

early stocking stages or periods of abrupt environmental change can trigger the transition from subclinical infections to overt disease outbreaks. Chronic or repeated stress can also lead to long-term health impairment, manifested as reduced feeding, slower growth, and decreased survival rates. Moreover, the gut microbiota plays an important mediating role in this process. High-density culture and nutritional imbalance can disrupt microbial homeostasis, resulting in reduced beneficial bacteria and increased opportunistic pathogens, thereby further elevating disease risk (Chang et al., 2024; Murugan et al., 2024; Xiong et al., 2024).

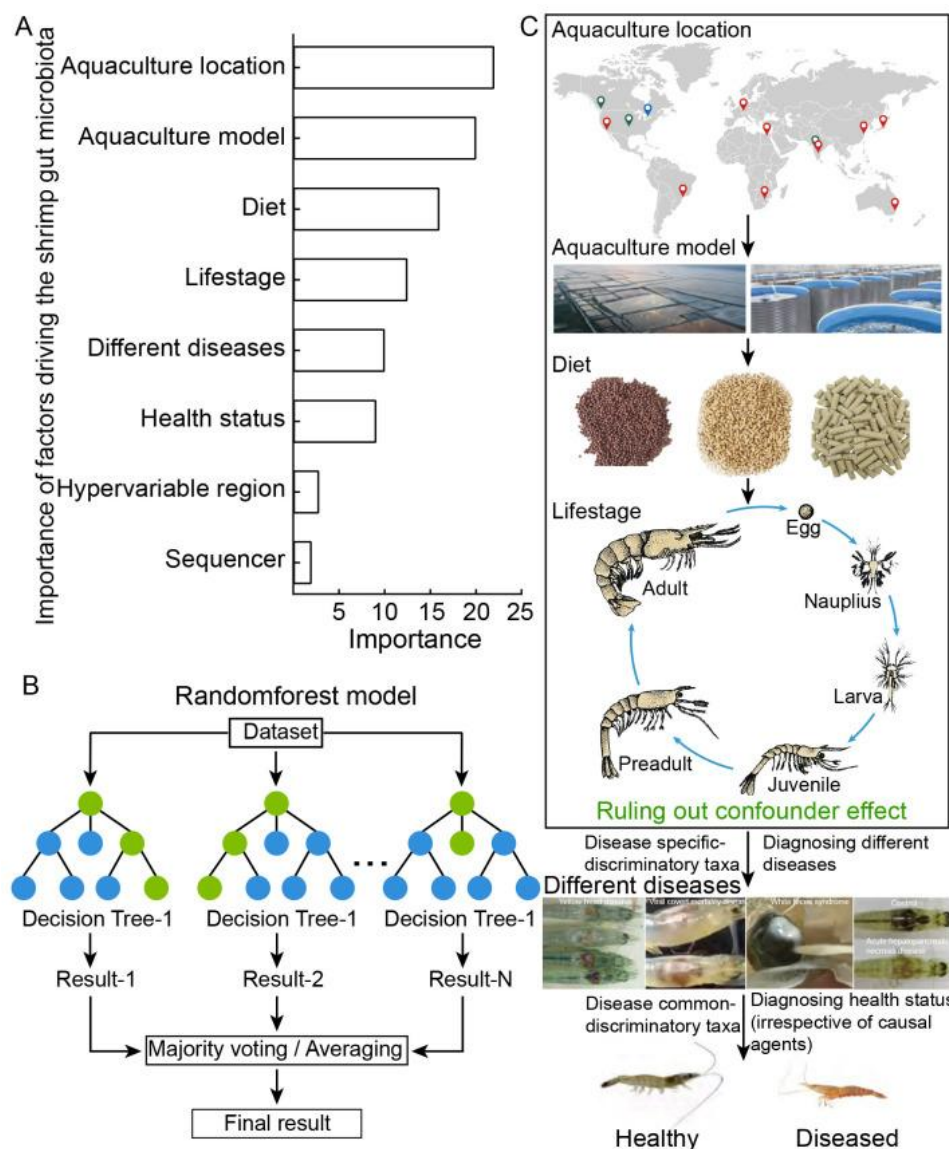


Figure 1 Flowchart screening disease common-discriminatory taxa for diagnosing shrimp health status (Adopted from Xiong et al., 2024)

Image caption: A: Quantifying relative importance of factors governing shrimp gut microbiota in descending order. B: Identifying discriminatory taxa for each factor using a random forest model. C: Identifying disease common-discriminatory taxa after progressive removal of effects of factors more important than health status in governing gut microbiota (Adopted from Xiong et al., 2024)

4 Advances in Disease Detection and Monitoring Technologies

4.1 Conventional detection methods and their limitations

In the early stages of shrimp disease diagnostics, conventional approaches primarily relied on clinical observations and classical laboratory techniques. These methods include visual inspection, microscopic examination, histopathological analysis, electron microscopy, and culture-based isolation of cultivable bacteria. In