Sahara.

At the same time, Morales Agacino organised a six-year (1941-1946) extensive inventory of the entomofauna of the Spanish Sahara (Table 1; Fig. 1). Morales Agacino was in charge of the study of Polyneoptera, while Mateu Sanpere and Francisco Español Coll identified Coleoptera (see Bellés 1999), and José Giner Marí Hymenoptera. Type specimens of the new species discovered were deposited in the collection 'Misiones Antiacridianas' of the Museo Nacional de Ciencias Naturales (MNCN, Madrid) (Morales Agacino 1945b; Izquierdo *et al.* 1997). In parallel to these scientific

TABLE 1. — Entomological surveys performed by Morales Agacino and his collaborators from 1941 to 1946. Abbreviations: **D**, ex Franco-Spanish protectorate of the Oued Dra Region; **SH**, Saquia Al Amra Region; **RO**, Rio del Oro. Symbol: \*, members of the French-Moroccan-Spanish mission of the 'Locust Biology Study' group joined on April, 20th-28th 1942 at Bir Moghreïn (Mauritania).

Missions	Collectors	Region	From	Departure	To	End	Weeks
1941	Morales Agacino	SH	Dakhla, Ras Jouby	X.1941	Gueltat Zemmour	20.XI.1941	7
1941	Morales Agacino	RO	Dakhla	02.XI.1941	Tichla – Zoug	15.XII.1941	6
1942	Morales Agacino <i>et al.</i> *	SH	Bir Moghreïn	08.IV.1942	Smara	01.V.1942	3
1943	Morales Agacino & Mateu Sanpere	SH, RO	Tan-Tan, Ras Jouby	01.I.1943	Atuifer	21.V.1943	19
1943	Mateu Sanpere	SH, RO	Smara	20.VII.1943	Tichla	28.XII.1943	22
1944	Mateu Sanpere	SH	Touaroum	31.X.1944	Smara	18.XII.1944	7
1945	Mateu Sanpere	D, SH, RO	Dawra	04.IV.1945	Smara	22.IV.1945	3
1945	Morales Agacino	RO	Dakhla	30.XI.1945	Cap Blanc	27 déc 45	4
1946	Morales Agacino	RO	Bir Gandouz	02.I.1946	Dakhla	23.IV.1946	15

efforts to explore the biodiversity of Spanish Sahara, the Spanish Military Cartography Service draw up in 1941-1949 an exceptional map of the Spanish Sahara (Rodríguez Esteban 2011).

After 1949, scientific activity decreased in this part of the Sahara (Chatelin & Bonneuil 1995). Pasquier in Algeria and Rungs in Morocco carried on the locust control against *Dociostaurus maroccanus* (Thunberg, 1815) and *Schistocerca gregaria*. From 1968 onwards, research in systematics and ecology focused more north, on the Atlas Mountains and the Oued Dra region (Descamps 1968, 1970; Morales Agacino & Descamps 1968; Descamps & Mounassif 1972).

The Morales Agacino inventory revealed a very high species diversity on the Atlantic part of the Sahara: 356 species and subspecies were collected all over the Spanish Sahara, viz. 143 species (= 40.2%) of Coleoptera Tenebrionidae Latreille, 1802 and Carabidae Latreille, 1802 (Español Coll 1943, 1944, 1946, 1948, 1950, 1952; Mateu Sanpere 1947), 130 species (= 36.5 %) of parasitoid Hymenoptera (Giner Marí 1944, 1945, 1947), 56 species (= 15.7 %) of Orthoptera, and 27 species (= 7.5%) of other Polyneoptera (Morales Agacino 1945a, b, 1947a, 1948, 1949) (see Table 4; Appendices 1-4).

In a general frame of global climatic and environmental change, there is a need for temporal monitoring of ecosystems, which in turns requires reference inventories. The observations made in the 1940s in the Spanish Sahara were in line with this approach; they were unfortunately not exploited thereafter and are still little used today. One reason could be a lack of clear geographical information, as the old toponyms based on variable phonetic transcriptions cannot be found on current maps.

The aim of our paper is to facilitate the use of the observations of Morales Agacino and his colleagues for comparisons and research. Phonetic place names are first updated and associated to precise localities, as clear geographical data are a prerequisite to taking a fresh look at these inventories, and reconsidering the collected specimens. As an example, the first author reanalysed the data for Orthoptera Acridomorpha.

Clearly, the inventory performed during the forties is a reference database for the Moroccan Atlantic Sahara, that could reveal a powerful tool to assess the impact of environmental changes in the future, such as the Sahara expansion

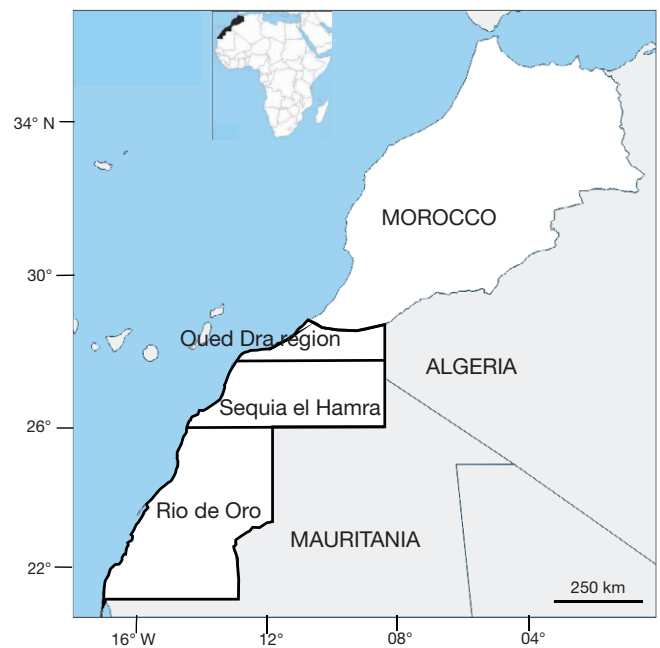


FIG. 1. — Studied area with the limits of Spanish Sahara. After Rodríguez Esteban (2011).

and changes in associated phytocenosis (Murat 1939; Guinea 1945). Precise geographical data can also help reconsidering long-lasting issues in taxonomy.

## MATERIAL ET METHODS

### Study area

At the time of Morales Agacino's entomological surveys, the Spanish Sahara was partitioned into three zones (Fig. 1): the Franco-Spanish protectorate of the Oued Dra region (D) from Tarfaya to Tan-Tan 28°25'N, the Saquia Al Hamra region (SH) from the wadi of the same name to Cap Boujdour 26°08'N, and the Rio de Oro (RO) in the south, down to Cap Blanc at the border with Mauritania 21°N. This area is about one thousand kilometers from north to south and less than 400 km from the Atlantic coast to the eastern border with Mauritania and Algeria.

There is no high altitudinal barrier with the Central Sahara on the east. The reliefs are rugged but not very high (701 m a.s.l., east of Aousserd; 429 m a.s.l., Galb Ahbari, in Adrar Sottouf Massif). In the north the sandstone massif of the Tiris Zemmour comes to an end. In the south there are numerous granitic hills (inselbergs) surrounded by sandy or rocky plains (Figs 6C; 10A). Wad A's Saquia Al Hamra is the only important wadi reaching the ocean, being the northern boundary of the desert. Otherwise, wadis are rarely watery and almost always end in sand plains (Fig. 9A). The coast is arid and windswept, dominated by cliffs or collapsed sandstone-limestone platforms, which dominate the coastline by 60-80 meters (Ortlieb 1975) (Fig. 6A). From Cap Jubu to Cap Boujdour, the aeolian dunes silt up the beaches, where cliffs retreat inwards. In the Rio de Oro, inland from Cap Blanc up to Rio de Oro Bay, there are two massifs of sandstone-limestone fossil dunes weathered into depressions and mounds called Aguerguer (Fig. 6B). The numerous steep, saline or gypseous dips (Sebkhsats) are characteristic of this coastal region (Fig. 6D).

Vegetation is affected by three distinct climatic trends. The Mediterranean climate of the south Morocco is limited by the barrier of the Atlas Mountains, while the high thermal contrast of the Sahara is tempered near the coast by the humid air of the monsoon, with frequent sea mists and wind. The result is in an overlap of phytogeographic limits, as mapped by Murat (1939, 1944) and Guinea (1945). From Dakhla to Bir Moghreïn (Mauritania) the average annual thermal amplitude (T°C Max-T°C Min) increases from 6°C to 11°C. The average annual precipitations amount 130 mm spread in 13 days from September to January at Dakhla, but only 40 mm spread in six days in winter at Bir Moghreïn (Source: <https://www.weatherbase.com>, consulted on 09.IX.2021). Over 470 km, the climate thus changes from a Mediterranean with moderate contrasts to a hot and arid semi-continental climate.

#### *Morales Agacino and Mateu Sanpere sampling method*

Morales Agacino and Mateu Sanpere were fond of the desert and always undertook their expeditions with dromedary caravans (see Bellés 2015; Morales Agacino 1947b; Viejo Montesinos & Gomis Blanco 2006). They carried out eight survey expeditions over six years within the international scope of the Desert Locust control (Viejo Montesinos & Gomis Blanco 2006). Field trips in the three occupation zones occurred once or twice a year, lasting from several weeks to up to five months (Table 1). The same protocol was applied throughout all the surveys, including the following observations: number of captured individuals, sex, stage of development, date, name of collector, and name of place in Sahrawi translated into phonetics. The collection of plants and insects could take place on foot, at the pace of the caravan. Morales-Agacino usually recorded all his field observations in notebooks still available at the Library of the Universidad Autónoma de Madrid, Madrid. He also captured species attracted to acetylene lamps at night, such as the grasshoppers *Platypterna gracilis* Krauss, 1902 and *Platypterna geniculata* Bolivar, 1913 (Acridi-

dae MacLeay, 1821, Gomphocerinae Fieber, 1853) (Morales Agacino 1945a, 1947a; Viejo Montesinos & Gomis Blanco 2006). Specimens collected in one place on one date were shared by speciality among the team members. All the results were published in *EOS: Revista Española de Entomología*. Desert Locust reports were published in the *Boletín de Patología Vegetal y Entomología Agrícola* (Morales Agacino 1943), and the types of newly described taxa were deposited in the museums of Madrid (collection 'Misiones Antiacridianas') and Barcelona (Morales Agacino 1945b; Izquierdo *et al.* 1997).

#### *Collecting localities: finding out the routes followed by the Morales Agacino and Mateu Sanpere surveys*

Very few pieces of information are available to identify the localities of Morales Agacino's 1941-1949 field trips: 21 localities (Fig. 2B) are identified by Morales Agacino (1943) for three expeditions (1941, 1942, 1943); Morales Agacino (1948) published an out-of-text map locating nine sites where the grasshopper *Anacridium melanorhodon* (Walker, 1870) (Acrididae, Cyrtacanthacridinae Kirby, 1910) was found; and Mateu Sanpere (1947) gave a draft without scale with six locations, including the well Pozo Mesit, unknown on any map, and Aserifa, which proved homonymous with a second Aserifa location (see *infra*). Finally Giner Marí (1944) located 36 names on a sketch map of his 1943 field trip with Mateu Sanpere, a map that confirmed our findings afterwards. These informations were relevant but not detailed, especially as no geographical coordinates were associated with the currently used locality names. Also, Sahrawi names with multiple homonyms or approximate writing are not easy to find on today's map.

Fortunately, all the collecting dates have been published. From this information, one of us (AL) managed to follow the chronology of the trips and to reconstruct their paths: First, the place names with their collecting date were checked for toponyms on the 1949 Spanish Sahara map 1/500 000. Second, after establishing a logical progression, the route was plotted on the 1:250 000 topographic map of Morocco for coordinates in DMS. The booklets of the Spanish Sahara map (1949) provide information on reliefs, wadis, Sebkhsats, mountains, massifs, dune areas, pastures, wells with their diminutives and local variants. Table 2 shows an example of the approach with an extract from the 1946 mission. Additional information (see below section 4c, location of Aserifa) was found in the map tracing the route followed by Giner Marí and Mateu Sanpere during the 1943 mission (Giner Marí 1945). All the geographical information of the localities visited by Morales Agacino is in Table 3 and 5. The georeferenced coordinates are mapped and published as supplementary data.

#### *Spatial mapping of climate*

Mokhtari *et al.* (2014) calculated an average Daget continental index (1977) with data available in the open-access Worldclim global climate database (Hijmans *et al.* 2004). The Daget continentality index (K'/C) is the ratio of two indices plotted on a diagram: the X-axis is the thermal continentality index (Gorcziński's index K'), the Y-axis is the rainfall continentality (Angot's index C). The precipitation-thermal

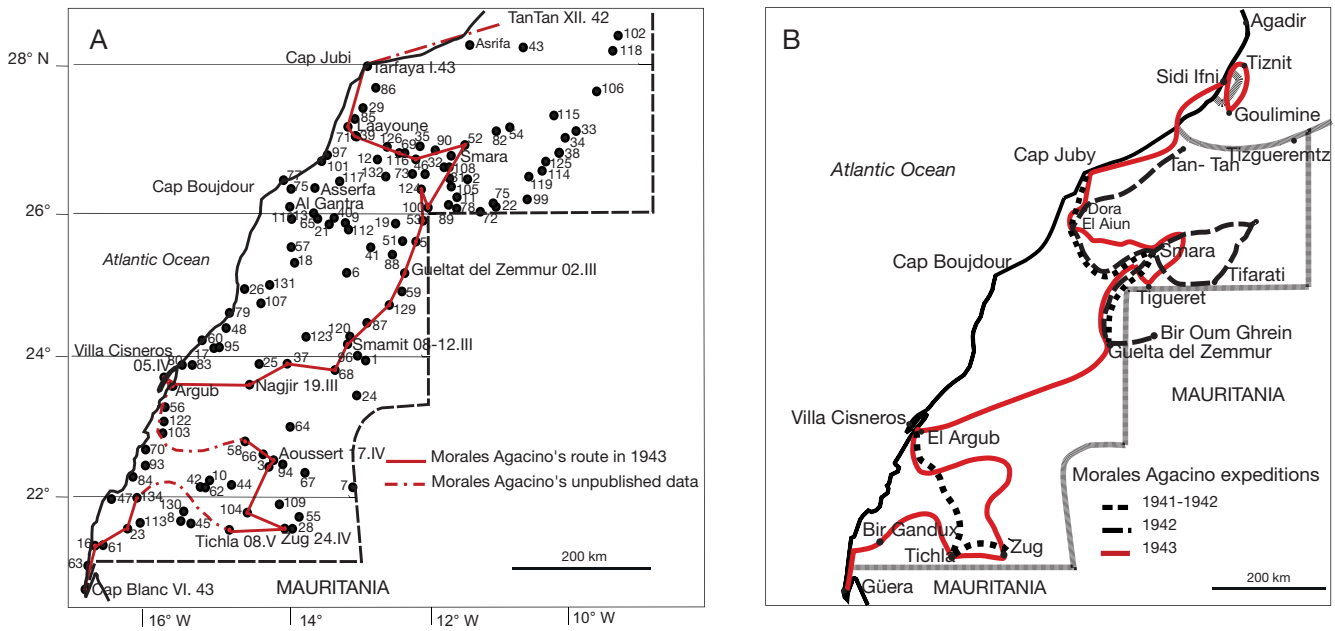


FIG. 2. — Routes of Morales Agacino expedition in Spanish Sahara: **A**, localities cited in the text with the reference numbers in Table 3; the route of the 1943 mission is reconstructed based on Morales Agacino’s published data (red lines); **B**, route of 1941, 1942, 1943 missions, after off-text map in Morales Agacino (1943).

TABLE 2. — Course schedule of Morales Agacino’s expedition from January to Mid-February 1946, after Morales Agacino’s (1947) collection data. Abbreviation: **Nb**, number of species collected on the D day; **ND**, no information available for the first days of the field trip.

Km	Days	Date	Nb	Collection place	Water supply	Vegetation cover	Visual landmarks
Start of the mission, Bir Gandux military checkpoint at the Mauritanian border							
ND	ND	02.I.1946	3	Bir Gandux	Permanent well	Grazing areas.	–
ND	ND	03.I.1946	4	Uad Erchan	–	–	Wadi
ND	ND	06.I.1946	1	Grara Mulejiad	–	Arable depression	–
ND	ND	07.I.1946	2	Aguerbas	–	–	Rocky hills. Adrar Sottouf Massif
ND	ND	09.I.1946	1	Gleib Erchekma	Well	Grazing areas	Small inselberg. Adrar Sottouf Massif
ND	ND	09.I.1946	1	Yelua	Permanent well	Grazing areas	East edge of Adrar Sottouf Massif
0	–	10.I.1946	1	Gelb Amarraset	–	–	High peaks, Adrar Sottouf Massif
38	1	11.I.1946	2	Kudia Leganam	–	–	Hills visible from far away
39	6	17.I.1946	2	Gleib El Fernan	–	–	Inselbergs, Adrar Sottouf Massif
43	3	20.I.1946	2	Tuama	–	–	Twin peaks along Awsserd-Tichla track
75	10	01.II.1946	1	Heneifisat	–	–	Two groups of rocky peaks
20	1	02.II.1946	2	Daya Dyib-bet	Temporary pond	–	Rocky hills (Gleibat Ed-Diba)
107	8	10.II.1946	1	Agüenit	Permanent well	–	Rocky hill
79	3	13.II.1946	1	Le Yuad	Well	–	Massif (400-500m)
26	2	15.II.1946	1	Taderruret	–	–	Inselberg visible from faraway
14	1	16.II.1946	3	Aussert	Populated place	–	–
Km/D = 14		23.IV.1946	–	End of the mission, Sebja Dam (Villa Cisneros)	–	–	–

diagram of continentality ( $K'/C$ ) ranges into three climates (see Daget 1977).

1) the Oceanic climate ( $C < 1, K' < 25$ ) with low contrasts of temperatures and precipitations;

2) the Mediterranean climate ( $C \leq 1, K' \geq 25$ ) with a summer dry season, and three gradual variants: Mediterranean climate under maritime influences (M1), Mediterranean climate with low contrasts of temperatures and precipitations (M2), and Mediterranean climate with thermal amplitudes depending on the distance from the Ocean (M3);

3) the semi-continental climate ( $1 < C < 2, K' > 25$ ) with three variants of thermal continentality: (Sc3) with  $25 < K' < 80$ ,

and two variants (Sc1) and (Sc2) of mixed Mediterranean and Saharan influences in the extreme south of the region (Fig. 5D).

