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An annotated checklist and bibliography of the mosquitoes of Spain (Diptera: Culicidae)

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Abstract

A revised list of the mosquito species occurring in Spain is presented. Fifty-nine species are recorded by the authors or noted in the literature. However, due to lack of voucher specimens and the unreliability of several older reports, only 53 species records are considered valid. All special cases are discussed.

Introduction

As in many other European countries (Samanidou-Voyadjoglou & Darsie, 1993), the study of mosquitoes in Spain during the first half of the 1900s was related to the fight against malaria, leading to a considerable amount of information on anopheline species. An excellent review on the study of mosquitoes in Spain can be found in Encinas Grandes (1982). The first review was by Arias Encobet (1912), who published a list of Diptera in Spain that included 12 Culicidae. In 1920, the creation of the *Comisión Central Antipalúdica* (Central Antimalarial Committee) enhanced the basic entomological research carried out by the De Buen brothers, Gil Collado, Caballero and others, resulting in the listing of some 30 species by 1930. Culicidological studies during the early thirties, until the Spanish civil war, added 6 species, including the members of the *Anopheles maculipennis* complex (Gil Collado, 1937 in Encinas Grandes, 1982). There was an episode of malaria resurgence during the post-war period, which led to resuming the sanitary campaigns for mosquito control in 1943 (Rico-Avelló y Rico, 1950). The list was increased by 14 species with the description of the new species *Ae. quasirusticus* by Torres Cañamares (1951a), the review on aedines by Clavero (1946), and studies on anophelines by Romeo Viamonte (1950) and Gil Collado (1954).

Few studies were carried out between 1960 and 1982. Among them, we highlight an unpublished doctoral dissertation by García Calder-Smith (1965), the work of Blázquez and Zulueta, an annotated review by Torres Cañamares (1979) and the cited work from Encinas Grandes (1982), which contains the latest list of 56 species for continental Spain and the Balearic and Canary islands.

Since 1982 several mosquito control services have been created in coastal areas of Spain. They have carried out several taxonomic and distribution studies in collaboration with universities, enhancing the knowledge of the mosquitoes of Spain. As checklists are being revised by individual countries to better define the European culicid fauna, we present here a revised list for Spain. This list has been compiled using bibliographic references and our own data. Unfortunately, no voucher specimens could be checked since the location of most of the material on which occurrence records are based is uncertain. Thus, this is mostly a literature-based review, and records need to be confirmed by fieldwork. In the reference section we have tried to overcome confusion in quoting Spanish authors where, in the past, one or the other or both parental family names have been cited.

The geographic area considered in the checklist has been restricted to Palaearctic Spain, i.e. the peninsula plus the Balearic Islands; therefore, three species found in the Canary Islands, *Anopheles sergentii* Theobald, *Aedes eatoni* (Edwards) and *Culex arbieeni* (Salem), are not included. Although the list includes 59 species, four of them are doubtful (marked in the list with *) and two are probably extinct (marked with **). Among the 53 species, some need to be confirmed, especially because many authors did not provide collection data or retain voucher specimens. Currently valid names of the species are used, but the original combinations are included (between square brackets). All of these cases are discussed in the notes section.

All taxa are arranged alphabetically following *A catalog of the mosquitoes of the World* (Knight & Stone, 1977) and its supplements (Knight, 1978; Ward, 1984a; Ward, 1992) and more recent literature. The only exceptions

are two species previously included in the subgenus *Ochlerotatus* of *Aedes*, which are now placed in *Rusticoidus* (Encinas Grandes, 1982; Reinert, 1999). No subspecific taxa are included because of lack of information.

The species belong to seven genera as follows: 13 *Anopheles*, 1 *Orthopodomyia*, 1 *Uranotaenia*, 6 *Culiseta*, 2 *Coquillettidia*, 25 *Aedes* and 11 *Culex*. Three of the 59 species are new records recognised by the authors in 1989 (*Coquillettidia buxtoni*), 1998 (*Culex deserticola*) and 1999 (*Culex torrentium*).

Differences between this and the previously published list (Eritja *et al.*, 1998) are due to typographic omission and the inclusion of additional collection data.

