International Journal of Multidisciplinary Research and Growth Evaluation.

Analysis of the Status and Development Trends in Procambarus clarkii Aquaculture in China

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Article Info

ISSN (Online): 2582-7138
Impact Factor (RSIF): 8.04
Volume: 07
Issue: 03
May-June 2026
Received: 26-02-2026
Accepted: 28-03-2026
Published: 30-04-2026
Page No: 125-130

Abstract
As an important specialty species in China's freshwater aquaculture industry, *Procambarus clarkii* has developed into a well-established industrial system encompassing seed production, farming, processing, and market circulation. This review summarizes recent advances in both research and industry development of *P. clarkii* aquaculture in China. Emphasis is placed on progress in seed production and rearing, nutritional requirements and feed development, major disease prevention, and diversified farming models, including rice-crayfish co-culture, intensive pond culture, and extensive water surface enhancement. In addition, the species distribution of major production areas, trends in farming output, industry structure, and the status of processing technologies is systematically analyzed. Despite rapid expansion, the industry still faces several constraints, including seed quality, incomplete disease prevention systems, homogenization of farming models, increasing environmental pressures, and limited value addition in processed products. Future development should focus on germplasm conservation and genetic improvement, advancement of green aquaculture technologies, precision disease management, development of high-value products, and integrated industrial chain optimization. These efforts are expected to support the sustainable and high-quality development of the *P. clarkii* industry.

Keywords: *Procambarus clarkia*, aquaculture, research status, production status, development trends

1. Research Status of Procambarus clarkii Farming

Procambarus clarkii is a specialty species with high economic value and cultural influence in China's freshwater aquaculture. It possesses nutritional, culinary, and deep-processing value, and is regard as a key premium farmed freshwater shrimp species that contributes significantly to rural industrial revitalization. With strong consumer demand both domestically and internationally, processed crayfish products have also become an important export category. Aquaculture production exhibits a clear regional concentration, primarily distributed across provinces in the middle and lower reaches of the Yangtze River, such as Hubei, Hunan, Jiangsu, and Anhui. Among these, Hubei Province accounts for over 40% of national output, forming an industry pattern centered in central China and extending nationwide. In recent years, the industry has grown rapidly, reaching a farming area exceeding 29.5 million mu and an output of nearly 100 billion yuan in 2023, making it a "star species" in Chinese aquaculture. Scientific research on *P. clarkii* began in the 1970s, with exploratory studies on biology and farming techniques starting in the 1980s. After the late 1990s, breakthroughs in artificial breeding technology led to rapid development, and farming models diversified to include rice field culture, lotus root field culture, and extensive water surface enhancement. Among these, rice-crayfish co-culture has become the most representative model due to its combined ecological and economic benefits. In terms of processing, *P. clarkii* has developed a diversified system including frozen raw products (shrimp meat, peeled tail meat), frozen cooked seasoned whole shrimp/tail meat, etc., with thermal processing techniques like steaming and frying, as well as seasoning technologies, becoming increasingly mature [1].

However, the industry still faces challenges. Diseases outbreaks, such as white spot syndrome virus disease, bacterial diseases, and seasonal "May disease" remain major constraints on stable production and sustainable development [2]. From a literature perspective, the number of publications related to *P. clarkii* has shown phased growth alongside industry development, with research hotspots focusing on disease prevention, optimization of farming models, nutrition and feeds, and water quality regulation [3]. This present study aims to systematically analyze the current status, challenges, and development prospects of the *P. clarkii* industry, providing reference for promoting sustainable development and supporting rural revitalization.

