

ECOLOGY AND DISTRIBUTION OF *SIMULIUM ERYTHROCEPHALUM*, A HEALTH-IMPORTANT SPECIES IN WESTERN SPAIN

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Abstract *Simulium erythrocephalum* (De Geer, 1776) is an arthropod of great medical-sanitary importance due to its haematophagic way of feeding. The adults of this dipterans, which exhibit a marked anthropophilic behaviour, tends to emerge simultaneously, then usually producing massive attacks. In Spain there is a limited knowledge about its distribution and bioecology, situation that should be strengthened if it is taken into account the increasing incidence that is occurring in certain areas of the country. The main aim of this study is to contribute to the increase of the knowledge of this simuliid species, providing valuable information. The samplings revealed a scarce and reduced presence of the aforementioned species in the prospected area, located in western Spain, although it is utterly important not to abandon the monitoring of the populations of this dipteran. Additionally, considering its capacity to act as a vector of the filaria *Onchocerca volvulus* Bickel, 1982 (the parasitic pathogen responsible of human onchocerciasis) and although the helminth presence has not been reported in Spain, its epidemiological interest is discussed.

Key Words Simuliidae, anthropophilic species, health importance, public health, vectors of pathogens, bioecology

INTRODUCTION

The historical study of blackflies in Spain has been characterized mainly by works dedicated to the study of the simuliid fauna of specific areas, taxonomy and other branches of biology. However, its study has not been tackled from a deep sanitary point of view, due to the low transcendence that their occasional and localized bites had in the past. For this reason, this telmophagus insect needs to be studied in greater detail, mainly due to its current public health interest (López-Peña and Jiménez-Peydró, 2019). Nonetheless, from several decades ago to these days the situation has changed significantly. Unfortunately, this dipterous group is acquiring large importance and resonance in certain territories of the national demarcation such as Zaragoza (Ruiz-Arrondo et al., 2012, 2017; Ruiz-Arrondo, 2018), Madrid (Soriano et al., 2019), and the Valencian Autonomous Region (López-Peña and Jiménez-Peydró, 2015; Barbera et al., 2018, López-Peña et al., 2021a, 2021b) where their populations are being increased and expanding their distribution along the river basins and canalizations of irrigation.

This circumstance has been promoted by causes as the improvement of river water quality, and the expansion of plant species used by the immature stages as a fixing surface. All of them are benefiting the increase of populations of simuliid species present in the aforementioned areas, as well as their dispersion, settlement and colonization of areas in which their presence had not been detected. Said casuistry is leading to a gradual and rapid increase in the discomfort caused by this arthropod on the inhabitants located in their natural habitats or very close to them.

Among the species of simuliids present in Spain (López-Peña and Jiménez-Peydró, 2017a), *S. erythrocephalum* stands out, whose females cause discomfort (Post, 1983; Ruiz-Arrondo et al., 2012; Villanúa-Inglada et al., 2013; Ruiz-Arrondo et al., 2014; Ricoy-Llavero, 2015; López-Peña and Jiménez-Peydró, 2017b; López-Peña, 2018; López-Peña et al., 2021a), (Živković, 1971; Ignjatović-Ćupina, 2006). Due to simultaneous hatching of adults, the population densities reached are so high, due to simultaneous hatching of adults, that they are considered a pest.

It is known that this species shows anthropophilic preference when it comes to obtaining blood (Živković, 1970; Rivosecchi, 1978; Ignjatović-Ćupina, 2006). One of the most noteworthy aspects is the females' tendency to gather in swarms and to attack massively (Ignjatović-Ćupina, 2006). For all these reasons, and together with the fact that some laboratory studies have shown that it is a competent vector species for the transmission of *O. volvulus* (Ham and Bianco, 1983), it would not be strange to think about the possibility that it could act as a carrier of this filaria in the near future in Europe. Thus, the purpose of this study is to provide information about the distribution and ecology of this outstanding species to enhance the knowledge of it.

MATERIALS AND METHODS

This study is based on a detailed treatment and review of the Simuliidae samples collected in 1996 from the hydrographic basin of the Tormes river located in Salamanca province (western Spain) (Figure 1). The fixed immature blackfly specimens preserved in 80% ethanol alcohol were processed from the stored samples. Both mature larvae and pupae individuals were separated and identified through the use of dichotomous keys (González, 1997; Bass, 1998). For that purpose, it was employed both a Wild M8 Heerbrugg and a Leica M80 10450630 stereomicroscopes owing to visually analyse the morphological features that characterise each species.

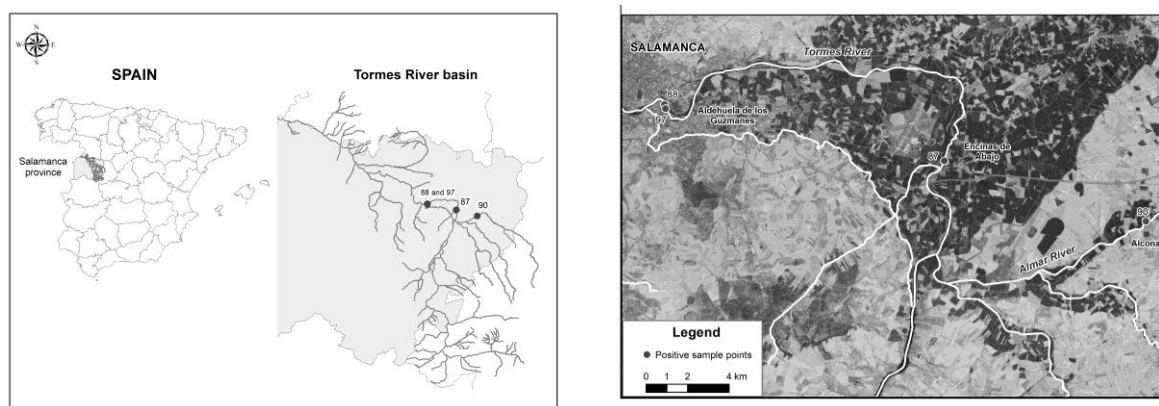


Figure 1. Map of the study area, showing the locations of the sampling points, where the specimens of *S. erythrocephalum* were collected.