SPECIES THAT HAVE BEEN RECORDED IN THE SPANISH LITERATURE

Subfamily ANOPHELINAE

Genus *Anopheles* Meigen, 1818

Subgenus *Anopheles* Meigen, 1818

1 *algeriensis* Theobald, 1903
2 *atroparvus* Van Thiel, 1927
3 *claviger* (Meigen, 1804)
4 *hyrcanus* (Pallas, 1771)
*5*** *labranchiae* Falleroni, 1926 (note 1)
6 *maculipennis* Meigen, 1818 (note 2)
7 *marteri* Senevet & Prunelle, 1927
8 *melanoon* Hackett, 1934 (note 3)
9 *petragnani* Del Vecchio, 1939
10 *plumbeus* Stephens, 1828

Subgenus *Cellia* Theobald, 1902

11 *cinereus* Theobald, 1901 [as *An. hispaniola* Theobald, 1903]
12 *multicolor* Cambouliu, 1902
*13** *superpictus* Grassi, 1899 (note 4)

Subfamily CULICINAE

Genus *Aedes* Meigen, 1818

Subgenus *Aedes* Meigen, 1818

14 *geminus* Peus, 1970 [as *cinereus* Meigen, 1818](note 5)

Subgenus *Aedimorphus* Theobald, 1903

15 *vexans* (Meigen, 1830)
16 *vittatus* (Bigot, 1861)

Subgenus *Finlaya* Theobald, 1903

17 *echinus* (Edwards, 1920) (note 6)
18 *geniculatus* (Olivier, 1791)
19 *gilcolladoi* Sánchez-Covisa *et al.*, 1985 (note 6)

Subgenus *Ochlerotatus* Lynch Arribalzaga, 1891

20 *berlandi* Séguy, 1921
21 *cantans* (Meigen, 1818)
22 *caspius* (Pallas, 1771)
23 *cataphylla* Dyar, 1916
24 *detritus* (Haliday, 1833)
*25** *dorsalis* (Meigen, 1830) (note 7)
26 *flavescens* (Müller, 1764)
27 *leucomelas* (Meigen, 1804)
28 *mariae* (Sergent & Sergent, 1903)
29 *pulcritarsis* (Rondani, 1872)
30 *pullatus* (Coquillett, 1904)
31 *punctor* (Kirby, 1837)
32 *sticticus* (Meigen, 1838)

33 *surcoufi* (Theobald, 1912) [as *excrucians* (Walker, 1856)] [note 8]
34* *zammitii* (Theobald, 1903) [note 9]

Subgenus *Rusticoidus* Shevchenko & Prudkina, 1973
35 *quasirusticus* Torres Cañamares, 1951
36 *refiki* Medschid, 1928
37 *rusticus* (Rossi, 1790)

Subgenus *Stegomyia* Theobald, 1901
38** *aegypti* (Linnaeus, 1762) [note 10]

Genus *Culex* Linnaeus, 1758
Subgenus *Barraudius* Edwards, 1921
39 *modestus* Ficalbi, 1890

Subgenus *Culex* Linnaeus, 1758
40 *laticinctus* Edwards, 1913
41 *mimeticus* Noé, 1899
42 *pipiens* Linnaeus, 1758 [note 11]
43 *theileri* Theobald, 1903
44 *torrentium* Martini, 1925 [note 12]
45 *univittatus* Theobald, 1901 [note 13]

Subgenus *Maillotia* Theobald, 1907
46 *deserticola* Kirkpatrick, 1925 [note 14]
47 *hortensis* Ficalbi, 1889

Subgenus *Neoculex* Dyar, 1905
48 *impudicus* Ficalbi, 1890
49 *territans* Walker, 1856

Genus *Culiseta* Felt, 1904

Subgenus *Allotheobaldia* Broelemann, 1919
50 *longiareolata* (Macquart, 1838)
Subgenus *Culicella* Felt, 1904
51 *fumipennis* (Stephens, 1825)
52 *litorea* (Shute, 1928)
53* *morsitans* (Theobald, 1901) [note 15]
Subgenus *Culiseta* Felt, 1904
54 *annulata* (Schrank, 1776)
55 *subochrea* (Edwards, 1921)

Genus *Coquillettidia* Dyar, 1905
Subgenus *Coquillettidia* Dyar, 1905
56 *buxtoni* (Edwards, 1923) [note 16]
57 *richiardii* (Ficalbi, 1889)

Genus *Orthopodomyia* Theobald, 1904
58 *pulcripalpis* (Rondani, 1872)

Genus *Uranotaenia* Lynch Arribalzaga, 1891
Subgenus *Pseudoficalbia* Theobald, 1912
59 *unguiculata* Edwards, 1913

NOTES

1. *Anopheles labranchiae* was found in 1933 (Gil Collado, 1940) in a ricefield area of 1000 km^2 in the Alicante and Murcia Provinces of southeastern Spain, where the regional transmission rate of malaria was 28-fold higher than in regions where *An. atroparvus* was the only vector. Severe local malaria epidemics in the 18th century

suggest that this species was present at that time. In 1946, this species was still very abundant in the area, even the only anopheline present in certain locations (Clavero & Romeo Viamonte, 1948b). However, surveys carried out in 1973, 1978 and 1979 indicated that *An. labranchiae* had disappeared (Blázquez & De Zulueta, 1980); moreover, the ricefields have been abandoned.