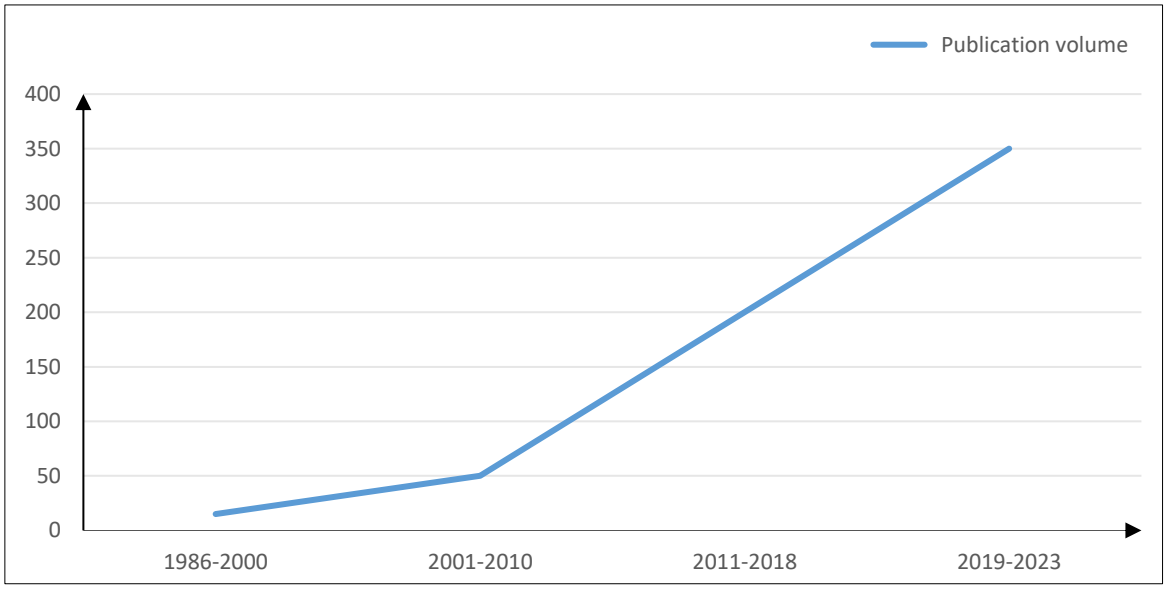

Fig 1: Trend in the number of crayfish research papers

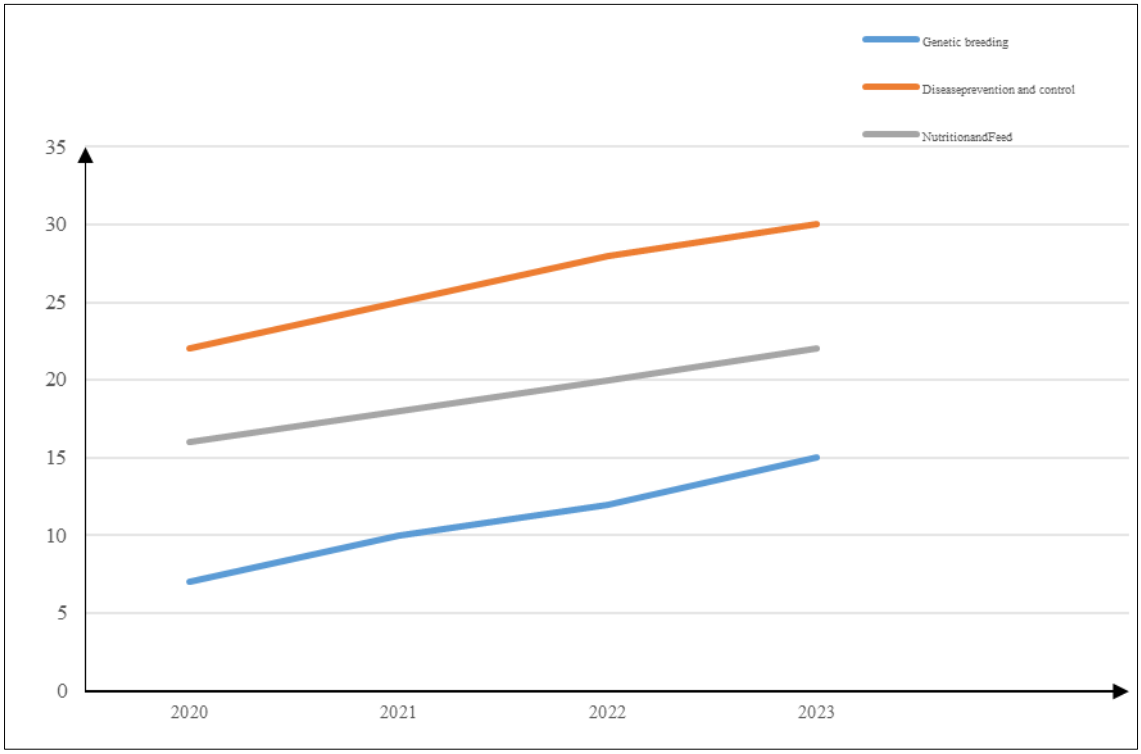

Fig 2: Trend in the number of papers on different research directions of *Procambarus clarkii*

1.1. Seed Production and Rearing of *Procambarus clarkii*

Seedling rearing constitutes the fundamental sector underpinning the industrial development of *Procambarus clarkii*. In China, the existing seed production systems for this species are generally classified into two categories: natural reproduction and controlled artificial reproduction. During the initial phase of industrial development, seedling acquisition predominantly depended on the harvesting of wild juveniles from natural water bodies. Alongside the continuous expansion of aquaculture scale, pond-based natural breeding has been widely popularized. Under this breeding mode, parent crayfish are cultured for natural mating and spawning, which effectively cuts down production costs. Nevertheless, it commonly results in unsynchronized reproductive rhythm, uneven juvenile specifications, and unstable seed quality. In recent years,

controlled artificial breeding has attracted growing research and industrial attention. Multiple optimized techniques, including greenhouse temperature regulation, selective parent stock breeding, and *in vitro* embryo incubation, have greatly enhanced the seed supply capacity and survival rate of cultured juveniles [4-5]. Furthermore, the staging identification of ovarian development based on morphological features provides technical references for the rapid screening of sexually mature female parents. Nevertheless, the current seedling rearing industry still confronts prominent bottlenecks, such as germplasm