For Morocco,  $K'$  varies from 15 on the coast to over 80 on the southeast Mauritanian border (Mokhtari *et al.* 2014).

Spatialized Worldclim data of annual mean temperature and precipitation from 1950 to 2000 are available at a resolution of one kilometer. Mokhtari *et al.* (2014) have translated the regional continentality trends into maps (Mokhtari *et al.* 2014: 56, fig. 3). We have plotted the characteristic distributions of some species collected by Morales Agacino for the southern part of Morocco on the continentality index map of Mokhtari *et al.* (Fig. 5).

## VOCABULARY

The definitions of geographical names in the Table 3 are from Murat's glossary (1939: 201) and from the booklets of the 1949 map of the Spanish Sahara.

Aadam, Adam	the area that delimits the tributaries watershed of a river;
Aftout, Aftut	a sandy depression on hard ground between two dune chains;
Bir, Pozo, Hassi, Hasi, Aaglet, El Kantara	different kind of wells according to their depth and location; in Arabic, a bridge or a pass between two places, called Al Gantra in the Sahrawi language;
Galb	diminutive Gleib, plural Gleibat steep-sided hill of magmatic rock (currently an inselberg);
Grara(s)	slight depression where rainwater accumulates, casually cultivated in barley cereal;
Gueltat	a natural rainwater basin in rock;
Hammada	rocky plateau;
Hofrat	great depression;
Jang, Hang, Jeneig	a wadi canyon or a mountain pass;
Nebcas, Nebkhas	small dunes of sand blown up against tufts of vegetation;
Sebkhat, Sabkhat, Sebjet, Sebja	deep depressions in salty or gypseous sediments; tary deposits;
Ras	head or source of a river;
Fum	mouth of a river.

## ABBREVIATIONS

DMS	Degree, minute, second (geographical coordinates);
MNCN	Museo nacional de Ciencias naturales, Madrid;
MNHN	Muséum national d'Histoire naturelle, Paris;
UAM	Universidad Autónoma de Madrid, Madrid.

## RESULTS

### SAMPLING CONSTRAINTS OF COLLECTION SITES

In the 1940 decade, the 260 000 km<sup>2</sup> of desert in the Spanish colony were not fully explored. The assistance of guides was therefore essential. The eight surveys (Table 1) had to be planned over limited periods of three to 16 weeks of dromedary ride, and a linear sampling of collecting sites was established according to three constraints: navigation in a desert environment, topography of the terrain, that needs to be practicable by dromedaries, and supplies limit. Wells with available water, grazing areas and landmarks dictated the choice of stages (Table 3). In Morales Agacino's publications, the observations associated with collected species often referred to visual landmarks, such as hills, rocky peaks or cliffs visible from a great distance on the routes followed by the nomads (Morales Agacino 1947b).

As an example of these constraints, we detail an extract of Morales Agacino's 1946 survey (Jan. 2 to mid-Feb.) by examining the published collection dates (Morales Agacino 1947a) and consulting the notes attached to the Spanish Sahara (1949) map describing the localities (Table 2): the first stop mentioned after a seven-day ride was at Gleig Erchekma and Yelua, two localities where grazing is abundant on the eastern edge of the Adrar Sottouf Massif. The next chosen stop was not Le Yuad, the shortest route to Aousserd, but Aghouinit,

100 km to the east, an eight-day mehari to fetch fresh water from a permanent well. The time between the water points must have been a real problem to plan.

During this 45-day survey, only ten species of Polyneoptera were collected: five orthopteran Caelifera (*Acrotylus longipes* (Charpentier, 1845); *Ochrilidia gracilis* (Krauss, 1902); *Ochrilidia geniculata* (Bolivar, 1913); *Anacridium melanorhodon melanorhodon* (Walker, 1870); *Tenuitarsus angustus* (Blanchard, 1836)); two Mantodea (*Eremiaphila murati* Chopard, 1940; *Heteronutarsus aegyptiacus* Lefèbvre, 1835); two Blattodea (*Heterogamodes ursina* (Burmeister, 1838); *Heterogamodes cerverai* (Bolivar, 1886); and one orthopteran Tettigoniidae Krauss, 1902 (*Diogena fausta* (Burmeister, 1838)).

Over the whole program, 33 Acridomorpha species were collected in 124 localities, which gave an average of 2.3 acridids per locality. Published results show however that 44% of the localities hosted only one acridid species. Related to the number of surveyed kilometers this estimate illustrates the extent of the task undertaken.

### COLLECTING LOCALITIES

We managed to identify overall 134 collecting localities of Morales Agacino's surveys. Their present-day toponyms and their geographic coordinates in DMS on the Moroccan topographic map at 1/250.000 are given in Table 3, and their geodata are given in the Supplementary Table 1.

Location data are plotted in Figure 2A with an identifier of their current names listed in Table 3. Their distribution is relatively homogeneous and dense throughout the study area, although sparser in the Oued Dra region and the central part of the Rio de Oro. The mission of Morales Agacino and Mateu Sanpere to the *Schistocerca gregaria* outbreak areas (Jan.-May 1943) is reconstructed (Fig. 2A) and compared with the survey sketch-map published in 1943 (Fig. 2B) (Morales Agacino 1943). Our reconstruction is consistent with the published map, except for two additional areas in the Rio de Oro, which correspond to undocumented collects by Morales Agacino in the Nagir along the Argub-Aousserd road and at Adrar Sottouf Massif (Morales Agacino 1943).

### GENERAL INSECT SURVEYS

Table 4 and Appendices 1-4 list all the species collected during the eight surveys in the Spanish Sahara by Morales Agacino for Polyneoptera (Table 4 for Orthoptera, Appendix 1 for other Polyneoptera), Mateu Sanpere for Coleoptera Carabidae Latreille, 1802 (Appendix 2), Español Coll for Coleoptera Tenebrionidae Latreille, 1802 (Appendix 3), and Giner Marí for Hymenoptera (Appendix 4).

Identifications provided by Morales Agacino and his colleagues could not be checked, owing to this scale of the survey, except for Acridomorpha (see below). Species names are listed as published, but associated with the current status of the species. Morphological examination of the specimens will be necessary to confirm identifications. Except for the Acridomorpha (see below), we have checked the identifications provided by Morales Agacino and his colleagues as far as we could manage the scale of the collections.



TABLE 3. — Annotated list of the localities cited by Morales Agacino, Mateu Sanpere, Español Coll and Giner Marí, during their entomological surveys in Spanish Sahara (1941–1946), with variation in names, geolocation and a brief description of the localities. Map references: map of the Spanish Sahara (1949) and map of Morocco (1993). Locality numbers: see Fig. 2A and Fig. 4. See also Georeferenced cartography.gpx in Supplementary Table 1.

Locality no.	Spanish toponyms	Current toponyms Spanish map, Moroccan map	Geographical coordinates	Descriptions
1	Adam Tikerdat	Timquerdad, Timquerdad	23°56'00"N, 12°57'00"W	Watershade of the Echfal wadi, a permanent well.
2	Adoloa Amgala	Amgala, Amgala	26°26'14"N, 11°26'34"W	A hill that stretches (Doloaa) over fifty kilometres along the Win Targuet wadi.
3	Agailas	Agailás, Aghaylas	22°27'56"N, 14°22'51"W	Location of a permanent well.
4	Agli Ben Ali	Sidi Baba Aali, Agli Baba 'li	26°44'00"N, 13°33'00"W	A tomb near the coast.
5	Aglimim Mel-las	Aguelmin Mel-las, Aguelmin Mellas	25°27'17"N, 12°11'34"W	A tributary of the Khang Santama wadi.
6	Agued Daaxa	Aagued Edhacha, Gued Ad-Dhacha	25°08'42"N, 13°13'48"W	Aftout with Acacia raddiana trees, graras and grazing areas.
7	Agüenit	Agüenit, Aghwinit	22°11'00"N, 13°08'24"W	Stony ground and a ruined fortress, location of a permanent well.
8	Aguerbas	Agrubas labiad, Agroubbas Labyad	21°43'00"N, 15°41'00"W	Small hills in the southern part of the Adrar Sottouf massif.
9	Ain Rag	Aain Rag, Ayn Arreg	25°50'03"N, 13°14'57"W	A well on the edge of the Al Khatt wadi.
10	Ajabari	Ahbari, Galb Ahbari	22°16'43"N, 15°15'28"W	This granitic rock in the northern part of the Adrar Sottouf massif is the highest peak (429 m a.s.l.)
11	Amguilli Sguelma	Udei Agüidir, Wad Amagli Zgalma	26°11'19"N, 11°35'57"W	Amagli Zgalma is a small tributary of the Win Targuet wadi.
12	Amuiserat	Amuisirat, G'idat Amwizirat	26°42'35"N, 12°46'32"W	Watershed of the Itgui wadis.
13	Aridal	Aridal, Aridal	25°58'06"N, 13°43'09"W	A well at the south-east bank of the Aridal Sebkhata.
14	Aserifa (D)	Asreifa, Asrifa	28°17'24"N, 11°24'37"W	Is a steeply sloping edge of the Hameidia El Gueblia close to the coast and the Cheibeca wadi.
15	Aserifa (SH)	Asreifa, Asserfa	26°19'00"N, 13°42'00"W	Plain to the north-east of Aridal Sebkhata, this collecting site is on a map by Mateu Sanpere (1947: 149).
16	Atuifer	Atuifat, Gor At-Twifat	21°22'35"N, 16°57'09"W	Sandstone rocky hills in the Aguerguer region. Karstic relief with cap-rock columns.
17	Audebdidet	Audebdibet, Awdibdiba	24°06'17"N, 15°11'35"W	Depression at the western edge of the sandstone buttes of the Aguerguer.
18	Auijefrat	Auhaifraten, Awhifraten	25°17'00"N, 14°00'00"W	Grazing areas and graras in Imiric-li region.
19	Auletix	Uad Auleitis, Wad Awletis	25°49'29"N, 12°30'24"W	Wad Awlitix ends up in the Hofrat Laayerma depression.
20	Aussert	Ausert, Awsserd	22°33'26"N, 14°18'40"W	Populated place. Group of steep granitic peaks.
21	Benkara	Bencara, Benkara	25°48'53"N, 13°29'21"W	Hill with steep escarpments, 63 m high above the surrounding plain of El Mesiah.
22	Bir el Hamar	Bir Lehmar, wad Bir Lahmar	26°03'21"N, 11°01'17"W	A well and a wadi are of the same name there.
23	Bir Gandux	Bir Gandús, Bir Gandouz	21°36'43"N, 16°28'15"W	A permanent well of drinking water and important grazing areas.
24	Bir Labid	Bir El Abid	23°27'05"N, 13°04'55"W	A brackish water well on the bank of Wad Atui.
25	Bir Nzarane	Bir Nzarane, Bir Anzarane	23°53'10"N, 14°31'28"W	A drinkable water well.
26	Bu Kerch	G. Bu Quercha, Graret Boukarache	24°55'16"N, 14°44'23"W	Deep depression cultivated on the bank of the Assak wadi north of the Timokrarin hills.
27	Cabo Juby	Cabo Yubi, Ras Joubi	27°56'52"N, 12°55'24"W	Cap Juby is famous for its former postal airfield.
28	Daya Dyyib-bet	Gleibat Ed Diba, Gleibat Adyad	21°36'37"N, 14°01'56"W	A temporary pond in the area is missing. Small isolated hills with the name (Gleibat Ed Diba) could be an option?
29	Dora	Daora, Dawra	27°25'14"N, 12°59'21"W	Populated place and a well.
30	El Aiun	Aaiun, Laâyounne	27°09'39"N, 13°12'41"W	Province of the region Laâyounne-Saquia Al Hamra.
31	El Argub	Aarbug, Al Argoub	23°36'53"N, 15°52'38"W	Populated place in front of Villa Cisneros (Dakhla).
32	El Armas	Lermaz, Lermaz	26°39'50"N, 11°42'41"W	Lermaz is quite hilly, with many streams running through it.
33	El Farsia	El Farsia, Hassi Al Farciya	27°06'09"N, 09°50'16"W	Source of the Wad A's Saquia Al Hamra and a well.
34	El Gaxuch	Al Gachouch, Al Gachouch	27°00'35"N, 09°59'56"W	A tributary at the head of the Wad A's Saquia Al Hamra.
35	El Hasiat	Lahsaiat, Lermaz	26°50'49"N, 12°12'26"W	The name is due to the colour of the calcareous soil.
36	El Kantara	El Gantra, Al Gantra	26°03'24"N, 14°04'17"W	Al Gantra is a pass between both Aridal and Arryd Sebkhats.
37	El Krab	Carb Infrac, Krab Infrac	23°53'23"N, 14°06'34"W	Rugged plateau to the east of Bir Enzarane.
38	El Mekeiteb	Lemcaiteb, Lamkayteb	26°48'20"N, 10°05'15"W	Is the name of the valley of the Ben Sacca wadi, location of a well.
39	El Meseied	Meseied, Lamsiyed	27°02'00"N, 13°06'00"W	Oasis in the A's Saquia Al Hamra valley.
40	El Mesiah	El Mesiah, El Meslah	25°54'13"N, 13°24'54"W	Great barren plain bounded to the west by the Benkara rock, grazing areas.
41	Ezmul Agazel	Semul Agasal, Zmoul Aghassal	25°29'49"N, 12°52'28"W	A small hill along the track, from Laâyounne to Gueltat Zemmour, that crosses the Lagtam plain.
42	Gelb Amarraset	Gleibat Amarrasit, Amarrasit	22°11'17"N, 15°23'40"W	These granitic rocky peaks and buttes are among the highest peaks in the Adrar Sottouf massif.
43	Genei Ali	Jeneig Aali, Hassi Khenigat Ali	28°15'28"N, 10°37'09"W	Pass across the Jebel Rich and a well.
44	Gleib El Fernan	Gleibal El Fernán, Gleyb Al Farnán	22°13'00"N, 14°55'59"W	Groups of rocky inselbergs in the northeast of Adrar Sottouf massif.

Table 3. — Continuation.

Locality no.	Spanish toponyms	Current toponyms Spanish map, Moroccan map	Geographical coordinates	Descriptions
45	Gleib Erchekma	Gleibat Arch Amar	21°41'00"N, 15°32'00"W	Mounds at the source of the Arch Amar wadi, location of a well and grazing areas.
46	Gleibat Tefeigum	Tifiguiuen, Tifiquirn	26°42'42"N, 12°12'28"W	Rocky hills, sources of tributaries of the Wad A's Saquia Al Hamra.
47	Grara Mejeiris	Gréier Lemheiris, Griyer Lamhiriz	22°02'37"N, 16°45'29"W	Humid grara casually cultivated.
48	Greit Uld El Aait	Graret Uld El Aacal, Graret Ould Al ' Agel	24°25'00"N, 15°03'00"W	A slight depression (graret) that can be flooded, is on the edge of the Aguerguer sandstone buttes.
49	Guelta del Zemur	Guelta Zemmur, Gueltat Zemmour	25°08'26"N, 12°22'22"W	A rainy-water basin, is at the western tip of the Zemmour sandstone massif.
50	Güera	Güera, Lagwira	20°46'24"N, 17°05'50"W	Populated place at Cap Blanc
51	Guerat Sba	Quediat Seba, Oudiyat Sba	25°34'56"N, 12°24'12"W	Two twins hills fifteen km apart to the north of the Zemmour Massif.
52	Hang Sekum	Uad Jang Saccum, Khang Saccoum	26°54'37"N, 11°28'57"W	The Terguet and Leijchebi wadis flow into the Khang Assakoum canyon.
53	Hanga Rambla	Jang Ramla, Khang Ar-Ramla	25°56'44"N, 12°04'43"W	Khang Ar-Ramla is a wadi canyon.
54	Hausa	H. Hausa, Hawza	27°06'01"N, 11°01'03"W	A limestone mound at the confluence of both Quesat and A's Saquia Al Hamra wadis.
55	Heneifisat	Jeneifisat, Khneyfissa	21°46'29"N, 13°56'01"W	Two small hills (K. Lkhadra and K. Lbayda) on the western edge of the Tiris region.
56	Imililik	Sebja Imilili, Sebkhata Imilili	23°17'23"N, 15°54'57"W	Shallow salty depression with reeds.
57	Imiricli Lebiad	Imiricli Labiad, Imirikli Labyad	25°30'00"N, 14°03'00"W	A very arid region south of the Sebkhata Aridal, graras casually cultivated in the northern part.
58	Inillan	Iniyana, Eniya	22°49'00"N, 14°44'00"W	Isolated hills above the surrounding the Wad Bu Loutad plain.
59	Ixergan	Ichergan, Ichargane	24°53'17"N, 12°24'47"W	Chain of three steep mountains 120 m high, remains of an eroded plateau.
60	Jatuta el Bar	Graret Jatút El Bar, Graret Khtout Al Bar	24°13'31"N, 15°24'19"W	Small wet depressions casually cultivated on the coast near Cap Leven.
61	Kraib el Mais	Arbet Lemais, Ragueta Lam' iz	21°23'00"N, 16°50'00"W	A vast area of dunes in the east of the Aguerguer region.
62	Kudia Leganam	Quediat Legnem, Koudyat Lagnam	22°10'48"N, 15°19'12"W	Hills (150 m high) in the Adrar Sottouf massif, are visible from a long way away.
63	Las Cuevecillas	Los Lobos, Los Labos	21°06'05"N, 17°03'23"W	Cliffs of Cap Blanc near Tarf El Guerguerat.
64	Layeyiyat	Laayayia El Jadra, La' jajiya Al Khadra	23°01'04"N, 14°04'00"W	Two groups of hills (L. El Jadra and L. El Beida) on either side of the Dumas Sebkhata.
65	Lexeixe	Lahcheicha, Lachiycha	25°53'28"N, 13°39'36"W	A vast plain between the Benkara rock and the Aridal Sebkhata.
66	LeGlat, Leiglat	Leglat Derraman, Derraman	22°38'19"N, 14°27'56"W	Steep rock (300-400 m high) west of Awsserd.
67	Le Yuad	Leyuad, Lajwad	22°23'01"N, 13°50'50"W	Name of three great massifs (400-500 m high) in the Tiris region, location of a well.
68	Medengue	Imudeguen, Imoud Guen	23°48'08"N, 13°24'09"W	Imoud Guen Labyed is a broad sandy plain on the western edge of Tiris.
69	Mejayub El Meftub	Lemhaiuib Meftuc, Wad Lamhajib	26°47'50"N, 12°22'14"W	Left-bank tributary of the Wad A's Saquia Al Hamra.
70	Melgui El Garek	Melga El Gàreg, Malga Al Ghareg	22°47'46"N, 16°10'44"W	Wet depression where the wadi Fadrat El Ghareg ends up in the dunes.
71	Meseied	Meseied, Lamsiyed	27°02'00"N, 13°06'00"W	Place of a well and an oasis on the banks of the Wad A's Saquia Al Hamra.
72	Metlani	Metlani, Uad El Motlani	25°59'20"N, 11°15'16"W	At the Mauritania border, source of the El Motlani wadi.
73	Musgag	Um Echgag, Oum Achgag	26°32'00"N, 12°13'59"W	At this place is a Daiet and a Gour.
74	Neggir	Negyir, Nagjir	23°36'00"N, 14°40'01"W	Large rocky plateau surrounded by jagged cliffs (100-200 m high).
75	Ogranat	Ugranat, Waghranat	26°18'13"N, 14°03'09"W	There are no wells or pastures on this barren plateau.
76	Pozo Meirich, Uad Ratmia	Hasi Meheiris, Oudei Mhiriz	26°06'19"N, 11°03'49"W	The Rkhamiya wadi is at the confluence of the Bir Lhamar and Mhiriz wadis.
77	Pozo Mesit	Hasi Habàs ?, Hasi Habbaz ?	26°25'28"N, 14°09'48"W	Hasi Habbaz at Cap Cinq is a well that fit Pozo Mesit cited by Mateu Sanpere (1947).
78	Pozo Nebka	Nebca, Nebka	26°01'55"N, 11°36'09"W	Place of a well on the upper course of the Terguet wadi. Nebca is tiny dunes against tussocks of vegetation.
79	Pozo Tuf	Hasi Tuf, Ayn Touf	24°36'13"N, 14°59'17"W	A well on the coast.
80	Raguia	Sebjet Raguia, Sebkhata Arragulya	23°55'48"N, 15°42'00"W	Sebkhata to the north of the Dakhla Bay.
81	Ras Seluan	Uad Uein Seluan, Wad Win Sallwane	26°26'58"N, 11°42'29"W	Wad Win Sallwane is a tributary of the Wad A's Saquia Al Hamra.
82	Raud el Each	Raudat El Hach, Sidi El Haj Hmar Al Lahia	27°02'26"N, 11°09'37"W	A tomb in the Saquia Al Hamra valley.

