Beyond *Aeromonas hydrophila*: Isolation of *Aeromonas veronii* from Koi Carp (*Cyprinus carpio var. koi*) with Ulcerative Disease (Case Report)

Andreia Garcês[1], Luís Sousa[1, 2], Filipe Silva[1, 2], Isabel Pires[2]

[1]*Wildlife Rehabilitation Center Teaching Veterinary Hospital of University of Trás-os-Montes and Alto Douro, Quinta dos Prados, 4500-801, Vila Real, Portugal*

[2]*CECAV, Centre for Animal Sciences and Veterinary Studies, Associate Laboratory for Animal and Veterinary Science—AL4AnimalS, University of Trás-os-Montes and Alto Douro, Quinta dos Prados, 4500-801, Vila Real, Portugal*

Keywords: *koi carp, fish, bacteria, ulcerative syndrome, Aeromonas veronii.*

Abstract: *Koi carp (Cyprinus carpio var. koi) are globally popular ornamental fish, valued for their distinctive coloration and patterns. However, infectious disease outbreaks remain an important health concern, particularly bacterial infections associated with skin ulceration, systemic disease, and mortality. Motile aeromonad infections in freshwater fish, including koi carp, have traditionally been attributed mainly to Aeromonas hydrophila, while other species may have been underdiagnosed or overlooked. In this report, we describe the isolation of Aeromonas veronii from koi carp in a private collection that presented with lesions consistent with koi ulcer disease, along with the associated macroscopic findings.*

Introduction

Aeromonas veronii is a Gram-negative, facultatively anaerobic bacterium widely distributed in freshwater environments and associated with infections in both aquatic animals and humans. In fish, it is considered an opportunistic pathogen that primarily affects immunocompromised hosts or those exposed to stressors such as poor water quality, temperature fluctuations, and overcrowding (Tasci et al., 2025). Infections caused by this organism have been reported in several fish species, including Nile tilapia (*Oreochromis niloticus*) (Aly et al., 2023), climbing perch (*Anabas testudineus*) (Ehsan et al., 2023), channel catfish (*Ictalurus punctatus*) (Hoai et al., 2019), among others.

Koi carp (*Cyprinus carpio var. koi*) are high-value ornamental freshwater fish selectively bred for their vivid coloration and distinctive patterns (Alavinezhad et al., 2021; Tasci et al., 2025). Originally developed in Japan, koi are now widely kept in garden ponds, private collections, and decorative aquatic systems worldwide. Despite their popularity and economic value, koi are susceptible to several infectious diseases, particularly bacterial infections affecting the skin and internal organs (Adamek et al., n.d.; Alavinezhad et al., 2021).

Koi ulcer disease (KUD) is an important condition in ornamental carp because it can cause severe skin ulceration, systemic infection, mortality, and economic losses in private collections and ornamental fish facilities. However, its epidemiology remains poorly defined, as many outbreaks occur in private ponds and are not systematically reported or investigated (Alavinezhad et al., 2021; Tasci et al., 2025). Disease emergence is commonly associated with predisposing factors such as seasonal temperature changes, recent introduction of new fish, handling, transport, high stocking density, and poor water quality, which may compromise immune function and damage the skin barrier. KUD is characterized by cutaneous erosions and deep ulcerative lesions that may progress to systemic infection and death if left untreated (Adamek et al., n.d.; Alavinezhad et al., 2021). The disease has most frequently been associated with Aeromonas species, particularly *Aeromonas salmonicida* and *Aeromonas hydrophila* (Bai et al., 2023). However, other motile aeromonads, including *A. veronii*, may be underdiagnosed or overlooked in ulcerative syndromes of koi carp.

Therefore, the objective of this report is to describe the clinical, macroscopic, microscopic, bacteriological, and antimicrobial susceptibility findings associated with the isolation of *A. veronii* from koi carp belonging to a private collection presenting with lesions consistent with Koi ulcer disease. This case highlights the importance of accurate bacterial identification in ulcerative diseases of ornamental fish and contributes to the recognition of *A. veronii* as a potential pathogen associated with KUD.

