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BRIEF COMMUNICATION

# Pelagic observations of the midwater scorpionfish *Ectreposebastes imus* (Setarchidae) suggests a role in trophic coupling between deep-sea habitats

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## Abstract

During pelagic video transects off Santo Antão, Cabo Verde, we encountered the midwater scorpionfish *Ectreposebastes imus* in midwater between 300 and 800 m over a bottom depth of about 1000 m. The fish were typically positioned vertically with their heads pointing upwards. These first midwater observations of *E. imus* suggest migratory (potentially feeding) behaviour into the pelagic realm and hence a possible role of this species in the trophic coupling between the pelagic and benthic habitats in the deep seas of Cabo Verde and elsewhere in its global distribution.

**KEYWORDS**
behaviour, Cabo Verde, eastern tropical Atlantic, *in situ* observations, Scorpaeniformes, submersible, vertical migration

The deep-pelagic zone of the open ocean includes the largest yet least explored habitat on the planet (Robison, 2004). Increasing exploration efforts in recent decades have repeatedly confirmed the undiscovered biodiversity that exists in the deep sea (Robison, 2009). The identification of ocean biodiversity and understanding of the function of abundant taxa is required for an integrative insight of ocean food webs. Such efforts will help to unravel pathways in the biological carbon pump, a major ecosystem service (Thurber *et al*., 2014) which involves the downward transport of organic carbon from the photic zone into the ocean interior (Robinson *et al*., 2010). Fishes contribute to the biological carbon pump *via* diel vertical migration behaviour (*e.g*., Saba *et al*., 2021). For example, mesopelagic fishes, such as most myctophids, gonostomatids, sternoptychids and stomiids, feed at night in the surface layers and migrate at dawn to mesopelagic depths where they digest food, respire and defecate, resulting in the vertical transport of organic matter (Saba *et al*., 2021; Sutton, 2013). Although less well known, some benthic fishes also perform diel vertical migrations from the seafloor into the water column (Humphries *et al*., 2017).

The archipelago of Cabo Verde is a hotspot of marine biological diversity off West Africa. Although Cabo Verde is considered part of the Macaronesian biogeographical province, recent studies show a distinct benthic community suggesting evolutionary isolation (Freitas *et al*., 2019). The coastal ichthyofauna of Cabo Verde is mainly of tropical origin, with more than 20 endemic species (Wirtz *et al*., 2013). Afrotropical Guinean species dominate the archipelago, followed by amphi-Atlantic tropical and subtropical species enriched by Mediterranean and circumtropical species (Brito *et al*., 2007). Although artisanal fisheries target the reef fish communities inshore (Dancette, 2019), the fish community at greater depths remains poorly documented. One distinct group of mostly benthic fishes that inhabit the Cabo Verde inshore waters of the archipelago are the scorpaeniformes or scorpionfishes (Wirtz *et al*., 2013).

The deepwater family of deep-sea bristly scorpionfishes Setarchidae Matsubara, 1943, consists of four genera and 10 species (Wada *et al*., 2021). Two setarchids are known from Cabo Verde: the channelled rockfish *Setarches guentheri* Johnson 1862 (Eschmeyer & Collette, 1966; Fricke *et al*., 2018) and the midwater scorpionfish

*Ectreposebastes imus* Garman, 1899 (González *et al*., 2014). *E. imus* has a circumglobal distribution in tropical and subtropical seas, where it is found above the upper slope and deep continental shelf, and in the vicinity of oceanic islands between 150 and 2000 m (González *et al*., 2014). In the eastern Atlantic, it is known from the Canary Islands (Escánez & Brito, 2011) where it was captured from 800 to 1500 m in 2009. The only specimen record from Cabo Verde so far (110 mm total length, 91 mm standard length) was captured on the bottom at 651–670 m in June 2005 off Ponta Varandinha, Boa Vista Island (González *et al*., 2014). Most records report specimens from bottom trawl between 500 and 800 m (Bianchi *et al*., 1999) in west Africa coasts, but some specimens, including adults, were captured in midwater trawls at 275 m over 915 m as well at 300 m over 1800 m and 750 m over 2400 m (Eschmeyer & Collette, 1966). The species is well adapted for living in midwater since it has no swim bladder, the spines are weak and the bones are not strongly ossified (Eschmeyer & Collette, 1966). The ingestion of sergestid shrimp, which inhabit mesopelagic layers of the world oceans, suggests feeding migration into the water column (Eschmeyer & Collette, 1966). *Via* pelagic horizontal video transects using a manned submersible and a towed camera system we encountered individuals of *E. imus* in the water column of the Cabo Verde island of Santo Antão, providing the first pelagic *in situ* observations of the species.

