

## COMMENT

# Re-evaluating the putative sonic role of the retractor dorsalis in lionfishes

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In 2023, the sound-producing apparatus of several lionfish species (Pteroinae), belonging to the genera *Pterois* Oken (1817) and *Dendrochirus* Swainson (1839), was described (Parmentier et al., 2024). In all examined species, sound production involves vibration of the swimbladder driven by high-speed sonic muscles. This system exhibits several distinctive anatomical features, including a specific organization of the swimbladder and a pair of extrinsic sonic muscles with a unique bipennate arrangement.

In a subsequent study, Holmes et al. (2025) revisited the sound-producing apparatus of *Pterois* species to investigate potential sexual and ontogenetic differences in muscle size. In doing so, they proposed the presence of an additional pair of muscles potentially involved in sound production, referred to as the ‘anterior extrinsic sonic muscles’ (AESM), which were initially described as inserting onto the swimbladder. This first description was later corrected in an erratum, in which the authors indicated that these muscles do not insert onto the swimbladder but instead make contact with its anterior region and insert onto the vertebral column (Holmes et al., 2025). The erratum further identified the AESM as corresponding anatomically to the retractor dorsalis.

Although the anatomical identification and insertion patterns have been revised, the functional interpretation remains ambiguous. Retaining the term ‘AESM’ for a muscle identified as the retractor dorsalis not only is inconsistent with established anatomical nomenclature but also obscures functional interpretation. Moreover, the proposed involvement of the retractor dorsalis in sound production, initially based on an implied insertion onto the swimbladder and subsequently on proximity or contact with it, is not supported by experimental or biomechanical evidence.

The aim of the present comment is therefore to clarify the anatomical position and function of the retractor dorsalis and to explain

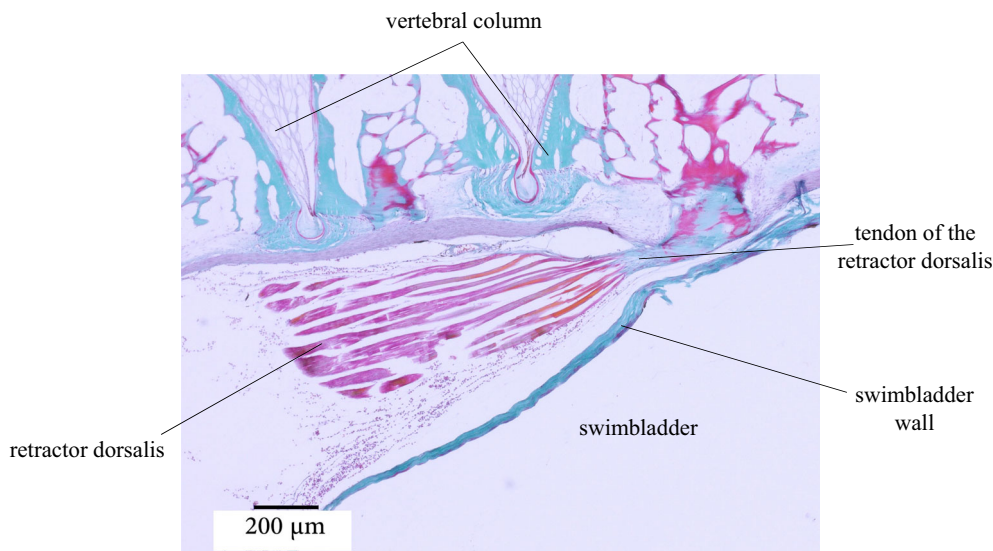
why this muscle does not contribute to sound production in this system.

At the level of the branchial basket, pharyngobranchials 2, 3 and 4 form the upper pharyngeal jaws. These structures are suspended beneath the neurocranium by muscles, mainly the internal and external levators, as well as by pharyngobranchials 1. This suspension confers high mobility to the upper pharyngeal jaws, allowing anteroposterior movements involved in food transport from the branchial basket to the oesophagus (Lauder, 1983).

Posterior movements of the upper pharyngeal jaws are produced by contraction of the retractor dorsalis, which inserts on these jaws and on the vertebral column (Vandewalle et al., 2000; Winterbottom, 1974). In Pteroinae, the retractor dorsalis inserts on the third vertebra, whose vertebral body bears two ventral processes serving as attachment sites (Figure 1). From this insertion point, the muscle runs alongside the swimbladder wall without forming any direct mechanical attachment (Figure 1).