degradation of parent stock, vertical transmission of pathogenic microorganisms, and technical instability in large-scale standardized seed production. The shortage of high-quality certified seedlings remains a critical limiting factor restricting the high-quality and sustainable development of the whole industrial chain.

1.2. Nutritional Requirements and Feed Development of *Procambarus clarkii*

As a typical omnivorous crustacean, *Procambarus clarkii* possesses highly flexible feeding habits, whereas its optimal growth and physiological performance are dependent on nutritionally balanced diets. Current studies on the nutritional demands of *P. clarkii* primarily concentrate on dietary protein, lipids, mineral elements and functional feed additives. Nutrient requirements vary distinctly among different developmental stages. Specifically, the optimal dietary protein level for juvenile individuals is generally maintained at 30–35%, while the protein proportion in adult feeds can be appropriately reduced to approximately 28%. Moreover, adequate supplementation of lipids, calcium, phosphorus and essential fatty acids is indispensable for sustaining somatic growth, normal molting processes and internal physiological homeostasis. For instance, a dietary linolenic acid to linoleic acid ratio of 0.45–0.46 has been proven conducive to improving the growth performance of *P. clarkii* [6-8]. With the advancement of aquaculture industry, feed types for this species have evolved from conventional natural baits to compound formulated feeds, low-fishmeal feeds and functional feeds. In particular, the research and application of low-fishmeal feeds occupy a vital strategic position in the sustainable development of crayfish aquaculture.