Case Report

In the summer of 2025, a private owner submitted two deceased fish to the clinic following mortality events in a private outdoor artificial lake. The lake had an approximate volume of 20 000 L, was equipped with a UV filtration system, and its water temperature varied with ambient conditions. According to the owner, all the fish in the lake had exhibited similar macroscopic clinical signs. To date, only those two individuals have been found dead. The collection consisted of approximately 30 koi carp of varying sizes (100 g to 3 kg) and ages. Nearly all fish had

Corresponding author: andreiamvg@gmail.com

been acquired from suppliers in Germany, with the most recent acquisition occurring approximately six months before the onset of clinical signs and mortality. Clinical signs had been observed for approximately one week and progressively worsened despite corrective measures implemented by the owner, including cleaning of the tank, replacement of the filtration system, and disinfection of the water (salt and pergamation of potassium).

A post-mortem examination was subsequently performed. External examination revealed multifocal to diffuse scale loss associated with cutaneous ulcerations across the body surface (Figs. 1–2). Several ulcers (0.5–4 cm) were surrounded by hyperaemic margins and were most prominent in the cranial and caudal peduncle regions (Figs. 1–2). Erosive and frayed lesions of the caudal and pectoral fins were also observed. Additional findings included focal subcutaneous haemorrhages in the regions underlying the pectoral and pelvic fins, anal swelling, and moderate abdominal distension. Internal examination revealed generalized congestion of the visceral organs. The gall bladder was markedly distended with bile, and the intestinal tract was hyperaemic, haemorrhagic, and inflamed. In one specimen, the gills appeared diffusely congested.

Samples obtained from skin ulcers and internal organs were inoculated onto Blood Agar, CNA, and MacConkey Agar plates (bioMérieux, France), and incubated aerobically and anaerobically at 35–37°C for 48 h. Bacterial isolates were iden-tified using the VITEK® 2 system with the GN ID Card REF 21341 (bioMérieux, France). The isolates were identified as *Aeromonas veronii*. Automated antimicrobial susceptibility testing was conducted using the VITEK® 2 Compact system (bioMérieux, France) with the AST-GN98 card, following the manufacturer's instructions. Minimum inhibitory concentrations (MICs) were determined automatically and interpreted according to the guidelines of the Clinical and Laboratory Standards Institute (CLSI, CLSI VET01-S2). The antibiogram revealed

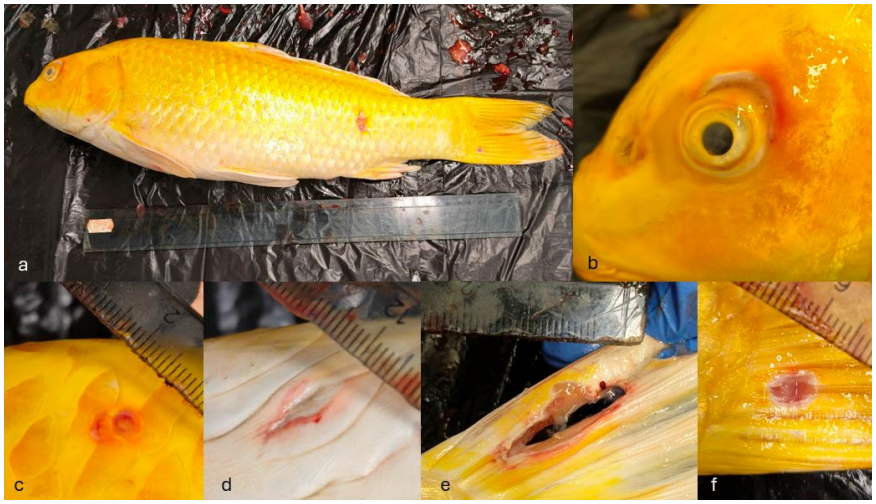

Fig. 1. Full body image from koi carp (*Cyprinus carpio var. koi*); b–f: ulcerative lesions.