Table 3. — Continuation.

Locality no.	Spanish toponyms	Current toponyms Spanish map, Moroccan map	Geographical coordinates	Descriptions
83	Sebja Dam	Sebjet Eddam, Sebkhath Ad-Dame	23°55'48"N, 15°36'00"W	Sebkhath at the bottom of the Dakhla bay.
84	Sebja de Fares	Sebjet Fares, Sebkhath Fares	22°22'26"N, 16°22'00"W	Sebkhath on the eastern edge of the Acla Fares dunes parallel to the coast.
85	Sebja Echaiba	Grair Lajcheb?, Grair Lajaneb ?	27°16'12"N, 13°06'36"W	Sebkhath or humid depression?
86	Sebja Tah	Sebjet Tah, Sebkhath Tah	27°42'00"N, 12°48'00"W	The Atlantic Sahara largest Sebkhath is 50 km wide.
87	Sebja Yebeilat	Sebjet Agsumal, Sebkhath Aghzoumal	24°27'14"N, 12°55'50"W	This Sebkhath is at the south of the Yebeilat El Bid hills range (300 m high).
88	Seljet et Leben	Cheljat Elbena, Chalkhat Al Ben	25°23'48"N, 12°33'14"W	Source of this small stream (Cheljat) is in the Zemmour Massif.
89	Seluan (Fum)	Wad Uein Seluan, Wad Win Salwane	26°05'00"N, 11°43'25"W	The mouth of the Salwane wadi, a tributary of the Wad A's Saquia Al Hamra.
90	Sidi Ahamed El Arosi	Sidi Ahmed Laarosi, Sidi Ahmed La rosei	26°50'17"N, 11°55'13"W	Tomb in the valley of the Wad A's Saquia Al Hamra.
91	Smamit	Glat Semamit, Glat Smamit	24°09'37"N, 13°13'02"W	Rugged plateau edged by cliffs and canyons, many small gueltats.
92	Smara	Semara, Smara	26°44'03"N, 11°40'40"W	City currently Province of Laâyoune-Saquia Al Hamra region.
93	Tabarkal-la	Uad Tebarcal-la, Wad Tbark Allah	22°32'30"N, 16°10'54"W	A well and a wadi of the same name.
94	Taderruret	Tederruret, Tidrouret	22°30'00"N, 14°10'30"W	Inselberg overlooking the plain, is visible from a long way away.
95	Taguerzimet	Taguersimet, Hassi Taguerzimt	24°06'58"N, 15°06'52"W	A well in the Aguerguer sandstone buttes.
96	Tarf Abda	Tarf Aabda, Tarf 'Abda	24°00'00"N, 13°04'12"W	Cliff on the northern edge of the Tiris.
97	Taruma	Twarim, Touaroum	26°46'15"N, 13°30'58"W	There is a brackish water well and a little salty depression (Sebjet) nearby.
98	Tichla	Tichla	21°35'43"N, 14°57'57"W	Populated place, a wadi and a well, a group of steep inselbergs and buttes in an Acacia raddiana' plain.
99	Tifariti	Tifariti, Tfarity	26°09'33"N, 10°33'38"W	Ruined fort and a permanent well.
100	Tigueret	Tiguelelalten, Tiglalatine	26°02'45"N, 12°01'38"W	A large meseta in the northwest of the Dolou massif
101	Tislatin	Dait Tislatin	26°40'59"N, 13°33'58"W	A depression floodable (Dait), is on the north of El Hasian.
102	Tizguerrentz	Tuisgui Remz, Tizgui Remz	28°25'14"N, 09°12'57"W	Pass towards the Draa valley in the Djebel Ouarkiz and source of the Tighzert wadi.
103	Togba	Aain Togba	22°55'48"N, 15°57'00"W	Wadi and numerous wells at the east of the Carbet Hamma cliffs.
104	Tuama	Quediat Tuama, Glab Twama	21°50'00"N, 14°42'00"W	Glab Twama are two twins conical inselbergs in a large sandy plain along the track from Awsserd to Tichla.
105	Uad Abogdad	Udei Bogdad, Wad Boghdad	26°20'07"N, 11°41'00"W	The source of the Boghdad wadi is on the Legaaida plateau.
106	Uad Arrad	Wad Arraid, Wad Arraid	27°39'00"N, 09°32'00"W	A group of wadis also called Udian Arraid which end in the grasas of Mahbes Arraid.
107	Uad Asak	Uad Assag, Wad Assaq	24°43'26"N, 14°29'52"W	Very long wadi. It ends up in the sands before reaching the sea.
108	Uad Asli Uduik	Udei Aasli Dueic, Wad L'Agli	26°36'36"N, 11°45'09"W	Wad L'Agli is a tributary of the Wad A's Saquia Al Hamra.
109	Uad Atui	Uad Atui, Wad Atwi	21°56'51"N, 14°13'31"W	Very long wadi, it sources near Awsserd and ends in Mauritania.
110	Uad Belaruk	Uad Bu Laarug, Wad Bou La 'roug	25°53'17"N, 14°02'38"W	Bou La'roug wadi ends up in the Arrid Sebkhath.
111	Uad Busakka	Uad Ben Sacca, Wad Ben Zakka	26°47'57"N, 10°05'20"W	Tributary of the Ternit wadi.
112	Uad El Arrad (RO)	Uad Aarred, Wad 'Arrid	25°44'32"N, 13°12'13"W	Wad 'Arrid is a tributary of the Al Khatt wadi.
113	Uad Erchan	Uad Archan, Wad Archane	21°41'32"N, 16°17'03"W	A wadi with many tributaries.
114	Uad Ernit	Uad Erni, Wad Erni	26°33'13"N, 10°20'23"W	Wad Erni is a tributary of the Lakchaybi wadi.
115	Uad Eskaikima (Ras)	Chebeicat Escaiquima (Ras)	27°19'03"N, 10°09'54"W	Source of the Escaiquima wadi, grasas casually cultivated.
116	Uad Grat	Uad Legrad, Wad Laghrad	26°47'58"N, 12°27'10"W	A tributary of the Wad A's Saquia Al Hamra.
117	Uad Izik	Uad Laalem ?, Izic, Izik	26°24'29"N, 13°20'02"W	No Uad Izik was found. Map by Matheu Sanpere locate Izik along the western edge of the arid plateau (1947: 149).
118	Uad Jak	Uad Saac	28°12'39"N, 9°17'42"W	Uad Saac is a tributary of the Tighzert wadi.
119	Uad Kebiat	Uad El Caabiat, Wad Al Ka'biyat	26°28'23"N, 10°32'11"W	Wad Al Ka'biya is a tributary of the Erni wadi.
120	Uad Komba	Uad Bomba, Wad Boumba	24°15'56"N, 13°10'58"W	A tributary of the An Noç wadi that ends in the Sebkhath Aghzoumai.
121	Uad Kraa	Uad Craa, Wad Lakra	24°35'04"N, 14°51'55"W	This well is at Wad Lakra mouth.
122	Uad Laarad	Uad Laarad, Wad La'rad	23°05'30"N, 15°55'55"W	A twenty km long wadi, north of the Al'Atf plateau, it ends at the foot of the Gor El Hofra.

Table 3. — Continuation.

Locality no.	Spanish toponyms	Current toponyms map, Moroccan map	Spanish Geographical coordinates	Descriptions
123	Uad Lejcheibi	Fadrat Lajcheb, Fadrat Lakhcheb	24°15'40"N, 13°49'53"W	A tributary of the wad Atui in Tichia plain, grazing areas and small canalized wadis (Fadrat).
124	Uad Meharitz	Udei Lemharir, Wad Lamharit	26°17'51"N, 12°07'36"W	A small tributary of the Wad A's Saquia Al Hamra wadi. Part of the wadi between the foothills of Dolou and Seken massifs.
125	Uad Ternit	Uad Ternit, Wad Ternit	26°40'52"N, 10°17'10"W	Wad Ternit is a tributary of the Lakchaybi wadi.
126	Uad Tigsert (Fum)	Uad Tigsert, Wad Tighzert	26°53'03"N, 12°37'55"W	Left-bank tributary of the Wad A's Saquia Al Hamra.
127	Villa Cisneros	Villa Cisneros, Ad-Dakhla, Dakhla	23°42'05"N, 15°55'54"W	Populated place in the peninsula of the Dakhla Bay, ex Villa Cisneros.
128	Xera	Edchera, Ad-Dchira	27°01'34"N, 13°03'32"W	Location of a well.
129	Yebeilat	Yebeilat, Jbylat Al Biya	24°42'00"N, 12°36'00"W	Mountain chain (300 m high) of buttes and ridges south of the Ichargane and Zemmour massifs.
130	Yelua	Yelua, Rag Labyad	21°51'00"N, 15°38'23"W	Some grazing areas and a permanent well along the Jalwa wadi.
131	Yerifia	Aaglet Yeraifia, Jrifia	24°58'40"N, 14°22'09"W	A well in the bed of a stream (Aaglet) or a temporary rain ponds (Dait) and a grara, south of the Imiric-li region.
132	Zemlet Ad Dbax	Samlat Edbech, Zamlat Adbach	26°28'28"N, 12°39'08"W	A low plateau with a reg surface in the north-western part of the Lehdeb plain.
133	Zug	Zug, Zoug	21°36'47"N, 14°08'48"W	Populated place, a well and the Atui wadi. Rocky basalt peaks overlooking a sandy plain.
134	Uad Lagaila	El 'Aagaia, Al 'Aggaya	22°08'13"N, 16°15'38"W	The name is due to the abundance of <i>Zygophyllum waterlottii</i> Maire (local name Agaila) and from the many streams that end in the Hofrat dunes.

DATA FOR ORTHOPTERA

One of us (AL) focused on Orthoptera Acridomorpha. The data summarized in Table 4 were used to produce distributional maps by species or groups of species, which proved reasonably accurate to interpret their distributions according to environmental data, or confirmed taxonomic hypotheses.

33 species of Caelifera have been recorded (Table 4). Among these, three Pamphaginae Burmeister, 1840, viz. *Paracinipe exarata* (Bolivar, 1936), *Glauvarovia mendizabali* Morales Agacino, 1945 and *Glauia saharae* Morales Agacino & Descamps, 1968, were found to be the southernmost of the 83 species of Pamphaginae known from North Africa (Morales Agacino & Descamps 1968; Descamps 1970; Chobanov & Massa 2022). All the four genera of Dericorythidae known from North Africa are present in the studied area, including one genus represented by a single endemic species, *Bolivaremia domenechi* Morales Agacino, 1949. In contrast to the many species originating from the Mediterranean border of Sahara, only three taxa, *Anacridium melanorhodon melanorhodon* (Walker, 1829), *Poekilocerus bufonius hieroglyphicus* (Klug, 1829) and *Sphingonotus canariensis* Saussure, 1884, are Sahelian species that extend occasionally to Rio de Oro. Morales Agacino (1945a) collected eight nymphs of *Poekilocerus bufonius hieroglyphicus*, 1 ♂ and 1 ♀ nymphs (15.IV.1943) at Leglat = Derramán and 6 larvae (14.XII.1941) close to Zug. One of us (AG) observed also one larva at Derramán, west of Aousserd (22°36'N, 14°28'W; 360 m, 19-20.XII.2017). Such breeding, in localities where the obligatory host plant, i.e., *Calotropis procera* Aiton, 1811, has not been found, is unlikely to result in fertile population (Popov & McE Kevan 1979).

We detailed below some of the questions that the inventories of Morales Agacino could help reanalysing, namely the synonymy between *Pamphagulus mateui* Morales Agacino, 1949 and *Pamphagulus vicinus* Ramme, 1931 (Dericorythidae); the type locality of *Bolivaremia domenechi* Morales Agacino, 1949; the location of Aserifa, a paratype locality of *Bolivaremia domenechi laevigata* Morales Agacino, 1949; and the extension of the distributions of pamphagid grasshoppers in the Atlantic Sahara as documented by Morales Agacino collections.

*Synonymy of Pamphagulus mateui Morales Agacino, 1949 and Pamphagulus vicinus Ramme, 1931*

Descamps (1970) compared two paratypes of *Pamphagulus mateui* with the female type of *Pamphagulus vicinus* Ramme, 1931 and studied eight males and three females of *P. vicinus* from the Sebkhah Tah preserved at the MNHN. He concluded that *Pamphagulus mateui* Morales Agacino, 1949 is a synonym of *Pamphagulus vicinus* Ramme, 1931: "(...) aucune différence de nature à justifier des divisions spécifiques n'a pu être relevée. *P. vicinus* est cependant très variable quant à la rugosité tégumentaire et l'ampleur de la saillie pronotale." [(...) no differences that could justify specific divisions could be found. *P. vicinus* is, however, highly variable for integument roughness and for the extent of pronotal projection.] (our translation).

Also, the subspecies, *Pamphagulus mateui audebdidetensis* Morales Agacino, 1949, was collected in six localities. In two of these six localities, viz. Bu Kerch and Agli Ben Ali, it was collected the same day with *P. mateui mateui*; it was also collected the same day at Jatuta el Bar with *P. vicinus* (Table 5). Descamps (1970) did not raise the issue of *Pamphagulus mateui*

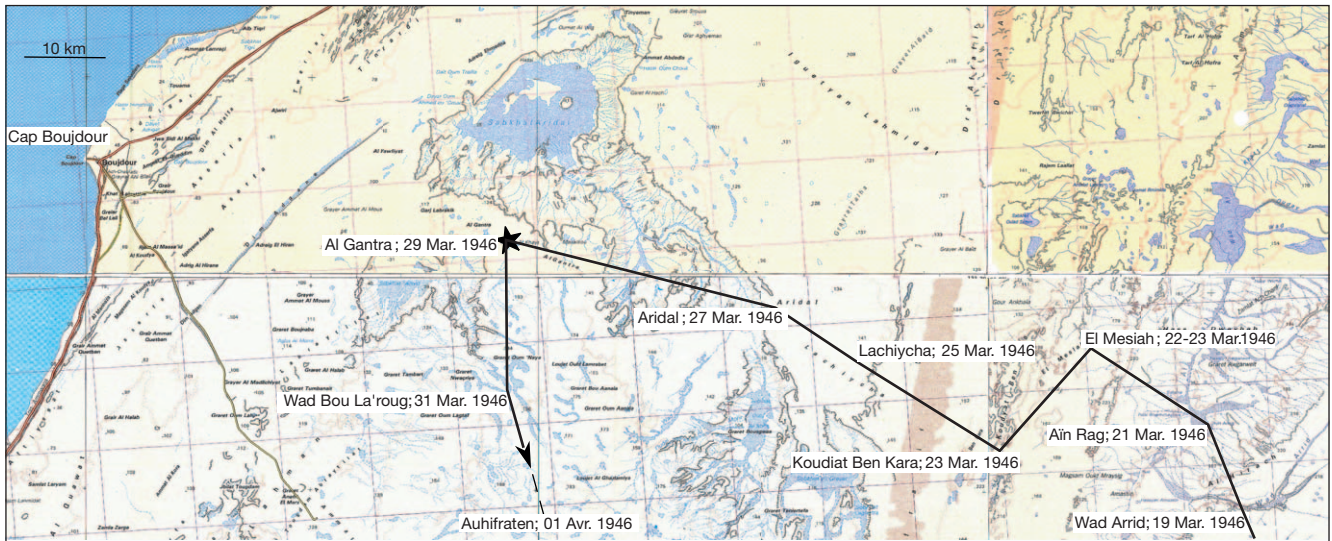


FIG. 3. — Localisation of the locality El Kantara = Al Gantra along the course of Morales Agacino's 1946 expedition. Symbol: ★, type locality of *Bolivaremia domenechi* Morales Agacino, 1949. Modified from Map of Morocco (1993).

*audebdidetensis*. But mapping the distributions of the three *Pamphagulus* taxa shows a consistency between the data of Morales Agacino & Descamps (Fig. 4; Table 5).

