ISSN 2616-5910 Vol. 6, Issue 1: 41-46, DOI: 10.25236/AJALS.2025.060106

# A Study on the Effects of pH Variation on the Mortality Rate of the Australian Blue Lobster

**Yongbo Li, Hailan Yang, Jie Zhan***

*College of Biological Sciences and Agriculture, Qiannan Normal University for Nationalities, Guizhou, Duyun, 558000, China*

***Abstract:*** *PH value is a key parameter in water, which has an important influence on the physiological activities of aquatic organisms. Water quality is one of the important factors affecting the survival and reproduction of aquatic animals. This study examined the effect of pH stress on mortality of Australian blue lobster. The pH value are recorded and measured when the death occurs during the different stages of breeding from young to adult Australian blue lobster. Thus, the optimum pH of each culture stage can be obtained, and the culture technology of lobster can be improved. This provides valuable information for understanding the importance of water pH to the survival of Australian blue lobster, and has certain guiding significance for aquaculture and ecological conservation.*

***Keywords:*** *Australian blue lobster; pH value; death rate; Breeding technology*

## 1. Introduction

Native to the Australian northern tropical regions, the Australian freshwater lobster, commonly known as the freshwater lobster or the red claw crayfish[1] [2] ,belongs to the order Decapoda within the family Parastacidae close to the crabs and shrimps of crustaceans. The physical characteristics are represented by the brownish-green body with a bright red membranous band at the tip of the outer claw. Taxonomically, the redclaw crayfish is characterized as a member of the phylum Arthropoda, class Crustacea, subclass Malacostraca, order Decapoda, and family Parastacidae.The term "lobster" comes from its robust and formidable appearance that is reminiscent of sea lampreys. The species is indigenous to the tropical regions of northern Australia. The redclaw crayfish can endure extreme weather conditions confidently since it usually lives in water temperatures that range between 15°C to 35°C. They generally spend the day hiding, the night foraging, and are active at night, swimming on the bottom of the water. The animals are omnivorous and may eat small animals, an artificial feeding paste, and humus, which makes them easy to breed.

From April to May, the lakes are normally stocked and harvesting is mainly from October to November. In the lower and middle reaches of the Yangtze River, the species makes two to three generations per year, whereas in the middle and upper reaches, there are three to five generations annually. Since it was introduced to China in the last few years as a freshwater economic shrimp, the Australian freshwater lobster has been promoted for its giant size, fast growth, and high productivity and is now one of the industry's high-qualities. This type of shrimp is very nutritious and has meat that is soft, smooth, sweet, and has a taste that is different from the normal kind. Its robustness and the fact that it can be transported for long distances are further reasons for liking it.

Due to a marked decline in the farming profitability of mainstream species such as Pacific white shrimp and Macrobrachium rosenbergii, interest in Australian freshwater lobster aquaculture has surged in recent times [3]. However, a significant challenge remains: the survival rate is low when juveniles grow from 0.6–1 cm at hatching to 2–3 cm[4]. Moreover, if ponds are not properly cleared of wild fish and shrimp, these opportunistic predators may prey on the vulnerable juveniles[5], further reducing survival rates. Among various factors, water pH is critical to the survival of juvenile lobsters. Acid rain often lowers the pH of aquaculture water[6], and as a stress factor, a low pH can trigger stress responses that compromise the lobsters' self-regulation and immune defense systems. Numerous domestic and international studies have reported on the immune responses of freshwater shrimp[7].

The primary farming practices for Australian freshwater lobster are mainly large-scale open water farming, intensive pond farming [8], and layered intensive farming with super-enhanced measures[9]. The species of Australian freshwater lobster was brought into China around 1992, mostly through pond farming with supplementary paddy field cultivation. The province of Hubei led Australian freshwater lobster farming as one of the first regions and various regions have also incorporated aquaculture practices into their local environment [10]. Freshwater lobsters are the main predators in aquatic ecosystems, which plays a significant role in shaping the dynamics of aquatic communities. A lot of different animals depend on them not only ecologically but also economically [11]. Due to their ecological and economic importance, the effective management and conservation of freshwater lobsters are a must.

