DISTRIBUTION OF THE FRESHWATER SHRIMP, *ATYAEPHYRA DESMARESTII* (MILLET, 1831) IN PORTUGAL (DECAPODA, NATANTIA)

BY

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ABSTRACT

This article provides a literature review about the distribution of the freshwater shrimp, *Atyaephyra desmarestii* (Millet, 1831) in Portugal. The information obtained shows that *A. desmarestii* has been found in many Portuguese watercourses, including reservoirs, rice fields, coastal lagoons and temporary streams. Despite the ecological relevance of this shrimp in aquatic communities, scientific information about its distribution in the country is still fragmentary and scattered. Thus, in view of its potential use as a test organism for the biomonitoring of anthropogenic stress imposed on aquatic ecosystems, there is a need for further investigations so as to account for a complete picture of the area of distribution of the species in Portugal.

ZUSAMMENFASSUNG

Dieser Artikel gibt einen Überblick über die derzeit bekannte Verbreitung von *Atyaephyra desmarestii* (Millet, 1831) in Portugal. Daraus folgt, dass *A. desmarestii* in Portugal in vielen langsam fliessenden Gewässern, Reservoirs, Reisfeldern, temporären Gewässern und sogar in Küstennähe in Lagunen vorkommt. Die bisherigen Verbreitungsdaten sind jedoch als lückenhaft und verstreut zu bezeichnen. Diese Tatsache, sowie die potentielle Bedeutung dieser Art im Biomonitoring von anthropogenem Stress in Gewässerökosystemen verlangen nach weiteren Untersuchungen.

INTRODUCTION

Many decapods inhabit marine and brackish waters, those occurring in fresh waters being relatively scarce. According to Mateus (1963), only a few decapod species have been recorded in Portuguese fresh waters, namely the native crayfish *Austropotamobius pallipes* (Lereboullet, 1858) and the shrimp *Atyaephyra desmarestii* (Millet, 1831). More recently, the alien red swamp crayfish, *Procambarus*

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Crustaceana 75 (11): 1375-1385

clarkii (Girard, 1852) has been reported from many Portuguese freshwater bodies (Ramos & Pereira, 1981; Anastácio & Marques, 1995; Fidalgo et al., 2001).

The freshwater crayfish, *Austropotamobius pallipes* was collected in northeastern Portugal from several tributaries and subtributaries of the Douro river system, as well as from a few tributaries of the Mondego and Tejo systems (Almaça, 1987, 1990). However, this species has now almost disappeared from Portuguese rivers due to a disease caused by a fungus, while *Procambarus clarkii*, a cambarid from northeastern Mexico and the southern U.S.A., is a widely expanding species, and is currently found all over the world (Hobbs et al., 1989). The first record of *P. clarkii* in Portugal dates back from 1979 at the river Caia, southern Portugal (Ramos & Pereira, 1981) and it has invaded many other aquatic biotopes, since it has a high capacity to rapidly colonize new aquatic environments. The interactions of this alien species with native ones remain unknown, and the species' presence has been reported, for example, in the Mondego system (Anastácio & Marques, 1995), in the river Douro (Afonso, 1996), in the Aveiro region (Fidalgo et al., 2001), and in the Cávado river (Fidalgo, unpubl.).

The caridean, *A. desmarestii* was originally observed in northern Africa and southern Europe, typically inhabiting the Mediterranean area (Gauthier, 1924). From there it spread through French rivers and channels to the river Rhine. Next, it was introduced via ships into the Rhine-Main-Danube channel, thus reaching all the way from the North Sea to the Black Sea. To our knowledge, the first Portuguese record of this species is that of Brito Capello (1866), who reported its presence close to Coimbra (as *A. rosiana*). It was also found in the Netherlands (Redeke, 1936; Vorstman, 1955; Van den Brink & Van der Velde, 1986). In Austria it has recently (1998) been found as well (Zitek & Melcher, 1999).

This crustacean is a phytophilous, eurythermal, and euryhaline species, preferring oxygen-rich, slow flowing, macrophyte-rich waters, with species such as *Myriophyllum* sp., *Potamogeton* sp., and *Ceratophyllum* sp. The success of *A. desmarestii* in colonizing new aquatic environments is very likely due to its high adaptability to different temperatures, since the species has been found along a latitudinal gradient between northern Africa (Gauthier, 1924) and the Netherlands (Vorstman, 1955; Van den Brink & Van der Velde, 1986). Furthermore, the species tolerates a wide range of chlorinities as well (Van den Brink & Van der Velde, 1986).

As an unusual component of the river benthos, *A. desmarestii* attracted the interest of investigators as early as 1842 (Joly, 1843), and more recently Galhano (1979), Descouturelle (1980), and Fidalgo (1983, 1985a, b, 1987, 1989a, b, c, 1990a, b) provided abundant information on several biological and ecological aspects of this species.

