The Status Quo of Industrial Development of Cold Water Fishes in Henan Province

CHEN You-guang[1]*, YU Zhen-hai[1], Jing Ying[1], LI Zhi-xun[2]

1. Fresh Water Fishery Research Institute of Shandong Province, Ji'nan 250117, China; 2. Henan Academy of Fishery Science, Zhengzhou 450044, China

Abstract This article first analyzes the status quo of industrial development of cold water fishes in Henan Province. And then it points out the main problems in the process of cold water fish industrialization as follows: the parent fish rearing of cold water fishes and the supply of roe and fry are inadequate; the demand for feed nutrition, research and development of disease prevention and control technology lag behind. In order to provide scientific basis for promoting the industrial independent innovation and international competitiveness, finally the following ideas and recommendations for industrial development of cold water fishes are put forward: strengthening policy support for the enterprises, and striving to create the leading enterprises, to achieve dramatic development; implementing the strategy of developing fishery by relying on science and technology, promoting the industrial independent innovation and competitiveness; creating specialized cooperative organizations, actively improving the supporting system, and expanding the space for development of the industry.

Key words Henan Province, Cold water fishes, Industrial development, Status quo

In recent years, due to special economic value, nutritional value and biological characteristics, the cold water fishes have captured people's attention. As the cold water fishes in natural waters are caught excessively and the global resources dwindle substantially, since the mid-20th century, people have gradually begun to pay attention to and study the method of increasing resources and strengthening breeding[1].

China attaches great importance to the cultivation of cold water fishes, especially in the poor mountainous areas. The practice has proved that the development of cold water fish industry is an effective way to promote adjustment of China's rural industrial structure and increase farmers' income. Henan Province, located in the junction of open coastal regions and China's central and west regions, is an intermediate zone in the course of China's economy advancing and developing from east to west by echelon, and also an important transfer station of roe and fry of cold water fishes and commercial fish in China. Since Henan Province has unique geographical advantages, expanding and promoting the cold water fish industry can provide roe, fry and commercial fish nearby, which is of great strategic significance to enhancement in international competitiveness of China's cold water fish products.

This article aims to probe into the status quo and development of cold water fish industry in Henan Province, and provide a reference for promoting the industrial development of cold water fishes in Henan Province and enhancing independent innovation of industry and competitiveness in the international market.

Received: January 15, 2012 Accepted: April 5, 2012
Supported by Special Fund for Agro-scientific Research in the Public Interest (201003055).
* Corresponding author. E-mail: chenyouguang2000@yahoo.com.cn

1 The status quo of cultivating enterprises of cold water fishes

1.1 Natural conditions and cultivating distribution The topography of Henan Province is high in the west and low in the east, fair in the north and concave in the south. Its north, west, south sides are surrounded by the Taihang Mountains, the Funiu Mountains, the Tongbai Mountains and the Dabie Mountains, with the vast basin within; the central and eastern Henan Province is the vast Huang – Huai – Hai Alluvial Plains. It extends across the valley of the Yangtze River, Huaihe River, Yellow River, Haihe River. Rivers in the province mostly originate from the western, northwestern and southeastern mountains, and the area of hillsaccounts for 44.3% and, with 493 rivers and basin area more than 100 km^2. Due to great gradient, rushing current, clean water, few food organisms, and low water temperature, many rivers are valuable water resources for the cultivation of cold water fishes. In view of the status quo, Henan Province implemented the construction of green fishery zone along the Yellow River in 2003, promoting rapid development of the fishing industry[2]. The survey results show that the majority of cultivation enterprises of cold water fishes in Henan Province are mostly concentrated in the western, northwestern and northern mountainous areas, such as Lushi County in Sanmenxia City, Mount Guanyun, Lingbao City, Shan County, Linzhou in Anyang City, and Jiyuan City; there are 4 breeding enterprises and 1 cultivation enterprise of cold water fishes with the annual output more than 15 tons; in addition, some small-scale enterprises are scattered in Zhengzhou, Puyang, Pingdingshan, Xinyang, Shangqiu, Nanyang and other cities, as shown in Fig.1.