A study was conducted in order to observe the reproductive process, in its entirety, of the Australian blue lobster. To do that, the researchers measured the pH levels of water and followed the mortality rates at different life stages. Furthermore, the scientists examined the sudden pH changes impact on the survival of juvenile lobsters and the best water pH levels that can be provided to each farming stage. The aim is to offer a scientific basis for the improvement of the disease resistance and overall health of Australian blue lobsters in aquaculture.

## 2. Materials and Methods

### *2.1 Experimental Materials*

Juvenile freshwater lobsters of Australian origin were collected from Huazhong Agricultural University in Wuhan, Hubei Province. They were kept for observation in a holding pond at a quantity of 1,000 juveniles whose body length ranged from 0.7 to 1.2 centimeters and whose color was transparent. These juveniles were not only healthy, but they were also robustly vibrant and exhibited mostly good health.

### *2.2 Experimental Site*

The experiment was done in a canvas-covered lobster pond at the lab aquaculture shed of the College of Biological Sciences and Agriculture.

### *2.3 Equipment and Instruments*

pH Test Strips (pH 5.5–9.0): Provided by Hangzhou Special Paper Co., Ltd. and Shanghai Xinsheng Chemical Technology Co., Ltd.Electronic Balance: Shanghai Youke Instrument & Meter Co., Ltd.Mp-70209FW Haier Refrigerator: Galanz Microwave Life Appliance Co., Ltd.GZX-9246MBE Electric Hot Air Drying Oven: Shanghai Boxun Industrial Co., Ltd. (Medical Equipment Division)GR110DR Vertical Automatic Pressure Steam Sterilizer: Zhiwei (Xiamen) Instrument Co., Ltd.SHB-IIIS Circulating Water Multi-Purpose Vacuum Pump: Zhengzhou Great Wall Science & Technology Trade Co., Ltd.12V Lithium Battery-Powered Water Pump: Hangzhou Delixi Group Co., Ltd.

### *2.4 Experimental Reagents*

Quicklime: Sichuan Jinghetai Agricultural Technology Co., Ltd.Potassium High Ferrate: Shandong Wuchuang Yufeng Bio Co., Ltd.Yeast Mud: Provided by Jianjiang Distillery Development Co., Ltd. in Duyun, Guizhou Province.Pomacea canaliculata (Golden Apple Snail) and Zolla pinnata subsp. asiatica (commonly known as Manjianghong)Elodea nuttallii (waterweed),Potamogeton crispus (curly-leaf pondweed): Collected from the Jianjiang River in Duyun.

### *2.5 Material Preparation*

Pomacea canaliculata: Thoroughly wash the snails till they are free from dirt and put them in sterilization bags and treat them with high-pressure to boil them at a temperature of 121°C for 30 minutes. Let them cool and store them in the refrigerator until use after that.

Quicklime: You can prepare a glutinous lime slurry by mixing quicklime with clean water in a ratio of 1:3. Then, evenly distribute it when the concentration is at 10–20 mg/L and no clumping is observed in the lobster pond.

Yeast Mud: Extract surplus water from the yeast mud by using a vacuum pump and then spread it on an iron tray and dry at 43°C in a drying oven for the production of dried yeast powder.

ISSN 2616-5910 Vol. 6, Issue 1: 41-46, DOI: 10.25236/AJALS.2025.060106

### *2.6 Experimental Procedures*

#### *2.6.1 Rearing of Juvenile Lobsters*

The rearing facility for juvenile lobsters is located in the aquaculture shed of the College of Biological Sciences and Agriculture, using a recirculating aquaculture system. The rearing tanks are rectangular canvas-lined containers (6 m in length, 2 m in width, and 1.2 m in height) oriented east-west to maximize natural oxygen utilization, with an average water depth of 0.25 m and a water pH maintained between 7.2 and 8.0. In June, when the water temperature exceeds 18°C, 1,000 Australian blue lobster juveniles are stocked into the pond. Prior to stocking, appropriate acclimatization is required; the juveniles are generally dripped with water 2–3 times and then placed along the water's edge to allow them to crawl into the pond on their own[12]. To simulate a natural ecosystem, each pond is supplied with Zolla pinnata subsp. Asiatica [13] is used to enhance photosynthesis, suppress the growth of blue-green algae and moss, reduce ammonia nitrogen and nitrite levels, while also promoting molting. Additionally, a flat-roof shelter constructed from plastic partitions is provided as a resting area for the lobsters. Water quality is adjusted every 7–10 days to improve the substrate and maintain the water as rich, active, tender, and fresh. To avoid eutrophication, potted aquatic plants (previously soaked in lime water for disinfection and pH adjustment) are introduced. During water changes in the nursery pond, water is drawn from a purification tank, and the behavioral responses of the juveniles as they grow into young lobsters are observed. Protein powder feed is provided, with approximately 75% of the daily feed given in the evening and 25% in the morning. Mortality rates and water pH are recorded every three days.

