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Notes on the occurrence of *Syngnathus rostellatus* (Teleostei: Syngnathidae) in the Mediterranean

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Syngnathus rostellatus *is a nearshore pipefish species whose distributional range extends along the European Atlantic coast between Bergen (NO) and the Bay of Biscay (ES). Several recent articles suggest that this species has experienced a major range expansion of more than 4000 km into the eastern Mediterranean, but a critical review of these studies indicates that the majority of these reports are based on specimen misidentifications. Considering a reliable report of* S. rostellatus *from the Mediterranean coast near Gibraltar, it appears that the current distribution of this species is restricted to the north-eastern Atlantic Ocean and the southern Mediterranean coast of the Iberian Peninsula.*

Keywords: range expansion, species identification, *Syngnathus rostellatus*, pipefish

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INTRODUCTION

There is increasing evidence that human-mediated environmental changes, including the erosion of geographical barriers, the introduction of exotic species, and habitat degradation, are influencing the distribution of species (e.g. Rahel, 2007; Hiddink & ter Hofstede, 2008). The accelerated rate of human modifications of the natural environment is paralleled by an increasing number of reports documenting extensions and contractions of the historical ranges of many species (e.g. Sax & Gaines, 2003; Azzurro, 2008; Thomas, 2010). The value of these studies is entirely dependent on the accurate identification of specimens, and the misidentification of material can lead to erroneous conclusions of major shifts in species' ranges.

Close to 40 nominal species of the globally-distributed genus *Syngnathus* are currently recognized in the Eschmeyer's *Catalogue of Fishes* (2010). Of these, eleven are known to occur in Europe, making this the most species-rich group of syngnathid fish in the region (Dawson, 1986). While nine of these species names are in common use (e.g. Dawson, 1986), two species from the Black Sea (*S. affinis*, Eichwald, 1831 and *S. argentatus*, Pallas, 1814) were only recently reinstated by Kuiter (2009). Kuiter (2009), however, provides no justification for the reinstatement of these species names, and a more systematic analysis of Black Sea pipefish will be necessary in order to clarify their species status. The taxonomic status of at least two additional species is also unclear. The nearshore *S. agassiz* Michahelles, 1829 *sensu* Canestrini (1872) was synonymized with *S. abaster* by Lueken (1967), but this species was reinstated by Roig (1979) on the basis of an exhaustive analysis of historical and contemporary collections from the Balearic Islands and Spanish coast, a Spanish-language report that appears to have been overlooked by subsequent researchers. Genetic and morphometric analyses of pipefish material from the Mediterranean and Black Seas suggest that *S. nigrolineatus* Eichwald, 1831 may also represent a distinct species (Hablützel & Wilson, unpublished data). Clearly, the taxonomy of *Syngnathus* pipefish is in a state of flux, and the genus is in need of a full systematic revision.

Of the nine commonly-recognized species, two (*S. phlegon* Risso, 1827 and *S. schmidti* Popov, 1928) are pelagic, while the others (*S. abaster* Risso, 1827 *sensu* Canestrini (1872), *S. acus* Linnaeus, 1758, *S. rostellatus* Nilsson, 1855, *S. taenionotus* Canestrini, 1871, *S. tenuirostris* Rathke, 1837, *S. typhle* Linnaeus, 1758 and *S. variegatus* Pallas, 1811) are all nearshore inhabitants (Dawson, 1986), and are dominant members of nearshore eelgrass habitats along the European coastline.

Syngnathus rostellatus (Nilsson's pipefish) was originally described from western Sweden (Nilsson, 1855), and the northern French *S. dumerilii* Moreau, 1870 in Duméril (1870) is now considered a junior synonym of this species (Fries *et al.*, 1895; Wheeler, 1973). Ehrenbaum (1905–1909) described the distribution range of *S. rostellatus* as the Atlantic coast between Bergen and the Sea of Biscay (Figure 1). *Syngnathus rostellatus* is found at moderate densities in the Kattegat of western Sweden, and while there are scattered reports of individual specimens in the southern Baltic (e.g. Ehrenbaum, 1905–1909; Otterstøm, 1917), a recent exhaustive survey of this region failed to detect this species (HELCOM, 2007). These earlier descriptions have been complemented by subsequent reports of *S. rostellatus* from the northern Irish coast (Douglas & Egan, 1983) and sites as far south as Málaga,

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Spain (Helling (1943); Reina-Hervás *et al.* (1981–1982)) (Figure 1). *Syngnathus rostellatus* has recently been reported from sites within the Mediterranean as far east as southern Turkey (Louisy, 2002; Gökoglu *et al.*, 2004; Ben Amor *et al.*, 2008) (Figure 1), suggesting that this species may be experiencing a major range extension.

