frontiers | Frontiers in Marine Science

TYPE Editorial
PUBLISHED 09 November 2023
DOI 10.3389/fmars.2023.1309683

OPEN ACCESS

EDITED AND REVIEWED BY
Rui Rosa,
University of Lisbon, Portugal

*CORRESPONDENCE
Miquel Planas
mplanas@iim.csic.es

RECEIVED 08 October 2023
ACCEPTED 31 October 2023
PUBLISHED 09 November 2023

CITATION
Planas M, Gristina M, Palma J, Qin G, Rose E, Roth O and Teske PR (2023) Editorial: Syngnathid fishes: biology, ecology, physiology, conservation and innovative rearing techniques.
Front. Mar. Sci. 10:1309683.
doi: 10.3389/fmars.2023.1309683

Editorial: Syngnathid fishes: biology, ecology, physiology, conservation and innovative rearing techniques

Miquel Planas[1]*, Michele Gristina[2], Jorge Palma[3], Geng Qin[4], Emily Rose[5], Olivia Roth[6] and Peter R. Teske[7]

[1]Department of Marine Ecology and Resources, Instituto de Investigaciones Marinas-Spanish National Research Council (IIM-CSIC), Vigo, Spain, [2]Institute of Anthropic Impacts and Sustainability in Marine Environment (IAS), National Research Council of Italy, Palermo, Italy, [3]Centre of Marine Sciences (CCMAR), Centro de Ciências do Mar, Universidade do Algarve, Faro, Portugal, [4]Chinese Academy of Sciences (CAS) Key Laboratory of Tropical Marine Bio-Resources and Ecology, South China Sea Institute of Oceanology, Chinese Academy of Sciences (CAS), Guangzhou, China, [5]Department of Biology, Valdosta State University, Valdosta, GA, United States, [6]Marine Evolutionary Biology, Zoological Institute, Kiel University, Kiel, Germany, [7]Centre for Ecological Genomics and Wildlife Conservation, Department of Zoology, University of Johannesburg, Auckland Park, South Africa

KEYWORDS

syngnathids, biology, ecology, physiology, seahorse, pipefish

Editorial on the Research Topic
Syngnathid fishes: biology, ecology, physiology, conservation and innovative rearing techniques

Syngnathids (a bony fish family that includes seahorses, pipefishes and seadragons) have unique morphological and biological traits that include fused jaws, an exoskeleton and male parental care (Ahnesjö and Craig, 2011). They are mostly found in shallow coastal areas, and their unconventional life history renders them particularly vulnerable to population depletion (Foster and Vincent, 2004). Although some species have been listed as Vulnerable, Endangered, and even Critically Endangered by the IUCN Red List of Threatened Species, many are classified as Data Deficient (DD) due to insufficient information (IUCN, 2020; Pollom et al., 2021). Therefore, further research is needed to understand their distribution, population trends and main threats. A significant portion of the research on syngnathids is relatively recent (Cohen et al., 2017; Segaran et al., 2023). This Research Topic provides 12 original research and review contributions that provide an overview of current trends in research related to the biology, physiology, ecology and conservation of syngnathids.

We have gained considerable insights into syngnathid evolutionary innovation, particularly concerning the evolution of male pregnancy (Lin et al., 2016; Roth et al., 2020). The review by Parker et al. sheds light on the unique modification of the syngnathid immune system and its associations with physiology and reproduction, and highlights future research objectives.

Climate change forces species to extend their physiological tolerance limits, or undergo range shifts. Efforts to minimize future biodiversity losses should consider: (1) species'

distributions correlated with environmental conditions (Mascaró et al., 2016; Hernández-Urcera et al., 2021; Pierri et al., 2022; Borges et al., 2023), (2) adaptive mechanisms responding to environmental changes (Aurélio et al., 2013; Faleiro et al., 2015; Qin et al., 2018; Carneiro et al., 2021; Carneiro et al., 2022; Gomes et al., 2023), and (3) prediction and modeling of future environmental scenarios for species distribution.

Most syngnathids inhabit variable environments and face anthropogenic threats, resulting in habitat loss and population declines. Of particular concern is the use of dried syngnathids in Traditional Chinese Medicine (TCM) (Vincent et al., 2011). Seahorses, in particular, are believed to be nutritionally beneficial for humans, and Cabral et al. focused on the nutritional value of cultured *Hippocampus hippocampus*. The relative fatty acid composition was similar to that of other seahorse species valued in TCM, with males exhibiting a more suitable profile for human consumption.