#### *2.6.2 Rearing of Young Lobsters*

Once young lobsters grow to about 3.5–3.8 cm in length and are reared for a month, they are classified as young lobsters. During this phase, the portion of powdered feed is gradually reduced and replaced by animal-based food, cooked, and finely chopped meat of Pomacea canaliculata to be more specific[14]. The amount of feeding is 10–15% of a lobster body weight per day, while a daily intake of 8–10% of the body's mass is typical when the body length is between 3.5 and 5 cm. The animals may not get enough food, and it can lead to delayed growth, as well as a decrease in the capability of the immune system that consequently decreases the overall rearing efficiency of the farm as well[15]. Every day at this time food is recorded, the pH of the water is measured every 3 days, and the death of the young lobsters is controlled. The dead organisms are removed immediately to avert the water pollution effects. If the pH value is below the standard level, by using quicklime, the pH will be brought back to the right range of 7.2–8.0.

#### *2.6.3 Rearing of Adult Lobsters*

The juveniles along with the adult lobsters that manage to grow in the span of two months have an average length of up to 22 cm and weigh about 59.3 g. The proper feeding of young lobsters can be achieved by using the "timing, dosing[14], quality, and positioning" principles together with the feeding characteristics of Procambarus clarkii and a special feed for Australian lobsters. Other times the feeding of young lobsters is the case of Pomacea canaliculata meat and bran every three days to increase the nutrition and thereby, to improve their intestinal digestive capacity. Additionally, any undigested snail meat is immediately taken out of the tank.

### *2.7 Data Analysis*

Data obtained from the experiments were organized and analyzed using Excel.

## 3. Results and Analysis

### *3.1 Analysis of Mortality Rate Due to pH Variations in the Larvae Rearing Stage*

As shown in Figure 1, at a low pH of 5.6, the larvae exhibit intolerance to weakly acidic conditions, resulting in a relatively high average mortality rate. Between pH 7 and 7.6, the average mortality rate gradually declines[15], and between pH 7.6 and 8, the mortality rate remains relatively stable. The highest mortality peak occurs at pH 5.6, indicating that the larvae tolerate pH values best in the 7.6–8 range.

