frontiers | Frontiers in Marine Science

TYPE Editorial
PUBLISHED 12 October 2022
DOI 10.3389/fmars.2022.1056109

Check for updates

OPEN ACCESS

EDITED AND REVIEWED BY
Yngvar Olsen,
Norwegian University of Science and Technology, Norway

*CORRESPONDENCE
Yangfang Ye
yeyangfang@nbu.edu.cn

SPECIALTY SECTION
This article was submitted to Marine Fisheries, Aquaculture and Living Resources, a section of the journal Frontiers in Marine Science

RECEIVED 28 September 2022
ACCEPTED 04 October 2022
PUBLISHED 12 October 2022

CITATION
Ye Y (2022) Editorial: Nutrition, disease, environmental stress, and microorganisms in crustacean aquaculture. *Front. Mar. Sci.* 9:1056109. doi: 10.3389/fmars.2022.1056109

Editorial: Nutrition, disease, environmental stress, and microorganisms in crustacean aquaculture

Yangfang Ye*

School of Marine Sciences, Ningbo University, Ningbo, China

KEYWORDS
crustacean, nutrition, disease, environmental stress, aquaculture

Editorial on the Research Topic
Nutrition, disease, environmental stress, and microorganisms in crustacean aquaculture

According to Food and Agriculture Organization (FAO, 2022), global aquaculture production of crustaceans retained its growth trend in 2020 and reached 11.2 million tons, valued 81.5 billion US dollars. With the rapid expansion of aquaculture production of crustaceans (mainly shrimp and crabs), factors as nutrition, disease, and environmental stress are an existing constraint to the sustainability and growth of the global crustacean aquaculture industry (Asche et al., 2021). For a long time, the focus of traditional crustacean aquaculture studies has been primarily on crustaceans themselves (Ye et al., 2014; Ye et al., 2016; Chen and He, 2019; Ye et al., 2020; He et al., 2022), but nowadays the microbial communities hosted by the crustaceans have drawn attention of researchers.

In recent years, it is becoming increasingly clear that animals can no longer be considered as autonomous entities but rather as holobionts, encompassing the host plus its associated microbiota (McFall-Ngai et al., 2013; Bordenstein and Theis, 2015). This recognition has opened up a new field in biology and caused researchers to reexamine the questions on crustacean aquaculture. Therefore, it is crustaceans and their associated microbiotas that pull together to face factors as nutrition, disease, and environmental stress. Correspondingly, the field of crustacean microbiology has remarkably advanced in terms of information on the microbial functions in the nutrient digestion, disease defense, and stress response of the host.

Nutrients are critical in supporting the survival, development, and growth of crustaceans. Both live food and formulated diet should be digested before absorption by crustaceans. It is generally recognized that the gut microbiota provides the crustaceans with a complementary enzymatic arsenal for food ingestion (Dempsey and Kitting, 1987; Pinn et al., 1999; Lau et al., 2002; Oxley et al., 2002; Zbinden and Cambon-Bonavita, 2003). For example, bacteria and fungi in the hindgut assist digestion of wood fragments for *Munidopsis andamanica* (Hoyoux et al., 2009). Further, the proteasome metabolic capacity of the intestinal bacteria may facilitate the feed protein utilization of *Litopenaeus vannamei* (Duan et al., 2020) while a more complex and cooperative gut eukaryotic interspecies interaction may facilitate nutrient acquisition efficiency of shrimp (Dai et al., 2017). However, every coin has two sides. Microorganisms such as viruses, bacteria, and fungi could be pathogens for crustaceans. Diverse diseases, such as emulsification disease of swimming crab (Wang et al., 2006) and white faeces syndrome of shrimp (Hou et al., 2018), have occurred in crustacean farming. The innate immune of crustaceans is vital for disease control. However, probiotics are considered as a practical alternative in disease prevention of crustaceans through immune enhancement, disease resistance, modulation of the gut microbiota, and competitive exclusion of pathogens (Castex et al., 2008; Talpur et al., 2012). For example, dietary supplementation of lactic acid bacteria (*Enterococcus faecalis* Y17 and *Pediococcus pentosaceus* G11) could modulate the immune system of mud crab and protect the host against *Vibrio parahaemolyticus* infection (Yang et al., 2019). Thus, the healthy gut microbiome affects the colonization, growth, and virulence of invading pathogens (Sassone-Corsi and Raffatellu, 2015; Bäumler and Sperandio, 2016; Xiong et al., 2019), which is vital for the fitness of host.