1.2 Cultivation area and output In 2009, the aquaculture area in Henan Province reached 251 800 square meters, and the total output of aquatic products reached 929 000 tons. But

the survey and research results show that the total cultivation area of cold water fishes is only 81 190 square meters; the output of commercial fish is 355 tons; 1 million eyed eggs are spawned; 0.6 million fries and fingerlings are cultivated; the cultivation area of commercial fish averages 17.45 kg/m^2. In 2010, the output of cold water fishes and commercial fish reached 510 tons; 2 million eyed eggs are spawned; 1 million fries and fingerlings are cultivated; the cultivation area of commercial fish averages 22.09 kg/m^2 (Table 1). Therefore, the output of cold water fishes has a small share in the total output of aquatic products in Henan Province, and the development of cold water fish industry is sluggish, but the cultivation output has been rising steadily.

1.3 Cultivation species and technology research and development In the 1990s, Henan Province introduced and cultivated cold water fishes, starting late, but since the beginning of the 21st century, the cultivation of cold water fishes has developed very quickly, gradually shifting from single-species culture to multi-species breeding; the aquaculture production, the public leisure and vacation and fishing industry have been combined organically, enhancing the vitality of the cold water fish industry. At present, most of the salmonoid fishes cultivated in Henan Province are *Oncorhynchus mikiss* introduced from Yunnan, the rainbow trout introduced from Beijing or Shanxi, *Plecoglossus altivelis* and other species introduced from Shanxi; sturgeon is *Acipenserschrenckii Brandt* and *Acipensergueldenstaeti Brandt* introduced from Heilongjiang, *Polyodon spathala* introduced from Wuhan, *Acipenser baerii Brandt* introduced from Beijing Fangshan, and several hybrid species.

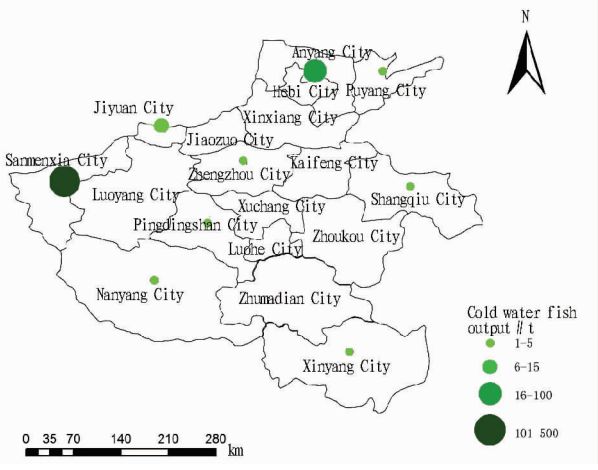

Fig.1 Regional distribution of cultivation output of cold water water fishes in Henan Province

Table 1 The cultivation area and output of cold fishes in Henan's cities during the period 2009–2010

Year	Cultivation Region	Total area		Output		Output Per unit
		Area of fry and fingerling//m^2	Cultivation area//m^2	Output of commercial fish//t	Eyed eggs (unit: 10^4)/Rearing of fry and fingerling(unit: 10^4)	Commercial fish//kg/m^2
2009	Anyang City	–	58 690	90	–	1.53
	Sanmenxia City	10 000	22 000	250	100/60	20.83
	Jiyuan City	–	500	15	–	30.00
	Total	10 000	71 190	355	100/60	17.45(average)
		81 190				
2010	Anyang City	–	58 690	75	–	1.28
	Sanmenxia City	10 000	12 000	420	200/100	35.00
	Jiyuan City	–	500	15	–	30.00
	Total	10 000	71 190	510	200/100	22.09(average)
		81 190				

Note: The output statistics of some small-scale farms have not been collected.