ISSN 2616-5910 Vol. 6, Issue 1: 41-46, DOI: 10.25236/AJALS.2025.060106

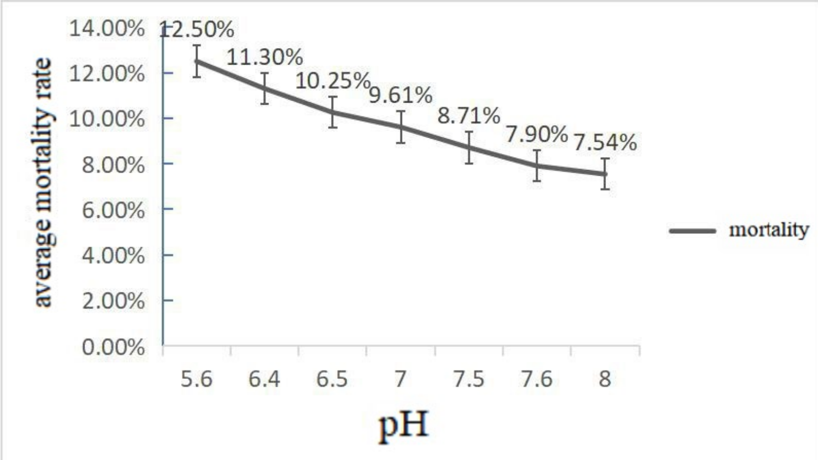


*Figure 1. Average mortality of larvae with pH changes at stage*

During the test phase, it was recognized that rich normal distribution of Zolla pinnata subsp. asiatica (Manjianghong)algae were the most dominant ecosystem in the pond. Hence, it was mainly the high-nutrient state that led to an increased DO content which was a result of the enriched organic matter. However, present at the same time several camels were sighted to be out of it water and climbing a bank. The thick plant growth leads to more oxygen being taken away by the roots' mitochondria, while the leaves' oxygen produced in the process of photosynthesis[16] is deficient to replace the dissolved oxygen, therefore a severe decrease in oxygen appears. Both pH and dissolved oxygen are positively correlated thus a decrease in the dissolved oxygen will come along with a decrease in pH.

### *3.2 Analysis of Mortality Rate Due to pH Variations in the Young Lobsters Rearing Stage*

Figure 2 implies that at the stage of growth when lobsters are young, the pH of 6.4 causes intolerance to weakly acidic solutions, this in turn concludes to a high average mortality rate. At the pH levels of 6.4 to 7.0, the average mortality rates decline with an increase in the pH level. The lowest mortality rate comes when the pH levels range from 7.5 to 8 during which the mortality rates increase again when the pH level goes above 8 to indicate that the pH range for optimal growth of the lobster is 7.5-8.

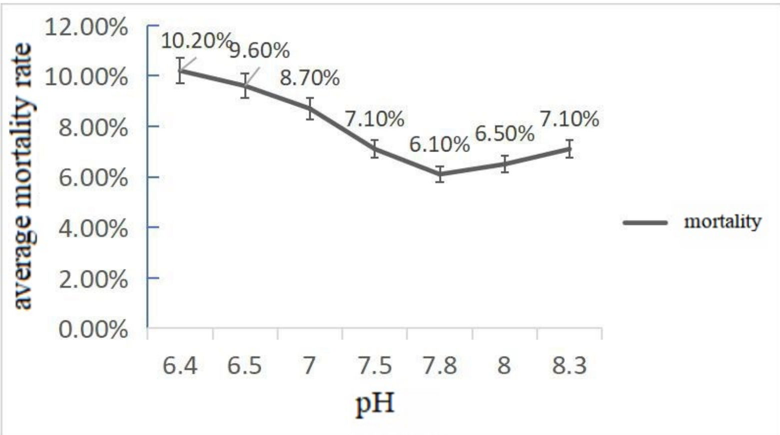


*Figure 2. Average mortality of juvenile shrimp with pH changes at stage*

Fluctuations in pond pH are primarily brought about by all those extra feed and the decomposition of lobster waste. Throwing food in excess away means that some of it will not be eaten, hence its high protein content will be the reason behind considerable protein degradation and the increasing of ammonia nitrogen levels[17] , in the end, the situation will defile the water. While feed rots, it releases acid into the water that flows to the containers making it acidic. That is why it is necessary that you feed the lobster in a way to only be sufficient but not in excess. It's always advisable that you don't feed them when you see the floating yellow materials in the water. If low pH levels exist, which is to say, the presence of quicklime is necessary. The regular examination of water conditions and the immediate

ISSN 2616-5910 Vol. 6, Issue 1: 41-46, DOI: 10.25236/AJALS.2025.060106

adjustment of both water quality as well as the quantity of feed are the necessary operations.

### *3.3 Analysis of Mortality Rate Due to pH Variations in the Adult Lobsters Rearing Stage*

Figure 3 shows that at a water pH of 6.5, adult lobsters experience a relatively high mortality rate. Between pH 6.5 and 7.0, the average mortality rate gradually decreases, and it further declines between pH 7.0 and 7.8. However, compared to larvae and young lobsters, adult lobsters display greater tolerance to pH variations, with the optimal pH range being between 7.4 and 8.1.

