Endolymphatic lesions associated with *Cryptococcus*-like yeast in a Captive Bowmouth Guitarfish (*Rhina ancylostoma*): A case report and environmental exposure hypothesis

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Abstract

Endolymphatic syndrome (ELS) is an uncommon disorder affecting elasmobranch fishes and is characterized by cystic or nodular lesions associated with the endolymphatic system. Fungal infections have occasionally been reported in Captive sharks and rays; however, cryptococcal infections in elasmobranchs remain exceptionally rare. We describe a Captive female Bowmouth Guitarfish (*Rhina ancylostoma*) that developed subcutaneous swellings associated with the endolymphatic system. Microscopic examination revealed encapsulated yeast-like organisms morphologically consistent with *Cryptococcus-like yeast*. Because no fungal culture or molecular identification was performed, definitive species identification could not be established. Based on environmental observations, pigeon droppings were considered a potential environmental reservoir of cryptococcal propagules, while the carrot beetle (*Tomarus gibbosus*) was hypothesized to act as a possible mechanical carrier. These proposed exposure pathways remain speculative and should not be interpreted as evidence of confirmed transmission. This case highlights the importance of environmental biosecurity, wildlife exclusion, and comprehensive microbiological and molecular investigations in public aquarium systems. The findings should be regarded as hypothesis-generating and may contribute to future research on the environmental epidemiology of fungal diseases affecting Captive elasmobranchs.

Keywords: Bowmouth Guitarfish, *Rhina ancylostoma*, *Cryptococcus*-like lesions, Endolymphatic syndrome, Aquarium biosecurity, Environmental exposure, Case report

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Introduction

Fungal diseases in elasmobranchs have been reported only sporadically during the past four decades, with most documented cases occurring in sharks and rays maintained under human care in public aquaria. The first documented fungal infection involved *Exophiala pisciphila* in a smooth dogfish (*Mustelus canis*) (Gaskins and Cheung, 1986). Subsequently, fatal infections caused by Fusarium solani were reported in Captive bonnethead sharks (*Sphyrna tiburo*) (Smith *et al*., 1989), followed by granulomatous fusarial dermatitis in scalloped hammerhead sharks (*Sphyrna lewini*) (Crow *et al*., 1995). More recent investigations have documented *Fusarium solani* infections affecting the eye, brain, otic capsule, and endolymphatic ducts of Port Jackson sharks (Pereira *et al*., 2015), hammerhead sharks (Lécu *et al*., 2018), and rough-tail stingrays (Hsu *et al*., 2021), indicating that opportunistic fungal pathogens remain an important health concern for Captive elasmobranchs.

Recent reviews have concluded that fungal diseases reported in elasmobranchs are predominantly associated with members of the *Fusarium solani* Species Complex (FSSC), while emphasizing that information regarding the epidemiology, diagnosis, and treatment of fungal infections in sharks and rays remains limited (Desoubeaux *et al*., 2018; Canizares-Cooz *et al*., 2024). The increasing maintenance of large elasmobranch species in public aquaria has improved opportunities for recognizing emerging pathogens, describing new disease syndromes, and developing appropriate diagnostic and therapeutic approaches.

The Bowmouth Guitarfish (*Rhina ancylostoma*) is a vulnerable benthic elasmobranch frequently maintained in large public aquaria. Maintaining optimal environmental conditions and preventing the introduction of opportunistic pathogens are essential components of health management in Captive populations. Among environmental fungal pathogens, species belonging to the genus *Cryptococcus* are encapsulated yeasts commonly associated with pigeon droppings and other organic substrates, where they may persist for prolonged periods (Littman *et al*., 1965; Liu *et al*., 2012; Rad, 2013; Esakkiammal and Sheeba-Rajakumari, 2025). Although cryptococcosis is well recognized in mammals, birds, reptiles, and several aquatic animals, reports involving elasmobranch fishes remain exceptionally uncommon.

The anatomy of the elasmobranch endolymphatic system provides a biologically plausible route through which environmental microorganisms may gain access to deeper tissues. The paired endolymphatic pores communicate with the endolymphatic ducts and inner ear throughout life, creating a direct anatomical connection between the external environment and the otic region (Quiring, 1930; Popper and Fay, 1977; Evangelista *et al*., 2010). Recent veterinary investigations have further suggested that environmental lesion pathways may facilitate pathogen entry into these structures under suitable pathological conditions (Chang and Okihiro, 2024). Nevertheless, the involvement of *Cryptococcus*-like organisms in endolymphatic lesions of elasmobranchs has not been adequately investigated.