In the 1970s, the focus of the domestic and foreign study on sturgeon gradually shifted to artificial cultivation[3,4]. The fishes initially introduced by Henan Province are salmonoid fishes, such as rainbow trout and golden trout[5]. Since the beginning of the 21st century, under the strong support of the national, provincial and municipal agricultural departments and water conservancy departments, Henan Province has put more efforts into research and development, speeding up the cultivation development of cold water fishes. In terms of the studies on salmonoid fishes, Sun Xingwang, *et al.* (2001) carried out the study on the cultivation technique of rainbow trout in Norway[6]. Ji Guangwen, *et al.* (2004) carried out river enhancement and releasing test on *Plecoglossus altivelis*, using slow flowing water to cultivate *Plecoglossus altivelis*, in order to know the growth characteristics of *Plecoglossus altivelis*, which solved the bottleneck problem of transport of *Plecoglossus altivelis* fry[7]. From April, he conducted artificial releasing of *Plecoglossus altivelis* in Hehua Village part of Qi River, and the average size of Plecoglossus altivelis caught at the end of year was 100 g, achieving success; then he conducted research of cultivation of *Plecoglossus altivelis* and *Brachymystax lenok*, coupled with feed[8,9]. In terms of sturgeon fishes, Zhao Daoquan (1999) made studies on growth law of the Russian sturgeon at the young stage, feed nutrition and breeding effect[10–13], factory-based intensive cultivation and many other techniques; used the Russian sturgeon to adjust the cultivation structure of the soft-shelled turtle cultivation enterprises, achieving better results. Li Xiuling (2008) conducted researches on cultivation of the Siberian sturgeon fry and fish cultivation technique[14–15], and Wang Shuiliang (2007) conducted researches on factory-based cultivation technique of *Polyodontidae*[16]. In 2003, the green fishery belt construction project along the Yellow River was implemented, using the reservoir in Jiyuan City to carry out cage culture. Silver carp and bighead carp, *Cyprinus carpio*, Channa argus, Channel catfish were cultivated. In addition, the cage culture of the sturgeon was carried

out. In 2007, more than 1500 cages of fishes in Jiyuan City were cultivated[17]. Yang Zhiguo *et al.*, launched research on high-yield and high-efficiency cultivation modes of sturgeon[19], including sturgeon cultivation using slow flowing pond water, factory-based cultivation in mountainous areas and other cultivation modes, thus promoting pond cultivation, cage cultivation, as well as reproduction and releasing in reservoirs and rivers, in low-lying saline land along the Yellow River and the Central Plains area; formulated some sturgeon technical regulations[20-23]. For a decade, there has been a number of scientific research results emerging one after another[12], such as Research of Factory-based Intensive Cultivation Technique of the Russian Sturgeon, Research of Salmon Cultivation Technique, winning the second and third prize of provincial scientific and technological progress[12], which has greatly promoted the development of cold water fish industry.

1.4 Cultivation method and facility research The cultivation modes of cold water fishes in China mainly include natural water cultivation mode and factory-based cultivation mode[24]. The natural water cultivation mode includes artificial releasing in natural waters, cage and enclosure cultivation; the factory-based cultivation mode includes open outdoor water cultivation, indoor factory-based cultivation, and closed circular water cultivation system. In the light of the situation of cultivation in local areas, Li Tongguo (2006), expounded the conditions for building farm, in the study of building cultivation farm of cold water fishes[5], including water source and water temperature, water flow and water amount, amount of dissolved oxygen, electricity and transport, sales market and so on; proposed key technologies specific requirements concerning pond type, shape and structure of pond, the area and number of pool. Qian Mingquan (2006) further studied factory-based sturgeon cultivation mode using dual circulating water[25]. Chen Jie (2008) raised technical requirements of net and cage setting in the water, shape and size, frame production, the stocking of fingerlings, feed and feeding, day-to-day management and overwintering, in the study of cultivation net and cage[23]. At present, open-water cultivation, cage culture and releasing in natural waters, have become the major cultivation modes in Henan Province.

1.5 The state of deep processing enterprises The existing aquatic products processing enterprises in Henan Province are mainly engaged in processing of escargot, shrimp, whitebait and other characteristic aquatic products, as well as the refrigeration and preservation of conventional freshwater fishes. Since Henan Province is constrained by the aquaculture output of cold water fishes, aquaculture products are mostly sold nearby, or directly enter hotels and restaurants; there is a shortage of products in free market of agricultural products. At present, the deep processing link of cold water fishes is still prominently weak, and sound industrial chain has not taken shape.