No specimens were captured for this study, we only used observations. Observations were made between 16 February 2018 and 23 February 2018 during cruise POS520 on research vessel POSEIDON (Hoving *et al*., 2018). Pelagic observations were obtained using the towed camera system PELAGIOS (Hoving *et al*., 2019), which was used to perform horizontal video transects at specific depths from the surface down to 2500 m at approximately 1 knot (0.51 $ms^{-1}$) ships speed. Additionally, using the manned submersible JAGO (Hissmann & Schauer, 2017), the midwater realm down to 400 m was explored to observe, document and collect pelagic organisms. All collected video was viewed and annotated using MBARI's annotation software Video Annotation References System (VARS) (Schlining & Stout, 2006) and we here report on the observations of *E. imus*.

Midwater scorpionfish *E. imus* were encountered during PELAGIOS transects over 935–1222 m bottom depth (Table 1). Four observations of *E. imus* were made with PELAGIOS at transects at 300, 350, 500 and 800 m but the other observations were made during ascent between transect depths and the exact depth is not known, only a range (Table 1). The quality of these images was not good but the distinct body shape and colour strongly suggest that the objects are *E. imus*. These include five observations from 600 to 800 m, four observations from 430 to 900 m and two observations from 0 to1000 m. Most individuals were observed in a vertical position (Figure 1). Usually specimens of *E. imus* are dark maroon or nearly black (Morais *et al*., 2016) but some of the specimens observed by PELAGIOS were orange.

With the manned submersible JAGO we encountered an individual at 350 m (Figure 1). This allowed close-up footage and recognition of some body features of *E. imus*, including (a) the general body shape, (b) the six anal fin rays, which can be distinguished in the photograph, and (c) the number of rays in the caudal fin. In the present observation (Figure 1), we can enumerate 14–15 caudal fin rays and assuming another five which cannot be counted due to the angle in the photograph, this may give 20 caudal fin rays, which is the number reported for *E. imus* by Escánez and Brito (2011).

Despite the exceptionally wide distribution of *E. imus*, very little is known about its general ecology and few observations and specimen descriptions exist in the literature. Our observations are the first to document *E. imus* in the water column and only the second documentation of the species in Cabo Verde waters since González *et al*. (2014). Most of the fish were observed in a vertical position in the water column, with their heads up. Other fishes that are known to adopt a vertical position in midwater are the nemichthyid eel of the genus *Avocettina* (Miller *et al*., 2014) and oarfish *Regalecus glesne* Ascanius 1772 (Benfield *et al*., 2013), and this positioning is a more widely adopted behaviour in midwater fishes, as also noted by Barham (1971). Vertical positioning reduces the silhouette of the fish against downwelling light, and hence may reduce predation by upward-looking predators. Another potential advantage of being positioned vertically in comparison to a horizontal position may be that only movement of the tail is needed to maintain the preferred depth (Miller *et al*., 2014). Vertically swimming through the water column may also be an effective way to detect the layers with most dense prey, as has been suggested for vertically undulating cod (Bjornsson & Reynisson, 2013).

The family of scorpionfish is typically benthic. Migration into the water column by *E. imus* was previously proposed since stomach contents have revealed shrimp of the genus *Sergestes* which are mesopelagic crustaceans. Our observations confirm a partly pelagic lifestyle of *E. imus*. It is thus possible that this species utilizes both habitats, in

**TABLE 1** Details on the observations of *Ectreposebastes imus* in Cabo Verde waters in February 2018

| Observation no. | Date | Latitude | Longitude | Depth (m) | Bottom depth (m) | Position *in situ* |
|---|---|---|---|---|---|---|
| 1–5 | 16.2.2018 | 16.9 | −25.3 | 600–800 | 1222.3 | 2 v, 3 h |
| 6–9 | 16.2.2018 | 16.9 | −25.3 | 430–900 | 1222.3 | 3 v, 1 h |
| 10, 11 | 17.2.2018 | 16.9 | −25.3 | 300 | 1003.5 | 1 v, 1 h |
| 12 | 17.2.2018 | 16.9 | −25.3 | 500 | 1003.5 | v |
| 13, 14 | 17.2.2018 | 16.9 | −25.3 | 0–1000 | 1003.5 | 2 v |
| 15 | 19.2.2018 | 16.9 | −25.3 | 800 | 935.3 | v |
| 16 | 19.2.2018 | 16.9 | −25.3 | 350 | 1057.4 | v |