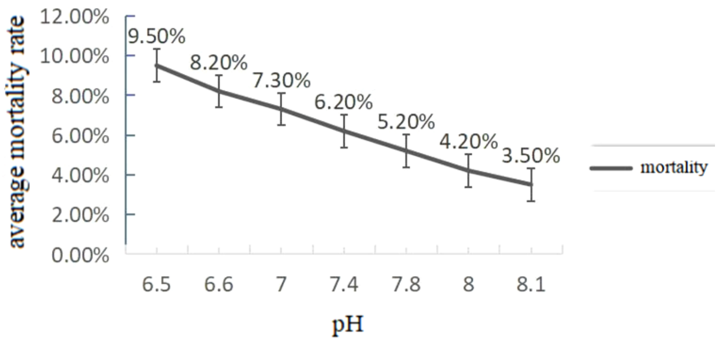


*Figure 3.Average mortality of pH changes in shrimp formation stage*

In aquaculture, ammonia nitrogen is the key harmful substance, and most of it is either in the form of ammonia ($NH_3$) or ammonium ion ($NH_4^+$). The latter is mainly being born as a result of the ammonification process of unused food and excretory materials. Also, surplusing of ammonia nitrogen is due to the downtime of shrimp and crayfish microvilli to inactivate ammonia. This leads to ammonia accumulation in the blood, which, together with an increase in blood pH, may cause eventual toxicity. Factors from the outside, like temperatures and pH levels, will be the reason for the fact that the balance between $NH_4^+$ and $NH_3$ is destroyed. In the case when pH is lower than 7.8, only about 2% of the total ammonia is represented by $NH_3$; pH increase results in $NH_3$ increase, and so when the pH reaches 10, the ammonia will be about 10% of the total. Besides, the decrease in temperature reduces the fraction of $NH_3$[18]. In the case of high-temperature days, the increase in decomposition of organic matter results in a rise in the concentration, and concomitantly the toxic ammonium nitrogen ($NH_4^+$) also. This excess ammonia nitrogen damages gill tissue cells and inhibits the activity of enzymes related to immunity, respiration, and metabolism, thereby hindering oxygen transport and exchange. This imbalance creates oxidative stress, damages the immune defense system, and can result in an increased frequency of molting under stress[19]. Excess ammonia nitrogen in the water is also associated with the lobsters frequently leaving the water in an "escape" response.

## 4. Conclusion

According to the research, the best pH level of Australian blue lobster larvae is the range of 7.6-8.0, for young lobsters between 7.5 and 8.0, and for adult ones between 7.4 and 8.1. Prolonged exposure to a weakly acidic solution causes a decrease in the vital activities of individuals in the lobster population producing a decrease in their vitality[20].

During the process of aquaculture, it is a must to monitor water quality often and at the same time to keep the pH balance as close as possible to the possible loss to avoid unnecessary mortality. An approach to the issue of water acidification is through feeding improvements—I.e., a precision feeding system— which can reduce both feed waste and water pollution[21]. Furthermore, use of artificial aeration will help to keep dissolved oxygen levels above 5 mg/L (and at least not below 3 mg/L)[22]to speed up the decomposition of organic matter and to prevent acidification.

Moreover, the application of microalgae in the pond can enhance photosynthesis, suppress the growth of blue-green algae and moss, reduce ammonia nitrogen and nitrite levels, and promote molting in the lobsters. The use of bottom fertilizers and EM (Effective Microorganisms) solutions, applied every 7–10 days, can help adjust water quality and improve the pond substrate, keeping the water rich, active, tender, and fresh. Australian freshwater lobsters are relatively tolerant of low oxygen conditions, so as long as water quality is properly managed, hypoxia and terrestrial escape behaviors should be avoided[22].

ISSN 2616-5910 Vol. 6, Issue 1: 41-46, DOI: 10.25236/AJALS.2025.060106

**Acknowledgements**

This research was supported by the Modern Industrial College of Qiannan Nationalities Normal University under the project "Research on the Facility Aquaculture Technology of Australian Freshwater Lobster QNSY (sn)2023010."