The present case report describes endolymphatic lesions containing encapsulated yeast-like organisms morphologically compatible with *Cryptococcus-like yeast*. in a Captive Bowmouth Guitarfish (*Rhina ancylostoma*). Based on environmental observations, pigeon-derived contamination and the possible mechanical transport of fungal propagules by adult carrot beetles (*Tomarus gibbosus*) are proposed as hypotheses for environmental exposure. Because microbiological confirmation of these environmental sources was not performed, these proposed pathways should be regarded as hypothetical rather than confirmed mechanisms of disease transmission. This report is intended to generate hypotheses and encourage future microbiological, molecular, and epidemiological investigations of fungal diseases in Captive elasmobranchs (Fig. 1).

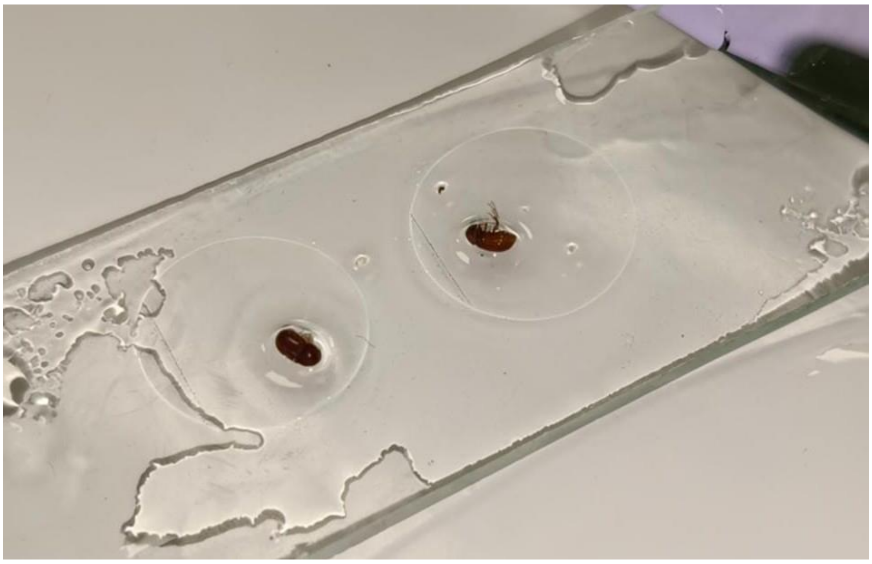

Figure 1; Carrot beetle - *Tomarus gibbosus* – Adult.

Materials and methods

Case description

A one-year-old female Bowmouth Guitarfish (*Rhina ancylostoma*), measuring 147 cm in total length and weighing 33.35 kg, was maintained in a large public marine aquarium. The animal was presented for clinical evaluation after exhibiting abnormal swimming behavior characterized by barrel rolling and persistent tilting to the left side. Based on the initial clinical assessment, differential diagnoses included central nervous system disease and endolymphatic system disease. Clinical examination revealed accumulation of tan-purulent material associated with reddening surrounding the endolymphatic pores, following the contour of the skull and corresponding to the anatomical location of the inner ear structures.

Clinical examination and sample collection

The external lesions were examined macroscopically, and representative photographic documentation was obtained. Material collected from the affected endolymphatic swellings was subjected to microscopic examination. Encapsulated yeast-like organisms morphologically compatible with *Cryptococcus-like yeast*. were observed within the lesion material. Morphological assessment was used as the basis for the presumptive diagnosis.

Environmental observations

Following clinical examination, the surrounding aquarium environment was inspected to identify possible environmental sources of fungal exposure. Particular attention was directed toward wildlife activity, including the presence of feral pigeons and adult carrot beetles (*Tomarus gibbosus*), because these organisms have been reported as potential environmental reservoirs or mechanical carriers of *Cryptococcus* species or related yeasts (Kidd *et al*., 2003; Lee *et al*., 2006; Coelho *et al*., 2025). These observations were considered hypothesis-generating only, and no environmental microbiological sampling was performed.

Diagnostic limitations

No fungal culture, biochemical identification, polymerase chain reaction (PCR), DNA sequencing, or antifungal susceptibility testing was performed. Consequently, identification of the organism was limited to morphological compatibility with *Cryptococcus*-like yeast, and definitive identification at the species level could not be established. The proposed environmental exposure pathways were likewise not confirmed microbiologically and should therefore be regarded as hypothetical.

Results

Clinical findings

The affected Bowmouth Guitarfish (*Rhina ancylostoma*) presented with abnormal swimming behavior characterized by persistent lateral tilting and repeated barrel-rolling movements, suggesting impairment of the vestibular system. Clinical examination demonstrated bilateral swelling associated with the endolymphatic pores, accompanied by localized erythema and accumulation of tan to cream-colored purulent material over the dorsal cranial region corresponding to the anatomical location of the endolymphatic ducts and otic capsules (Fig. 2).