It provides feasible strategies to cut aquaculture production costs and mitigate the reliance on limited fishmeal resources. Furthermore, functional feed additives, such as astaxanthin and compound organic acids, which focus on hepatopancreatic protection, molting promotion and muscle quality improvement, have emerged as prevailing research focuses. Such additives are designed to strengthen the anti-stress capability and commercial characteristics of cultured *Procambarus clarkii*. Nevertheless, existing specialized feed formulations still exhibit insufficient pertinence and low nutrient utilization efficiency. Further innovations in precision nutrition research and customized feed development are therefore urgently required to address these limitations [9-10].

1.3. Major Diseases and Farming Models of *Procambarus clarkii*

Major diseases afflicting *Procambarus clarkii* encompass viral, bacterial and parasitic disorders. Among these, white spot syndrome virus (WSSV) disease, bacterial gill rot, enteritis and ciliate infestation are the most prevalent and destructive. Seasonal disease outbreaks, commonly known as "May disease", frequently induce mass mortality of cultured *P. clarkii*, thereby severely limiting yield increases [11]. Disease prevention and control for this species adhere to the core principle of "prevention first". Integrated control strategies, including pond disinfection, water quality regulation, seedling pathogen quarantine and ecological prevention measures, are implemented to mitigate disease occurrence risks. For instance, regular calcium supplementation is conducted to enhance the molting performance of *P. clarkii*, and compound organic acids are applied to optimize aquaculture water environmental conditions.

In terms of farming models, China has established a diversified aquaculture system for *P. clarkii*, mainly comprising rice-crayfish co-culture, intensive pond culture, lotus root field intercropping and extensive water surface enhancement aquaculture [12-13]. Rice-crayfish co-culture, an ecological model integrating rice planting and crayfish farming, has become the dominant farming mode owing to its dual ecological and economic benefits, as well as the reduced application of chemical fertilizers and pesticides, realizing ecological recycling of agricultural resources. Intensive pond culture realizes high-yield cultivation through high-density stocking and refined management, yet it imposes more stringent requirements on water quality control and disease prevention. Nevertheless, several existing farming models are confronted with prominent challenges such as severe model homogenization, aggravated aquaculture environmental pressure and non-standard tail water discharge. Accordingly, the upgrading of green ecological aquaculture technologies will be a pivotal development direction for the sustainable cultivation of *P. clarkii* in the future.

2. Current Status of Aquaculture Production of Procambarus clarkii in China

According to FAO and the China Crayfish Industry Development Report (2024), China is the world's largest producer and consumer of *P. clarkii*, accounting for over 98.7% of global output. Its industry scale and growth rate rank first globally. In 2023, national farming area reached 29.5 million mu, with output of 3.161 million tons, up 5.36% and 9.35% year-on-year respectively, accounting for 9.26% of total freshwater aquaculture output and ranking fourth among freshwater farmed species. Rice-crayfish co-culture was the core model, with 25.3 million mu (85.76% of area) and output of 2.75 million tons (87% of total), driving industry growth.

Regionally, farming is highly concentrated in the middle and lower Yangtze River region. Hubei, Anhui, Hunan, Jiangsu, and Jiangxi are core production provinces, with combined output of 2.8607 million tons in 2023, accounting for 90.50% of national output. Hubei is the top province, producing 1.2427 million tons (nearly 40% of national output), with counties like Jianli, Honghu, and Qianjiang leading nationally. Recently, farming has expanded southward and northward, with emerging regions like Guangxi, Hainan, and Heilongjiang developing off-season farming using climate differences to supplement market supply, though scale remains far smaller than traditional regions.

Artificial farming of *P. clarkii* in China began in the late 1990s, initially relying on wild catch and extensive farming.

After 2000, with the promotion of rice-crayfish co-culture and intensive pond models, the industry entered rapid growth: output rose from 265,500 tons in 2007 to 852,300 tons in 2016, 2.6336 million tons in 2021, and exceeded 3.16 million tons in 2023—an 11-fold increase over 16 years. In 2024, national output further increased to 3.4476 million tons, maintaining steady growth. A complete industrial chain covering breeding, farming, processing, logistics, and catering has formed, making it a pillar industry for fishery efficiency, farmer income growth, and rural revitalization.