On the basis of these distributional data, the synonymy of the two subspecies of *P. mateui* should be reconsidered, as they occur together in the same collecting sites. In the same way, the examination of the specimens collected by Morales Agacino should help considering if *P. mateui* should be synonymized with *P. vicinus*, as suggested by Descamps (1970): a single species, *Pamphagulus vicinus*, could actually be present along the coast of Atlantic Sahara from the Sebkhah Tah (27°40'N, 12°48'W) to the Cap Blanc peninsula (21°06'N, 17°03'W).

*El Kantara: Rio de Oro, type locality of Bolivaremia domenechi* Morales Agacino, 1949

El Kantara is the Arabic name for a bridge, a pass; this toponym is unknown on the Spanish maps of the 1940s and in today's Moroccan maps. To find out that Al Gantra means a bridge in the Sahrawi language has been a challenge! Interpretation of the route followed by Morales Agacino in 1946 showed that he went through Al Gantra (Fig. 3). Al Gantra is a broad, flat strip of land, 20 × 5 kilometres wide, which separate the Aridal and Aarred sebkhas, a pass for caravans to the sea, confirmed on a 1926 map of the French army available on the website of the Université Montaigne, Bordeaux. The translation of El Kantara by Al Gantra on modern maps is explained by the fact that the Sahrawi pronounce the 'k' as a 'g' (Taine-Cheikh 1989: 2). So, the type locality has to be labelled El Kantara = Al Gantra (26°03'24"N, 14°04'17"W). El Kantara is the origin of a large and rich Acridomorpha community (Tables 6; 7).

*Two localities named Aserifa*

Aserifa (SH) is the name given by Morales Agacino to the paratype locality of *Bolivaremia domenechi* var. *laevigata* Mo-

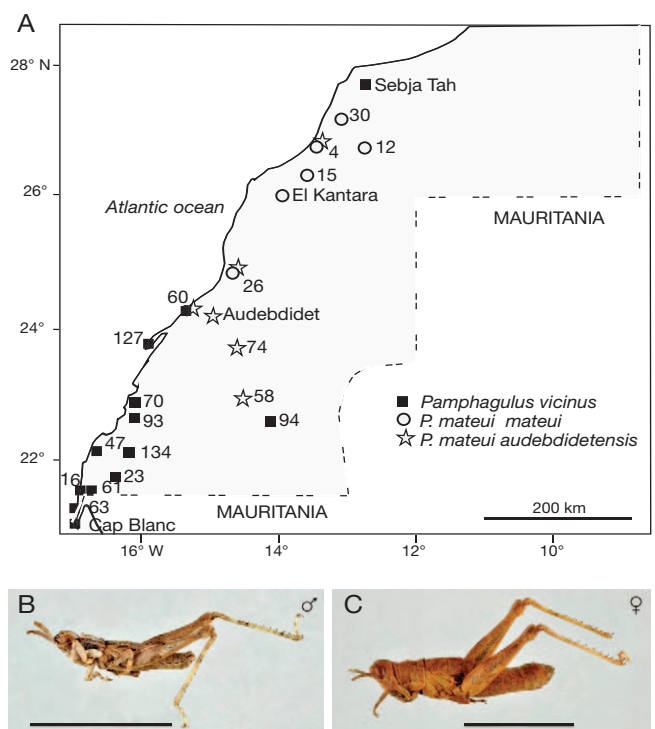


FIG. 4. — *Pamphagulus* taxa in Spanish Sahara: **A**, Distribution of *Pamphagulus vicinus* Ramme, 1931, *Pamphagulus mateui mateui* Morales Agacino, 1949 and *Pamphagulus mateui audebdidetensis* Morales Agacino, 1949 (Orthoptera Acridomorpha Dericorythidae); **B, C**, habitus of *Pamphagulus vicinus* Ramme, 1931: **B**, male, specimen MNHN-EO-CAELIF159; **C**, female, specimen MNHN-EO-CAELIF160. Locality numbers: see Tables 3 and 5. After Morales Agacino (1949).

rales Agacino, 1949. It is also the collection site of 32 species of Polyneoptera, Hymenoptera and Coleoptera. The location of Aserifa near Cap Boujdour, as deduced from the 1943 mission schedule in the Saquia Al Hamra region, is supported by two sketch maps (Giner Mari 1944; Mateu

TABLE 4. — List of Orthoptera collected by Morales Agacino *et al.* in the Spanish Sahara in 1941-1945, with correspondences in Morales Agacino's papers (1943-1949). Symbol: \*, unpublished synonymy incorporated in the Orthoptera Species File online (Cigliano *et al.* 2021); we are aware of no paper by Descamps & Wintrebert (1967) where this synonymy would have been proposed. Abbreviation: **C.S.**, current status.

Upper Classification Species	Year of issue
Caelifera	
Acridoidea MacLeay, 1821	
Acrididae MacLeay, 1821	
Cyrtacanthacridinae Kirby, 1910	
<i>Anacridium moestum melanorhodon</i> (Walker, 1870)	1945a, b, 1947, 1948
C.S. <i>Anacridium melanorhodon melanorhodon</i> (Walker, 1870)	–
Eremogryllinae Dirsh, 1956	
<i>Eremogryllus hammadae</i> Krauss, 1902	1945a, 1947
<i>Notopleura rothschildi</i> Uvarov, 1923	1945a, 1947
Eyprepocnemidinae Brunner von Wattenwyl, 1893	
<i>Thisoicetrus annulosus</i> (Walker, 1870)	1945a, b, 1947
C.S. <i>Heteracris annulosus</i> Walker, 1870	–
<i>Thisoicetrus harterti</i> Bolivar, 1913	1945a
C.S. <i>Heteracris harterti</i> (Bolivar, 1913)	–
Gomphocerinae Fieber, 1853	
<i>Platypterna geniculata</i> Bolivar, 1913	1947
C.S. <i>Ochrilidia geniculata</i> (Bolivar, 1913)	–
<i>Platypterna rothschildi</i> Bolivar, 1913	1947
C.S. <i>Ochrilidia geniculata</i> (Bolivar, 1913)	–
<i>Platypterna gracilis</i> Krauss, 1902	1945a, 1947
C.S. <i>Ochrilidia gracilis</i> (Krauss, 1902)	–
Oedipodinae Walker, 1871	
<i>Acrotylus longipes</i> (Charpentier, 1845)	1947
<i>Acrotylus patruelis</i> (Herrich-Schaffer, 1838)	1945a
<i>Helioscirtus gravesi</i> Uvarov, 1924	1947
<i>Hilethera aeolopoides</i> (Uvarov, 1922)	1945a
<i>Hyalorrhypis calcarata</i> (Vosseler, 1902)	1947
<i>Scintharista notabilis</i> (Walker, 1870)	1945a
<i>Sphingonotus fonti</i> (Bolivar, 1902)	1947
C.S. <i>Vosseleriana fonti</i> (Bolivar, 1902)	–
<i>Sphingonotus canariensis</i> Saussure, 1884	1947
C.S. <i>Sphingonotus (Neosphingonotus) canariensis</i> Saussure, 1884	–
<i>Sphingonotus obscuratus lameerei</i> Finot, 1902	1945a
C.S. <i>Sphingonotus (Sphingonotus) obscuratus lameerei</i> Finot, 1902	–
<i>Sphingonotus octofasciatus</i> (Serville, 1839)	1945a
C.S. <i>Sphingonotus (Sphingonotus) octofasciatus</i> (Serville, 1839)	–
<i>Sphingonotus rubescens</i> Walker, 1870	1947
C.S. <i>Sphingonotus (Sphingonotus) rubescens</i> (Walker, 1870)	–
<i>Sphingonotus savignyi</i> Saussure, 1884	1947
C.S. <i>Sphingonotus (Sphingonotus) savignyi</i> Saussure, 1884	–
Tropidopolinae Jacobson, 1905	
<i>Tropidopola cylindrica</i> (Marschall, 1836)	1945a
Pamphagidae Burmeister, 1840	
Pamphaginae Burmeister, 1840	
<i>Acinipe exarata</i> Bolivar, 1936	1945a, b
C.S. <i>Paracinipe exarata</i> (Bolivar, 1936)	–
<i>Glauia (Glauvarovia) mendizabali</i> Morales Agacino, 1945	1945b
C.S. <i>Glauvarovia mendizabali</i> Morales Agacino, 1945	–
Trinchinae Stål, 1876	
<i>Tuarega insignis</i> (Lucas, 1851)	1945a, 1947

Table 4. — Continuation.

Upper Classification Species	Year of issue
Dericorythidae Jacobson & Biancchi, 1905	
Dericorythinae	
<i>Anemesacris zolotarevskyi</i> var. <i>elongata</i> Morales Agacino, 1949	1949
<i>Anemesacris abajoi</i> Morales Agacino, 1949	1949
C.S. <i>Anemesacris zolotarevskyi</i> Uvarov, 1938	–
<i>Bolivaremia domenechi</i> Morales Agacino, 1949	1949
<i>Bolivaremia domenechi</i> var. <i>laevigata</i> Morales Agacino, 1949	1949
<i>Dericorys lobata bolivari</i> Krauss, 1892	1947
<i>Dericorys murati</i> Uvarov, 1938	1945a
<i>Pamphagulus uvarovi zugata</i> Morales Agacino, 1949	1949
<i>Pamphagulus ifniensis</i> (Bolivar, 1936)	1949
<i>Pamphagulus mateui</i> Morales Agacino, 1949	1949
C.S. <i>Pamphagulus vicinus</i> Ramme, 1931	–
<i>Pamphagulus mateui audebdidetensis</i> Morales Agacino, 1949	1949
C.S. <i>Pamphagulus vicinus</i> Ramme, 1931	OSF * (26.III.2021)
Pyrgomorphaidea Brunner von Wattenwyl, 1874	
Pyrgomorphaidae Brunner von Wattenwyl, 1874	
Pyrgomorphae Brunner von Wattenwyl, 1874	
<i>Poekilocerus hieroglyphicus</i> Klug, 1832	1945a
C.S. <i>Poekilocerus bufonius hieroglyphicus</i> (Klug, 1832)	–
<i>Pyrgomorpha cognata</i> Krauss, 1877	1947
<i>Tenuitarsus angustus</i> (Blanchard, 1836)	1947
Tetragoidea Rambur, 1838	
Tetrigidae Rambur, 1838	
Tetriginae Rambur, 1838	
<i>Paratettix meridionalis</i> (Rambur, 1839)	1945a, 1947
Tridactyloidea Brullé, 1835	
Tridactylidae Brullé, 1835	
Tridactylinae Brullé, 1835	
<i>Tridactylus variegatus</i> (Latreille, 1809)	1947
Ensifera	
Tettigonoidea Krauss, 1902	
Tettigoniidae Krauss, 1902	
Bradyporinae Burmeister, 1838	
<i>Steropleurus innocentii</i> (Finot & Bonnet, 1885)	1945a, 1947
C.S. <i>Uromenus innocentii innocentii</i> (Finot & Bonnet, 1885)	–
Hetrodinae Brunner von Wattenwyl, 1878	
<i>Eugaster fernandesi</i> Bolivar, 1935	1945a, b, 1947
C.S. <i>Eugaster guyoni fernandesi</i> Bolivar, 1935	–
Phaneropterinae Burmeister, 1838	
Phaneroptera nana Fieber, 1853	1947
C.S. <i>Phaneroptera (Phaneroptera) nana</i> Fieber, 1853	–
<i>Odontura liouvillei teknicus</i> Morales Agacino, 1947	1947
C.S. <i>Odontura maroccana</i> Bolivar, 1908	–
Tettigoniinae Krauss, 1902	
<i>Platycleis sabulosa</i> Azam, 1901	1949
Grylloidea Laicharting, 1781	
Gryllidae Laicharting, 1781	
Gryllinae Laicharting, 1781	
<i>Gryllus bimaculatus</i> De Geer, 1773	1945a, 1947
<i>Gryllulus intercalatus rungsi</i> Morales Agacino, 1947	1947
C.S. <i>Tartarogryllus rungsi</i> (Morales Agacino, 1947)	–
<i>Gryllulus brunneri</i> (Saussure, 1877)	1945a, 1947
C.S. <i>Acanthogryllus brunneri</i> (Saussure, 1877)	–
<i>Gryllulus burdigalensis</i> (Latreille, 1804)	1945a
C.S. <i>Eumodicogryllus bordigalensis</i> (Latreille, 1804)	–
<i>Gryllulus canariensis</i> Chopard, 1938	1945a, 1947
C.S. <i>Acheta meridionalis</i> (Uvarov, 1921)	–

Table 4. — Continuation.

Upper Classification Species	Year of issue
<i>Gryllulus chudeaui</i> (Chopard, 1927)	1945a, 1947
C.S. <i>Acheta chudeaui</i> (Chopard, 1927)	—
<i>Gryllulus domesticus</i> (Linnaeus, 1758)	1945a, 1947
C.S. <i>Acheta domesticus</i> (Linnaeus, 1758)	—
<i>Gryllulus guanchicus</i> (Krauss, 1892)	1949
C.S. <i>Modicogryllus guanchicus</i> (Krauss, 1892)	—
<i>Gryllulus hispanicus</i> (Rambur, 1838)	1945a
C.S. <i>Acheta hispanicus</i> Rambur, 1838	—
<i>Eugryllodes kerkennensis</i> Finot, 1893	1945a, 1947
Gryllomorphae Saussure, 1877	
<i>Gryllomorpha gestroana</i> Bolivar, 1914	1947, 1949
C.S. <i>Gryllomorpha</i> ( <i>Gryllomorpha</i> ) <i>gestroana</i> Bolivar, 1914	—
Gryllotalpoidea Leach, 1815	—
Gryllotalpidae Leach, 1815	—
Gryllotalpinae Leach, 1815	—
<i>Gryllotalpa africana</i> Palisot de Beauvois, 1805	1945a

Sanpere 1947). The relevant toponym on the 1:500 000 map of 1949 is Asreifa to the north-east of the Sebkhata Arridal. Asreifa is a diminutive of Aserifa, which, according to the booklet attached to the map, means a hard terrain covered with a layer of loose soil, which could represent wind-blown sand deposits, on which the stones of the Aftout plain are outcropping. On the topographic map of 1993 (1/250 000 scale), the toponym Asserfa replaces Asreifa in the north-east of the Sebkhata Arridal.

Aserifa (SH) in the Saquia Al Hamra region is homonym of a place visited by Mateu Sanpere in the Oued Dra region named Aserifa (D) by Morales Agacino. These two homonymous localities have led to confusions over collection dates (Morales Agacino 1947a). On May 24th, 1944, during his visit to this place, Mateu Sanpere collected 12 species, including *Glauvia* (*Glauvarovia*) *mendizabali* (Table 6). The route followed by Mateu Sanpere, detailed in Giner Marí (1945), is consistent with the toponyms Asreifa mentioned on the Spanish map and Asrifa on the 1/250 000 Moroccan map. Asrifa is near the coast and north of the mouth of the Cheibca wadi. It is the steeply sloping edge of the Hameidia El Gueblia (meaning a small hammada). To differentiate the two Aserifa localities, their proper toponyms should be retained: Aserifa (SH) = Asserfa (26°19'00"N, 13°41'60"W); Aserifa (D) = Asrifa (28°17'24"N, 11°24'37"W), 300 km away to the north (Table 6).

#### *Extended distribution of Pamphagidae grasshoppers in the Atlantic Sahara*

The specimens collected by Morales Agacino and his colleagues are a valuable source of data to document the distribution of several species. We give here two examples, i.e., *Glauvarovia mendizabali* Morales Agacino, 1945 and *Paracinipe exarata* (Bolivar, 1936) (Pamphagidae Burmeister, 1840).

\* *Glauvarovia mendizabali* is known from the localities indicated in the description of the species, i.e., Taguerzimt = Taguerzimt, 24°07'19"N, 15°06'42"W (type locality), and Bu

Kerch = Boukarche, 24°55'16"N, 14°44'23"W (MNCN); three additional specimens from the lower valley of the Oued Dra are preserved in the MNHN (Morales Agacino & Descamps 1968). This species has been collected however during three field trips (1944, 1945 and 1946: see infra), but these data were not considered by Morales Agacino & Descamps (1968) who limited the distribution of *G. mendizabali* to the region north of the Oued Dra valley. Recently, Massa (2012) checked the identity of a male collected at Pozo Mesit (Saquia Al Hamra region, 6.XI.1944, Mateu J. col., MNHN), further extending the distribution of the species.

Morales Agacino (1947a) mentioned eight additional localities for *G. mendizabali*, from the lower Oued Dra Valley to the Sebkhata Ad-Dame (Rio de Oro bay) over 600 km of coastline: Aserifa (D) = Asrifa, 28°17'24"N, 11°24'37"W; Taruma = Touaroum, 26°46'15"N, 13°30'58"W; Dora = Dawra, 27°25'14"N, 12°59'21"W; Sebja Tah = Sebkhata Tah, 27°41'60"N, 12°48'00"W; Sebja Echaiba = Lajcheb, 27°16'12"N, 13°06'36"W; El Kantara = Al Gantra, 26°03'24"N, 14°04'17"W; Pozo Tuf = Ayn Touf, 24°36'13"N, 14°59'17"W; Sebja Dam = Sebkhata Ad-Dame, 23°55'48"N, 15°35'60"W.

\* **The type locality of *Paracinipe exarata***, i.e., Sidi Ifni, is located south of Agadir, where the species is relatively common up to the Oued Dra. According to Descamps & Mounassif (1972), the southernmost locality documented for that species is Tarfaya, Hassi-Zhar. Massa (2013) mentioned that the species 'is distributed in the western area of Morocco'.

Morales Agacino (1945a, b; 1947a) listed this species in five localities hinterland from Genei Ali to Bu Kerch, extending the distribution of *P. exarata* to the south of Boujdour: Genei Ali = Jeneig Aali = Khenigat Al, 28°15'28"N, 10°37'09"W; Dora = Dawra, 27°25'14"N, 12°59'21"W; Aserifa = Aserifa, 26°19'00"N, 13°41'60"W; Imirikli Lebiad = Imirikli Labya, 25°30'00"N, 14°03'00"W; Bu Kerch = Boukarche, 24°55'16"N, 14°44'23"W.

#### *Orthoptera distribution related to indices of continentality and maritime influence*

The data brought by the surveys by Morales Agacino and his collaborators (Table 1) bring to light four patterns of distribution for the collected species (Fig. 5): these patterns reflect the combined influence of the Ocean, the Atlas Mountains and the Sahara on the climate.