Concerning its food preference, *A. desmarestii* is an omnivorous decapod, which ingests a variety of foods, such as algae and mud, as well as faecal pellets. In fact, its coprophagy may represent an important source of food and thus constitute a mechanism for transferring energy in the ecosystem (Fidalgo, 1990b). The shrimp also is an important food item for fish, which observation is supported by García-Berthou & Moreno-Amich (2000a, b), who pointed out the respective relevance as an important dietary item for the rudd, *Scardinius erythrophthalmus* (Linnaeus, 1758) and for the pumpkinseed sunfish, *Lepomis gibbosus* (Linnaeus, 1758), introduced into Lake Banyoles, Spain. To our knowledge, the shrimp is highly esteemed as a bait by Portuguese sport fishermen, suggesting its use for aquacultural purposes. Hence, the possible role of the shrimp as fish feed was envisioned by analysing its biochemical composition (protein, lipid, and carbohydrate content) and by studying its life cycle under laboratory conditions (Fidalgo, 1985a) as well as by estimating the assimilation efficiency of the shrimps fed on different dietary items (Fidalgo, 1985b, 1990a, b).

In the saproby system, it has been related with waters of good quality (saproby index 1.9). However, as the saproby index only evaluates organic matter pollution and oxygen depletion, and not toxicity, this classification for the species might only be justified in those respects. The sensitivity of *A. desmarestii* to toxicants still has to be established. Thus, taking into account (i) the ecological relevance of *A. desmarestii* in aquatic communities and (ii) the lack of a comprehensive survey relative to its geographical distribution in Portugal, the aim of the present work is to summarize all available information on the latter topic.

MATERIAL AND METHODS

Aiming to collect as much information as possible about the distribution of the freshwater shrimp, *Atyaephyra desmarestii* in Portugal, a review of the existing literature was carried out. Special attention was given to the bibliography available at the Department of Zoology and Anthropology (Faculty of Sciences, University of Porto). However, by starting our literature search we were immediately confronted with incomplete and fragmentary data. These data were scattered over various reports, mainly related to biological assessment of water quality as based on macroinvertebrate communities, and some reports were not easily accessible.

At the same time, an exchange of letters with some Portuguese limnologists yielded a few additional data about the area of distribution of the shrimp in this country.

RESULTS

The information obtained on the occurrence of *Atyaephyra desmarestii* in Portugal is summarized in fig. 1. Based on these data, we can state that *A. desmarestii* has widely expanded throughout Portuguese fresh waters, since it has been recorded in several watercourses, both in the northern and the southern part of the country. From north to south, the shrimp was collected from the rivers Minho (Nobre, 1894; Afonso et al., 1991; Vieira et al., 1999), Lima (Fontoura, 1983, 1984; Fontoura & Moura, 1984) and Cávado (Fontoura, 1991; Afonso, 1996).

Larvae of *A. desmarestii* were also found in some horizontal hauls carried out in the reservoir of Ermal, which is located in the river Ave (Galhano et al., 1978).

In the Portuguese part of the drainage area of the river Douro, *A. desmarestii* has been observed from the estuarine parts up to about 300 km distance from the river mouth. During the years 1981-1985, many specimens were collected in an area still influenced by the tides (which corresponded to the prospective area of the existing Crestuma/Lever impoundment), at about 20 km distance upstream from the Atlantic Ocean (Fidalgo, 1985a). There, the shrimp was particularly abundant in the vegetation, under stones, and in the mud near the river banks. In the Douro system as a whole, it has also been collected from several tributaries, such as the Tâmega (Cortes, 1989; Fontoura, 1990; Afonso et al., 1991; Afonso, 1996), Tua (Cortes, 1989; Afonso et al., 1991; Afonso, 1996), Sabor (Afonso, 1996; Jesus, unpubl.), Corgo (Cortes, 1989), Sousa (Afonso, 1996), and Coa (Afonso, 1996). The shrimp was also found in a stretch of the river Douro close to Peso da Régua (Cortes, 1989) as well as in three reservoirs built in this river, viz., those of Carrapatelo (Galhano, 1979), Bemposta (Fontoura, 1986), and Crestuma/Lever (Fidalgo, 1989c; Afonso, 1990).

The shrimp was collected from a watercourse near Coimbra (Brito Capello, 1866) as well as from rice fields in the Mondego river valley (Müller, 1962), as well as from two of its tributaries, the river Alva (Mateus, 1963; Coimbra, unpubl.) and the river Ceira (Coimbra, unpubl.).