RESULTS AND DISCUSSION

The biological responses to environmental conditions, as well as their optima and tolerances to relevant environmental factors for this important species, which presence in Salamanca dates from the end of the 20th century (González, 1990) should be studied. Looking into the specific ecological requirements of pre-imaginal stages of *S. erythrocephalum* is demanded to achieve the target of avoiding and/or reducing its bites. Therefore, preliminary data regarding this particular species are provided on this researching review, which are presented below.

Table 1. Environmental data of the sampling points where *S. erythrocephalum* was found.

Sampling points	Date	Locality	Province	Autonomous Region	River	UTM Coordinates	Altitud (m)	Water T ^o (°C)	Riverbed	River vegetation
87-T	10/6/96	Encinas de Abajo	Salamanca	Castile and Leon	Tormes River	30TTL9134	750	19.2	Sandy	Ranunculaceae, Juncaceae
88-T	19/6/96	Aldehuela de los Guzmanes	Salamanca	Castile and Leon	Tormes River	30TTL7737	775	22	Sandy	Only bank vegetation, not in the river bed
90-T	23/6/96	Alconada	Salamanca	Castile and Leon	Almar River (Tributary of the Tormes River)	30TUL0032	822	23	Pebbly	Chlorophiceae, Gramineae, Ranunculaceae, Thyphaceae
97-T	30/6/96	Aldehuela de los Guzmanes	Salamanca	Castile and Leon	Tormes River	30TTL7737	775	22	Stony	Cyperaceae, Gramineae, Juncaceae, Thyphaceae

Of 63 analysed samples out of 98 taken in the study area, *S. erythrocephalum* has been found so far in four sampling stations, three of them located in the Tormes River and the other one in one of its tributaries, the Almar River. However, there are still 35 samples waiting for being examined, which means that these results are only preliminar. Anyhow, up to now the outstanding results of this species with a palearctic distribution are that the specimens were only found during the June samplings (Table 1.), showing seasonality. The identified specimens were reported at an average elevation of 780.5 meters above sea level (m a.s.l.) (range = 750 - 822 m a.s.l.). This abiotic variable is of great importance since elevation can determine the river's water temperature, could play a key role in the ecology and distribution of blackfly species since it regulates their metabolisms and life cycles. In eastern Spain this species was reported from a minimum elevation of 7 m a.s.l. and a maximum one of 372 m a.s.l. and the pupal habitat of *S. erythrocephalum* was associated with low altitude (López-Peña, 2018; López-Peña et al., 2021b). Therefore, this finding reveals that the distribution of this species is not only restricted to low elevations. Regarding the water temperature, it ranged from 19.2 to 23 °C, fact that adjust to López-Peña (2018) information that reported this species from 19.2 to 27.3 °C, and indicating that its pupal habitat was associated with high water temperature. Nonetheless, this species is considered to be eurythermal. With regard to the water flow velocity, the breeding habitats are characterized by a minimum current speed of 0.38 m/s, a maximum of 0.833 m/s and an average of 0.575 m/s. On this matter, it has been described a species preference for lentic waters (Martínez and Portillo, 1999), but it was also depicted in waters of medium and high velocity (López-Peña et al., 2021b). In addition, the confirmed relative abundance at the moment is 0.80 %, but it may remain with no variation or be increased when finishing the samples review. Concerning the type of water, the pupae of this species were found in both clear and very turbid waters, being consequently capable for tolerating turbid waters to a greater or lesser degree. Moreover, the origin of the main riverbed substrate at each sampling point was different, being sandy at points 87-T and 88-T, pebbly at 90-T and stony at 97-T. However, the specimens obtained were found in the associated vegetation, characterized by the Ranunculaceae, Juncaceae and Thyphaceae families, among others.

The results of this report show, according with previous studies (López-Peña et al., 2021a), that *S. erythrocephalum* is a generalist species able to tolerate wide ranges of ecological conditions. However, despite being a generalist species, it has specific habitat requirements (López-Peña et al., 2021a).

CONCLUSIONS

In agreement with other authors (Post, 1983; Ignjatović-Ćupina, 2006; Ruiz-Arrondo et al., 2017), it is concluded that *S. erythrocephalum* is one of the simuliid species with the greatest impact on the human population of this region of the country. Nevertheless and fortunately, its potential as vector in Spain is practically non-existent. In any case, and according to what is stated in this paper, it is utterly necessary to understand in greater detail the biology of this species, as well as its phenology and ecological dynamics. All of them are necessary to implement adequate surveillance and control strategies in order to keep its populations as low as possible and to minimize its effects. A deeper knowledge of the autoecology of this blackfly species will help to improve pest management programs with the objective of providing and preserving the human wellbeing.

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