\* **Mediterranean species** show a continuous distribution along the Atlantic coast (Fig. 5A):

Four apterous Pamphagidae endemic to Morocco are typical of the fauna in Pays Ifni, Sous, and the Oued Dra: *Glauvia saharanae* Morales Agacino & Descamps, 1968, *Glauvia durienui* (Bolivar, 1878), *Glauvarovia mendizabali* and *Paracinipe exarata* (Morales Agacino & Descamps 1968; Descamps & Mounassif 1972; Massa 2013). Morales Agacino's data show that the distributions of *Paracinipe exarata* and *Glauvarovia mendizabali* extend farther south continuously. We also mention here that one male of *Glauvia saharanae* has been collected at Tarfaya (locality around Amotte) (Thewys leg., 08.V.1968, MNHN)

TABLE 5. — Geographic distributions of *Pamphagulus vicinus* Ramme, 1931 and of the two subspecies of *Pamphagulus mateui* Morales Agacino, 1949 (Orthoptera, Acridomorpha, Dericorythidae), with details on localities, dates of collect, source of the data (litterature, collections); the localities are characterized by their geographical coordinates and their number refers to the localities in the Table 3.

Taxa	Localities, dates	Locality no.	Sources	Geographical coordinates
<i>Pamphagulus vicinus</i> Ramme, 1931				
	Presqu'île du Cap Blanc, 01.III.1908		Ramme (1931: 195) MNHN, type ♀	21°06'N, 17°03'W
	Amuiserat, 15.XI.1941	12	Descamps (1970: 28) MNHN, <i>P. mateui</i> syn.	26°42'35"N, 12°46'32"W
	Tarfaya, Sebkhah Tah, 03.V.1968	86	Descamps (1970: 29) MNHN, specimens ♂, ♀	27°41'60"N, 12°48'00"W
	Jatuta el Bar, 15.XI.1943	60	Morales Agacino (1949: 151)	24°13'31"N, 15°24'19"W
	Villa Cisneros, 02.XI.1941	127	Morales Agacino (1949: 151)	23°42'05"N, 15°55'54"W
	Melgui El Garek, 15.XII.1945	70	Morales Agacino (1949: 151)	22°47'46"N, 16°10'44"W
	Tabarkal-la, 15.XII.1945	93	Morales Agacino (1949: 151)	22°32'30"N, 16°10'54"W
	Taderruret, 15.II.1946	94	Morales Agacino (1949: 151)	22°30'00"N, 14°10'30"W
	Grara Mejeiris, 20.XII.1945	47	Morales Agacino (1949: 151)	22°02'37"N, 16°45'29"W
	Bir Gandux, 23.XII.1945	23	Morales Agacino (1949: 151)	21°36'43"N, 16°28'15"W
	Kraib el Mais, 24.XII.1945	61	Morales Agacino (1949: 151)	21°22'60"N, 16°49'60"W
	Atuifer, 25.XII.1945	16	Morales Agacino (1949: 151)	21°22'35"N, 16°57'09"W
	Las Cuevecillas, 27.XII.1945	63	Morales Agacino (1949: 151)	21°06'05"N, 17°03'23"W
<i>Pamphagulus mateui mateui</i> Morales Agacino, 1949				
	El Aiun, 22-28.IX.1943	30	Morales Agacino (1949: 156)	27°09'39"N, 13°12'41"W
	Agli Ben Ali, 29.X.1943	4	Morales Agacino (1949: 156)	26°44'00"N, 13°33'00"W
	Amuiserat, 15.XI.1941	12	Morales Agacino (1949: 156)	26°42'35"N, 12°46'32"W
	Aserifa (SH), 29.X.1943	15	Morales Agacino (1949: 156)	26°19'00"N, 13°41'60"W
	El Kantara, 29.III.1946	36	Morales Agacino (1949: 156)	26°03'24"N, 14°04'17"W
	Bu Kerch, 08.XI.1943	26	Morales Agacino (1949: 156)	24°55'16"N, 14°44'23"W
<i>Pamphagulus mateui audebdidetensis</i> Morales Agacino, 1949				
	Agli Ben Ali, 29.X.1943	4	Morales Agacino (1949: 157)	26°44'00"N, 13°33'00"W
	Bu Kerch, 08.XI.1943	26	Morales Agacino (1949: 157)	24°55'16"N, 14°44'23"W
	Jatuta el Bar, 15.XI.1943	60	Morales Agacino (1949: 157)	24°13'31"N, 15°24'19"W
	Audebdidet, 06.XII.1941	17	Morales Agacino (1949: 157)	24°06'17"N, 15°11'35"W
	Neggir, 19.III.1943	74	Morales Agacino (1949: 157)	23°36'00"N, 14°40'01"W
	Inillan, 18.IV.1943	58	Morales Agacino (1949: 157)	22°49'00"N, 14°43'60"W
	Uad Lagaila, 15.V.1943	134	Morales Agacino (1949: 157)	22°08'13"N, 16°15'38"W

TABLE 6. — Definitions of El Kantara and Aserifa type localities of *Bolivaremia domenechi* Morales Agacino, 1949 and *Pamphagulus mateui* Morales Agacino, 1949 (Orthoptera, Acridomorpha).

Morales Agacino data	Further updated informations
PAMPHAGIDAE Burmeister, 1840	
<i>Glauia (Glauvarovia) mendizabali</i> Morales Agacino, 1945	
Sáhara Español ♂ holotype, Bu Kerch (RO) ♀ allotype Taguerzimmet (RO)	Boukarche, 24°55'16"N, 14°44'23"W, Taguerzimt, 24°07'19"N, 15°06'42"W
Sáhara Español 6 larvae, Aserifa (D), 03.XI.1944	Asrifa, 24.V.1944, 28°17'24"N, 11°24'37"W
Sáhara Español 1 larva, El Kantara (RO), 29.III.1946, Morales Agacino.	Al Gantra, 26°03'24"N, 14°04'17"W
DERICORYTHIDAE Jacobson & Biancchi, 1905	
<i>Pamphagulus mateui mateui</i> Morales, 1949	
Sáhara Español ♂ holotype, ♀ paratype, El Kantara (RO), 29.III.1946, Morales Agacino	Al Gantra, 26°03'24"N, 14°04'17"W
<i>Pamphagulus mateui audebdidetensis</i> Morales, 1949	
Sáhara Español ♂ holotype, ♀ allotype, Audebdidet (RO), 6.XII.1941, Morales Agacino	Awdibdiba, 24°06'17"N, 15°11'35"W
Sáhara Español 1 larva specimen, Aserifa (SH), 29.X.1943, Mateu Sanpere	Asserfa, 26°19'00"N, 13°41'60"W
<i>Bolivaremia domenechi</i> Morales Agacino, 1949	
Sáhara Español ♀ holotype, ♀ paratype, El Kantara (RO), 29.III.1946, Morales Agacino	Al Gantra, 26°03'24"N, 14°04'17"W
<i>Bolivaremia domenechi</i> var. <i>laevigata</i> Morales Agacino, 1949	
Sáhara Español ♀ holotype, El Kantara (RO), 29.III.1946, Morales Agacino	Al Gantra, 26°03'24"N, 14°04'17"W
Sáhara Español ♀ paratype, Aserifa (SH), 29.X.1943, Mateu Sanpere	Asserfa, 26°19'00"N, 13°41'60"W

(Descamps 1970). The dericorythid *Pamphagulus vicinus*, known from Sebkhah Tah – Tarfaya (MNHN), occurs with two of the above-mentioned species, i.e., *Glauvarovia mendizabali* and *Paracinipe exarata*, as far south as Dakhla (24°N). Farther south, between Dakhla and Cap Blanc, *P. vicinus* is present on the coast but also inland in a region where the contrasts

in temperature and rainfall no longer show the characteristic gradation from west to east. Semi-continental climatic variants Sc1, Sc2 overlap with the Mediterranean variants M1, M2, M3. The type locality of *Pamphagulus vicinus* is Cap Blanc, with four collection sites in the region. This species could extend its distribution in Mauritania to Bir El Hamar – Zem-



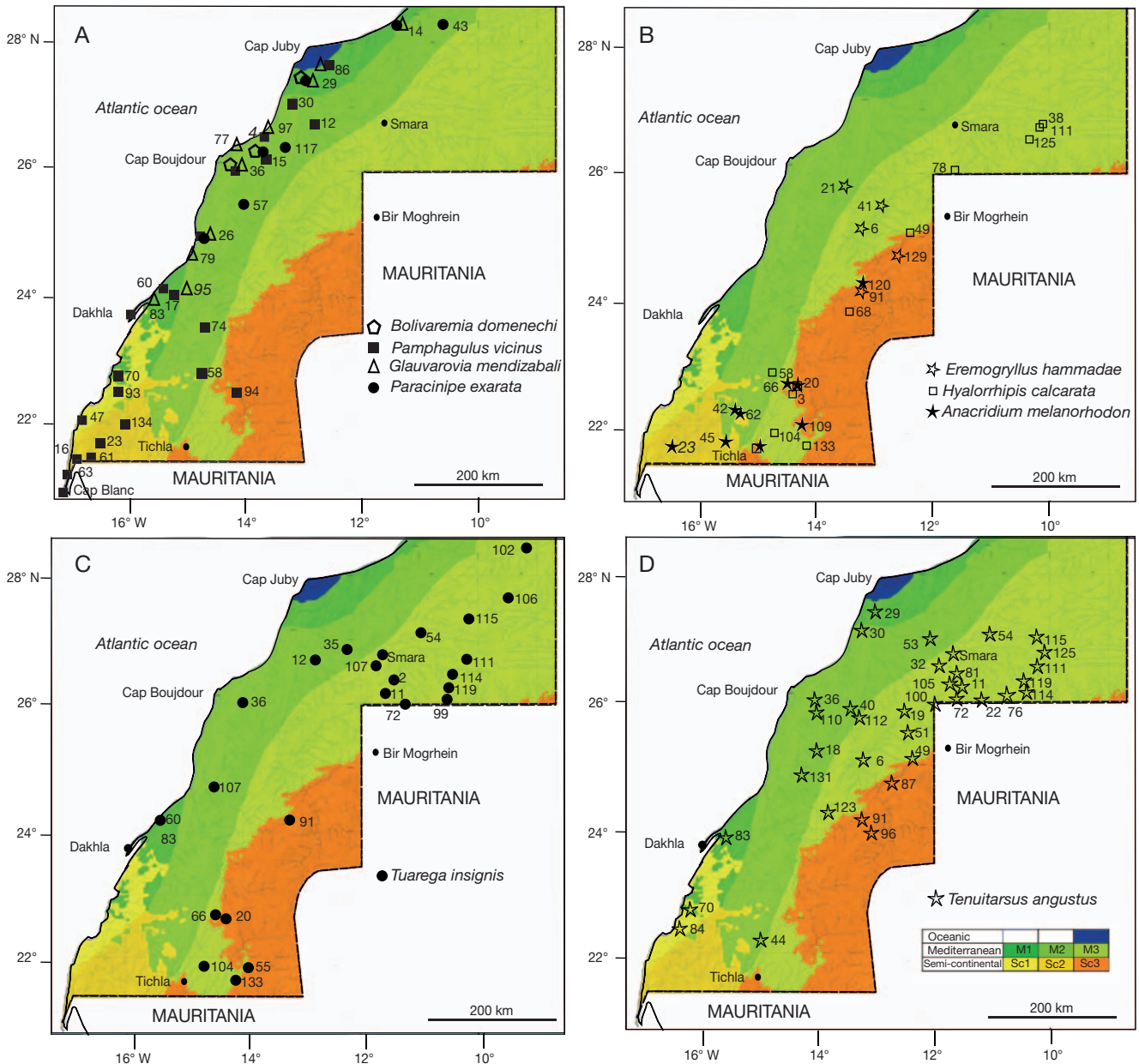


FIG. 5. — Distributions of nine species of Orthoptera Acridomorpha in a cline defined by maritime and continental influences in Spanish Sahara. These maps allow to figure out distributional patterns resulting from the spatialization of the continental index of Daget (1977) through the climate map of Morocco by Mokhtari et al. (2014): **A**, endemic species to the Atlantic coast; **B**, species of the Pre-Sahara and semi-deserts; **C**, species endemic to the Sahara; **D**, arenicolous species adapted to living in desert. See also georeferenced cartography.gpx in Supplementary Table 1.

mour (Morales Agacino 1945a) and Maaders at the Oued Dra (Descamps 1970), as the rare *Dericorys murati* Uvarov, 1938, known from Tasiast, Mauritania (Uvarov 1938).

\* **Five examples of desert species** expanding in the Atlantic Sahara (Fig. 5B-D):

*Anacridium melanorhodon* (Walker, 1870) is a Sahelian arboricolous species wandering in summer (Fig. 5B). It occasionally reaches the southern part of the Atlantic Sahara (Tichla, Zug, Aousserd) and up to the valley of the Wad A's Saquia Al Hamra (Morales Agacino 1948). Its preferendum is a semi-continental climate (Sc1, Sc2 and Sc3).

*Eremogryllus hammadae* Krauss, 1902 (Acrididae, Eremogryllinae Dirsh, 1956) and *Hyalorrhapis calcarata* (Vosseler, 1902) (Acrididae, Oedipodinae Walker, 1871) inhabit the semi-desertic north-western Sahara, and they are typically adapted to the desert (Chopard 1943): *E. hammadae* buries itself in the sand (Uvarov & Volkonsky 1939), while *H. calcarata* stands on the long spurs of its hind tibiae to avoid overheated sand. Morales Agacino (1947a) mentioned *E. hammadae* from Ezmul Agazel (sandy plain of Lagtam), Bankara (sandy plain of El Mesiah) and in the sandy reg of the aftout Agued Daaxa. *H. calcarata* was collected from Tichla, Zug and Tuama, i.e., in the region of inselbergs and small hills of the *Acacia raddiana* sandy



Fig. 6. — Examples of localities in ex-Spanish Sahara: **A**, Mouth of the Cra wadi at the coast, sandstone-limestone platforms in staircase steps (24°41'N, 14°53'W); **B**, fossil formation of dunes named Aguerguer in the background; in the rocky foreground, a seedling of *Otolyphis pubescens* (Desf.) Pomel, Asteraceae (23°43'N, 15°14'W; 70 m). Photos: Annie Garcin.

plains. Morales Agacino (1947a) mentioned *H. calcarata* at Medengue broad sandy plain on the western side of Tiris and at Pozo Nebka, an area of very tiny dunes against tussocks of vegetation, two sandstone regions intersected by numerous wadis (Wad A's Saquia Al Harma upper basin and Tiris Zem-

mour). According to Morales Agacino's data, the distributions of *E. hammadae* and *H. calcarata* overlay the mediterranean transition (M3) from north to south and partly in the warmest region of the semi-continental climate (SC3). These desert species clearly avoid the oceanic coast (Fig. 5B).



Fig. 6. —Continuation. **C**, Asserfa, a stony-sandy plain, northern Cap Boujdour (26°22'N, 13°58'W); **D**, edge of Sebkhat Tah, where *Bolivaremia domenechi* Morales Agacino, 1949 has been observed. Photos: Annie Garcin.

*Tuarega insignis* (Lucas, 1851) is a Sahara endemic, inhabiting stony environments and regs (Fig. 5C): it is the only species of Pamphagidae present in the whole northwestern Sahara (from Morocco to Libya) and central Sahara (Hoggar, Tassili, Adrar, Tibesti). In the Atlantic Sahara, Morales Agacino (1945a, 1947a) mentioned *T. insignis* mainly in the

upper basin of the Wad A's Saquia Al Hamra, east of Smara and up to the Oued Dra valley (Tizguerrentz, 28°N); but also in the south, i.e., Aousserd, Zug and on the Atlantic coast at Jatuta el Bar (24°N): collecting *T. insignis* on the coast is unexpected compared to all other collection sites inland (Fig. 5C).

*Tenuitarsus angustus* (Blanchard, 1836) (Pyrgomorphidae Brunner von Wattenwyl, 1874, Pyrgomorphinae Brunner von Wattenwyl, 1874) is a species inhabiting warm deserts (Fig. 5D), with a preference for sand and thin gravel environments (Korsakoff 1958); it is adapted to overheated sands, having long hind tibial spurs and long and slender middle legs. *T. angustus* is known to occur largely throughout the Sahara, being mentioned from Somalia (type, MNHN), the Middle east, Egypt, Libya, Tunisia (Tozeur: Tlili *et al.* 2020; MNHN), Algeria (Hoggar: Chopard 1943; Tindouf: Morales Agacino 1945a; Ghardaïa: Zergoun *et al.* 2019), Mauritania (Damen and Aftout Faye, MNHN); and Morocco (Maaders of the Oued Dra: Descamps 1970, MNHN). Few citations of this species are found through its huge area of distribution, but 35 citations exist for the Atlantic Sahara alone (Morales Agacino 1945a, 1947a): as shown on Fig. 5D, all these localities are grouped in the Saquia Al Hamra region (El Aïun, Hausa, Smara), in the north of the Rio de Oro (Agued Daaxa, Smamit, El Mesiah), in Aousserd and in Gleib el Fernan for the southernmost part. On the coast, Morales Agacino found *T. angustus* at Fares, Sebja Dam (Rio de Oro Bay), El Kantara and Pozo Mesit (Cap Boujdour). The north-south distribution pattern of *Tenuitarsus angustus* contrasts with the continental cline explaining the distribution of the other two Saharian species, i.e., *E. hammadae* and *H. calcarata*.

## DISCUSSION

### MORALES AGACINO SURVEYS IN ATLANTIC SAHARA: A FINAL ASSESSMENT AND PERSPECTIVES

The six-year scientific program of Morales Agacino and his colleagues is the only entomological inventory ever performed in the Sahara, over such an extensive surface (260 000 km<sup>2</sup>) and a long time (Appendices 1-4; Tables 1, 3). In total, 356 species and subspecies, mostly new for this region, have been collected. In terms of diversity, carabids and scavenging-predatory tenebrionids represented the dominant elements of the deserticolous fauna, together with parasitic Hymenoptera. Although this could result from a bias in the specialization of the expedition members, these diversity data could suggest that a control of the populations of phytophagous insects as *Schistocerca gregaria* through biological control may be possible: this could have answered the ultimate goal of Morales Agacino's program, as the 'Locust Biology Study Project' primarily sought any means to control the Desert Locust by affecting the reproductive success of solitary populations (Zolotarevsky & Murat 1938; Morales Agacino 1943; Korsakoff 1958; Lomer 1997).