In the river Tejo, *A. desmarestii* was found near Abrantes in an area located downstream the Belver reservoir, where this species represented about 15% of the macroinvertebrates and was a dominant taxon, together with Caenidae, Chironomidae, and Lumbriculidae (cf. Afonso, 1989).

The presence of the shrimp has also been recorded in the Guadiana river (Fontoura, 1985). It was abundant in a temporary stream that drains into the Degebe river, a tributary of the Guadiana system (Coimbra et al., 1996). It has also been found in the river Vascão, another tributary of the Guadiana system (Gerhardt et al., in prep. a).

As mentioned above, *A. desmarestii* usually lives in lentic freshwater environments, and the species has also been found in coastal wetlands, for example, the

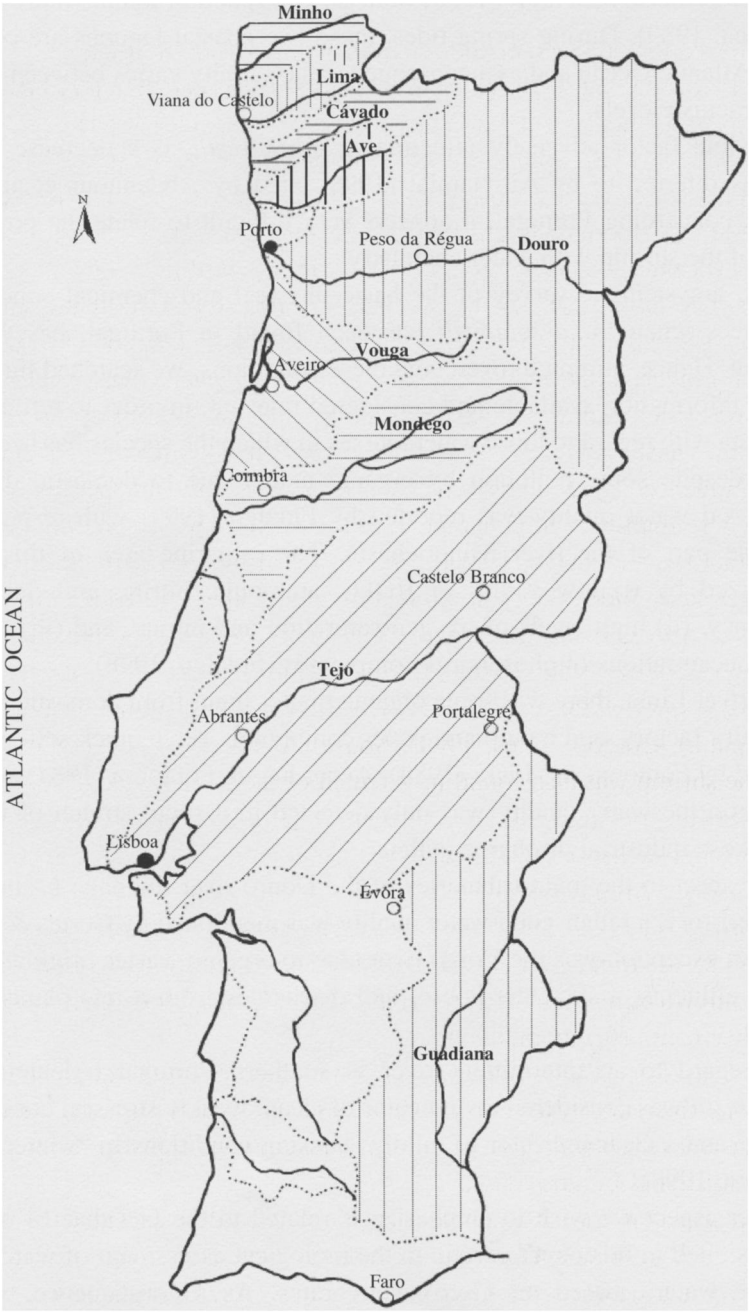

Fig. 1. Map showing the Portuguese drainage basins (hatched area) where the occurrence of the freshwater shrimp, *Atyaephyra desmarestii* (Millet, 1831) is known. The various types of hatching surrounding the river names indicate the respective drainage basins referred to in the text.

lagoons of Esmoriz (Carvalho, 1936; Mateus, 1963) and of Santo André (Cancela da Fonseca, 1989). During spring tides, these two coastal lagoons are connected with the Atlantic Ocean and as a consequence the salinity varies between freshwater and brackish levels.

A possible factor adversely affecting *A. desmarestii*, is a decrease in water quality, as referred to by Ait-Hamlat (1998, cited by Abdennour et al., 2000). However, concerning Portugal, it appears very difficult to relate the presence or absence of the shrimp with water chemistry.

In fact, a systematic survey of the basic physical and chemical conditions at those places where *A. desmarestii* has been found in Portugal, has yet to be carried out. Hence, aiming to overcome these conditions, we searched through the scientific information available and considered relevant, in order to retrieve water quality data with regard to those watercourses in which the species has been found.