Information on stressors is required for estimating future distributional shifts under a global warming scenario. Current knowledge on threats is limited (McCauley et al., 2015), but attempts have been made to estimate its cumulative human impacts. High-accuracy models predicted that 5 of 17 DD seahorses are threatened, and indicated that bycatch and pollution are the best predictors of threat category (Zhang and Vincent, 2019). Silveira et al. evaluated bycatch captures of *H. patagonicus* in trawling fisheries in Brazil, and reported annual incidental captures exceeding 2 million seahorses (6 individuals/day/vessel). Conservation management at a fine scale should consider local ecological knowledge and social perceptions of human communities that depend on wild syngnathid resources, especially for data-poor species. Fontelles Ternes et al. investigated the perception of seahorse-watching operators regarding abundance, local threats, and conservation insights in Brazilian mangrove ecosystems. All survey participants considered seahorses to be threatened (55% highlighted declines in abundance) and proposed environmental surveillance, zoning and education as the main conservation actions to limit the further decline of seahorse populations.

Shallow coastal areas, such as estuaries and lagoons, receive chemicals that influence the reproduction of aquatic animals. Long-term exposure to low levels of endocrine-disrupting chemicals can cause population collapse. When studying the brood pouch transcriptome in male Syngnathus scovelli during synthetic estrogen exposure, Rose et al. (2023) observed female-specific ornamentation, and identified candidate brood pouch genes as future biomarkers. Changes in iridescence, an important sexual signal in several pipefish species (Rosenqvist and Berglund, 2011), may disrupt sexual selection (Sárria et al., 2011). With an algorithm, Tosto et al. aimed to detect geographical variation in female ornamentation of *S. scovelli*, indicating that external factors such as chemicals could affect the strength of sexually selected iridescence signals.

The effects of global warming were experimentally investigated in adult *H. guttulatus* by Costa et al. In agreement with previous findings in juveniles (Planas et al., 2012), no increased growth gain was identified under extreme temperature increases (24°C), despite higher activity and food consumption. Although thermal stress at extreme temperatures could not be confirmed, Del Vecchio et al. (2022) reported that prolonged exposure of *H. erectus* to even sublethal temperatures resulted in the accumulation of injurious effects, resulting in cell death. Furthermore, Aurélio et al. (2013) reported great resilience to heat stress in adult *H. guttulatus*. However, early life history stages displayed greater thermal sensitivity with potential cascading consequences for their growth and survival. Faleiro et al. (2015) suggested that future ocean changes might further threaten seahorse conservation as a consequence of the combined effects of warming and acidification. Monteiro et al. identified areas of environmental suitability for European syngnathids over the next century. Particularly dramatic changes are predicted within semi-enclosed seas (e.g., the Baltic, Mediterranean and Black Sea), resulting in the northward range expansions.

The distribution of syngnathids is linked to vegetation cover, which determines feeding ecology (Moreau and Vincent, 2004; Teske et al., 2007; Borges et al., 2023). The interaction and competition between sympatric species might select for behavioral changes, as shown experimentally for European seahorses by Spatafora et al. (2023). The authors concluded that an increased density of the seahorse *H. guttulatus* resulting from greater habitat availability affected the behavior of *H. hippocampus*, reducing its activity, and modifying the distributions of both species. Most syngnathids feed on small prey, mainly crustaceans, but show local trophic adaptations, depending on both prey availability and snout characteristics (Manning et al., 2019). Although gut content analysis is useful for assessing dietary regimes, the analysis of stable isotopes provides potentially more precise information on the contribution of food sources to the diet (Peterson and Fry, 1987). However, Planas reported variability of estimates in the reconstruction of the dietary regime in *S. acus*, depending on the time lag between the sampling of both potential dietary resources and target fishes. Tamara et al. elucidated the diet of *H. guttulatus* using a non-invasive DNA metabarcoding technique, improving our understanding of habitat-specific prey selection. Diet composition differed between habitats, as did trophic flexibility, which may be essential for the resilience of this species. Due to some limitations of metabarcoding compared to metagenomics because not all prey species may be detectable using the former, Serite et al. compared both techniques to assess the diversity of prey items in two estuarine pipefishes, *S. watermeyeri* and *S. temminckii*. In addition to determining that dietary competition is limited because each pipefish has a preferred type of prey, their findings suggest that metagenomics may, in some cases, outperform metabarcoding.

Syngnathids face a range of challenges and threats. This Research Topic of research and review articles provides valuable insights, and highlights key areas for future research. Although interesting advances have been made in the knowledge of syngnathids' biology and ecology, much research is still needed to safeguard these fascinating creatures. Advancing our knowledge of syngnathids requires generating data by means of a multidisciplinary approach

encompassing several key areas of research that should be prioritized in the future: population assessment, distribution, habitat use and niche partitioning, bycatch mitigation, molecular research (particularly genomics), species interactions, habitat protection and restoration, climate change impact and resilience, aquaculture and husbandry, conservation and community engagement, and legal protection. Further advances on these topics are fundamental prerequisites for formulating effective and rational conservation strategies for the family Syngnathidae.