Table 1: Crayfish Farming Output by Province in China, 2019–2023 (Unit: 10,000 tons)

Province	2019	2020	2021	2022	2023
Hubei	81.24	99.00	107.68	113.84	130.00
Hunan	23.76	31.00	31.00	42.36	50.00
Anhui	21.75	41.00	40.90	59.52	65.00
Jiangsu	16.68	20.00	20.00	21.00	22.00
Jiangxi	11.02	15.00	15.00	17.00	19.00

Source: China Fishery Statistical Yearbook, 2020–2024

2.1. Current Status of Variety Promotion

The cultured seeds of *Procambarus clarkii* in China are highly dependent on wild-caught broodstocks or self-propagated seeds, resulting in inconsistent seed quality. To date, no specialized improved variety of *P. clarkii* has been approved and certified by the National Committee for Aquatic Germplasm and Improved Varieties. Although representative producing regions such as Qianjiang Crayfish and Jianli Crayfish in Hubei Province have acquired national geographical indication trademarks, they are plagued by insufficient brand promotion and weak market influence of nationwide dominant variety brands. Moreover, the breeding of improved *P. clarkii* varieties is still in the pilot and demonstration stage, and a large-scale and standardized variety promotion system has not yet been established.

2.2. Current Status of Seed Self-Sufficiency

The seed self-sufficiency rate of cultured *Procambarus clarkii* in China has not yet reached a fully satisfactory level. In the early stage of *P. clarkii* aquaculture, production was highly reliant on wild seeds collected from natural water bodies. In recent years, the proportion of artificially propagated seeds has increased continuously, but there remains a prominent supply-demand gap in high-quality seeds. It is estimated that the annual shortage of *P. clarkii* seeds exceeds 10 billion individuals. Additionally, the seed supply is highly concentrated in traditional aquaculture provinces, including Hubei, Hunan, Anhui and Jiangsu. Inter-regional long-distance transportation of seeds not only increases the risk of cross-regional transmission of aquatic pathogens but also leads to a significant decline in seed survival rate.

2.3. Current Status of Industrial Chain Support

The industrial chain of *Procambarus clarkii* aquaculture has achieved a relatively complete layout, whereas multiple weak links still restrict its sustainable development. The breeding sector is predominantly operated by small-scale household farmers and medium-sized farms, with a scarcity of large-scale leading enterprises, resulting in inadequate levels of standardized production and intensive management. Meanwhile, the existing aquatic disease prevention and control system remains imperfect, and technical supporting services covering seedling quarantine, water quality management and other key links are insufficiently popularized. In the processing segment, production is mainly limited to primary processed products such as frozen shrimp tails and peeled shrimp meat, while the proportion of high-value deep-processing commodities, including astaxanthin extraction and chitin utilization from shrimp shells, remains low. In terms of marketing and circulation, product sales still rely heavily on live wholesale and offline direct trading. Although e-commerce platforms and pre-cooked aquatic food channels have witnessed rapid development, the overall operation is constrained by imperfect cold chain logistics systems.

2.4. Current Status of Economic Benefits

Overall economic returns from *P. clarkii* farming are favorable, but profits vary by model. Mainstream rice-crayfish co-culture in typical Hubei regions yields ~75–150 kg of crayfish per mu, with average profit of 1,500–3,000 RMB/mu [14-17]. Intensive pond culture yields 150–250 kg/mu, with profit of 3,000–6,000 RMB/mu. Factory recirculating aquaculture yields higher output (10–20 kg/m³), short cycles, and large profit margins (~500–1,000 RMB/m³), but initial costs are high. Overall, rice-crayfish co-culture is the mainstream model for farmer income growth due to combined ecological and economic benefits.