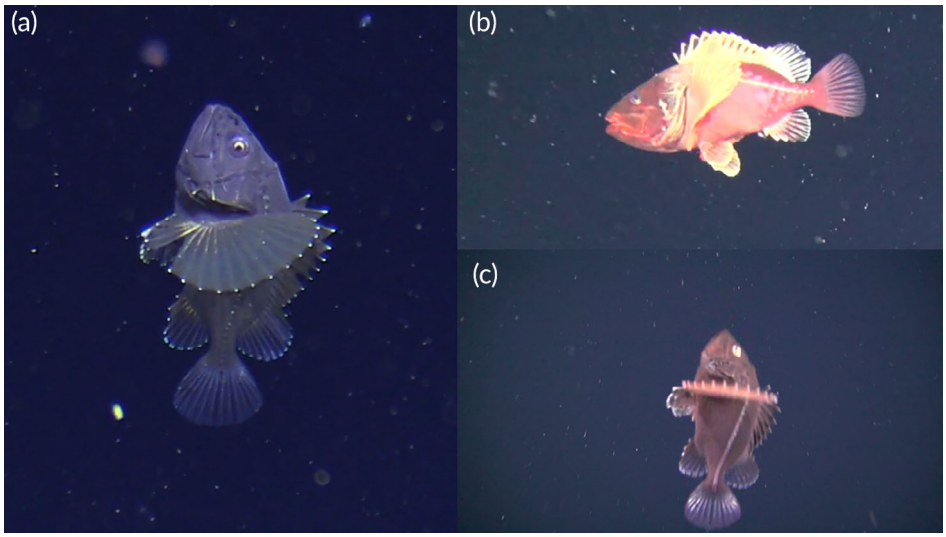


**FIGURE 1** *Ectreposebastes imus* (a) observed by submersible JAGO in midwater at 350 m off the island of Santo Antão, Cabo Verde. Side view of the fish in vertical position with head up, as it was observed when encountered by submersible, (b) observed by PELAGIOS in the horizontal position and (c) observed by PELAGIOS in the vertical position

particular because it is captured with bottom trawl and pelagic trawl (Poss, 2016). Other benthic fishes that are known to forage in midwater include skate fishes and balistids (triggerfishes) (Escánez & Brito, 2011; González *et al*., 2014; Humphries *et al*., 2017). By feeding in midwater and resting and excreting on the seafloor this vertical migration behaviour may result in carbon transport between the pelagic and benthic zones (Sutton, 2013). At Cabo Verde, food in the pelagic realm may be particularly accessible for fishes that inhabit the steep island slopes as the deep scattering layer interacts with the island mass. For example, vertically migrating pyrosomes have been observed deposited on the island slope in the region (Stenvers *et al*., 2021). The pelagic faunal communities at the depth of the *E. imus* observations off Santo Antão, Cabo Verde consist of various fishes, euphausiids and gelatinous organisms including siphonophores and hydromedusae (Hoving *et al*., 2018). Although *E. imus* and *S. guentheri* have been reported to feed primarily on pelagic or semipelagic invertebrates (Poss, 2016), future studies on stomach contents will reveal the diet of *E. imus* in Cabo Verde waters,

*In situ* observations by submersibles and towed cameras can provide novel insights in the biology of fishes and their role in the deep-sea ecosystem. *In situ* observations by remotely operated vehicle has allowed documentation of feeding and mimicking behaviours of fishes (Robison, 1999, 2004) and associations between fish and hydromedusae (Drazen & Robison, 2004). These observational video techniques may also allow discovery of new fish species and records in areas that are hard to sample with nets, including trenches (Linley *et al*., 2016) and seamounts (*Serranus cabrilla* (Linnaeus 1758) (Freitas *et al*., 2019). Here we contribute a novel part of the life history of a poorly documented, but widely distributed fish. Future research efforts are needed to document *E. imus* on the seafloor and in the water column, and to quantify the diel vertical migration behaviour, foraging behaviour, diets and role of this fish in the transport of organic matter between the deep pelagic and benthic realm of the Cabo Verde Islands.

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## AUTHOR CONTRIBUTIONS

H.J.H. conceived the study idea and obtained funding. H.J.H. and R.F. generated and analysed data and wrote the manuscript.

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## REFERENCES

Barham, E. G. (1971). Deep-sea fishes: Lethargy and vertical orientation. In G. B. Farquhar (Ed.), *Proceedings of an international symposium on biological sound scattering in the ocean* (pp. 100–116). Washington, DC: Maury Center for Ocean Science.