Morales Agacino did not highlight this potential use of the desert entomofauna for anti-locust strategies. On the contrary, in his 1945 article (p. 310), he made a very cautious assessment of the initial inventory results, considering the data too preliminary to draw any conclusions, given the immensity of the surveyed territory and the low density of the collected species (which appears clearly in the results). By contrast, Morales Agacino considered that the desert fauna

was interesting mainly in terms of biogeography and adaptation to the desert (Morales Agacino 1945a). This idea came up again when he assessed the economic importance of the Sahelian Locust, *Anacridium melanorhodon*, in southern Rio de Oro (Morales Agacino 1948). He detailed the landscape, geology and botanical features of the nine stations where he observed *A. melanorhodon*, mainly in low-density populations in a solitary phase. He concluded that no severe damages could happen unless rational agriculture develops: this ecological and agronomic perspective was far from the logic of the insect inventory, but reveals of a precursor. In the Algerian oases of the Central Sahara (Ghardaïa, M'zab valley), fruit trees and gardening are now a reality in agricultural perimeters irrigated by sprinklers or drip irrigation (Zergoun *et al.* 2019): the inventory of Orthoptera Acridomorpha in these oases reports 44 species, with Acrididae accounting for more than 80%. Eighteen of these species are in the Morales Agacino's collections, for example, *Schistocerca gregaria* and the potential pest *Anacridium melanorhodon*. Graminivorous Acrididae such as *Locusta migratoria cinerascens* Fabricius, 1781, also became plagues in cereal crops when pivot irrigation was introduced in southern Algeria (Benfekih & Petit 2010; Soudani & Moussi 2020).

### Morales Agacino inventories as a source of data for biogeographic studies

Because of the duration, geographical scale and scientific protocol of the surveys, the data assembled by Morales Agacino for Polyneoptera constitute a reference inventory for the Atlantic Sahara, that can help measuring environmental changes related to the vulnerability of biocenosis. Further, the phytogeographical studies during the 1940s are also a valuable initial state to support hypothesis of adaptive adjustments (Guinea 1945; Murat 1939, 1944). This could be used for example to study the fauna and flora of the Atlantic edge, this littoral band of 30 to 50 km wide under maritime influence, and several species, i.e., *Anacridium melanorhodon* and *Eremogryllus hammadae*, could reveal good indicators to identify changes of the semi-continental climate limit (Fig. 5). In contrast, some desert species do not respond along the continental Daget gradient. This is the case for example of mobile species, such as *Tenuitarsus angustus* or *Tuarega insignis*, which occupy habitats according to their ecological preferenda only (surface of the substratum, or plant cover); as another example, *Sphingonotus rubescens* is found in cultivated environments.

To re-use Morales Agacino's data in systematics, biogeography and community ecology, a prerequisite was to have unambiguous names of collecting localities and avoid confusion between localities. The examples of Aserifa and El Kantara (Table 6) are particularly clear in the matter. As a main result of our paper, 134 localities are now defined with their names (including several variants), geographic coordinates and main characteristics of vegetation and habitats. Some of them could be visited and photographed, showing the type of landscape and vegetation they exhibit (Figs 6; 9; 10). This will help define the distribution areas of the species and understand their ecological preferenda.



FIG. 7. — *Bolivaremia domenechi* Morales Agacino, 1949: **A**, original drawing by Morales Agacino (1949); **B**, specimen observed in the North of Boujdour (26°22'N, 13°58'W; 50 m), dorsal view; **C**, specimen observed at the Sebkhatah Tah (27°39'N, 12°55'W; 25 m), side view. Photos: Annie Garcin.

In the same time, some species could be photographed for the first time, illustrating their habitus known up-to-now by Morales Agacino's drawings only: we illustrate here *Bolivaremia domenechi* (Fig. 7), *Glauvarovia mendizabali* (Fig. 8) and *Eremogryllus hammadae* (Fig. 9B).

*The grasshopper community at El Kantara = El Gantra*  
At El Kantara (Table 7), ten grasshopper species were caught on 29.III.1946, including three species of Dericorythidae out of the seven recorded in the whole Spanish Sahara (Table 4), which highlights the originality and richness of this spot

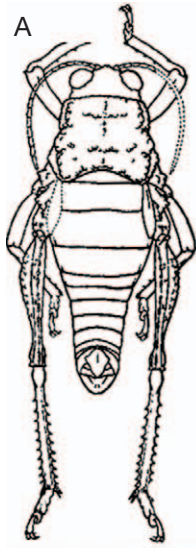




FIG. 8. — *Glauvarovia mendizabali* Morales Agacino, 1945: **A**, original drawing by Morales Agacino (1945); **B-D**, female found at Graret Ould Al Aqel (24°25'N, 15°3'W; 50 m), in ventral (**B**, first illustration of the species sternites), dorsal (**C**), and side (**D**) views; **E, F**, male found at Fom Draa (28°40'N, 11°7'W; 40 m), dorsal (**E**) and frontal (**F**) views. Note the short tegmina in both male and female. Photos: Annie Garcin.

(Morales Agacino 1947a, 1949), especially when compared to the mean number of species per locality (see above). Very few details about the habitats prospected at El Kantara have been given by Morales Agacino, so it remains difficult to explain the observed grasshopper diversity there and especially the discovery of a new Dericorythidae. Morales Agacino (1949:

166) wrote in the description of *Bolivaremia domenechi*: “Se recogieron ambos ejemplares a la hora meridiana, sobre un terreno denudado, pedregoso, salpicado aquí y allá de raras matitas de ‘ansig’ (*Aristida plumosa*) y convivencia con nuestro *Pamphagulus mateui*”. [Both specimens (of *Bolivaremia domenechi*) were collected at the meridian hour, on a denuded,



FIG. 9. — *Eremogryllus hamadae* Krauss, 1902: **A**, sandy bed of a wadi close to Labouirat = Labbayrat (27°57'N, 9°58'W; 400 m); **B**, adult about to burry himself in the sand, dorsal view. Photos: Annie Garcin.





FIG. 10. — *Poekilocerus bufonius hieroglyphicus* (Klug, 1832): **A**, Derramán metamorphic inselberg in the sandy plain, west of Aousserd (22°38'N, 14°27'W; 360 m); **B**, larva found in Derramán, side view. Photos: Annie Garcin.

stony ground, scattered here and there with rare patches of 'ansig' (*Aristida plumosa*) and coexisting with our *Pamphagulus mateui*.] (our translation).

Morales Agacino (1949: 167) listed the following collection sites of *Bolivaremia domenechi* var. *laevigata*: El Kantara, 29.III.1946 (Rio de Oro); Dora, 4.IV.1945 and Aserifa, 29.X.1943 (Saquia Al Hamra), and he mentioned "Las condiciones de captura de estos ejemplares han sido iguales o muy parecidas a las ofrecidas por la forma típica, en convivencia con la cual fueron recogidos algunos de los ejemplares aquí

reseñados". [The conditions of the capture of these specimens have been the same or very similar to those of the typical form, with which some of the specimens recorded in this article coexisted'.] (our translation).

In the Algerian and Tunisian Chotts and salinized steppes, the Amaranthaceae family plants are hosting the species *Dericorys millierei* Bonnet & Finot, 1884 and *Dericorys albidula* Serville, 1838 (Moussi *et al.* 2011; Mahloul *et al.* 2016; Tlili *et al.* 2019). At El Kantara, Morales Agacino reported only the plant species *Aristida plumosa*, a Poaceae which grows in

TABLE 7. — Habitat preferences of the 10 Acridomorpha species (Orthoptera) collected at El Kantara = Al Gantra.

Family, species	Habitat	References
Dericorythidae Jacobson & Biancchi, 1905 <i>Bolivaremia domenechi</i> Morales Agacino, 1949 <i>Pamphagulus vicinus</i> Ramme, 1931 <i>Dericorys lobata</i> (Brullé, 1840)	Bare ground, stony, rare patches of <i>Aristida plumosa</i> Bare ground, stony, rare patches of <i>Aristida plumosa</i> Saline soil, Amaranthaceae	Morales Agacino 1949 Morales Agacino 1949 Moussi <i>et al.</i> 2011; Mahloul <i>et al.</i> 2016; Tlili <i>et al.</i> 2019
Pamphagidae Burmeister, 1840 <i>Tuarega insignis</i> (Lucas, 1851) <i>Glauvarovia mendizabali</i> Morales Agacino, 1945	Rocky soil Sandy soil, <i>Crotalaria saharae</i> , <i>Anabasis articulata</i>	Morales Agacino 1945a Morales Agacino 1947a
Acrididae MacLeay, 1821 <i>Notopleura rothschildi</i> Uvarov, 1923  <i>Sphingonotus savignyi</i> Saussure, 1884 <i>Sphingonotus rubescens</i> Walker, 1870 <i>Ochrlidia gracilis</i> (Krauss, 1902)	Reg, saline soil, <i>Atriplex halimus</i> , <i>Limonium</i> beaumieranum Desert habitats Varied habitats Humid habitats, Poaceae, <i>Aristida acutiflora</i> , <i>Nucularia perrini</i> bushes	Morales Agacino 1947a Morales Agacino 1947a Morales Agacino 1947a; Uvarov 1977 Morales Agacino 1947a
Pyrgomorphidae Brunner von Wattenwyl, 1874 <i>Tenuitarsus angustus</i> (Blanchard, 1836)	Sandy soil, fine gravels	Morales Agacino 1945a

coastal dunes in Egypt, in association with halophytic plants of the Amaranthaceae family: *Anabasis articulata*, *Salsola vermiculata*, *Cornulaca monocantha* (Elkharbotly & Balah 2016). The presence of two Sebkhats, i.e., Aridal and Aarred, at the edge of El Kantara shows that the environment is favourable for the halophytic plants that are known to host Dericorythidae in other Saharan areas. The Pamphagidae *Glauvarovia mendizabali* and the Eremogryllinae *Notopleura rothschildi*, collected at El Kantara (Table 7), are also known to be associated with halophytes (Morales Agacino 1947a).

By contrast, the Gomphocerinae *Ochrlidia gracilis* and the Oedipodinae *Sphingonotus rubescens* (Walker, 1870) are opportunist graminivorous in oasis where they cause light damage to irrigated crops (Haskell 1982). At the oasis of Ghardaïa, *O. gracilis* becomes dominant in the grasshopper community, representing 16-18% of the acridids sampled in crops and palm groves with Poaceae weeds (Zergoun *et al.* 2019).

Finally, three species, *Tuarega insignis*, *Sphingonotus savignyi* and *Tenuitarsus angustus* are deserticolous acridids with a preference for bare soil, which are present throughout the Sahara.

According to these data, El Kantara hosts a mixed grasshopper community with three desert species, two opportunistic species of crops and four species adapted to salinized soil, i.e., *Pamphagulus vicinus*, *Dericorys lobata*, *Glauvarovia mendizabali* and *Notopleura rothschildi*. In this supposed landscape, the presence of the rare species *Bolivaremia domenechi* remains problematic. More samplings and field studies are necessary to identify the habitat of that species and also check for the habitat of all the species collected at El Kantara = Al Gantra.

## CONCLUSION

The Morales Agacino inventory could clearly support extended project of biodiversity assessment. The collected specimens of the ‘Locust Biology Study’ are now deposited in three museums: the Museum of Madrid (collection ‘Mis-

iones acridianas’, which includes Orthoptera); the Museum of Barcelona, which possesses some of the Tenebrionidae of Español Coll and some types of Carabidae of Mateu Sanpere; and the Regional Museum of Natural Sciences of Turin, to which Mateu Sanpere has donated his personal collection of Coleoptera (Bellés 2015). In the general collection of the Madrid Museum, the Orthoptera of the Spanish Sahara are quite a few and seem to have been little studied (Izquierdo *et al.* 1997). We are aware of only two studies of this material: De Beaumont (1953) examined types and specimens of *Bembix* in Giner Mari’s collection; and Descamps (1970) studied the paratype of *Pamphagulus mateui* deposited by Morales Agacino in MNHN. In these collections, some types have not been re-examined since their descriptions, and as we show above, specimens that extend or clarify the distribution range of little-known species have never been considered.

The exceptional inventory performed by Morales Agacino, Giner Mari, Español Coll and Mateu Sanpere in the Spanish Sahara would be almost impossible today, because of its duration over several years and because of the political instability of the region. The particular location of the sampled area, between the desert and the ocean, increases the potential interest of the assembled data in a context of global climatic disruption. It would be tremendously interesting to carry out a comparative sampling expedition to check the state of biodiversity after 80 years. But even in the meantime, considering the collected specimens would improve our knowledge of the diversity of this part of Africa and would at least acknowledge the scientific input of Morales Agacino and his colleagues.

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1949 military map of the Spanish Sahara has been a tremendous help to reconstruct the work of Morales Agacino and his team; and Mr. Enrique Bohigas Jayme (Archivo Cartográfico y de Estudios Geográficos del Centro Geográfico del Ejército), who provided the first author a digital version of this 1:500.000 map with accompanying booklets, a key map for our research. Finally we warmly thank Xavier Bellés (CSIC Barcelona) and an anonymous reviewer for comments on the manuscript and additional bibliography.

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APPENDICES

APPENDIX 1. — Polyneoptera (except Orthoptera) listed in Morales Agacino's publications. Abbreviation: **C.S.**, current status. Taxonomic sources: Cockroach Species File (<http://cockroach.speciesfile.org>), Dermaptera Species File (<http://dermaptera.speciesfile.org>), Phasmida Species File (<http://phasmida.speciesfile.org>), Mantodea species file (<http://mantodea.speciesfile.org>) and wikispecies (<https://species.wikimedia.org>). OSF2 Mantodea Species File (version 5.0/5.0) last consulted 03/12/2020.

Order, family, species	Date of publication
<b>Blattodea</b>	
Blattidae Latreille, 1810	
<i>Blatta flavilatera</i> var <i>castanea</i> (Adelung, 1903)	1945a
C.S. <i>Hebardina flavilatera</i> (Saussure, 1895)	–
<i>Periplaneta americana</i> (Linnaeus, 1758)	1945a, 1947
<b>Corydiidae</b> Saussure, 1864	
<i>Heterogamodes ursina</i> (Burmeister, 1838)	1945a, 1947
<i>Heterogamodes cerverai</i> (Bolivar, 1886)	1945a b, 1947
<b>Ectobiidae</b> Brunner von Wattenwyl, 1865	
<i>Blattella germanica</i> (Linnaeus, 1767)	1945a, 1947
<i>Blattella cordofana</i> (Brunner von Wattenwyl, 1865)	1949
C.S. <i>Phymatosilpha cordofana</i> (Brunner von Wattenwyl, 1865)	–
<i>Lobolampra janeri</i> (Bolivar, 1894)	1945a
C.S. <i>Phyllodromica (Lobolampra) janeri</i> (Bolivar, 1894)	–
<i>Supella supellectilium</i> (Serville, 1838)	1947
C.S. <i>Supella longipalpa</i> (Fabricius, 1798)	–
<b>Mantodea</b>	
Toxoderidae Westwood, 1889	
<i>Amblythespis granulata</i> (Saussure, 1870)	1947
C.S. <i>Severinia granulata</i> Saussure, 1870	–
<b>Gonyptetidae</b> Westwood, 1889	
<i>Elaea marchali pallida</i> Chopard, 1941	1945a, 1947
<b>Eremiaphilidae</b> Saussure, 1869	
<i>Eremiaphila moreti</i> Bolivar, 1886	1945a, 1947
<i>E. moreti</i> var <i>maculata</i> Morales Agacino, 1947	1947
<i>Eremiaphila murati</i> Chopard, 1940	1945a b, 1947
<i>Eremiaphila rufula</i> Chopard, 1941	1945a
<i>Heteronutarsus aegyptiacus</i> Lefebvre, 1835	1945a b, 1947
<b>Tarachodidae</b> Handlirsch, 1930	
<i>Tarachodes saussurei</i> Giglio-Tos, 1911	1947
<i>Iris oratoria</i> (Linne, 1758)	1945a b, 1947
<b>Hymenopodidae</b> Giglio-Tos, 1927	
<i>Catasigerpes tridens</i> (Saussure, 1872)	1947
C.S. <i>Oxypiloidea tridens</i> Saussure, 1872	–
<i>Sphodromantis viridis</i> Forskål, 1775	1945a, 1947
<b>Empusidae</b> Saussure, 1869	
<i>Empusa guttula</i> (Thunberg, 1815)	1947
<i>Blepharopsis mendica</i> (Fabricius, 1775)	1945a
<b>Dermaptera</b>	
Forficulidea Latreille, 1810	
Forficulidae	
<i>Forficula barroisi</i> Bolivar, 1893	1945a, 1947
C.S. <i>Forficula lucasi</i> Dohrn, 1865	–
<i>Forficula senegalensis</i> Audinet-Serville, 1838	1945a
<i>Anisolabis annulipes</i> (Lucas, 1847)	1945a, 1947
C.S. <i>Euborellia annulipes</i> (Dohrn, 1864)	–
<i>Labidura riparia</i> (Pallas, 1773)	1945a, 1947
<i>Labidura riparia</i> var. <i>inermis</i> Brunner, 1882	1945a
<b>Phasmatodea</b>	
Phasmatidae Leach, 1815	
<i>Ramulus aegyptiacus</i> (G. R. Gray, 1835)	1945a, 1947
C.S. <i>Clonaria aegyptiaca</i> (G.R. Gray, 1835)	–

APPENDIX 2.— Coleoptera Carabidae Latreille, 1802 listed during 1941-1945 surveys in the Spanish Sahara. Abbreviation: **C.S.**, current status. Taxonomic sources: Biological Library (<https://www.biolib.cz>); Catalogue of life (<https://www.catalogueoflife.org>); Chavanon (2018); Global Biodiversity Information (gbif.org).