1.6 The state of feed processing enterprises Henan Province is the province producing the most grain in China. The food and feed processing is competitive industry in Henan Province, and there are processing enterprises in cities, including 6 representative fish feed production enterprises, which can produce complete formula feed according to nutrition mixture ratio of feed for salmonoid fishes, *Acipenseridae fishes* and other cold water fishes. In terms of the feed research, the researches like Zhao Daoquan's research of the Russian sturgeon feed[11] and Long Yong's research of digestive physiology and nutritional needs of sturgeon[26], are few, lagging behind the researches in Denmark, Norway, Russia and other countries.

1.7 The state of disease prevalence and control research and development The diseases affecting cold water fishes include bacteria, fungi, parasites and nutritional diseases. The survey research results show that the disease incidence of salmonoid fishes in Henan Province is higher than that of sturgeon, and once there is a disease, it will cause great losses. Some companies reduce the cultivation of salmonoid fishes, and increase the cultivation of sturgeon. The diseases affecting sturgeon are common, including bacteria, fungi, parasites and nutritional diseases, and the most common diseases are skin rot, gill rot, enteritis, hemorrhage, curvature of the spine and other illnesses. The researchers also timely carried out the researches of sturgeon disease control, such as separation, identification, diagnosis and treatment of A. hydrophila of bacterial septicemia in sturgeon by Yang Zhiguo *et al.*, treatment and prevention of parasitic disease of *Polyodontidae* by Zhang Guozhen[27-29]. Although certain effects have been achieved, there are still many refractory symptoms.

2 The main problems in the industrialization process of cold water fishes

2.1 The parent fish rearing of cold water fishes and the supply of roe and fry are inadequate In 2008, rainbow trout and sturgeon was hatched artificially and sturgeon was propagated artificially with success[31]. Although there has a good foundation in breeding system of cold water fishes, the construction of breeding system is still shaky in terms of market demand and modern fishery requirements. The main manifestations are as follows. First, there is technical bottleneck in conservation and breeding of the sturgeon germplasm, quality and supply of fine strain. Second, the cultivation of sturgeon parent fish is inadequate. The breeding age of the Chinese sturgeon is above 8-10, but the enterprises never cultivate parent fish and reserve parent fish with planning, in accordance with age echelon, basically relying on outsourcing or the introduction of eyed eggs and fry. Third, the breeding species of cold water fishes are single, and the enterprises generally lack the ability to adjust according to market demand, therefore, the conversion of scientific and technological achievements is inadequate, which restricts the industrialization process of the cold water fish.

2.2 The demand for feed nutrition, research and development of disease prevention and control technology lag behind Although there are many feed processing enterprises, there is a shortage of enterprises which researched and developed feed aiming at nutritional needs of cold water fishes. The majority of cultivation enterprises are located in remote mountainous areas, with rugged road; even if there are good feed manufacturers, the feed prices will be increased corresponding-

ly due to time-consuming feed transport. And if we long feed fishes with non-exclusive feed, it will impair immunity of fishes, making the growth rate of fish slow, survival time short in the process of transport and incidence of disease high.

Within the region, the cultivation enterprises have fed fishes for many years; some universities and research institutes specialize in the research of fish disease[27-30], achieving certain results. In the survey, we find that the holding capacity of the aquarium in cultivation enterprises is constantly enhanced, but due to restriction of water flow and limited water renewing rate, coupled with high frequency of changing the feed, it makes the sturgeon grow slowly, its physique deteriorate and diseases increase. In addition, the level of culturists' cognition of disease observation, diagnosis and medication method and so on, is limited; as soon as there is a disease, the treatment is difficult, and if the disease is serious, it will cause incline in cultivation efficiency and generate great losses. Therefore, frequent occurrence of diseases has become a thorny issue to cultivation enterprises.