Here, we provide a morphological diagnosis of *S. rostellatus*, and use this tool to evaluate recent reports of *S. rostellatus* outside its historical distributional range (Dawson, 1986). Our analyses indicate that the majority of these recent reports stem from the misidentification of specimens and that the distribution of this species remains restricted to the north-eastern Atlantic Ocean and the Mediterranean coast of the Iberian Peninsula.

MATERIALS AND METHODS

Pipefish individuals were identified on the basis of the meristic and morphometric data provided in the original articles and, if available, from pictures. The original description of *Syngnathus rostellatus* by Nilsson (1855), together with subsequent descriptions by Moreau in Duméril (1870) and Dawson (1986) were used as references, and these descriptions were supplemented with the analysis of ethanol-preserved specimens from northern Spain (Sada) and western Sweden (Fiskebäckskil) (Table 1). Methods for the measurements and meristic counts used in this article follow Dawson (1986).

RESULTS

Identification

Syngnathus rostellatus differs from all other European species of the genus by the following combination of characters: distal margins of body rings without spine-like points; 13–17 trunk rings; 35–42 tail rings; 32–45 dorsal fin rays; 10–13 pectoral fin rays; lack of brown dots in the dorsal fin; and small size (<17 cm total length (TL)) (Table 1). While the meristic counts of the Black Sea population of *S. abaster* (*S. abaster nigrolineatus sensu* Berg (1949)) overlap with those of *S. rostellatus*, this species can be clearly distinguished from *S. rostellatus* both morphologically and genetically (Hablützel & Wilson, unpublished data)).

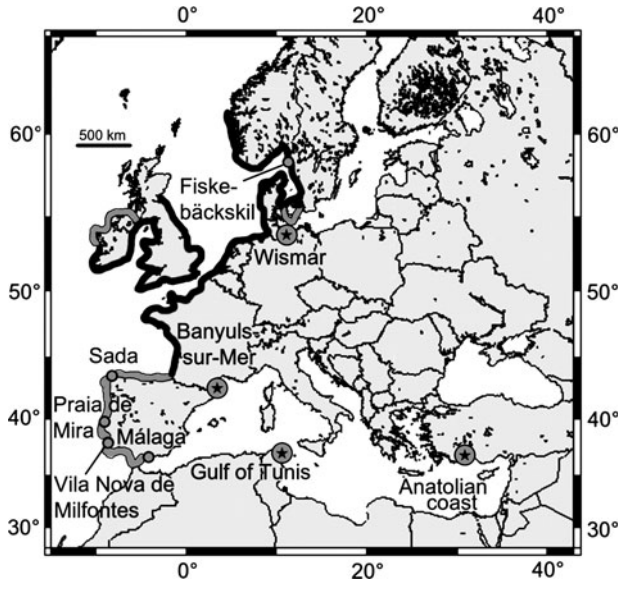

Fig. 1. The traditional distribution of *Syngnathus rostellatus* according to Dawson (1986) (black), extended by reports from the Irish (Douglas & Egan, 1983), Portuguese (Almeida, 1986) and Spanish (Reina-Hervás *et al.*, 1981–1982) coasts and the southern Baltic Sea (Ehrenbaum, 1905–1909; Otterstøm, 1917) (grey); collection localities of *S. rostellatus* discussed in the text are indicated (circles), as are reports of *S. rostellatus* based on apparent misidentifications of specimens (stars).