Author contributions

MP: Writing – original draft, Writing – review & editing. MG: Writing – review & editing. JP: Writing – review & editing. GQ: Writing – review & editing. ER: Writing – review & editing. OR: Writing – review & editing. PT: Writing – review & editing.

Funding

The author(s) declare that no financial support was received for the research, authorship, and/or publication of this article.

Acknowledgments

The authors would like to extend their heartfelt thanks to all syngnathids used in the studies of this Research Topic.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

The author(s) declared that they were an editorial board member of Frontiers, at the time of submission. This had no impact on the peer review process and the final decision

Publisher's note

References

Ahnesjö, I., and Craig, J. F. (2011). The biology of Syngnathidae: pipefishes, seadragons and seahorses. *J. Fish Biol.* 78, 1597–1602. doi: 10.1111/j.1095-8649.2011.03008.x

Aurélio, M., Faleiro, F., Lopes, V. M., Pires, V., Lopes, A. R., Pimentel, M. S., et al. (2013). Physiological and behavioral responses of temperate seahorses (*Hippocampus guttulatus*) to environmental warming. *Mar. Biol.* 160, 2663–2670. doi: 10.1007/s00227-013-2259-8

Borges, A. K. M., Alves, R. R. N., and Oliveira, T. P. R. (2023). Mapping seahorses in a Brazilian estuary: mangrove structures as key predictors for distribution and habitat preference. *PeerJ* 11, e15730. doi: 10.7717/peerj.15730

Carneiro, M. D., García-Mesa, S., Sampaio, L. A., and Planas, M. (2021). Primary, secondary, and tertiary stress responses of juvenile seahorse *Hippocampus reidi* exposed to acute acid stress in brackish and seawater. *Comp. Biochem. Physiol. B Biochem. Mol. Biol.* 255, 110592. doi: 10.1016/j.cbpb.2021.110592

Carneiro, M. D. D., García-Mesa, S., Sampaio, L. A., and Planas, M. (2022). Implications of salinity and acidic environments on fitness and oxidative stress parameters in early developing seahorses *Hippocampus reidi*. *Animals* 12, 3227. doi: 10.3390/ani12223227

Cohen, F. P. A., Valenti, W. C., Planas, M., and Calado, R. (2017). Seahorse aquaculture, biology and conservation: knowledge gaps and research opportunities. *Rev. Fish. Sci. Aquac.* 25, 100–111. doi: 10.1080/23308249.2016.1237469

Del Vecchio, G., Galindo-Sánchez, C. E., Tripp-Valdez, M. A., López-Landavery, E. A., Rosas, C., and Mascaró, M. (2022). Transcriptomic response in thermally challenged seahorses Hippocampus erectus: The effect of magnitude and rate of temperature change. *Comp. Biochem. Physiol. B Biochem. Mol. Biol.* 262, 110771. doi: 10.1016/j.cbpb.2022.110771

Faleiro, F., Baptista, M., Santos, C., Aurélio, M. L., Pimentel, M., Pegado, M. R., et al. (2015). Seahorses under a changing ocean: the impact of warming and acidification on the behaviour and physiology of a poor-swimming bony-armoured fish. *Conserv. Physiol.* 3, 1–77. doi: 10.1093/conphys/cov009

Foster, S. A., and Vincent, A. C. (2004). Life history and ecology of seahorses: implications for conservation and management. *J. Fish Biol.* 65, 1–61. doi: 10.1111/j.0022-1112.2004.00429.x

Gomes, M., Lopes, V. M., Mai, M. J., Paula, J. R., Bispo, R., Batista, H., et al. (2023). Impacts of acute hypoxia on the short-snouted seahorse metabolism and behaviour. *Sci. Tot. Environ.* 904, 166893. doi: 10.1016/j.scitotenv.2023.166893

Hernández-Urcera, J., Murillo, F. J., Regueira, M., Cabanellas-Reboredo, M., and Planas, M. (2021). Preferential habitats prediction in syngnathids using species distribution models. *Mar. Environ. Res.* 172, 105488. doi: 10.1016/j.marenvres.2021.105488

IUCN (2020) *2020 IUCN red List of Threatened Species (Online)*. Available at: http://www.iucnredlist.org/.

