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## **DISTRIBUTION OF SEAHORSES AND PIPEFISHES (TELEOSTEI, SYNGNATHIDAE) ALONG THE ITALIAN COAST**

### **DISTRIBUZIONE DI CAVALLUCCI MARINI E PESCI AGO (TELEOSTEI, SYNGNATHIDAE) LUNGO LE COSTE ITALIANE**

**Abstract** - Human activities have significantly impacted coastal ecosystems, leading to habitat changes and degradation, resulting in biodiversity loss, particularly affecting seahorses and pipefishes due to their unique biological and ecological characteristics. A decade ago, the IUCN Red List labeled most syngnathid species as 'Data Deficient,' indicating a lack of information on their distribution, population trends, and threats. This study aimed to improve our understanding of the extinction risk facing syngnathids by conducting a review of published and unpublished sources on their distribution in the confined areas along the Italian coast. A limited number of syngnathid species were found at many sites, although pipefish showed a broader distribution, often coexisting with seahorses. Among the most frequently recorded species were *S. abaster* for pipefishes and *H. hippocampus* for seahorses. The study underscores the significance of identifying and researching previously undiscovered populations, particularly in poorly studied areas, to enhance conservation efforts for vulnerable species.

**Key-words:** Syngnathids, seahorses, pipefishes, distribution, conservation

**Introduction** - Syngnathids, a diverse group of fishes including seahorses, pipefishes, seadragons and pipehorses, are globally distributed and commonly inhabit temperate to tropical coastal waters (Lourie *et al.*, 1999). Each species displays unique ecological preferences and spatial patterns, even when co-occurring. Some species are associated with multiple habitats, from vegetated communities to coral reefs (Lourie *et al.*, 1999) and most prefer confined environments (Foster & Vincent, 2004; Vincent *et al.*, 2011). Their distinct reproductive strategy involve male pregnancy, parental care, varied brooding structures, and relatively low offspring production. Additionally, they are generally sedentary, with limited swimming abilities and high site fidelity (Pierrri *et al.*, 2020). These traits make them highly vulnerable to threats such as overexploitation (for medicinal, curio, and aquarium trade purposes), as well as habitat degradation/loss, and pollution. Consequently, many syngnathid species are listed on the IUCN Red List of Threatened Species, with some categorized as "Data Deficient" due to insufficient information on their distribution and population status, largely because of their cryptic and sedentary behavior (IUCN, 2022).

Along the Italian coast, nine syngnathid species exist, comprising two seahorses and seven pipefish species. Although these creatures are commonly found in shallow coastal habitats, detailed information about population locations, abundance, and structure is often lacking. Given the declining wild populations (Pierrri *et al.*, 2021), acquiring such data is crucial for assessing their risk of extinction and implementing appropriate conservation measures on various scales. This study aimed to compile and analyze a broad range of data sources, both published and unpublished, to investigate the large-scale distribution of Italian syngnathids, particularly emphasized confined areas. The study's findings are expected to serve as a valuable resource for enhancing the conservation of these unique and vulnerable creatures.

**Materials and methods** - To compile comprehensive data on syngnathid distribution, an extensive literature review was conducted using various search engines, including Scopus ([www.scopus.com](http://www.scopus.com)), Web of Science ([www.webofknowledge.com](http://www.webofknowledge.com)), and Google Scholar ([scholar.google.com](http://scholar.google.com)). Additional efforts were made to include data from data-deficient areas by exploring reliable sources such as conference communications available on platforms like ISPRA (Istituto Nazionale per la Protezione e la Ricerca Ambientale, <https://www.isprambiente.gov.it/it>), IUCN (International Union for Conservation of Nature, [www.iucn.org](http://www.iucn.org)), and the Italian Ministry of the Environment ([www.snambiente.it/category/fonti-diverse/ministero-dellambiente/](http://www.snambiente.it/category/fonti-diverse/ministero-dellambiente/)). The search covered publications from 1933 to 2022, including peer-reviewed literature, theses, books, and scientific reports. Various keyword combinations were used, including "Syngnathidae", "seahorse", "*Hippocampus*", "pipefish", "*Syngnathus*", "*Nerophis*" and "Italian," to identify pertinent publications. Duplicate entries and those involving captive-bred individuals were excluded from the analysis. Additionally, reference lists from identified publications were used as supplementary sources.