Crustaceans have been challenged with a variety of biotic and abiotic factors. The associated microbes of crustaceans have also been challenged and respond phylogenetically and functionally (Zheng et al., 2016; Shi et al., 2019; Lin et al., 2020; Lu et al., 2022). For example, the acute hepatopancreatic necrosis in diseased shrimp caused a gastrointestinal microbiota imbalance highlighted by the enrichment of *Vibrio* and the significantly increased gene abundances of the NOD receptor signaling pathway, *Vibrio* infection, and *Vibrio* pathogenic cycle function (Dong et al., 2021). Thus, changes in the microbial community could determine the ability of the crustacean to cope with biotic and abiotic stress, subsequently leading to resistance, resilience, disease, or acclimatization of crustacean holobiont upon stress.

In summary, this Research Topic delivers new ideas for crustacean aquaculture accomplished up to date. We also note that it is timely to scale up the crustacean concept from the simple autonomous entity to the complex holobiont, to further understand the nutrition, disease, and environmental stress in crustacean aquaculture.

Author contributions

The author confirms being the sole contributor of this work and has approved it for publication.

Funding

This work was funded by the National Natural Science Foundation of China (32073024), the earmarked fund for CARS-48, and K. C. Wong Magna Fund in Ningbo University.

Conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

References

Asche, F., Anderson, J. L., Botta, R., Kumar, G., Abrahamsen, E. B., Nguyen, L. T., et al. (2021). The economics of shrimp disease. *J. Invertebr. Pathol.* 186, 107397. doi: 10.1016/j.jip.2020.107397

Bäumler, A. J., and Sperandio, V. (2016). Interactions between the microbiota and pathogenic bacteria in the gut. *Nature* 535, 85–93. doi: 10.1038/nature18849

Bordenstein, S. R., and Theis, K. R. (2015). Host biology in light of the microbiome: ten principles of holobionts and hologenomes. *PloS Biol.* 13, e1002226. doi: 10.1371/journal.pbio.1002226

Castex, M. L., Chim, D., Pham, P., Lemaire, N., Wabete, J. L., Nicolas, P., et al. (2008). Probiotic p. acidilactici application in shrimp *Litopenaeus stylirostris* culture subject to vibriosis in new Caledonia. *Aquaculture* 275, 182–193. doi: 10.1016/j.aquaculture.2008.01.011

Chen, Y. H., and He, J. G. (2019). Effects of environmental stress on shrimp innate immunity and white spot syndrome virus infection. *Fish Shellfish Immun.* 84, 744–755. doi: 10.1016/j.fsi.2018.10.069

Dai, W., Yu, W., Zhang, J., Zhu, J., Tao, Z., and Xiong, J. (2017). The gut eukaryotic microbiota influences the growth performance among cohabitating shrimp. *Appl. Microbiol. Biotechnol.* 101 (16), 6447–6457. doi: 10.1007/s00253-017-8388-0

Dempsey, A. C., and Kitting, C. L. (1987). Characteristics of bacteria isolated from penaeid shrimp. *Crustaceana* 52 (1), 90–94. doi: 10.1163/156854087X00105

Dong, P., Guo, H., Wang, Y., Wang, R., and Zhang, D. (2021). Gastrointestinal microbiota imbalance is triggered by the enrichment of *Vibrio* in subadult *Litopenaeus vannamei* with acute hepatopancreatic necrosis disease. *Aquaculture* 533, 736199. doi: 10.1016/j.aquaculture.2020.736199

Duan, Y., Huang, J., Wang, Y., and Zhang, J. (2020). Characterization of bacterial community in intestinal and rearing water of *Penaeus monodon* differing growth performances in outdoor and indoor ponds. *Aquac. Res.* 51 (10), 4279–4289. doi: 10.1111/are.14770

FAO (2022). *The state of world fisheries and aquaculture 2022. towards blue transformation* (Rome: FAO).

He, Y., Lin, W., Shi, C., Li, R., Mu, C., Wang, C., et al. (2022). Accumulation, detoxification, and toxicity of dibutyl phthalate in the swimming crab. *Chemosphere* 289, 133183. doi: 10.1016/j.chemosphere.2021.133183

Hou, D., Huang, Z., Zeng, S., Liu, J., Wei, D., Deng, X., et al. (2018). Intestinal bacterial signatures of white feces syndrome in shrimp. *Appl. Microbiol. Biotechnol.* 102, 3701–3709. doi: 10.1007/s00253-018-8855-2

Hoyoux, C., Zbinden, M., Samadi, S., Gaill, F., and Compère, P. (2009). Wood-based diet and gut microflora of a galatheid crab associated with pacific deep-sea wood falls. *Mar. Bio.* 156, 2421–2439. doi: 10.1007/s00227-009-1266-2

Lau, W. W. Y., Jumars, P. A., and Armbrust, E. V. (2002). Genetic diversity of attached bacteria in the hindgut of the deposit-feeding shrimp *Neotrypaea* (formerly *Callianassa*) *californiensis* (Decapoda: Thalassinidae). *Microb. Ecol.* 43, 455–466. doi: 10.1007/s00248-001-1043-3