Distribution

Almeida (1986) reported 12 *S. rostellatus* specimens (including 8 pregnant males) from Vila Nova de Milfontes (PT) (Figure 1). The reproductive status of the individual specimens was not indicated in the original paper, but the data provided indicate that the smallest pregnant male in this collection had a TL of ≤ 12.1 cm. *Syngnathus rostellatus*, *S. abaster*, *S. agassiz* and *S. typhle* are the only four coast-associated species of *Syngnathus* in western Europe which are reported to reach sexual maturity at this size. *Syngnathus abaster* has fewer dorsal fin rays (≤ 31), *S. agassiz* has less tail rings (≤ 35) and *S. typhle* has more pectoral fin rays (≥ 14) than does *S. rostellatus* (Table 1). The meristic counts of the specimens collected by Almeida (1986) are thus consistent with the identification of these specimens as *S. rostellatus* (Table 1). Almeida (1986) also re-examined specimens from Praia de Mira (PT) (Figure 1) collected by Helling (1943) and identified these individuals as *S. rostellatus*. On the basis of the details provided in Almeida (1986), we conclude that all of these individuals are indeed *S. rostellatus*.

Reports of *S. rostellatus* from Málaga (Figure 1) by Lozano & Rey (1919) and Reina-Hervás *et al.* (1981–1982) also appear to be reliable. While details on the specimens analysed by Lozano & Rey (1919) were not provided in the original publication, Reina-Hervás *et al.* (1981–1982) provided detailed information on five specimens collected from the same region. The low number of trunk rings detected in these specimens (16–17; Table 1) clearly separates them from juvenile *S. acus* (trunk rings: 18–19) which are otherwise similar in their general appearance. The *S. rostellatus* from Málaga also differ from *S. abaster*, *S. agassiz* and *S. typhle* in meristic counts (see above).

In contrast to these reliable reports of *S. rostellatus* from outside its historical range, several recent descriptions of *S. rostellatus* from sites in Tunisia and Turkey (Figure 1) appear to be in error. Photographs of the individuals included in both of these studies are provided in the original articles (Gökoglu *et al.*, 2004; Ben Amor *et al.*, 2008). Both pictures show large (18.7 cm and 21.1 cm TL), long-snouted species with high numbers of trunk rings (18 for the Tunisian and > 17 for the Anatolian individual (note that Gökoglu *et al.* used a non-standard trunk counting method which differs from other publications of syngnathid pipefish (e.g. Dawson, 1986))), indicating that neither of these specimens are *S. rostellatus* (Table 1; Figure 2). The specimens illustrated by Gökoglu *et al.* (2004) and Ben Amor *et al.* (2008) most closely resemble either *S. tenuirostris* or *S. acus* (Figure 2), species which are known to occur in the Mediterranean region (Kaup, 1856; Dawson, 1986).

Louisy (2002) reported a single *S. rostellatus* female from Banyuls-sur-Mer, France (Figure 1). The author did not

Table 1. Meristic characters of *Syngnathus rostellatus* from the original species description (Nilsson, 1855) and from more recent studies of the species. Morphological data for specimens outside the expected range for *S. rostellatus* are indicated in bold.

Location	N	Trunk rings	Tail rings	Dorsal fin rays	Pectoral fin rays	Length of largest specimen (cm TL)	Conclusion	Reference
Sweden	n.a.	16	40	32–34	10	12.4–14.8 (5–6 tum)	*S. rostellatus*	Nilsson, 1855
Côte du Hâvre (FR)	n.a.	14	36–39	34–36	11–12	10.3	*S. rostellatus*	Moreau in Duméril, 1870
Europe	n.a.	13–17	37–42	33–45	10–13	17.0	*S. rostellatus*	Dawson, 1986
Sada (ES)	30	14–16	39–42	37–42	10–12	13.0	*S. rostellatus*	This study
Fiskebäckskil (SE)	9	14–15	39–41	38–43	11–12	13.7	*S. rostellatus*	This study
Vila Nova de Milfontes (PT)	12	14–16	35–42	34–40	10–11	14.0	*S. rostellatus*	Almeida, 1986
Praia de Mira (PT)	6	15	39–42	37–42	11	16.9	*S. rostellatus*	Almeida, 1986
Málaga (ES)	5	16–17	34–41	36–38	11–12	n.a.	*S. rostellatus*	Reina-Hervás *et al.*, 1981–1982
Gulf of Tunis (TN)	1	**18**	39	35	12	**21.1**	*Syngnathus* sp.	Ben Amor *et al.*, 2008
Anatolian coast (TR)	1	**> 17**	41	33	13	**18.7**	*Syngnathus* sp.	Gökoglu *et al.*, 2004
Banyuls-sur-Mer (FR)	1	n.a.	n.a.	**29** or **30**	n.a.	n.a.	*S. abaster*	Louisy, 2002
Wismar (DE)	2	n.a.	n.a.	n.a.	n.a.	n.a.	*S. typhle*	Kuiter, 2009