Fig. 2. Full body image from koi carp (*Cyprinus carpio var. koi*); b–f: ulcerative lesions

resistance to tetracycline (MIC ⩾ 16.0 µg/mL) and susceptibility to amoxicillin-clavulanic acid (MIC = 8.0 µg/mL), gentamicin (MIC ⩽ 1.0 µg/mL), chloramphenicol (MIC ⩽ 2.0 µg/mL), trimethoprim-sulfamethoxazole (MIC ⩽ 20.0 µg/mL), enrofloxacin (MIC ⩽ 0.12 µg/mL), ceftiofur (MIC ⩽ 1.0 µg/mL), marbofloxacin (MIC ⩽ 0.5 µg/mL), and cefovecin (MIC ⩽ 0.5 µg/mL). Treatment was performed using daily enrofloxacin baths (Baytril® 2.5% oral solution, Bayer) for 5 h per day over a 7-day period. The fish were treated in a 5000 L tank at a concentration of 5 mg/L (Carpenter and Harms, 2022). At the end of the treatment course, the fish began to show clinical improvement, and no new lesions were observed.

Discussion

In this report, *A. veronii* was isolated from koi carp presenting with clinical and post-mortem signs consistent with KUD, including multifocal cutaneous ulcerations, scale loss, and systemic involvement. Although *A. salmonicida* and *A. hydrophila* are classically implicated in ulcerative and septicaemic diseases of cyprinids, studies increasingly recognize *A. veronii* as a significant pathogenic agent in freshwater fish. *A. veronii* has been isolated from diverse fish species with clinical presentations involving dermal ulceration, haemorrhages, exophthalmos, and internal organ congestion similar to those seen in *A. hydrophila* infections (Aly et al., 2023) .

The gross findings in the present cases mirror those documented for *A. veronii* infections in tilapia and carp species, where ulcerative syndrome and systemic pathology were prominent (Aly et al., 2023; Han et al., 2021; Wang et al., 2021). These manifestations also overlap extensively with signs reported in *A. hydrophila* infections, which include haemorrhagic skin lesions, tail and fin erosions, internal organ congestion, and high mortality under stress or poor environmental conditions (Bai et al., 2023; Shabana et al., 2025). Thus, from a clinical standpoint, *A. veronii*–associated ulcerative disease may be indistinguishable from *A. hydrophila*–mediated motile Aeromonas septicaemia without bacteriological and molecular identification.

Antimicrobial susceptibility varies widely among Aeromonas isolates, underlining the necessity of antimicrobial susceptibility testing for targeted therapy. The isolates in this case were resistant to tetracycline but susceptible to a range of agents, including enrofloxacin, gentamicin, and ceftiofur; this is consistent with susceptibility profiles in other reports where aeromonads showed variable resistance patterns but often remained susceptible to fluoroquinolones and aminoglycosides (Fadel et al., 2025; Han et al., 2021). The positive clinical response to enrofloxacin baths in the affected koi reinforces the importance of using in vitro susceptibility to guide treatment decisions. However, global concerns about antimicrobial resistance in aquatic pathogens call for the judicious use of antibiotics and exploration of alternative control strategies, such as vaccination or probiotics.

Environmental stressors, including suboptimal water quality and temperature fluctuations, are well-established risk factors for opportunistic Aeromonas infections in fish, lowering host defences and facilitating bacterial invasion. Although water parameters in this case were not extensively recorded, similar studies emphasize that poor water quality often precedes outbreaks of ulcerative and septicaemic disease in tilapia and carp, further implicating environmental management as a cornerstone of disease prevention.

Conclusion

This case report identifies *Aeromonas veronii* as a bacterium associated with ulcerative disease and systemic lesions in koi carp (*Cyprinus carpio var. koi*). The clinical, macroscopic, and microscopic findings were consistent with Koi ulcer disease, while bacteriological culture and antimicrobial susceptibility testing supported the selection of enrofloxacin bath treatment. These findings highlight the importance of accurate bacterial identification in ulcerative diseases of ornamental fish, since motile aeromonad infections should not be attributed exclusively to *Aeromonas hydrophila*. Comprehensive diagnostic testing is therefore essential for targeted treatment and responsible antimicrobial use.