In the study by Holmes et al. (2025), the authors initially interpreted the retractor dorsalis as inserting onto the swimbladder, which led them to propose a comparison with the sonic system described in *Parophidion vassali* (Risso, 1810) (Parmentier et al., 2022). Their hypothesis relies mainly on the statement that this muscle is ‘similar in location to the ventral muscles identified in cryptic cusk eels (*Parophidion vassali*)’ (Holmes et al., 2025). However, the muscular organization in *P. vassali* is different because they possess both retractor dorsalis and sound-producing muscles. In *P. vassali*, the ventral sonic muscles constitute the main drivers of swimbladder vibration and ensure direct mechanical coupling with the bladder (Parmentier et al., 2022). In lateral view, these muscles also mask a pair of retractor dorsalis muscles, highlighting the clear anatomical and functional separation between the sonic and pharyngeal systems.

In *P. vassali*, sonic muscles originate from rigid cranial structures, whereas the swimbladder represents the mobile element of the system. Muscle contraction therefore transfers mechanical



**FIGURE 1** Sagittal section in *Pterois volitans* showing the insertion of the retractor dorsalis onto the vertebral column.

energy efficiently to the bladder. By contrast, in both *Pterois* and *P. vassali*, the retractor dorsalis originates from the mobile upper pharyngeal jaws and inserts onto the rigid vertebral column, which represents the main anchoring structure. Its contraction thus results in posterior displacement of the pharyngeal apparatus rather than in displacement of the swimbladder. From a mechanical perspective, the sonic muscles and the retractor dorsalis are therefore fundamentally and functionally different, even when located in close anatomical proximity.

Although the authors acknowledge in their erratum that the retractor dorsalis does not insert onto the swimbladder, they continue to suggest a potential sonic role based on its proximity or contact with the anterior region of the bladder, for which an anatomical or mechanical description is not provided. Histological observations indicate that this contact is superficial: the retractor dorsalis runs alongside the swimbladder without any connective attachment (Figure 1). Furthermore, near the bladder, its insertion onto the vertebral column is tendinous, implying that muscle shortening does not occur at this level during contraction. Consequently, no functional mechanical linkage is established between the muscle and the swimbladder. Many axial muscles run adjacent to the swimbladder and contact its surface during routine movements, yet none have been demonstrated to contribute to sound production in the absence of direct mechanical insertions.

Passive or incidental contact during pharyngeal movements therefore does not provide a biomechanically plausible mechanism for sound production. Without specialized connective attachments, controlled force transmission to the bladder wall cannot occur. In addition, the swimbladder wall, composed of collagen and elastin fibres and containing a high proportion of water, exhibits strong viscous damping properties that rapidly dissipate mechanical energy (Fine et al., 2009; Fine & Parmentier, 2022). As a result, contact with surrounding tissues tends to damp vibrations rather than excite them. Moreover, this property is functionally advantageous, as it prevents the fish from inadvertently producing acoustic signals during routine feeding-related movements.

In established sonic systems, sound production requires controlled mechanical excitation and a defined structural coupling between the motor system and the sound-producing organ. This coupling may involve specialized muscles and/or associated skeletal or connective modifications (e.g., fenestrae, modified bony plates or localized wall specializations) that facilitate efficient force transmission, without necessarily implying a recoil-based mechanism (Fine & Parmentier, 2015; Parmentier & Fine, 2016). In both cases, a defined mechanical coupling is required to store and release energy in a controlled manner. No such coupling or elastic specialization is documented here for the retractor dorsalis. In the absence of these structures, neither forced excitation nor rebound-based mechanisms can be invoked.

In summary, the anatomical organization, insertion pattern and contraction mechanics of the retractor dorsalis in *Pterois* species are incompatible with a role in swimbladder-based sound production. In the absence of direct mechanical coupling, specialized elastic structures or experimentally demonstrated vibration of the swimbladder, this muscle cannot plausibly contribute to acoustic signal generation. The available evidence therefore is insufficient to support the thesis that the retractor dorsalis is involved in sound production in this system.

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#### DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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