Lin, W., Ren, Z., Mu, C., Ye, Y., and Wang, C. (2020). Effects of elevated pCO_2 on survival and growth of *Portunus trituberculatus*. *Front. Physiol.* 11, 750. doi: 10.3389/fphys.2020.00750

Lu, J., Li, X., Qiu, Q., Chen, J., and Xiong, J. (2022). Gut interkingdom predator-prey interactions are key determinants of shrimp health. *Aquaculture* 546, 737304. doi: 10.1016/j.aquaculture.2021.737304

McFall-Ngai, M., Hadfield, M. G., Bosch, T. C., Carey, H. V., Domazet-Lošo, T., Douglas, A. E., et al. (2013). Animals in a bacterial world, a new imperative for the life sciences. *PNAS* 110, 3229–3236. doi: 10.1073/pnas.1218525110

Oxley, A. P., Shipton, W., Owens, L., and McKay, D. (2002). Bacterial flora from the gut of the wild and cultured banana prawn, *Penaeus merguiensis*. *J. Appl. Microbiol.* 93 (2), 214–223. doi: 10.1046/j.1365-2672.2002.01673.x

Pinn, E., Nickell, L., Rogerson, A., and Atkinson, R. J. A. (1999). Comparison of gut morphology and gut microflora of seven species of mud shrimp (Crustacea: Decapoda: Thalassinidea). *Mar. Biol.* 133, 103–114. doi: 10.1007/s002270050448

Sassone-Corsi, M., and Raffatellu, M. (2015). No vacancy: how beneficial microbes cooperate with immunity to provide colonization resistance to pathogens. *J. Immunol.* 194, 4081–4087. doi: 10.4049/jimmunol.1403169

Shi, C., Xia, M., Li, R., Mu, C., Zhang, L., Liu, L., et al. (2019). *Vibrio alginolyticus* infection induces coupled changes of bacterial community and metabolic phenotype in the gut of swimming crab. *Aquaculture* 499, 251–259. doi: 10.1016/j.aquaculture.2018.09.031

Talpur, A. D., Memon, A. J., Khan, M. I., Ikhwanuddin, M., Daniel, M. M. D., and Abol- Munafi, A. B. (2012). Control of *Vibrio harveyi* infection in blue swimming crab, *Portunus pelagicus* larvae by the gut isolated lactic acid bacteria under challenge bioassay. *Pak. Vet. J.* 32, 408–411.

Wang, G. L., Jin, S., Chen, Y., and Li, Z. (2006). Study on pathogens and pathogenesis of emulsification disease of *Portunus trituberculatus*. *Adv. Mar. Sci.* 24 (4), 526–531. doi: 10.3969/j.issn.1671-6647.2006.04.015

Xiong, J. B., Nie, L., and Chen, J. (2019). Current understanding on the roles of gut microbiota in fish disease and immunity. *Zool Res.* 40, 70–76. doi: 10.24272/j.issn.2095-8137.2018.069

Yang, Q., Lü, Y., Zhang, M., Gong, Y., Li, Z., Tran, N. T., et al. (2019). Lactic acid bacteria, *Enterococcus faecalis* Y17 and *Pediococcus pentosaceus* G11, improved growth performance, and immunity of mud crab (*Scylla paramamosain*). *Fish Shellfish Immun.* 93, 135–143. doi: 10.1016/j.fsi.2019.07.050

Ye, Y., An, Y., Li, R., Mu, C., and Wang, C. (2014). Strategy of metabolic phenotype modulation in *Portunus trituberculatus* exposed to low salinity. *J. Agr. Food Chem.* 62 (15), 3496–3503. doi: 10.1021/jf405668a

Ye, Y., Lin, W., Ren, Z., Mu, C., and Wang, C. (2020). Effects of ocean acidification on crabs. *Acta Hydrobiologica Sin.* 44 (4), 920–928. doi: 10.7541/2020.109

Ye, Y., Xia, M., Mu, C., Li, R., and Wang, C. (2016). Acute metabolic response of *Portunus trituberculatus* to *Vibrio alginolyticus* infection. *Aquaculture* 463, 201–208. doi: 10.1016/j.aquaculture.2016.05.041

Zbinden, M., and Cambon-Bonavita, M. (2003). Occurrence of *Deferribacterales* and *Entomoplasmatales* in the deep-sea alvinocarid shrimp *Rimicaris exoculata* gut. *FEMS Microbiol. Ecol.* 46 (1), 23–30. doi: 10.1016/S0168-6496(03)00176-4

Zheng, Y., Yu, M., Liu, Y., Su, Y., Xu, T., Yu, M., et al. (2016). Comparison of cultivable bacterial communities associated with pacific white shrimp (*Litopenaeus vannamei*) larvae at different health statuses and growth stages. *Aquaculture* 451, 163–169. doi: 10.1016/j.aquaculture.2015.09.020