2. The records of *An. maculipennis sensu lato* prior to the splitting of the complex have been attributed to this species following Torres Cañamares (1934, 1944b), Gil Collado (1940) and Romeo Viamonte (1950).

3. The group *melanoon - subalpinus - messeae* is highly controversial. However, *An. melanoon* has been retained in the list because both Gil Collado (1940) and Torres Cañamares (1979) specifically stated that their records belonged to this taxon. This opinion is shared by Encinas Grandes (1982) who noted that the presence in Spain of *An. subalpinus* was doubtful. Future sampling is required to assess the occurrence of these species in Spain.

4. In 1903, MacDonald discovered *Anopheles superpictus* Grassi in Huelva Province and two more findings by De Buen and Peralbo were reported from Córdoba and Murcia (all three records quoted from Romeo Viamonte, 1950). According to Romeo Viamonte (1950), Torres Cañamares (1979), Encinas Grandes (1982) and Ramsdale & Snow (1999), these identifications may be erroneous and should be interpreted as the white-tipped palp form of *An. cinereus* described by Gil Collado (1930b). Romeo Viamonte notes that on the basis of climate and biotope, only the Murcia record could be assigned to *An. superpictus*, especially since this species has been found in Corsica and Sicily (Torres Cañamares, 1979). However, the occurrence of *An. superpictus* in Spain is highly doubtful.

5. *Aedes cinereus* has been recorded twice in Spain. The first, by Estellés & Mulero (1949 in Torres Cañamares, 1979), was based only on larvae. According to Peus (1970 in Encinas Grandes, 1982) and Torres Cañamares (1979), the records from El Paular in Madrid (Clavero, 1945) should be assigned to *Ae. geminus* Peus, 1970. Although none of the specimens is available, the author's original drawing of the hypopigium shows a gonostylus with a clearly divided tip and the external branch longer than the internal. Since the gonostylar tip is one of the few diagnostic characters for *Ae. geminus*, and this species was unknown to Clavero because it had not yet been described, it is reasonable to add *Ae. geminus* to the list, which leaves the question of whether *Ae. cinereus* is present in Spain unanswered.

6. *Aedes gilcolladoi* was described by Sánchez-Covisa *et al.* (1985a) during their study of *Aedes* (*Finlaya*) in Spain (Sánchez-Covisa *et al.*, 1985a; 1985b). The species was described from larvae that were similar to *Ae. echinus* and clearly different from *Ae. geniculatus*. Statistical and biometric comparisons with European specimens of *Ae. echinus* led the authors to conclude that the latter did not occur in Spain, where *Ae. gilcolladoi* replaced *Ae. echinus*. The larvae used to describe the species are deposited in the Departamento de Parasitología, Facultad de Farmacia, Universidad Complutense (Madrid), preserved in alcohol and mounted on microscope slides (Sánchez-Covisa, pers. comm.), but they have not been examined by us. Since there are no apparent differences between adults of *Ae. geniculatus*, *Ae. echinus* and *Ae. gilcolladoi* (Sánchez-Covisa, pers. comm.), further research is needed on this species as well as the taxonomy of the species complex.

7. *Aedes dorsalis* has been reported only once, from a single larval specimen, during a survey in the Ebro delta (Curto, 1990). There is still a great deal of confusion in the *dorsalis* subgroup within the subgenus *Ochlerotatus*. Since it is based on only one larva that is no longer available for examination, this species cannot be safely considered to be present in Spain, although it could be present in the Ebro Delta given its distribution in the south of France (Rioux, 1958).

8. *Aedes surcoufi* was resurrected from synonymy with *Ae. excrucians* (Knight, 1978) for the western European member of the *excrucians* complex. *Ae. surcoufi* has therefore been included in the list replacing the original records of *excrucians*.

9. Several reports on *Aedes mariae* originally referred to the varietal form *zammitii* (Gil Collado, 1932a, 1935a; Nájera, 1943; Clavero, 1946). This taxon was raised to the species rank (Knight & Stone, 1977) following Coluzzi & Bullini (1971) (in Encinas Grandes, 1982). According to Coluzzi *et al.* (1974), *Ae. zammitii* occupies the eastern Mediterranean whereas *Ae. mariae* is its western vicariant species, although the authors did not collect in Spain or any farther west than Italy. For this reason, the Spanish records should be attributed to *Ae. mariae*, especially because it is occurs along the Atlantic shore of Spain (Huelva and Santander Provinces). Torres Cañamares (1979) and Encinas Grandes (1982) consider that *Ae. zammitii* should be retained in the list because these species can be separated from *Ae. mariae* using morphological features (Encinas Grandes, 1982).