Thus, despite some pollution by organic matter due to domestic discharge, a quite good water quality was reported by Fidalgo (1999) with respect to the Portuguese part of the river Minho basin. The estuarine area of this river is characterized by (i) low values of BOD_5, ammonia, nitrite, and Secchi disk transparency, (ii) high levels of oxygen saturation and nitrate, and (iii) moderate to high concentrations of phosphorus compounds (Fidalgo, 1998).

In the river Lima, there was some organic matter input from domestic effluents, from a dairy factory, and a pulp and paper compound. Yet, a quick selfdepuration was found by Fontoura & Moura (1984). According to Fontoura (1984) a negative influence on the water quality was only detected in a small stretch of the river, close to those industrial discharge outlets.

With respect to the main tributaries of the Douro river drainage basin on Portuguese territory, a rather good water quality was mentioned by Cortes & Monzón (1990). An exception was the Corgo river, due to organic wastes originating from domestic effluents, a slaughter-house, and discharges from a few plants of food industries.

With regard to an intermittent river in southern Portugal (Alentejo), there *A. desmarestii* was considered an indicator of clean, weakly stressful conditions in "summer" and a clear indicator of mildly stressing conditions in "winter" (Graça & Coimbra, 1998).

Another aspect we wish to emphasize is related to the fact that 14 out of 55 references cited in this paper pertain to the biological assessment of water quality of surface waters, based on macroinvertebrates. As a consequence, sampling activities are conducted taking into account the sources of pollution and other environmental impact factors, which may explain that the species has not been found in some places where its general occurrence has earlier been established. In fact, the specific goals of those studies may explain the sporadic appearance

of the species in some rivers and streams; the results support our opinion about the inefficiency of some sampling strategies for collecting *A. desmarestii*, that insufficiently take into account its high mobility and/or its preference for oxygen-rich, slow flowing, macrophyte rich waters. In order to corroborate this statement, it can be pointed out that in a study of several sampling stations along the rivers Vouga and Caima, Moreira et al. (1988) did not refer to the presence of *A. desmarestii*. However, the shrimp was observed recently (2000) in this drainage basin (Gerhardt et al., in prep. b). Furthermore, in a recent investigation designed to assess the impact of small reservoirs on the macroinvertebrate communities, no reference was made to the presence of this species in the river Alva (Jesus, 2001). That study covered eight sampling stations located along this small river, which were inspected in autumn, winter, spring, and summer for two consecutive years (November 1998-August 2000). Yet, recently Coimbra (unpubl.) collected many specimens of *A. desmarestii* from this tributary of the river Mondego. Since these two studies failed to catch the shrimp, which all the same appears to occur there, we are convinced that the species can live in many other Portuguese streams and rivers, though not yet recorded in the available literature, provided that such environments fulfil the ecological requirements of the species. The high activity of this shrimp and the influence of the sampling programme (catch effort, choice of sampling sites, periodicity of sampling, etc.) may be responsible for the apparent absence of the species in some places.

The majority of the information obtained on the distribution of *A. desmarestii* in Portugal refers to the rivers Minho, Lima, Cávado, and Douro (northern Portugal). Available data from central and southern Portuguese rivers are more scarce than those from the north, though some information about the rivers Vouga, Mondego, Tejo, and Guadiana, as well as on the coastal lagoons of Esmoriz (northwest coast) and Santo André (southwest coast) has been obtained. By far the highest number of locations where the occurrence of *A. desmarestii* has been reported, concerns the Portuguese part of the Douro system. This is probably due to the higher number of studies carried out in this system and, as a consequence, such a higher catch effort may have resulted in a higher number of known occurrences of the shrimp.

In conclusion, the shrimp should be taken into account in biomonitoring and toxicological testing, due to its importance in European fresh waters. The ease of handling and culturing of this species are invaluable advantages for laboratory toxicity testing. However, as toxicological studies with *A. desmarestii* are rare up to now (e.g., Gerhardt et al., in prep. b), this field of research should be expanded. Also, additional information should be obtained about the geographical distribution of this important component of the aquatic communities throughout the country.

ACKNOWLEDGEMENTS

Thanks are due to Nuno Coimbra for confirming some locations in the Mondego and Guadiana systems where the shrimp has recently been observed. Thanks are also due to Luzia Sousa for her assistance in completing the distribution map.

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First received 11 May 2002.
Final version accepted 2 July 2002.

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Source: *Crustaceana*, Vol. 75, No. 11 (Dec., 2002), pp. 1375-1385
Published by: BRILL
Stable URL: http://www.jstor.org/stable/20105526
Accessed: 04/09/2009 02:29