Benfield, M. C., Cook, S., Sharuga, S., & Valentine, M. M. (2013). Five in situ observations of live oarfish Regalecus Glesne (Regalecidae) by remotely operated vehicles in the oceanic waters of the Northern Gulf of Mexico. *Journal of Fish Biology*, *83*(1), 28–38. https://doi.org/10.1111/jfb.12144.

Bianchi, G, K E Carpenter, J-P Roux, Fergus M, D Boyer, and H J Boyer. 1999. "*Field guide to the living marine resources of Namibia, January*. Rome: FAO.

Bjornsson, B., & Reynisson, P. (2013). Synchronous and vertically undulating swimming behaviour of Atlantic cod Gadus Morhua. *Aquatic Biology*, *19*, 13–18. https://doi.org/10.3354/ab00516.

Brito, A., Falcón, J., & Herrera, R. (2007). Características Zoogeográficas de La Ictiofauna Litoral de Las Islas de Cabo Verde y Comparación Con Los Archipiélagos Macaronésicos. *Revista de la Academia Canaria de Ciencias*, *18*, 93–109.

Dancette, R. (2019). Growing vulnerability in the small-scale fishing communities of Maio, Cape Verde. *Maritime Studies*, *18*(2), 205–223. https://doi.org/10.1007/s40152-019-00137-2.

Drazen, J., & Robison, B. (2004). Direct observations of the association between a Deep-Sea fish and a Giant Scyphomedusa. *Marine and Freshwater Behaviour and Physiology*, *37*, 209–214. https://doi.org/10.1080/10236240400006190.

Escánez, A., & Brito, A. (2011). First record of the Midwater Scorpionfish Ectreposebastes Imus (Scorpaeniformes: Setarchidae) in the subtropical eastern Atlantic (Canary Islands). *Marine Biodiversity Records*, *4*, E78. https://doi.org/10.1017/S1755267211000704.

Eschmeyer, W., & Collette, B. (1966). The Scorpionfish subfamily Setarchinae, including the genus Ectreposebastes. *Bulletin of Marine Science*, *16*, 349–375.

Freitas, R., Romeiras, M., Silva, L., Cordeiro, R., Madeira, P., González, J., et al. (2019). Restructuring of the 'Macaronesia' biogeographic unit: A marine multi-taxon biogeographical approach. *Scientific Reports*, *9*, 15792. https://doi.org/10.1038/s41598-019-51786.

Fricke, R, W Eschmeyer, and R Van der Laan. 2018. *Catalog of fishes: Genera, species, References*. San Francisco: California Academy of Sciences. https://www.calacademy.org/scientists/projects/eschmeyers-catalog-of-fishes

González, J., Jorge, J., Albertino Martins, J. I. S., Triay-Portella, R., Monteiro, C., Garcia-Martin, V., et al. (2014). New and rare Records of Fishes (Osteichthyes) from the Cape Verde Islands (eastern-Central Atlantic Ocean). *Cybium: International Journal of Ichthyology*, *38*, 289–300.

Hissmann, K., & Schauer, J. (2017). Manned Submersible 'JAGO'. *Journal of Large-Scale Research Facilities*, *3*, 1–12. https://doi.org/10.17815/jlsrf-3-157.

Hoving, H.-J., Christiansen, S., Fabrizius, E., Hauss, H., Kiko, R., Linke, P., … Körtzinger, A. (2019). The pelagic in situ observation system (PELAGIOS) to reveal biodiversity, behavior, and ecology of elusive oceanic Fauna. *Ocean Science*, *15*(5), 1327–1340. https://doi.org/10.5194/os-15-1327-2019.

Hoving, H. J. T., Hauss, H., Schütte, F., Merten, V., Fabrizius, E., Hissmann, K., et al. (2018). Cruise report POS520 RV POSEIDON Mindelo, Cape Verde (14/2/2018) – Mindelo Cape Verde (January 3, 2018) biological baseline studies in the pelagic deep seas of Cape Verde. *Kiel*, 1–29. https://doi.org/10.3289/CR_POS520.

Humphries, N., Simpson, S., & Sims, D. (2017). Diel vertical migration and central place foraging in benthic predators. In *Marine Ecology Progress Series* (Vol. *582*, pp. 163–180). https://doi.org/10.3354/meps12324.