Since the Santander record is based on only 3 adults (Clavero, 1946) and the Huelva collection data are unknown (Gil Collado, 1932a), we regard the record as highly doubtful.

10. Due to its repeated introduction from North Africa, *Aedes aegypti* was a common species in Spain during the first three decades of the 1900s. First found in 1899 in Gibraltar, Cádiz Province, there are references from 1939 in Barcelona (Margalef 1949, under the previous denomination of *Ae. fasciatus* Fabricius) and 1953 (Rico-Avelló y Rico, 1953). Since this previously abundant species has not been found more recently, it is believed to have disappeared from Spain.

11. Several studies still using the denomination *Cx. molestus* for some forms within the *Culex pipiens* complex have recently been published. Whereas this epithet could be useful for the designation of physiological variants, it is invalid from a taxonomic point of view (Ward, 1992), and therefore only *Culex pipiens* is considered in this list.

12. *Culex torrentium* is the most recently recorded species in Spain (Aranda *et al.*, 2000). Common in the French Pyrenees (Sicart, 1954), it was first reported from the Iberian Peninsula in Portugal (Ribeiro *et al.*, 1977).

13. *Culex perexiguus* was resurrected from synonymy with *Cx. univittatus* by White (1975). Harbach (1999) regarded the species of the *univittatus* group found in the Mediterranean Subregion as *Cx. perexiguus*, based on some specimens from Italy, Greece and Turkey that he had examined. Darsie & Samanidou-Voyadjoglou (1997) also recognised this taxon as occurring in Greece.However, White (1975) suggested that the Spanish reports referred to *Cx. univittatus*, and Encinas Grandes (1982) stated that specimens from Salamanca were unequivocally *Cx. univittatus* owing to the size of the ventral arm of the phallosome. For this reason we are recognising *Cx. univittatus* as the species in Spain.

14. *Culex deserticola* was recently recorded from Zaragoza Province (Ramos *et al.*, 1998) and this was the first confirmed record from continental Europe. A previous report by Séguy from Corsica (1965 in Schaffner, 1998) was considered unreliable by Schaffner (1998) because of lack of adults and the concurrence of the similar *Cx. hortensis*.

15. *Culiseta morsitans* has been recorded twice from Spain. The first record was based only on larval specimens, (Estellés & Mulero, 1949 in Torres Cañamares, 1979) collected in the Llobregat Delta in Barcelona, but the species has not been found there in the last 18 years. The second report (Clavero, 1950) did not indicate the developmental stage, location (not even province) or date. According to Torres Cañamares (1979), the male genitalia are needed to discriminate this species from *Cs. litorea*. Furthermore, Torres Cañamares considered the presence of *Cs. morsitans* highly doubtful in Spain. However, Maslov (1989) gives the distribution of *Cs. morsitans* as "... everywhere in Europe, Morocco and Algeria ...", and describes some valid larval characters to separate the species from *Cs. litorea*.

16. *Coquillettidia buxtoni* has been collected along the Catalan Mediterranean seashore, first in the Empordà region (Anonymous, 1989; our own data) and later in the Baix Llobregat area (1991; our own data).

SPECIES PROBABLY OCCURRING IN SPAIN

The Iberian Peninsula has a very special location between Europe and Africa. It comprises many climatic areas, ranging from cold rainy continental climatic areas in the north to subdesertic biotopes in the south, with wide intermediate variation. It is worth noting that even in the first half of the 1900s, during a period of exhaustive sampling, surveys were not uniformly distributed across Spain. Most collections were carried out in endemic areas of malaria such as the valleys of La Mata and La Vera in Cáceres, the entire Andalusian region, and the Llobregat Delta in Catalonia. Other areas were explored simply because entomologists happened to spend their holidays there.

To our knowledge, many provinces have never been extensively sampled. Central European species can be found in colder and rainy regions such as the Basque country. Other areas, such as the relict biotope where *Cx. deserticola* was found, should be carefully explored to assess the possible occurrence of Mediterranean and North African species like *Cx. martinii* Medschid, which is scattered from Morocco to France and Italy (Knight & Stone, 1977). Two *An. sergentii* records in the Mediterranean Region (Ramsdale & Snow, 1999), together with the occurrence of the species in the Canary Islands, raise the possibility of its presence in southern Spain.

It is now realised that the increase of worldwide trade can dramatically change local mosquito faunas (Ward, 1984b). The trade of used tyres has spread both *Aedes albopictus* (Skuse, 1894) and *Ae. atropalpus* (Coquillett, 1902). First introduced into North America, *Aedes albopictus* was later found in Albania (Adhami & Reiter, 1998) and Italy (Dalla Pozza & Majori, 1992), and has recently been discovered in France (Schaffner & Karsh, 1999). This species is believed to be able to disperse over large areas of Europe just as it has over many parts of North America.

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