Lin, Q., Fan, S., Zhang, Y., Xu, M., Zhang, H., Yang, Y., et al. (2016). The seahorse genome and the evolution of its specialized morphology. *Nature* 540, 395. doi: 10.1038/nature20595

Manning, C. G., Foster, S. J., and Vincent, A. C. J. (2019). A review of the diets and feeding behaviours of a family of biologically diverse marine fishes (Family Syngnathidae). *Rev. Fish Biol. Fish.* 29, 197–221. doi: 10.1007/s11160-019-09549-z

Mascaró, M., Amaral-Ruiz, M., Huipe-Zamora, I., Martínez-Moreno, G., Simões, N., and Rosas, C. (2016). Thermal tolerance and phenotypic plasticity in juvenile *Hippocampus erectus* Perr : effect of acute and chronic exposure to contrasting temperatures. *J. Exp. Mar. Biol. Eco.* 483, 112–119. doi: 10.1016/j.jembe.2016.07.005

McCauley, D. J., Pinsky, M. L., Palumbi, S. R., Estes, J. A., Joyce, F. H., and Warner, R. R. (2015). Marine defaunation: animal loss in the global ocean. *Science* 347, 1255641. doi: 10.1126/science.1255641

Moreau, M.-A., and Vincent, A. C. J. (2004). Social structure and space use in a wild population of the Australian short-headed seahorse *Hippocampus breviceps* Peters 1869. *Mar. Freshw. Res.* 55, 231–239. doi: 10.1071/MF03159

Peterson, B. J., and Fry, B. (1987). Stable isotopes in ecosystem studies. *Annu. Rev. Ecol. Syst.* 18, 293–320. doi: 10.1146/annurev.es.18.110187.001453

Pierri, C., Lazic, T., Gristina, M., Corriero, G., and Sinopoli, M. (2022). Large-scale distribution of the European seahorses (*Hippocampus* Rafinesque 1810): a systematic review. *Biology* 11, 325. doi: 10.3390/biology11020325

Planas, M., Blanco, A., Chamorro, A., Valladares, S., and Pintado, J. (2012). Temperature-induced changes of growth and survival in the early development of the seahorse *Hippocampus guttulatus*. *J. Exp. Mar. Biol. Ecol.* 438, 154–162. doi: 10.1016/j.jembe.2012.10.003

Pollom, R., Ralph, G., Pollock, C., and Vincent, A. (2021). Global extinction risk for seahorses, pipefishes and their near relatives (Syngnathiformes). *Oryx* 55, 497–506. doi: 10.1017/S0030605320000782

Qin, G., Johnson, C., Zhang, Y., Zhang, H., Yin, J., Miller, G., et al. (2018). Temperature-induced physiological stress and reproductive characteristics of the

migratory seahorse *Hippocampus erectus* during a thermal stress simulation. *Biol. Open* 7, bio032888. doi: 10.1242/bio.032888

Rosenqvist, G., and Berglund, A. (2011). Sexual signals and mating patterns in Syngnathidae. *J. Fish Biol.* 78, 1647–1661. doi: 10.1111/j.1095-8649.2011.02972.x

Roth, O., Solbakken, M. H., Tørresen, O. K., Bayer, T., Matschiner, M., Baalsrud, H. T., et al. (2020). Evolution of male pregnancy associated with remodeling of canonical vertebrate immunity in seahorses and pipefishes. *Proc. Natl. Acad. Sci. U.S.A* 117, 9431–9439. doi: 10.1073/pnas.1916251117

Sárria, M. P., Santos, M. M., Reis-Henriques, M. A., Vieira, N. M., and Monteiro, N. M. (2011). The unpredictable effects of mixtures of androgenic and estrogenic chemicals on fish early life. *Environ. Intern.* 37, 418–424. doi: 10.1016/j.envint.2010.11.004

Segaran, T. C., Aouissi, H. A., Noor, M. I. M., Wahid, M. E. A., Lananan, F., Petrisor, A.-I., et al. (2023). Assessing the state of seahorse research through scientometric analysis: an update. *Rev. Fish Biol. Fisheries*. 33, 1237–62. doi: 10.1007/s11160-023-09794-3

Teske, P. R., Lockyear, J. F., Hecht, T., and Kaiser, H. (2007). Does the endangered Knysna seahorse, *Hippocampus capensis*, have a preference for aquatic vegetation type, cover or height? *Afr. Zool.* 42, 23–30. doi: 10.1080/15627020.2007.11407373

Vincent, A. C. J., Foster, S. J., and Koldewey, H. J. (2011). Conservation and management of seahorses and other Syngnathidae. *J. Fish Biol.* 78, 1681–1724. doi: 10.1111/j.1095-8649.2011.03003.x

Zhang, X., and Vincent, A. C. J. (2019). Using cumulative human-impact models to reveal global threat patterns for seahorses. *Conserv. Biol.* 33, 1380–1391. doi: 10.1111/cobi.13325