3 Ideas and recommendations for industrial development of cold water fishes

At present, as to problems in the process of industrial development of cold water fishes in Henan Province, we should find solutions from the perspective of national policy. During the 12th Five-Year period, the state focus on the development of southwest China, one of the regions with the greatest potential for industrial development, where boast abundant cold water resources and unique indigenous cold water fishes. Henan has unique geographical location and cold water resource advantages, thus we should optimize the cultivation structure and speed up the industrialization construction of cold water fishes. From the perspective of the province's industrial development, we should lay stress on introduction of new species, purification and rejuvenation of original breed, increase in value and efficiency for enterprises, and upgrading of industrial technology. At the same time, we should well coordinate the mutual relations between production and processing, between conventional fishes and cold water fishes; determine the dominant species of cold water fishes; vigorously support and develop breeding and cultivation enterprises, improve the organizational level of enterprises, to create the overall advantage, avoid market risks, enhance competitiveness, achieve dual upgrading of the quality and efficiency, and accelerate the development of industrialization.

3.1 Strengthening policy support for the enterprises and striving to create the leading enterprises to achieve dramatic development We should increase policy support for industrialization management in major aquaculture production areas. Since the cold water fishes are mostly cultivated in remote and poor mountainous areas, it is inconvenient in transportation, communications and life, but these places are precisely the places with rich cold water resources. When the enterprises with economic strength carry out development, the local authorities should offer preferential policies in lease of land, use of water, construction of roads, sale of products, examination and approval of construction and other aspects, so that the owners are willing to invest in production, happily work and enjoy the benefits, gradually making the enterprises bigger and stronger. We should cultivate the leading enterprises to play an exemplary role, driving the development in the surrounding regions. Only when there are large-scale classy cultivation enterprises, can we advance the development process of the industry by leaps and bounds.

3.2 Implementing the strategy of developing fishery by relying on science and technology and promoting the industrial independent innovation and competitiveness Scientific and technological innovation is the driving force of industrial development. The industrial development needs to cultivate the technology development system integrating production, learning and research[32]. The government should increase investment in research funding. The research institutes should actively establish mutually beneficial cooperative relations with enterprises; research and develop new materials, new products and new methods based on the production reality, in order to convert scientific research achievements into productivity, achieve win-win; at the same time, constantly enrich the teaching content, and thus enhance the industrial independent innovation and competitiveness.

3.3 Creating specialized cooperative organizations, actively improving the supporting system and expanding the space for development of the industry In order to promote the development of cold water fish industry, in accordance with the ideas of diversification of founders and diversification of organizational forms, we should actively encourage the establishment of distinctive specialized cooperative organizations, establish new management model, improve the organizational level of enterprises, and carry out technical exchange and professional training, to form powerful combined strength. We should achieve organic combination of all production links in whole process of aquaculture production; improve the supporting system building of production, transportation, processing and sale, to form overall advantage; pay equal attention to domestic development and opening to the outside world; constantly open up space for development of cold water fish industry, to promote employment and increase farmers' income.

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resources, to provide services and social security meeting the basic level and quality stipulated by the state, for residents. The government can make use of the means of transfer payments to bridge the gap between rich regions and backward regions, to encourage the regions with high level of economic development to driving the economic development in backward regions, and promote balanced regional economic development.

3.6 Promoting the ability of residents in ancient towns and villages to cope with poverty reduction vulnerability

From the perspective of assets, ancient towns and villages residents can use tangible assets and intangible assets to confront poverty vulnerability, and assets can help reduce the number of hazards. Ancient towns and villages not only have different types of construction, inscribed tablet and record of events inscribed on a tablet, famous wood and ancient trees, and other types of material cultural heritage, but also have different types of local rules and regulations valid for all the inhabitants of a township, folk custom, traditional festival, folk belief, traditional craft and other types of non-material cultural heritage. All these are assets possessed by the ancient towns and villages. From the perspective of funds, ancient towns and villages should raise funds through various channels, formulate all-around agricultural financial pro-poor policies, adjust the fund use structure, strengthen fund management, improve fund use efficiency, implement the mechanism innovation, create the conditions for market capital entering into the area of poverty reduction, and promote the combination of the government's social objectives and enterprise's economic objectives, to achieve effective unification of social and economic benefits[5]. From point of view of education, we should develop education in ancient towns and villages, increase the stock of human capital in ancient towns and villages, and especially enhance investment in basic education in the Luliang area and the northern Shanxi frontier areas with economic backwardness. Promoting the quality of residents in ancient towns and villages is an important way to deal with vulnerability in poverty reduction.

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