N, number; 1 tum = 2.47 cm.

provide meristic data, but included two colour pictures of the living specimen. The low number of dorsal fin rays (29 or 30; Table 1) and the flattened form of the snout (versus the slightly convex snout of *S. rostellatus* (Figure 2)) suggest that the specimen is actually *S. abaster*. The report of *S. taenionotus* from southern France in Louisy (2002) also appears to be in error, and is based on an apparent misidentification of a *S. typhle* individual (data not shown). Unfortunately, the photographs and identifications used by Louisy (2002) have been incorporated into a recent global survey of syngnathid species (Kuiter, 2009), further propagating these errors.

Confusion about the distributional range of *S. rostellatus* also exists at its north-eastern periphery in the southern Baltic Sea. Kuiter (2009) recently reported two specimens from Wismar, Germany. We argue that both pictured specimens are misidentified and in fact are *S. typhle*, recognizable by the elevation of the snout evident in these individuals, diagnostic for this species (see Figure 2). One of the two specimens also shows a colour pattern of white spots which is known only from juvenile *S. typhle* and is not found in *S. rostellatus*.

Fig. 2. Photographs of the head morphology of the nearshore *Syngnathus* species discussed in this article, along with an indication of the collection locality of the individual specimens. (A) *Syngnathus abaster*, Scardovari (IT); (B) *S. acus*, Tasende (ES); (C) *S. agassiz*, Naples (IT); (D) *S. rostellatus*, Sada (ES); (E) *S. taenionotus*, Scardovari (IT); (F) *S. tenuirostris*, Bosphorus (TR); (G) *S. typhle*, Venice (IT); (H) *S. variegatus*, Crimea (UA). Scale bar: 1 cm. Pictures (A–E, G) taken from specimens collected by the authors and collaborators (A, B, D, E, G) or from the collections of the Senckenberg Museum in Frankfurt (C, SMF 8334 and the Muséum National d'Histoire Naturelle in Paris (F, MNHN 0000-6132; H, MNHN 0000-6134). Drawings (F, H) after Rathke (1837), see Kuiter (2009) for photographs of these species.

The lasting impact of historical errors on the European biogeography of *Syngnathus*

Dawson's (1986) key to European syngnathid species has been an important reference for researchers working on European *Syngnathus* species. Unfortunately, an error in the illustration included in this text has perpetuated confusion relating to species-level identification. While the meristic counts provided in Dawson (1986) are accurate, the illustration of *S. rostellatus* included in this report was derived from a sketch originally published in Fries *et al.* (1895) and subsequently reprinted by Poll (1947) in his review of Belgian marine fish. Unfortunately, while the original illustration (Fries *et al.*, 1895) referred to *S. typhle* (plate XXIX, figure 1), Poll (1947) mislabelled this specimen as *S. rostellatus* in both the text and the figure legend of his book (p. 186, figure 126), and Dawson kept this description in his text.

Poll (1947) made a second labelling error in his *Fauna de Belgique*, including an illustration of *S. rostellatus* originally published in Fries *et al.* (1895) in his description of *S. typhle* (plate XXVIII, figure 8b; note that this specimen is also inconsistently labelled as both *S. rostellatus* and *S. acus* in the original publication). Such labelling errors have undoubtedly contributed to the confusion surrounding the identification of European *Syngnathus* species, and we have attempted to remedy this situation here, including photographs of all of commonly recognized nearshore *Syngnathus* species known to occur in this region (Figure 2).

CONCLUSIONS

Considering the reliable reports of *S. rostellatus* from the Portuguese and the Spanish Mediterranean coasts, we suggest that the current range of *S. rostellatus* is broader than that indicated by Dawson (1986). The contemporary

range of this species extends from the Norwegian coast as far south as the western Mediterranean at Málaga, Spain (Figure 1). This distributional pattern coincides with the present frontal system between Almeria and Oran, which separates Atlantic waters to the west from Mediterranean waters to the east (Tintore *et al.*, 1988). Reports of *S. rostellatus* from Mediterranean sites east of Málaga appear to be erroneous, and stem from specimen misidentifications.

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