Linley, T. D., Gerringer, M. E., Yancey, P. H., Drazen, J. C., Weinstock, C. L., & Jamieson, A. J. (2016). Fishes of the Hadal zone including new species, in situ observations and depth Records of Liparidae. *Deep Sea Research Part I: Oceanographic Research Papers*, *114*, 99–110. https://doi.org/10.1016/j.dsr.2016.05.003.

Matsubara, K. (1943). Studies on the Scorpaenoid fishes of Japan (II). *Transactions Sigenkagaku Kenkyusyo*, *2*, 171–486.

Miller, M., Koyama, S., Mochioka, N., Aoyama, J., Watanabe, S., & Tsukamoto, K. (2014). Vertical body orientation by a snipe eel (Nemichthyidae, Anguilliformes) in the deep mesopelagic zone along the West Mariana ridge. In *Marine and Freshwater Behaviour and Physiology* (Vol. *47*, pp. 265–272). https://doi.org/10.1080/10236244.2014.926128.

Morais, L, M Sylla, and W Ivantsoff. 2016. "*The living marine resources of the eastern Central Atlantic. Vol. 3: Bony fishes, part 1: Elopiformes to Scorpaeniformes*. Rome: Food and Agriculture Organization of the United Nations.

Poss, S. G. (2016). Scorpaenidae. In K. E. Carpenter & N. E. De Angelis (Eds.), *The living marine resources of the eastern Central Atlantic* (Vol. 3, pp. 2250–2287). Rome: Food and Agriculture Organization of the United Nations.

Robinson, C., Steinberg, D. K., Anderson, T. R., Arístegui, J., Carlson, C. A., Frost, J. R., … Zhang, J. (2010). Mesopelagic zone ecology and biogeochemistry – A synthesis. *Deep Sea Research Part II: Topical Studies in Oceanography*, *57*(16), 1504–1518. https://doi.org/10.1016/j.dsr2.2010.02.018.

Robison, B. (2004). Deep pelagic biology. *Journal of Experimental Marine Biology and Ecology*, *300*, 253–272. https://doi.org/10.1016/j.jembe.2004.01.012.

Robison, B. H. (2009). Conservation of deep pelagic biodiversity. *Conservation Biology*, *23*(4), 847–858. https://doi.org/10.1111/j.1523-1739.2009.01219.x.

Robison, B. H. (1999). Shape change behavior by mesopelagic animals. *Marine and Freshwater Behaviour and Physiology*, *32*(1), 17–25. https://doi.org/10.1080/10236249909379034.

Saba, G. K., Burd, A. B., Dunne, J. P., Hernández-León, S., Martin, A. H., Rose, K. A., … Wilson, S. E. (2021). Toward a better understanding of fish-based contribution to ocean carbon flux. *Limnology and Oceanography*, *66*(5), 1639–1664. https://doi.org/10.1002/lno.11709.

Schlining, B., & Stout, N. (2006). MBARI's video annotation and reference system. *Proceedings of the Marine Technology Society/Institute of Electrical and Electronics Engineers Ocean Conference*, *2006*, 1–5. https://doi.org/10.1109/OCEANS.2006.306879.

Stenvers, V. I., Hauss, H., Osborn, K. J., Neitzel, P., Merten, V., Scheer, S., … Hoving, H. -J. T. (2021). Distribution, associations and role in the biological carbon pump of Pyrosoma Atlanticum (Tunicata, Thaliacea) off Cabo Verde, NE Atlantic. *Scientific Reports*, *11*(1), 9231. https://doi.org/10.1038/s41598-021-88208-5.

Sutton, T. (2013). Vertical ecology of the Pelagic Ocean: Classical patterns and new perspectives. *Journal of Fish Biology*, *83*, 1508–1527. https://doi.org/10.1111/jfb.12263.

Thurber, A. R., Sweetman, A. K., Narayanaswamy, B. E., Jones, D. O. B., Ingels, J., & Hansman, R. L. (2014). Ecosystem function and services provided by the Deep Sea. *Biogeosciences*, *11*(14), 3941–3963. https://doi.org/10.5194/bg-11-3941-2014.

Wada, H., Kai, Y., & Motomura, H. (2021). Revision of the resurrected Deepwater Scorpionfish genus Lythrichthys Jordan and starks 1904 (Setarchidae), with descriptions of two new species. *Ichthyological Research*, *68*, 373–403. https://doi.org/10.1007/s10228-020-00793-z.

Wirtz, P., Brito, A., Falcón, J., Freitas, R., Fricke, R., Monteiro, V., … Tariche, O. (2013). The coastal fishes of the Cape Verde Islands - new records and an annotated check-list: (Pisces). *Spixiana*, *36*, 113–142.

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