3. Development Trends of Procambarus clarkii Aquaculture

3.1. Improved Variety Breeding of Procambarus clarkii

Future research will focus on conducting phased and multi-generational systematic assessment of germplasm resources, innovating and conserving indigenous germplasm, and screening functional genes to elucidate the regional genetic diversity of *Procambarus clarkii*. To mitigate prevalent problems including germplasm recession and inconsistent seed quality, fundamental research and key technological innovation should be further strengthened, so as to break through the technical bottlenecks in selective breeding and cultivate improved strains characterized by rapid growth, high stress tolerance and uniform specification. Meanwhile, seedling production will advance toward standardized procedures and intensive management, thereby supporting the stable, safe and controllable development of the seed industry for *Procambarus clarkii* aquaculture.

3.2. Promotion of Green Aquaculture Models for *Procambarus clarkii*

Ecological culture modes such as *rice-Procambarus clarkii* co-culture will be further optimized and upgraded, and expanded to diversified integrated composite systems including rice-crayfish-fish and rice-crayfish-mushroom cultivation systems. Key technologies including integrated planting-breeding resource recycling, aquaculture tailwater purification and ecological environment regulation will be comprehensively applied to minimize the input of chemical fertilizers and pesticides, and further improve the ecological benefits and comprehensive economic benefits of *P. clarkii* aquaculture. Meanwhile, novel intensive culture modes including industrial recirculating aquaculture, facility-based aquaculture and photovoltaic-aquaculture integrated systems will be vigorously promoted. By making full use of idle greenhouses, low-lying farmlands and saline-alkali lands for aquaculture production, the seasonal and regional restrictions

on *P. clarkii* farming will be effectively broken, and the environmental dependence and pollution pressure of the aquaculture industry will be significantly reduced.

3.3. Precision Disease Prevention and Control of *Procambarus clarkii*

To address high-incidence diseases such as the "May Plague" and white spot syndrome virus (WSS) in *Procambarus clarkii*, future research efforts will focus on strengthening pathogen isolation, identification, and pathogenicity mechanism studies. This will facilitate the development of safe and efficient disease control products and integrated intervention schemes. Furthermore, a precision control system adhering to the principle of "prevention first, integrated management" will be comprehensively promoted. This system integrates seedling quarantine, water quality optimization, and biological control strategies, aiming to reduce the application of antibiotics and enhance the overall health status of aquaculture systems. Concurrently, established disease early-warning networks and standardized technical control standards will be instrumental in minimizing economic losses associated with disease outbreaks.

3.4. Nutrient Demand and Feed Formulation of *Procambarus clarkii*

Given the omnivorous feeding habit of *Procambarus clarkii*, future research will further elucidate the stage-specific nutritional requirements at different developmental stages including larvae, juvenile and adult fattening periods, so as to develop comprehensive, balanced and eco-friendly specialized compound feeds for this species, and reduce the dependence on natural baits in aquaculture practices. Moreover, research, development and application of low-fishmeal feeds, functional feeds and environment-friendly feeds will be vigorously promoted. Meanwhile, scientific feeding strategies will be optimized to enhance nutrient utilization efficiency, reduce aquaculture production costs and alleviate the environmental pressure caused by *P. clarkii* farming.

3.5. Integrated Industrial Chain Development of *Procambarus clarkii*

The *Procambarus clarkii* aquaculture industry will realize the extension and integration of the entire industrial chain. Specifically, the research and development of deep processed products including prepared dishes, seasoned aquatic products and snack foods will be intensified to boost the added value of aquaculture products. Furthermore, the integrated development of breeding, processing, cold-chain logistics, catering services and cultural tourism will be promoted, regional public brands of *P. clarkii* will be established, and both online and offline marketing channels will be further expanded. In addition, the comprehensive utilization of aquaculture byproducts such as shrimp shells and shrimp heads will be implemented to develop high-value products including chitin and astaxanthin, so as to realize the efficient recycling of resources. Ultimately, the industry will transform from the single primary farming sector to the coordinated development of primary, secondary and tertiary industries.

Acknowledgement

This work was supported by Undergraduate Innovation and Entrepreneurship Training Program of Yangtze University (Yz2025099).