**Coleoptera Carabidae Latreille, 1802**

<i>Agostenus (Chlaeniellus) bonelli</i> Mateu, 1947
C.S. <i>Chlaenius (Chlaeniellus) bonelli</i> (Mateu, 1947)
<i>Anthia (Termophila) venator</i> Fabricius, 1792
C.S. <i>Anthia venator</i> (Fabricius, 1792)
<i>Anthia (Termophila) sexmaculata</i> ab. <i>marginata</i> Latreille, 1823
C.S. <i>Anthia (Thermophilum) sexmaculatum marginatum</i> Latreille, 1823
<i>Apotomus rufithorax</i> Pecchioli, 1837
<i>Brachinus (Brachynolomus) liebkei occidentalis</i> Mateu, 1947
<i>Brachinus (Aploa) nobilis</i> Dejean, 1831
C.S. <i>Brachinus nobilis</i> Dejean, 1831
<i>Campalita maderae</i> (Fabricius, 1775)
C.S. <i>Calosoma (Campalita) maderae maderae</i> (Fabricius, 1775)
<i>Campalita olivieri</i> Dejean, 1831
C.S. <i>Calosoma (Caminara) olivieri</i> Dejean, 1831
<i>Campalita algirica</i> (Géhin, 1885)
C.S. <i>Calosoma (Campalita) algiricum</i> Gehin, 1885
<i>Cathoplius aliai</i> Escalera, 1944
C.S. <i>Carabus aliai</i> (Escalera, 1944)
<i>Chlaenius (Chlaenites) spoliatus</i> (P. Rossi, 1792)
<i>Chlaenius (Trichochlaenius) laeticollis</i> Chaudoir, 1876
C.S. <i>Chlaenius (Chlaenostenodes) laeticollis</i> (Chaudoir, 1876)
<i>Cicindela (Lutaria) dorsata</i> Brullé, 1834
C.S. <i>Myriochila dorsata</i> (Brullé, 1834)
<i>Cicindela (Myriochile) melancholica</i> Fabricius, 1798
C.S. <i>Myriochila (Myriochila) melancholica melancholica</i> (Fabricius, 1798)
<i>Cicindela (Habrotarsa) leucoptera</i> Dejean, 1831
C.S. <i>Habrodera leucoptera</i> Dejean, 1831
<i>Cicindela (Chetostyla) flexuosa</i> Fabricius, 1787
C.S. <i>Lophyra flexuosa</i> (Fabricius, 1787)
<i>Cymindis (Cymindis) discophora</i> Chaudoir, 1873
<i>Cymindis (Cymindis) laevistriata pseudosuturalis</i> Bedel, 1906
C.S. <i>Cymindis (Cymindis) suturalis pseudosuturalis</i> Bedel, 1906
<i>Dromius (Manadromius) saharensis</i> Mateu, 1947
C.S. <i>Paradromius saharensis</i> (Mateu, 1947)
<i>Dromius (Manadromius) sublinearis</i> Escalera, 1914
C.S. <i>Paradromius sublinearis</i> (Escalera, 1914)
<i>Dromius (Caladromius) mayeti</i> Bedel, 1907
C.S. <i>Caladromius mayeti</i> (Bedel, 1907)
<i>Dyschirius (Dischiridius) therondi</i> Puel, 1929
C.S. <i>Dyschirius (Dyschirius) beludsha</i> Tschitscherine, 1904
<i>Dyschirius (Dischiriodes) clypeatus</i> Putzeys, 1867
<i>Dyschirius (Dischiriodes) chalybaeus</i> Putzeys, 1866
<i>Egadroma marginatum</i> (Dejean, 1829)
C.S. <i>Stenolophus (Egadroma) marginatus</i> Dejean, 1829
<i>Emphanes</i> (s. str.) <i>latiplaga</i> (Chaudoir, 1850)
C.S. <i>Bembidion latiplaga</i> Chaudoir, 1802
<i>Graniger semeleleri</i> (Chaudoir, 1861)
C.S. <i>Cymbionotum semeleleri</i> (Chaudoir, 1861)
<i>Harpalus (Harpalus) tenebrosus</i> Dejean, 1829
<i>Masoreus orientalis</i> Dejean, 1828
<i>Masoreus desertorum</i> Escalera, 1914
C.S. <i>Atlantomasoreus desertorum</i> (Escalera, 1914)
<i>Masoreus wetterhallii</i> (Gyllenhal, 1813)
<i>Masoreus wetterhallii</i> var. <i>axillaris</i> Küster, 1852
C.S. <i>Masoreus wetterhallii testaceus</i> Lucas, 1846
<i>Masoreus wetterhallii</i> var <i>testaceus</i> Lucas, 1846
C.S. <i>Masoreus wetterhallii testaceus</i> Lucas, 1846
<i>Masoreus wetterhallii</i> var <i>aegyptiacus</i> Dejean
<i>Microlestes vittipennis</i> J. Sahlberg, 1908
C.S. <i>Anomotarus vittipennis</i> Baehr, 2003
<i>Microlestes corticalis</i> (L. Dufour, 1820)

## Appendix 2. — Continuation.

**Coleoptera Carabidae Latreille, 1802**

<i>Notaphus (Notaphocampa) foveolatus</i> Dejean, 1831
C.S. <i>Bembidion (Notaphocampa) foveolatum</i> Dejean, 1831
<i>Notaphus (Notaphus) varius</i> A.G.Olivier, 1795
C.S. <i>Bembidion (Notaphus) varium</i> (Olivier, 1795)
<i>Ocydromus (Ocydromus) andreae atlantis</i> Antoine, 1945
C.S. <i>Bembidion (Peryphus) hummieri hummieri</i> J. Müller, 1918 (s. lat.)
<i>Ocydromus (Ocydromus) atlanticus</i> (Wollaston, 1854)
C.S. <i>Bembidion (Ocydromus) atlanticum</i> (Wollaston, 1854)
<i>Orthomus barbarus atlanticum</i> Fairmaire,
C.S. <i>Orthomus (Orthomus) barbarus</i> (Dejean, 1828)
<i>Perileptus hesperidum</i> Jeannel, 1925
<i>Perileptus areolatus</i> (Creutzer, 1799)
<i>Pheropsophus africanus</i> (Dejean, 1825)
<i>Philochtus vicinus</i> (Lucas, 1846)
C.S. <i>Bembidion (Philochtus) vicinus</i> Lucas, 1846
<i>Platyтарus faminii</i> (Dejean, 1826)
<i>Poecilus (Paraderus) wollastoni</i> (Wollaston, 1854)
C.S. <i>Poecilus wollastoni</i> (Wollaston, 1854)
<i>Pogonus (Pogonus) gilvipes</i> Dejean, 1828
<i>Pogonus (Pogonus) chaldeus</i> (Marsham, 1802)
<i>Scarites (Scarites) buparius</i> (Forster, 1771)
<i>Siagona europaea</i> Dejean, 1826
<i>Sphodrus leucopthalmus</i> (Linnaeus, 1758)
<i>Syntomus lateralis</i> (Motschulsky 1855)
<i>Tachyura (Tachyura) diabrachys</i> (Kolenati, 1845)
C.S. <i>Elaphropus diabrachys</i> (Kolenati, 1845)
<i>Tachyura (Tachyura) variabilis</i> (Chaudoir, 1876)
C.S. <i>Elaphropus variabilis</i> (Chaudoir, 1876)
<i>Tachyura (Tachyura) inaequalis</i> (Kolenati, 1845)
C.S. <i>Elaphropus inaequalis</i> (Kolenati, 1845)
<i>Tachyura (Sphaerotachys) haemorrhoidalis</i> (Ponza, 1805)
C.S. <i>Elaphropus haemorrhoidalis</i> (Ponza, 1805)
<i>Zuphium varum</i> Vauloger de Beaupré, 1898
C.S. <i>Parazuphium (Neozuphium) damascenum</i> (Fairmaire, 1897)

APPENDIX 3. — Coleoptera Tenebrionidae Latreille, 1802 listed in Español Coll (1943–1952). Abbreviation: **C.S.**, current status. Main taxonomic sources: biolib.cz; Bouchard *et al.* 2021; Global Biodiversity Information (gbif.org); Iwan & Löbl 2021; Purchart 2009; Santos Mazorra & Aragüés Aliaga 2011; Vinolas *et al.* 1995; Wikipedia (<http://wikipedia.org>); Zoobank ([zoobank.org](http://zoobank.org) for Tenebrionidae).

Species	Date of publication
<i>Adelostoma sulcatum crassicornae</i> Peyerimoff, 1931	1943, 1946
C.S. <i>Adelostoma sulcata crassicornae</i> Peyerimoff, 1931	–
<i>Adesmia montana asperrima</i> Peyerimoff, 1931	1943
C.S. <i>Adesmia kiskreensis asperrima</i> Peyerimoff, 1931	–
<i>Akis rotundicollis</i> Escalera, 1933	1943
C.S. <i>Akis richteri</i> Quedenfeldt, 1889	–
<i>Akis susica</i> Escalera, 1933	1943
C.S. <i>Akis heydeni heydeni</i> Haag-Rutenberg, 1876	–
<i>Anemia (Anemia) pilosus</i> Tournier, 1868	1943
C.S. <i>Cheirodes pilosus</i> (Tournier, 1868)	–
<i>Anemia (Anemia) sardoa</i> Gén�, 1839	1952
C.S. <i>Cheirodes sardous</i> (Gen�, 1839)	–
<i>Anemia (Pseudanemia) brevicollis</i> (Wollaston, 1864)	1943
C.S. <i>Cheirodes (Pseudanemia) brevicollis</i> (Wollaston, 1864)	–
<i>Arthrodeis rungsi</i> Espa�ol, 1943	1943
C.S. <i>Arthrodeis (Arthrodeis) rungsi</i> Espa�ol, 1943	–
<i>Arthrodeis rungsi bulloni</i> Espa�ol, 1943	1943
C.S. <i>Arthrodeis (Arthrodeis) rungsi bulloni</i> Espa�ol, 1943	–
<i>Arthrodeis (Apentanes) bolivari</i> Espa�ol, 1950.	1950
Eos,T.E.: 364	–
<i>Belopus elongatus</i> (Herbst, 1797)	1943
C.S. <i>Centorus (Belopus) elongatus</i> (Herbst, 1797)	–
<i>Blaps vialattei</i> Peyerimoff, 1920	1943
C.S. <i>Blaps tripolitana</i> Karsch, 1881 *	–
<i>Blaps desertica</i> Escalera, 1913	1943
C.S. <i>Blaps tingitana</i> Allard, 1880**	–
<i>Blaps murati</i> Peyerimoff, 1943**	1946
<i>Blaps barbara</i> Solier, 1848	1943
C.S. <i>Blaps nitens barbara</i> Solier, 1848	–
<i>Cataphronetis fossoria</i> Wollaston, 1861	1946
C.S. <i>Phthora angusta</i> (Wollaston, 1861)	–
<i>Catomulus olcesi rugosicollis</i> Espa�ol, 1944	1944
<i>Catomulus olcesi minimus</i> Espa�ol, 1952	1952
C.S. <i>Catomulus olcesii olcesii</i> (Fairmaire, 1883)	–
<i>Cimipsa zarcoi</i> Espa�ol, 1944	1944
<i>Clitobius (Clitobius) ovatus</i> Erichson, 1843	1943
<i>Clitobius (Clitobius) oblongiusculus</i> Fairmaire, 1875	1943
<i>Crypticus (Sericius) fonti</i> Escalera, 1923	1943
C.S. <i>Pseudosericius fonti</i> (Escalera, 1923)	–
<i>Cyphostethe saharensis</i> Chobaut, 1897	1943
C.S. <i>Cyphostethe (Cyphostethoides) saharensis</i> (Chobaut, 1897)	–
<i>Dilamus volkonskyi battareli</i> Peyerimoff, 1943	1946
<i>Hegeter tristis</i> Fabricius, 1792	1946
<i>Erodium bicostatus vittatus</i> Peyerimoff, 1943	1946
<i>Erodium mateui</i> Espa�ol, 1946	1946
<i>Eulipus punctidorsis</i> Reitter, 1900	1943
C.S. <i>Eulipus elongatus punctidorsis</i> Reitter, 1900	–
<i>Eulipus punctidorsis quirogai</i> Escalera, 1905	1943
C.S. <i>Eulipus elongatus punctidorsis</i> Reitter, 1900	–
<i>Eulipus punctidorsis foveifrons</i> Escalera, 1935	1943
C.S. <i>Eulipus elongatus punctidorsis</i> Reitter, 1900	–
<i>Gnathocerus cornutus</i> (Fabricius, 1798)	1946
C.S. <i>Gnathocerus cornutus</i> (Fabricius, 1798)	–
<i>Gonocephalum setulosum</i> Faldermann, 1837	1943
<i>Gonocephalum (Megadasus) soricinum</i> Reiche & Saulcy, 1857	1943
C.S. <i>Gonocephalum soricinum</i> Reiche & Saulcy, 1857	–
<i>Gonocephalum (Gonocephalum) sardoa</i> Gen�, 1839	1952
C.S. <i>Cheirodes sardoa</i> (Gen�, 1839)	–
<i>Herlesa cavifrons</i> Fairmaire, 1863	1943

Appendix 3. — Continuation.

Species	Date of publication
<i>C.S. Herlesa cavifrons</i> (Fairmaire, 1863)	–
<i>Latheticus oryzae</i> Waterhouse, 1880	1943
<i>Litoborus forticostis saharensis</i> Español, 1946	1946
<i>C.S. Litoborus (Paralitoborus) forticostis saharensis</i> Español, 1946	–
<i>Mateuina kaszabi</i> Español, 1944	1944
<i>Mesomorplus setosus</i> Mulsant & Ray, 1853	1946
<i>Mesostena angustata</i> (Fabricius, 1775)	1943
<i>Mesostena angustata praesahariana</i> Koch, 1940	1943
<i>Micipsa princeps</i> Peyerimoff, 1934	1946
<i>Microtelus lethierryi</i> Reiche, 1860	1943
<i>Morica favieri</i> Lucas, 1859	1943
<i>Nesotes catomoides</i> Español, 1952	1952
<i>C.S. Nesotes (Nesotes) catomoides</i> Español, 1952	–
<i>Ocnera hispida</i> (Forskål, 1775)	1943
<i>C.S. Trachyderma hispidum</i> (Forskål, 1775)	–
<i>Opatrinus niloticus zolotarevskyi</i> Español, 1943	1943
<i>C.S. Opatrinus (Zidalus) niloticus zolotarevskyi</i> Español, 1943	–
<i>Opatroides punctulatus</i> Brullé, 1832	1943
<i>Oterophloeus alveatus</i> Peyerimoff, 1931	1952
<i>Oterophloeus alveatus densepunctatus</i> Escalera, 1935	1943
<i>C.S. Oterophloeus alveatus densepunctatus</i> (Escalera, 1935)	–
<i>Oxycara chudeaui</i> Gebien, 1910	1946
<i>C.S. Oxycara (Oxycara) gastonis</i> Reitter, 1903	–
<i>Oxycara gastoni</i> Reitter, 1903	1943
<i>C.S. Oxycara gastoni</i> (Reitter, 1903)	–
<i>Oxycara murati</i> Peyerimoff, 1942	1943
<i>Palorus (Circomus) subdepressus</i> Wollaston, 1864	1943
<i>C.S. Palorus subdepressus</i> (Wollaston, 1864)	–
<i>Pimelia (Homalopus) cordata mackenziei</i> Escalera, 1914	1943
<i>C.S. Pimelia (Pimelia) cordata mackenziei</i> Escalera, 1914	–
<i>Pimelia (Homalopus) cordata desertorum</i> Escalera, 1914	1943
<i>C.S. Pimelia (Pimelia) cordata desertorum</i> Escalera, 1914	–
<i>Pimelia (Homalopus) angulata antiaegypta</i> Koch, 1937	1952

Appendix 3. — Continuation.

Species	Date of publication
<i>Pimelia (Homalopus) angulata expiata</i> Peyerimoff, 1923	1943
<i>Pimelia (Homalopus) subquadrata chudeaui</i> Koch, 1941	1946
<i>Pimelia (Pimelia) granulithorax</i> Escalera, 1914	1946
<i>Pimelia (Pimelia) grandis latastei</i> Sénac, 1884	1943
<i>Pimelia (Pimelia) moralesi</i> Español, 1943	1943
<i>Prionothea coronata</i> Olivier, 1795	1943
<i>C.S. Prionothea coronata</i> Dejean, 1884	–
<i>Pterolasia squalida</i> Solier, 1836	1943
<i>Scaurus punctatus</i> Fabricius, 1798	1943
<i>C.S. Scaurus uncinus</i> (Forster, 1771)	–
<i>Scaurus microcephalus</i> Escalera, 1914	1943
<i>Scaurus quirogai</i> Escalera, 1914	1943
<i>C.S. Scaurus microcephalus</i> Escalera, 1914	–
<i>Scaurus quirogai lopezi</i> Español, 1943	1943
<i>C.S. Scaurus microcephalus lopezi</i> Español, 1943	–
<i>Scelosodis alluaudi</i> Peyerimoff, 1933	1943
<i>Scleron sulcatum saharensis</i> (Peyerimoff, 1931)	1943
<i>Sepidium desertica</i> Español, 1944	1946
<i>Sepidium histrix desertica</i> Español, 1944	1944
<i>C.S. Sepidium desertica</i> Español, 1944	–
<i>Storthocnemis steckeri dufouri</i> Peyerimoff, 1935	1943
<i>Tentyria (Tentyrina) senegalensis</i> (Solier, 1835)	1946
<i>Tentyrionota rotundicollis</i> Kraatz, 1865	1943
<i>C.S. Tentyrionota rotundicollis</i> (Kraatz, 1865)	–
<i>Thalpobia fontii</i> Escalera, 1935	1946
<i>Thalpobia fontii korsakovi</i> Español, 1946	1946
<i>Thalpobia meridionalis clermonti</i> Español, 1946	1946
<i>Thriptera maroccana</i> Thery, 1932	1946
<i>Tribolium (Tribolium) castaneum</i> (Herbst, 1797)	1943
<i>Tribolium (Stene) confusum</i> (Jacquelin du Val, 1868)	1946
<i>Trichosphaena perraudieri</i> (Marseul, 1867)	1943
<i>Zophosis atlantica</i> Escalera, 1913	1943
<i>Zophosis mozabita</i> Fairmaire, 1897	1943
<i>C.S. Zophosis nigroaenea</i> Deyrolle, 1867	–
<i>Zophosis ghiliani susica</i> Escalera, 1914	1943
<i>C.S. Zophosis (Septentriophosis) bicarinata susica</i> Escalera, 1914	–



APPENDIX 4. — Hymenoptera Sphecidae Latreille, 1802, Crabronidae Latreille, 1802, Pompilidae Latreille, 1805, Bradynobaenidae Saussure, 1892, and Mutillidae Latreille, 1802 listed in Giner Mari (1944, 1945, 1947). Abbreviation: **C.S.**, current status. Main taxonomic sources: Catalogue of life (<https://www.catalogueoflife.org>); Global Biodiversity Information (Gbiif.org); wikimedia (<https://species.wikimedia.org/wiki/Insecta>); Lelej (2002); Pagliano (2002, 2005); Pagliano & Romano (2017).

Appendix 4. — Continuation.