Gross lesions

Gross examination revealed enlargement of the endolymphatic region with inflammatory changes surrounding the external pores. Gentle compression of the affected area resulted in extrusion of viscous purulent exudate.

The distribution of the lesions was confined primarily to the endolymphatic structures, with no obvious evidence of generalized cutaneous fungal infection observed during external examination. The gross appearance was consistent with severe inflammatory involvement of the endolymphatic system.

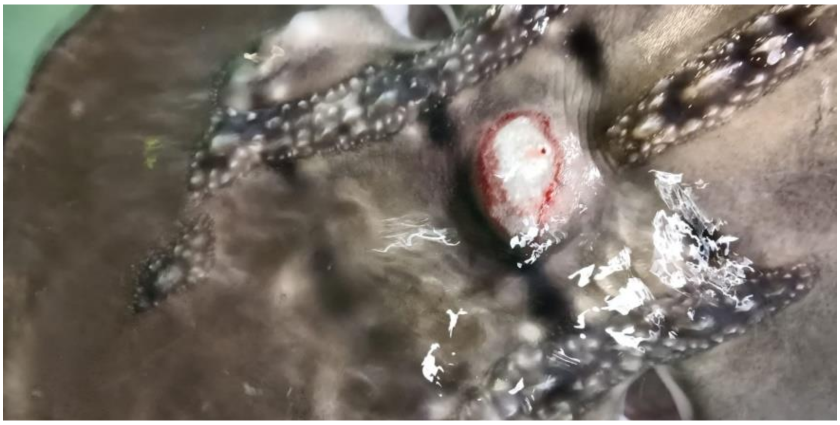

Figure 2: Swelling along the dorsal midline with endolymphatic system disease of Bowmouth Guitar Ray.

Microscopic findings

Direct microscopic examination of material collected from the lesions demonstrated numerous round to oval encapsulated budding yeast-like organisms intermixed with inflammatory debris. The organisms exhibited morphological characteristics compatible with members of the genus *Cryptococcus*. However, because diagnosis relied exclusively on microscopic morphology, definitive identification at the species level could not be established. No fungal culture, biochemical characterization, PCR, or DNA sequencing was performed to confirm the identity of the organisms.

Environmental observations

Environmental inspection of the aquarium complex identified the presence of free-ranging pigeons in areas surrounding the facility and adult carrot beetles (*Tomarus gibbosus*) within the environment. Based on published literature describing environmental reservoirs of *Cryptococcus* species and the association of yeasts with insects, these observations were considered possible environmental exposure factors. Nevertheless, neither pigeon droppings, insects, aquarium water, substrates, nor other environmental materials were microbiologically examined; therefore, no direct evidence linking these observations to the infection was obtained (Fig. 3).

Diagnostic interpretation

Based on the clinical presentation, gross lesions, and microscopic observation of encapsulated budding yeast-like organisms, a presumptive diagnosis of endolymphatic cryptococcosis (or cryptococcosis-like infection) was considered. Owing to the absence of fungal isolation and molecular confirmation, the diagnosis should be interpreted as morphologically compatible with *Cryptococcus-like yeast.* rather than microbiologically confirmed cryptococcosis.