The study considered various types of water bodies based on their physical and ecological characteristics, including: lagoons (L) - coastal basins adjacent to the sea separated by stable sandy barriers often with channels; fishing lagoons (FL) - sections of lagoons enclosed for fish farming with embankments, sluice gates, and basins; ponds (P) - sea-adjacent basins without natural sea connections; brackish lagoons (BL) - brackish water areas in European river deltas partially enclosed by sandbars and connected to the sea; semi-enclosed coastal areas (SECA) - marine water bodies with a single significant marine mouth opening typical of bays and inlets. Information collected included study types, syngnathid species, record year, study site, country, water body type, geographical coordinates, and habitat characteristics like seagrass or sandy substrates. This comprehensive data compilation aims to enhance our understanding of syngnathid species and strengthen conservation efforts in these diverse marine environments.

**Results** - After the validation and removal of the duplicates and uninformative studies, a dataset comprising 116 scientific publications regarding Italian waters was compiled. The first scientific publication on syngnathid species dates back to 1933, with a significant increase in the number of publications in the mid-2000s, peaking between 2013 and 2018. Reviewed articles make up the majority of publications, while other types of publications such as theses, books, and technical reports account for 33% of the total. Nine species of syngnathids were identified in the geographical area investigated: *Hippocampus guttulatus* Cuvier, 1829, *Hippocampus hippocampus* (Linnaeus, 1758), *Nerophis maculatus* Rafinesque, 1810, *Nerophis ophidion* (Linnaeus, 1758), *Syngnathus abaster* Risso, 1827, *Syngnathus acus* Linnaeus, 1758, *Syngnathus taenionotus* Canestrini, 1871, *Syngnathus tenuirostris* Rathke, 1837 and *Syngnathus typhle* Linnaeus, 1758.

Among the 43 confined areas studied, for which aquatic biodiversity lists were available, syngnathids were found at 29 sites along the Italian coast (Fig. 1). Pipefishes showed a wider geographic distribution than seahorses, having been recorded at 27 sites compared to 14 for seahorses. *S. abaster* was the most common pipefish species, found at 19 sites, followed by *S. typhle* (11), *S. acus* (7), *N. ophidion* (3), *S. taenionotus* (2), *S. tenuirostris* (1) and *N. maculatus* (1). Among seahorses, *H. hippocampus* (13) had a slightly wider distribution than *H. guttulatus* (8). Seahorses and pipefishes coexisted

at 11 sites, and the number of syngnathid species per water body ranged from one to nine, with the maximum recorded in the Venice Lagoon.

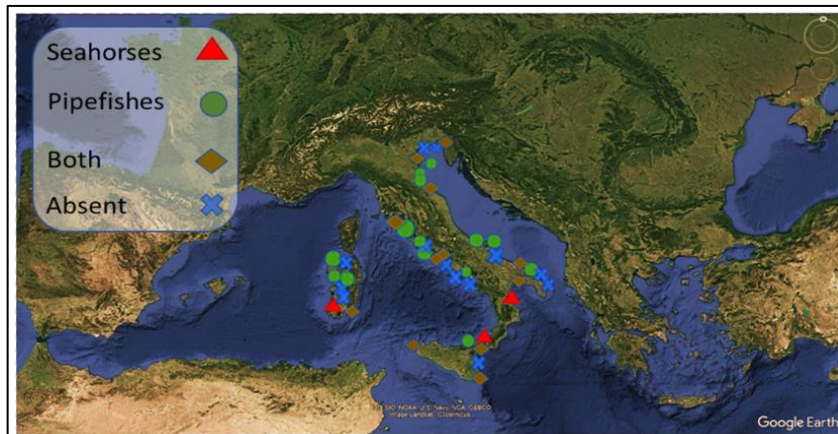


Fig. 1 - Geographical distribution of syngnathid species: seahorses are represented by red triangles, pipefishes by green circles, locations where both seahorses and pipefishes coexist are marked with brown squares, and areas with no recorded syngnathid species are indicated by blue crosses. *Distribuzione geografica delle specie di singnatidi: i cavallucci marini sono rappresentati da triangoli rossi, i pesci ago da cerchi verdi, le località in cui coesistono cavallucci marini e pesci ago sono contrassegnate da quadrati marroni, mentre le aree in cui non sono state registrate specie di singnatidi sono indicate da croci blu.*