Families, species	Date of publication
Sphecidae Latreille, 1802	
<i>Ammophila (Psammophila) atrocyanea</i> Eversmann, 1849	1944
C.S. <i>Podalonia atrocyanea</i> (Eversmann, 1849)	–
<i>Ammophila (Psammophila) atrocyanea</i> var. <i>massilissa</i> Morice	1947
<i>Ammophila (Psammophila) saharæ</i> Giner Mari, 1944	1944
C.S. <i>Podalonia schmiedeknechti</i> (Kohl, 1898)	–
<i>Ammophila (Psammophila) tydei</i> le Guillou, 1841	1944, 1945, 1947
C.S. <i>Podalonia tydei</i> (le Guillou, 1841)	–
<i>Ammophila (Psammophila) mauritanica</i> Mercet, 1906	1944, 1945, 1947
C.S. <i>Podalonia mauritanica</i> (Mercet, 1906)	–
<i>Ammophila (Psammophila) minax</i> Kohl, 1901	1944, 1945, 1947
C.S. <i>Podalonia minax</i> (Kohl, 1901)	–
<i>Ammophila (Eremochares) dives</i> Brullé, 1833	1945
C.S. <i>Eremochares dives</i> (Brullé, 1833)	–
<i>Ammophila (Eremochares) lutea</i> Taschenberg, 1869	1944
C.S. <i>Eremochares luteus</i> (Taschenberg, 1869)	–
<i>Ammophila (Coloptera) judaeorum</i> Kohl, 1901	1944, 1947
C.S. <i>Ammophila theryi</i> (gribodo, 1894)	–
<i>Ammophila (Ammophila) gracillima</i> Taschenberg, 1869	1945, 1947
<i>Ammophila (Ammophila) erminea</i> Kohl, 1901	1944, 1945, 1947
<i>Ammophila (Ammophila) propinqua</i> Taschenberg, 1869	1944, 1945, 1947
C.S. <i>Ammophila rubripes</i> Spinola, 1839	–
<i>Ammophila (Ammophila) poecilocnemis</i> Morice, 1900	1944, 1945, 1947
<i>Ammophila (Ammophila) strumosa</i> Kohl, 1906	1944, 1947
<i>Sphex (Calosphex) niveatus</i> Dufour, 1854	1945
C.S. <i>Prionyx niveatus</i> (Dufour, 1854)	–
<i>Sphex (Calosphex) nigropectinatus</i> Taschenberg, 1869	1947
C.S. <i>Prionyx nigropectinatus</i> (Taschenberg, 1869)	–
<i>Sphex (Parasphex) viduatus</i> Christ, 1791	1944, 1945, 1947
C.S. <i>Prionyx viduatus</i> (Christ, 1791)	–
<i>Sphex (Harpactopus) stschurowskii hyalipennis</i> Kohl, 1895	1947
C.S. <i>Prionyx stschurowskii hyalipennis</i> Kohl, 1895	–
<i>Sphex (Sphex) pruinosis</i> Germar, 1817	1947
Crabronidae Latreille, 1802	
<i>Cerceris (Apiraptrix) albicincta</i> Klug, 1845	1944, 1945
C.S. <i>Cerceris albicincta</i> Klug, 1845	–
<i>Cerceris (Apiraptrix) alfieri/alfieri</i> Mochi, 1839	1944, 1947
C.S. <i>Cerceris pulchella</i> Klug, 1845	–
<i>Cerceris (Apiraptrix) annexa</i> Kohl, 1898	1947
C.S. <i>Cerceris pallidula</i> subsp. <i>annexa</i> Kohl, 1898	–
<i>Cerceris (Apiraptrix) fluxa saharica</i> Giner Mari, 1945	1945
C.S. <i>Cerceris histrionica</i> Klug, 1845	–
<i>Cerceris (Apiraptrix) fischeri</i> Spinola, 1839	1945
<i>Cerceris (Apiraptrix) pulchella</i> Klug, 1845	1944, 1945
C.S. <i>Cerceris pulchella</i> Klug, 1845	–
<i>Cerceris (Apiraptrix) priesneri</i> Mochi, 1939	1947
C.S. <i>Cerceris priesneri</i> Mochi, 1939	–
<i>Cerceris (Cerceris) honorei</i> Mochi, 1939	1945
C.S. <i>Cerceris histrionica</i> Klug, 1845	–

Families, species	Date of publication
<i>Cerceris (Cerceris) bulloni</i> Giner Mari, 1945	1945, 1947
C.S. <i>Cerceris tricolorata</i> Spinola, 1839	–
<i>Cerceris insignis</i> Morice (non Klug), 1911	1945
C.S. <i>Cerceris tricolorata</i> Spinola, 1839	–
<i>Cerceris (Cerceris) escalerae/escalarai</i> Giner Mari, 1941	1944, 1945, 1947
<i>Cerceris (Cerceris) mateui</i> Giner Mari, 1945	1945
C.S. <i>Cerceris chlorotica</i> Spinola, 1839	–
<i>Cerceris (Cerceris) straminea</i> Dufour, 1854	1945
<i>Cerceris (Cerceris) quadricincta</i> Panzer, 1799	1947
<i>Philanthus coarctatus</i> Spinola, 1839	1945, 1947
<i>Philanthus niloticus</i> F. Smith, 1873	1944, 1947
C.S. <i>Philanthus coarctatus</i> Spinola, 1839	–
<i>Philantus pallidus</i> Klug, 1945	1944
<i>Philantus pachecoi</i> Giner Mari, 1944	1944, 1947
C.S. <i>Philantus rutilus</i> Spinola, 1839	–
<i>Philoponus españolii</i> Giner Mari, 1947	1947
<i>Philoponus splendidus</i> Giner Mari, 1945	1945
C.S. <i>Pseudoscobia splendida</i> (Giner Mari, 1945)	–
<i>Philoponoides tricolor</i> Giner Mari, 1944	1944
C.S. <i>Pseudoscobia tricolor</i> (Giner Mari, 1945)	–
<i>Astata (Astata) moralesi</i> Giner Mari, 1945	1945
<i>Astata (Astata) radialis</i> E. Saunders, 1910	1947
C.S. <i>Astata radialis</i> E. Saunders, 1910	–
<i>Astata (Astata) sp.</i>	1947
<i>Notogonia nigrita</i> (Lepelletier de Saint Fargeau, 1845)	1944, 1945, 1947
C.S. <i>Liris atratus</i> (Spinola, 1805)	–
<i>Dinetus gracilis</i> Giner Mari, 1945	1945
C.S. <i>Dinetus dentipes</i> E. Saunders, 1910	–
<i>Liris haemorrhoidalis</i> (Fabricius, 1804)	1947
<i>Tachysphex fluctuatus</i> (Gerstaecker, 1858)	1947
C.S. <i>Tachysphex sericeus</i> (F. Smith, 1856)	–
<i>Tachysphex panzeri</i> var. <i>oraniensis</i> Lepelletier de Saint Fargeau, 1845	1944
C.S. <i>Tachysphex panzeri</i> (Vander Linden, 1829)	–
<i>Tachysphex gracilitarsis</i> Morice, 1910	1944
<i>Tachysphex sp.</i>	1944, 1945
<i>Tachytes sp.</i>	1945
<i>Parapiagetia odontostoma</i> (Kohl, 1884)	1944
<i>Gastrosericus waltlii</i> Spinola, 1839	1944
<i>Gastrosericus aiunensis</i> Giner Mari, 1944	1944
C.S. <i>Gastrosericus waltlii</i> Spinola, 1839	–
<i>Palarus laetus</i> Klug, 1845	1944
<i>Palarus sp.</i>	1947
<i>Gorytes (Harpactus) laevis</i> race <i>saharæ</i> Giner Mari, 1944	1944, 1947
C.S. <i>Harpactus laevis</i> (Latreille, 1792)	–
<i>Gorytes (Harpactus) funereus</i> Giner Mari, 1944	1944, 1947
C.S. <i>Harpactus funereus</i> (Giner Mari, 1944)	–
<i>Laphyragogus pictus</i> Kohl, 1889	1945
C.S. <i>Stizus pubescens arenarum</i> Handlirsch, 1892	–
<i>Stizus deserticus</i> Giner Mari, 1944	1944
<i>Stizus ferrugineus</i> (F. Smith, 1856)	1944
C.S. <i>Stizus ruficornis</i> (J. Forster, 1771)	–
<i>Stizus fuliginosus</i> (Klug, 1845)	1944
C.S. <i>Stizus combustus</i> (F. Smith, 1856)	–
<i>Stizus hyalipennis</i> Handlirsch, 1892	1944, 1945
<i>Stizus spinulosus</i> Radoszkowski, 1876	1944
<i>Stizus storeyi</i> Turner, 1920	1944, 1945
C.S. <i>Stizus fuscatus</i> Morice, 1897	–
<i>Stizus anchorites</i> Turner, 1920	1945
C.S. <i>Stizus fuscatus</i> Morice, 1897	–
<i>Stizus tridens</i> (Fabricius, 1781)	1944
C.S. <i>Bembecinus tridens</i> (Fabricius, 1781)	–
<i>Bembex bulloni</i> Giner Mari, 1944	1944
C.S. <i>Bembex bulloni</i> Giner Mari, 1944	–
<i>Bembex brunneri</i> Handlirsch, 1893	1945
C.S. <i>Bembex brunneri</i> Handlirsch, 1893	–

Appendix 4. — Continuation.

Families, species	Date of publication
<i>Bembex chlorotica</i> Spinola, 1839	1947
C.S. <i>Bembex chlorotica</i> Spinola, 1839	–
<i>Bembex dahlborni</i> / <i>dahlbornii</i> Handlirsch, 1893	1944, 1945, 1947
<i>Bembex lusca</i> Spinola, 1839	1947
C.S. <i>Bembex lusca</i> Spinola, 1839	–
<i>Bembex saharae</i> Giner Marí, 1944	1944, 1945, 1947
<i>Bembex mediterranea</i> Handlirsch, 1893	1944, 1945, 1947
C.S. <i>Bembex olivacea</i> Fabricius, 1787	–
<i>Bembex fonti</i> Mercet, 1905	1945
C.S. <i>Bembex flavescens fonti</i> Mercet, 1905	–
<i>Bembex oculata</i> Panzer, 1801	1944, 1945, 1947
C.S. <i>Bembex oculata</i> Panzer, 1801	–
<i>Bembex</i> sp.	1944
<i>Bembex bolivari</i> Handlirsch, 1893	1945
C.S. <i>Bembex bolivari</i> Handlirsch, 1893	–
<i>Bembex portchinskii</i> Radoszkowski, 1884	1947
C.S. <i>Bembex portchinskii</i> Radoszkowski, 1884	–
<i>Bembex rostrata</i> race <i>algeriensis</i> W. Schulz, 1905	1947
C.S. <i>Bembex rostrata algeriensis</i> W. Schulz, 1905	–
<i>Bembex hedickiei</i> Giner Marí, 1945	1945
C.S. <i>Bembex hedickiei</i> Giner Marí, 1945	–
<i>Miscophus</i> sp.	1944
<i>Miscophus ctenopus</i> Kohl, 1884	1945
<i>Miscophus ctenopus</i> <i>gigas</i> Giner Marí, 1945	1945
C.S. <i>Miscophus ctenopus</i> Kohl, 1884	–
<i>Miscophus sericeus</i> Radoszkowski, 1876	1945
<i>Miscophus aegyptius</i> Morice, 1897	1945
<i>Miscophus gibbicollis</i> Giner Marí, 1945	1945
<i>Miscophus imitans</i> Giner Marí, 1945	1945
Pompilidae Latreille, 1805	
<i>Psammochares teterrimus</i> (Gribodo, 1884)	1945, 1947
C.S. <i>Pareiocurgus calidus</i> (Guerin, 1843)	–
<i>Psammochares plumbeus</i> (Fabricius, 1787)	1947
C.S. <i>Pompilus cinereus</i> (Fabricius, 1775)	–
<i>Psammochares sahlbergi</i> ? Morawitz, 1893	1947
C.S. <i>Evagetes sahlbergi</i> (Morawitz, 1893)	–
<i>Anoplius concinnus</i> (Dahlbom, 1845)	1947
<i>Anoplius infuscatus</i> (Van der Linden, 1827)	1945, 1947
<i>Priocnemis consimilis</i> Costa, 1858	1947
C.S. <i>Priocnemis faillae</i> De-Stefani, 1886	–
<i>Priocnemis pusillus</i> Schiödte, 1837	1947
C.S. <i>Priocnemis pusilla</i> Schiödte, 1837	–
<i>Tachyagetes sericans</i> (Klug, 1834)	1945
<i>Dicyrtomellus claviger</i> (Taschenberg, 1869)	1945, 1947
<i>Schistonyx umbrosus</i> (Klug, 1834)	1947
C.S. <i>Schistonyx perezii</i> (Tournier, 1895)	–
<i>Ceropales cribratus juncoi</i> Giner Marí, 1945	1945
C.S. <i>Ceropales juncoi</i> Giner Marí, 1945	–
Bradynobaenidae Saussure, 1892	
<i>Apterogyna nitida</i> Bischoff, 1920	1945, 1947
C.S. <i>Macroocula nitida</i> (Bischoff, 1920)	–
<i>Apterogyna olivieri</i> Latreille, 1809	1944
<i>Apterogyna patrizii</i> Invrea, 1932	1945, 1947
C.S. <i>Macroocula nitida</i> (Bischoff, 1920)	–
<i>Apterogyna geyri</i> Bischoff, 1920	1945, 1947
C.S. <i>Macroocula geyri</i> (Bischoff, 1920)	–
<i>Apterogyna latreillei</i> Klug, 1829	1944
<i>Apterogyna mateui</i> Giner Marí, 1945	1945
<i>Apterogyna mateui</i> var <i>bicolor</i> Giner Marí, 1945	1945, 1947
C.S. <i>Apterogyna mateui</i> Giner Marí, 1945	–
<i>Apterogyna mickeli</i> Giner Marí, 1945	1945

Appendix 4. — Continuation.

Families, species	Date of publication
Mutillidae Latreille, 1802	
<i>Myrcosa sbuiaensis</i> Giner Marí, 1945	1945
C.S. <i>Paramyrmosa sbuiaensis</i> (Giner Marí, 1945)	–
<i>Myrmilla mateui</i> Giner Marí, 1945	1945, 1947
C.S. <i>Myrmilla</i> ( <i>Pseudomutilla</i> ) <i>mateui</i> Giner Marí, 1945	–
<i>Myrmilla moralesi</i> Giner Marí, 1945	1945
C.S. <i>Myrmilla</i> ( <i>Pseudomutilla</i> ) <i>moralesi</i> Giner Marí, 1945	–
<i>Pseudophotopsis mateui</i> Giner Marí, 1945	1945
<i>Pseudophotopsis fumata</i> Bischoff, 1920	1944, 1947
<i>Tricholabiodes</i> sp.	1945, 1947
<i>Ephutomma saharica</i> Giner Marí, 1945	1945, 1947
C.S. <i>Dentilla saharica</i> (Giner Marí, 1945)	–
<i>Mutilla barbara</i> Linnaeus, 1758	1947
C.S. <i>Ronisia barbara</i> (Linnaeus, 1758)	–
<i>Mutilla maroccana</i> Olivier, 1811	1945
C.S. <i>Ronisia maroccana</i> (Olivier, 1811)	–
<i>Smicromyrme catanensis</i> Rossi, 1794	1944
C.S. <i>Trogaspidia catanensis</i> (Rossi, 1794)	–
<i>Smicromyrme pusilla</i> Klug, 1835	1945
C.S. <i>Physetopoda pusilla</i> (Klug, 1835)	–
<i>Smicromyrme tricolor</i> Klug, 1829	1947
C.S. <i>Trogaspidia tricolor</i> (Klug, 1829)	–
<i>Smicromyrme lybica invreai</i> Giner Marí, 1945	1945
<i>Smicromyrme</i> sp.	1945
<i>Dasylabris maura</i> (Linnaeus, 1758)	1947
C.S. <i>Dasylabris</i> ( <i>Dasylabris</i> ) <i>maura</i> (Linnaeus, 1758)	–
<i>Dasylabris maura</i> var. <i>rufoccephala</i> André, 1903	1945, 1947
C.S. <i>Dasylabris</i> ( <i>Dasylabris</i> ) <i>rufoccephala</i> André, 1903	–
<i>Dasylabris andrei</i> Mercet, 1903	1945
C.S. <i>Dasylabris</i> ( <i>Dasylabris</i> ) <i>andrei</i> Mercet, 1903	–
<i>Dasylabris arabica</i> var. <i>koenigi</i> Radoszkowski, 1888	1944
C.S. <i>Dasylabris</i> ( <i>Baltilla</i> ) <i>koenigi</i> Radoszkowski, 1888	–
<i>Stenomutilla argentata</i> (Villers, 1789)	1944, 1945, 1947
C.S. <i>Stenomutilla</i> ( <i>Stenomutilla</i> ) <i>argentata</i> (Villiers, 1789)	–
<i>Stenomutilla argentata</i> var. <i>rufinodis</i> Giner Marí, 1947	1947
C.S. <i>Stenomutilla</i> ( <i>Stenomutilla</i> ) <i>rufinodis</i> Giner Marí, 1947	–
<i>Stenomutilla quadricincta</i> Giner Marí, 1945	1945, 1947
C.S. <i>Stenomutilla</i> ( <i>Stenomutilla</i> ) <i>quadricincta</i> Giner Marí, 1947	–
Taxa not found in modern catalogues	
<i>Dasylabris araeanaria</i> var. <i>rufoccephala</i> André, 1903	1944
C.S. ? <i>Dasylabris</i> ( <i>Dasylabris</i> ) <i>rufoccephala</i> André, 1903	–
<i>Dasylabris araeanaria</i> var. <i>atriventris</i> André, 1903	1944
C.S. ? <i>Dasylabris maura atriventris</i> André, 1903	–

Supplementary Table 1. — Georeferenced cartography of Morales Agacino entomological expeditions. The GPX Viewer application with GPX editor (PlayStore and AppleStore) shows all the places mentioned in the text on an OpenStreet-Map, Google Standard or Google Satellite map, for the most relevant ones. A click on a marker gives the locality name of the place and its number no. in Table 3. The .gpx file can be edited with Notepad on Windows or TextEdit on macOS. [https://doi.org/10.5252/zoosystema2022v44a10\\_s1](https://doi.org/10.5252/zoosystema2022v44a10_s1)