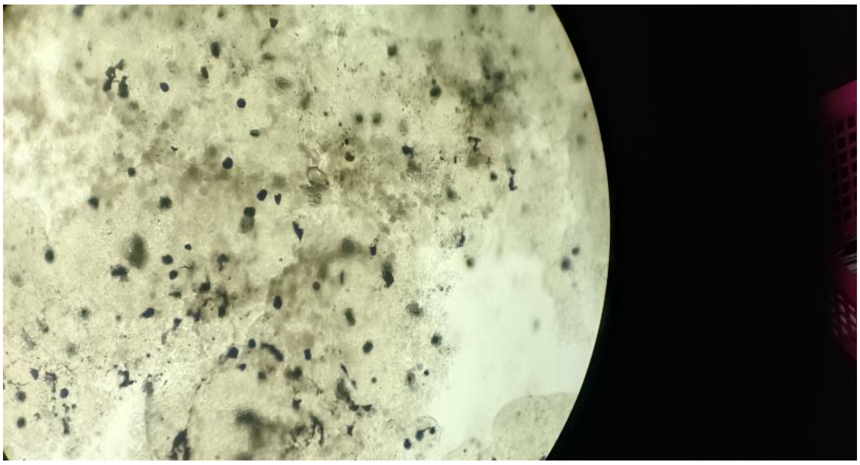

Figure 3: ***Cryptococcus-like yeast.***

Discussion

The present case describes endolymphatic lesions containing encapsulated yeast-like organisms morphologically compatible with *Cryptococcus spp*. in a Captive Bowmouth Guitarfish (*Rhina ancylostoma*). Compared with previously published reports, fungal diseases in elasmobranchs remain uncommon, with the majority of documented infections involving Captive sharks and rays maintained under aquarium conditions. Earlier reports described *Exophiala pisciphila* infection in a smooth dogfish (Gaskins and Cheung, 1986), fatal *Fusarium solani* infection in bonnethead sharks (Smith *et al*., 1989), granulomatous fusariosis in scalloped hammerhead sharks (Crow *et al*., 1995), ocular and endolymphatic fusariosis in Port Jackson sharks (Pereira *et al*., 2015), systemic infection in hammerhead sharks (Lécu *et al*., 2018), and fungal disease in rough-tail stingrays (Hsu *et al*., 2021). These reports collectively indicate that opportunistic fungal pathogens represent an important, although infrequent, cause of disease in Captive elasmobranchs.

Recent reviews have further demonstrated that most fungal infections reported in sharks and rays are associated with members of the *Fusarium solani* Species Complex, while emphasizing the limited understanding of fungal epidemiology, diagnosis, and treatment in elasmobranchs (Desoubeaux *et al*., 2018; Canizares-Cooz *et al*., 2024). Within this context, the present case expands the currently available information by describing lesions morphologically compatible with *Cryptococcus*-like organisms rather than *Fusarium*, thereby broadening the spectrum of fungal pathogens that should be considered during differential diagnosis of endolymphatic disease.

The diagnosis in the present study was based on microscopic observation of encapsulated budding yeast-like organisms recovered from endolymphatic lesions. Although the observed morphology was compatible with *Cryptococcus-like yeast.*, no fungal culture, biochemical identification, polymerase chain reaction (PCR), DNA sequencing, or antifungal susceptibility testing was performed. Consequently, the diagnosis should be regarded as presumptive, and the etiological agent cannot be confirmed beyond morphological compatibility. This limitation should be acknowledged when interpreting the findings and highlights the importance of incorporating molecular diagnostic techniques into future investigations.

Environmental contamination remains a biologically plausible explanation for exposure. Numerous investigations have identified pigeon droppings as important environmental reservoirs of *Cryptococcus* species, demonstrating prolonged environmental persistence of encapsulated yeasts under suitable ecological conditions (Littman *et al.*, 1965; Liu *et al.*, 2012; Rad, 2013; Esakkiammal and Sheeba-Rajakumari, 2025). Additional studies have shown that feral pigeons may disseminate a wide range of pathogenic microorganisms in urban environments (Haag-Wackernagel and Moch, 2004; Dickx *et al.*, 2010). The observation of pigeons in the vicinity of the aquarium therefore represents a biologically plausible environmental risk factor; however, because pigeon droppings were not sampled or cultured, this observation cannot be interpreted as evidence of confirmed transmission.

The possible contribution of insects should also be interpreted cautiously. Previous studies have isolated *Cryptococcus* species from insect-associated substrates and have demonstrated ecological associations between environmental yeasts and several insect groups (Kidd *et al.*, 2003; Lee *et al.*, 2006). Earlier investigations also documented ecological associations between Cryptococcus species and insect-associated habitats (van der Walt *et al.*, 1971; Kidd *et al.*, 2003; Lee *et al.*, 2006., Chakraborty *et al.*, 2020). More recently, Coelho *et al.* 2025) emphasized that insects may participate in the environmental dispersal of cryptococcal propagules under natural conditions. Nevertheless, no published evidence currently demonstrates that *Tomarus gibbosus* functions as a biological or mechanical vector of *Cryptococcus-like yeast*. Consequently, the presence of adult carrot beetles near the aquarium should be regarded only as a hypothesis-generating observation requiring microbiological confirmation.

The anatomical characteristics of the elasmobranch endolymphatic system may provide a potential pathway through which environmental microorganisms gain access to deeper tissues. Classical anatomical investigations demonstrated that the paired endolymphatic pores communicate directly with the endolymphatic ducts and otic capsules (Quiring, 1930; Popper and Fay, 1977; Evangelista *et al*., 2010). More recent pathological observations have suggested that these structures may facilitate pathogen entry when local tissue integrity is compromised (Chang and Okihiro, 2024). Although this anatomical relationship supports biological plausibility, direct evidence that *Cryptococcus*-like organisms entered through the endolymphatic pores was not obtained in the present study.

From a clinical perspective, this report emphasizes the importance of comprehensive environmental biosecurity in public aquaria housing elasmobranchs. Exclusion of wild birds, prevention of organic waste accumulation, implementation of effective insect management programs, and routine environmental microbiological surveillance should be considered integral components of preventive health management. Incorporation of fungal culture, molecular identification, environmental sampling, and phylogenetic analysis into future investigations will be essential for confirming pathogen identity, identifying environmental reservoirs, and clarifying transmission pathways in Captive shark and ray populations.

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