References

1. Chen GH, Wang ZH, Lu YT, *et al*. Influence of Different Steaming and Boiling Methods on the Taste of *Procambarus clarkii*. Science and Technology of Food Industry. 2025;46(21):337–345. (in Chinese)
2. Cheng BZ, Wang SC. Research progress on white spot syndrome virus in *Procambarus clarkii*. Scientific Fish Farming. 2022;(07):50–52. (in Chinese)
3. Wang WM. The exploitation and utilization of red swamp crayfish in China. Acta Hydrobiologica Sinica. 1999;(04):375–381. (in Chinese)
4. Guo XM, Zhu SQ. A preliminary study on the larval development of the crayfish *Procambarus clarkii*. Acta Zoologica Sinica. 1997;(04):37–46. (in Chinese)
5. Zhang CY, Li SH, Zhang HP. Lecture 3 on *Procambarus clarkii* farming technology: Seed breeding techniques. Fisheries Wealth Guide. 2005;(03):58. (in Chinese)
6. Li RC, Qian WQ, Gu L, *et al*. Research progress on the influence of environmental factors on *Procambarus clarkii*. Heilongjiang Fisheries. 2025;44(06):719–727. (in Chinese)
7. Jin HH, Xiao CB, Sun QR, *et al*. Protein requirements of juvenile *Procambarus clarkii* under rice field farming mode. Journal of Fisheries Science. 2024;48(10):149–162. (in Chinese)
8. Jin HH. Research on the Protein Requirement of *Procambarus clarkii* during Different Growth Stages [dissertation]. Southwest University; 2023. (in Chinese)
9. Qiu XY, Chang RB, Cai ML, *et al*. Different soybean processing products replacing fish meal on growth performance, hepatopancreatic damage, and intestinal microbiota of *Procambarus clarkii*. Acta Hydrobiologica Sinica. 2025;49(11):102512. (in Chinese)
10. Teng ZQ, Li H, Li W, *et al*. Low fish meal diet on growth performance, hepatopancreas-intestinal health, and muscle quality of red swamp crayfish (*Procambarus clarkii*). Acta Hydrobiologica Sinica. 2025;49(11):102507. (in Chinese)
11. Cao H. Intensive pond farming of *Procambarus clarkii*—Good benefits. Scientific Fish Farming. 2004;(09):26. (in Chinese)
12. Zhang CY, Li SH, Zhang HP. Lecture 6 on *Procambarus clarkii* farming technology: Lotus root field farming. Fisheries Wealth Guide. 2005;(07):59–60. (in Chinese)
13. Zhang CY, Li SH, Zhang HP. Lecture 7 on *Procambarus clarkii* farming technology: Mixed farming in fish ponds. Fisheries Wealth Guide. 2005;(08):58. (in Chinese)
14. Xu L. High-yield farming experiment of *Procambarus clarkii*. Anhui Agricultural Bulletin. 2008;(12):36–37. (in Chinese)
15. Ren QS, Xu J. Ecological mixed farming experiment of *Procambarus clarkii* and *Pelodiscus sinensis* in hilly areas of Nanling County. New Farmers. 2025;(15). (in Chinese)

16. Zheng D, Peng XT, Zhang X, *et al*. Comparative Analysis on Muscle Quality of *Procambarus clarkii* Under Different Aquaculture Models in Hubei Province. Science and Technology of Food Industry. 2023;44(10):91–97. (in Chinese)
17. Wu Y, Luo WY, Jie BF, *et al*. Experiment on partitioned breeding-farming rice-crayfish off-season model. Aquaculture. 2023;44(03):50–52. (in Chinese)

How to Cite This Article
Li Z, Mao R, Liu J, Ma S, Hu W. Analysis of the status and development trends in Procambarus clarkii aquaculture in China. Int J Multidiscip Res Growth Eval. 2026 May–Jun;7(3):125–130.