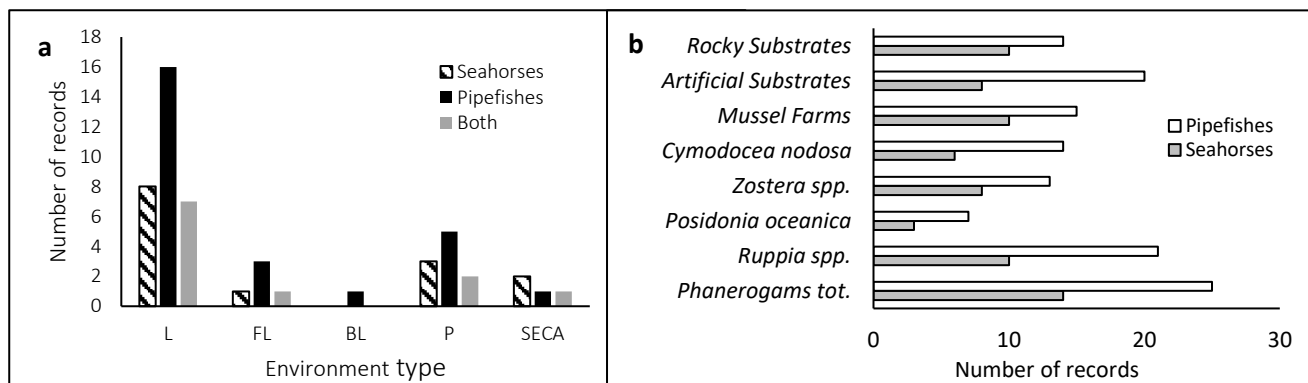


Fig. 2 - (a) Distribution of syngnathid species in various water body types: Lagoons (L); Fishing Lagoons (FL); Brackish Lagoons (BL); Ponds (P); Semi-Enclosed Coastal Areas (SECA) - (b) Distribution of seahorses and pipefish within the various habitats identified in the confined areas under investigation.

*(a) Distribuzione delle specie di singnatidi in vari tipi di corpi idrici: Lagune (L); Valli (FL); Sacche (BL); Stagni (P); Aree costiere semichiuse (SECA) - (b) Distribuzione di cavallucci marini e pesci ago all'interno dei differenti habitat individuati nelle aree confinate oggetto di indagine.*

In terms of water body type, most seahorses and pipefish were recorded in lagoons (L), followed by ponds (P) and fishing lagoons (FL) (Fig. 2a). Seagrasses were present in almost all water bodies where syngnathids were found (100% for seahorses; 92% for pipefish), with *Ruppia* L. spp. and *Cymodocea nodosa* (Ucria) Asch. as the most reported species. Artificial substrates (57% for seahorses; 67% for pipefish), rocky substrates (71% for seahorses; 44% for pipefish), and mussel/ aquaculture structures (71% for seahorses; 55% for pipefish) were also reported in water bodies where syngnathids were found (Fig. 2b).

**Conclusions** - Understanding the spatial distribution of species is fundamental for assessing their conservation status, particularly for sedentary species characterized by limited mobility, high site fidelity, and low reproductive rates. This challenge becomes even more complex when dealing with species displaying elusive behaviors.

Syngnathids, encompassing seahorses and pipefish, are flagship species in marine conservation due to their susceptibility to anthropogenic and environmental disturbances (Foster & Vincent, 2004; Vincent *et al.*, 2011). However, most of these species need a more comprehensive exploration of their biology and ecology, with a focus on their large-scale distribution.

Confined areas, characterized by features such as aquaculture structures, exhibit a higher prevalence of syngnathids, as previously observed in studies focusing on individual species (Gristina *et al.*, 2017; Correia *et al.*, 2018). The study identifies nine of the thirteen syngnathid species found in the Mediterranean Sea, with pipefish showing a wider geographic distribution, although there is overlap with seahorses, reflecting their similar ecological needs (Correia *et al.*, 2018). In recent years, the majority of research attention has been directed towards seahorses, particularly following a significant decline in Mediterranean populations, the causes of which remain unclear (Pierrri *et al.*, 2021). This situation likely extends to other syngnathid populations; however, the available literature lacks sufficient data to effectively assess changes in abundance. Consequently, further investigations are imperative to locate and characterize undiscovered populations, especially in poorly studied areas, contributing to a comprehensive understanding of distribution and aiding conservation efforts.

This review underscores several knowledge gaps, including the environmental and ecological factors influencing the presence or absence of syngnathids. Additionally, an analysis of historical data alongside current distribution patterns can unveil species disappearances and potential threats. The importance of applying existing knowledge regarding the geographical and ecological distribution of syngnathids has been highlighted in a recent IUCN resolution (WCC-2020-Res-095), which encourages widespread monitoring and conservation initiatives, including the establishment of marine protected areas.

In conclusion, advancing our comprehension of syngnathid distribution and ecology is imperative for their conservation, especially considering the impact of anthropogenic activities and climate change. The collection of standardized data across their range is essential for formulating effective conservation strategies and monitoring their status in coastal marine habitats.

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