References

1. Adamek, M., Teitge, F., Baumann, I., Jung-Schroers, V., El Rahman, S.A., Paley, R., Piackova, V., Gela, D., Kocour, M., Rakers, S., Bergmann, S.M., Ganter, M., Steinhagen, D., n.d. Koi sleepy disease as a pathophysiological and immunological consequence of a branchial infection of common carp with carp edema virus. Virulence 12, 1855–1883. https://doi.org/10.1080/21505594.2021.1948286
2. Alavinezhad, S.S., Department of Aquatic Health and Diseases, Faculty of Veterinary Medicine, University of Tehran, Tehran, Iran, Kazempoor, R., Department of Biology, Roudehen Branch, Islamic Azad University, Roudehen, Iran, Ghorbanzadeh, A., Department of Aquatic Health and Diseases, Faculty of Veterinary Sciences, Tehran Science and Research Branch, Islamic Azad University, Tehran, Iran, Gharekhani, A., Department of Veterinary Medicine, Maku Branch, Islamic Azad University, Maku, Iran, 2021. Isolation of Aeromonas hydrophila and Evaluation of Its Pathological Effects on Koi Fish (Cyprinus carpio). Iran J Med Microbiol 15, 465–476. https://doi.org/10.30699/ijmm.15.4.465
3. Aly, S.M., Abou-El-Atta, M.E., El-Mahallawy, H.S., Elaswad, A., ElAbyad, F.A., ElBanna, N.I., 2023. Aeromonas veronii and ulcerative syndrome in cultured Nile tilapia (Oreochromis niloticus) and their associated factors. Aquacult Int 31, 2867–2881. https://doi.org/10.1007/s10499-023-01113-8
4. Bai, L., Li, S., Fu, X., Wang, P., Guo, Y., Yu, D., 2023. Isolation and Identification of Aeromonas hydrophila from Pangasius bocourti with Bacterial Septicemia and Drug Screening for Treatment. Bulletin of the EAFP 43. https://doi.org/10.48045/001c.87432
5. Carpenter, J., Harms, C., 2022. Carpenter's Exotic Animal Formulary, 6th Edition, 6th ed. Saunders.
6. Ehsan, R., Rahman, A., Paul, S.I., Ador, Md.A.A., Haque, Md.S., Akter, T., Rahman, Md.M., 2023. *Aeromonas vero-*

nii isolated from climbing perch (*Anabas testudineus*) suffering from epizootic ulcerative syndrome (EUS). Aquaculture and Fisheries 8, 288–295. https://doi.org/10.1016/j.aaf.2021.11.005
7. Fadel, A., Mahmoud, M.A., Abdelsalam, M., Eissa, E.-S.H., Sherif, A.H., 2025. Aeromonas veronii infection in cultured Oreochromis niloticus: prevalence, molecular and histopathological characterization correlated to water physicochemical characteristics, with the protective autochthonous probiotic. Aquacult Int 33, 298. https://doi.org/10.1007/s10499-025-01960-7
8. Han, Z., Sun, J., Jiang, B., Hu, X., Lv, A., Chen, L., Guo, Y., 2021. Concurrent infections of *Aeromonas veronii* and *Vibrio cholerae* in koi carp (*Cyprinus carpio* var. *koi*). Aquaculture 535, 736395. https://doi.org/10.1016/j.aquaculture.2021.736395
9. Hoai, T.D., Trang, T.T., Van Tuyen, N., Giang, N.T.H., Van Van, K., 2019. *Aeromonas veronii* caused disease and mortality in channel catfish in Vietnam. Aquaculture 513, 734425. https://doi.org/10.1016/j.aquaculture.2019.734425
10. Shabana, S.M., Rashed, M.A., Atia, A.A., El-Hady, H.A.M.A., 2025. Characterization of Aeromonas hydrophila isolated from freshwater fish with control trial. Sci Rep 15, 32668. https://doi.org/10.1038/s41598-025-19907-6
11. Tasci, G., Ajmi, N., Altun, S., Saticioglu, I.B., Duman, M., 2025. Genome-Resolved Co-Infection by Aeromonas veronii and Shewanella sp. in Koi Carp: A Zoonotic Risk for Aquarists. Microorganisms 14. https://doi.org/10.3390/microorganisms14010036
12. Wang, B., Mao, C., Feng, J., Li, Y., Hu, J., Jiang, B., Gu, Q., Su, Y., 2021. A First Report of Aeromonas veronii Infection of the Sea Bass, Lateolabrax maculatus in China. Front. Vet. Sci. 7. https://doi.org/10.3389/fvets.2020.600587