**References**

*[1] Huang Z., Han S. "Disease Prevention and Control Techniques for Australian Freshwater Lobster." Rural New Technology, 2022(07): pp. 39-40.*

*[2] Wang Z. "Australian Freshwater Lobster." Hunan Agriculture, 2019(11): p. 27.*

*[3] Hong P. "Aquaculture Techniques for Australian Freshwater Lobster." Agricultural Technology and Equipment, 2022(12): pp. 133-135.*

*[4] Yuan Y. "Biological Characteristics and Artificial Breeding Techniques of Australian Freshwater Lobster." Henan Aquaculture, 2017(04): pp. 6-8.*

*[5] Li M. et al. "Trial of Healthy Aquaculture of Australian Freshwater Lobster." Aquaculture and Feed, 2019(10): pp. 56-57.*

*[6] Lin B. & Fang L. "Study on Common Water Quality Problems in Aquaculture." Jiangxi Aquaculture Science and Technology, 2020(06): pp. 32-33.*

*[7] Tao Y., Qiang J., Wang H., et al. "Effects of Low pH Stress on the Gill and Hepatopancreas Enzyme Activities and Tissue Structure of Procambarus clarkii." Chinese Journal of Fisheries Science, 2016, 23(06): pp. 1279-1289.*

*[8] Wang Q., Wang J., Chen H., et al. "Histopathology of Procambarus clarkii under Chronic Zinc Sulfate Stress." Chinese Journal of Fisheries Science, 2012, 19(01): pp. 126-137.*

*[9] Zhao H., Zhang Y., Huang L., et al. "The Immune System and Immune Prevention in Crustaceans." Chinese Veterinary Journal, 2003(01): pp. 41-44.*

*[10] Wang M. & Meng L. "Progress in the Research on Australian Freshwater Lobster Aquaculture." Aquaculture, 2021, 42(06): pp. 35-38.*

*[11] Chen W. & Jin S. "Selection and Temporary Rearing of High-Quality Postlarvae of Blue-Cheeked Shrimp in Shanghai." Shanghai Agricultural Science and Technology, 2016(05): pp. 62-63.*

*[12] Zheng G., Liang S., Qin Z., et al. "Aquaculture Techniques for Redclaw Crayfish." Agricultural Engineering Technology, 2023, 43(34): pp. 112-114.*

*[13] Budong M. "Causes and Prevention of Water Pollution in Aquaculture." China Science and Technology Information, 2020(11): pp. 60-61.*

*[14] Ren M., Wei S., He L., et al. "Effects of Four Different Feed Formulations on the Growth, Survival, and Body Color of Redclaw Crayfish." Journal of Hainan Tropical Ocean University, 2020, 27(05): pp. 11-16+68.*

*[15] Zhou H. "Effects of Water Quality and Feed on the Respiratory Metabolism of Philippine Clams." Dalian Ocean University, 2024.*

*[16] Qiu J. "Study on the Effects of Seawater pH Changes on the Photosynthetic Physiology and Feed Value of Typical Diatoms." Jiangsu Ocean University, 2022.*

*[17] Zhang X., Xie R., Zhang H. "Effects of Salinity on the Growth, Antioxidant Enzyme Activity, Oxygen Consumption, and Ammonia Excretion Rates in Tiger Puffer." Contemporary Fisheries, 2023, 48(11): pp. 73-76.*

*[18] Gu N. "Effects of Ammonia Nitrogen Stress on the Growth, Physiological Indicators, Gill and Hepatopancreas Microstructure, and Related Gene Expression of Fenneropenaeus chinensis." Shanghai Ocean University, 2021.*

*[19] Wu L., Li J., Zhou W., et al. "Effects of Short-Term Ammonia Nitrogen Stress and Recovery on Procambarus clarkii." Aquatic Sciences: pp. 1-14 [2024-04-10].*

*[20] Cui G. "Stress Responses of Eriocheir sinensis to pH and Ammonia, and the Mitigative Effects of Dietary Phospholipids and Astaxanthin." Soochow University, 2021.*

*[21] Yu T., et al. "Effects of pH Stress on the Antioxidant Enzyme Activity of Penaeus vannamei." Marine Science, 2015, 39(05): pp. 47-53.*

*[22] Zhang Y., Niu Y., Li Z., et al. "Why Should Aquaculture Pay Attention to 'C/N'?" Contemporary Fisheries, 2024, 49(01): pp. 81+83.*