Conservation Status of Chinese Giant Salamander

(*Andrias davidianus*)

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I Biological Characters

Andrias davidianus (Blanchard, 1871) is an endangered amphibian endemic to China. Belonging to Amphibia Caudata Crytobranchidae, it is the caudiferous amphibian endemic to China, and also is the biggest ancient animal with the longest life among the exiting amphibians in the world. In 1988, it was listed in Category 2 of national protected aquatic wildlife and CITES Appendix I. It was listed in CR threaten category by IUCN/SSC in 2004, and was listed as top of the 10 oddest endangered amphibians in the world by London Animal Association of UK in 2008. This family has 2 genera (Another genus is *Cryptobranchus*.) and 3 species, respectively *Andrias davidianus* (distributed in China), *Andrias japonicus* (distributed in Japan) and *Cryptobranchus alleganiensis* (distributed in America). Fossil of this family dates back to Paleocene 65 million years ago. The existing species of this family are characterized by rareness and disjunctive distribution. It is the amphibian family featured by the largest size and the least species. It has important significance in discussing evolution of vertebrate from aquatic animal to terrestrial animal (Dulleman and Trueb, 1985).

Andrias davidianus was recorded as baby fish in *A Chinese Bestiary* in the Warring States Period about 2200 years ago (Warring States Period). Morphology, behavior, distribution, usage and breeding of *Andrias davidianus* were recorded and described in detail by many researchers (Xiong and Zhang 1982). *Andrias davidianus* is also the amphibian having promising economic value. It has the history in some Chinese regions as food, medicinal material and ornamental animal.

Andrias davidianus has a cylindrical body, consisting of three parts, i.e. head, trunk and tail. It has wide, round and flat head and large mouth. Each tubercle on its head and trunk is composed of two closely paired miliary tubercles. Between the armpit and crotch along the side of body, there are longitudinal skin folds. Its limbs are short and flat, having four fingers and five toes. Its sound is like baby's crying, so it is commonly called as "baby fish". *Andrias davidianus* distribute in the mountain rivers and streams in elevation ranged from 200-2000m, while most of them distribute in elevation of 300-900m. It favorite rivers and streams with stone crevices, stone holes and permanent water with low and stable temperature. The highest distribution elevation was 4200m, in Dequ River, a branch of Tongtian River in Qumalai County, Qinghai Province. (Northwest Institute of Plateau Biology, The Chinese Academy of Sciences, 1989)

Andrias davidianus has important value in scientific research. As *Andrias davidianus* is the rare species living in the same period with dinosaur, and continuing to survive until now, it is called as "living fossil". In the evolution history of vertebrate system, it is the wild animal transiting from aquatic animal to terrestrial animal, so it has important value in scientific research of the origin, phylogeny, geographic distribution of land vertebrate and the earth's evolution history.

In addition, *Andrias davidianus* has significant ecological value. *Andrias davidianus*

belongs to the flesh-eater, which is the important species for the freshwater ecosystems of mountainous areas, holding the important ecological niche, playing an irreplaceable role in maintaining balance of the freshwater ecosystems of mountainous areas. *Andrias davidianus*'s living environment must have clean stream flow. Once water where it lives is slightly polluted, *Andrias davidianus* would give response accurately and timely. Therefore *Andrias davidianus* is also the important indicator species monitoring the water quality of the freshwater ecosystems.

II Status of Wild *Andrias davidianus*

1 Distribution shrinking and fragmented

Andrias davidianus was widespread in China before the 1970s, mainly distributed in the Yangtze River, the Yellow River and the streams of the upper and middle reaches of the Pearl River. It was reported by Fei, et al. (1993) that *Andrias davidianus* was originally distributed in 17 provinces in China, including Hebei, Henan, Shanxi, Shaanxi, Gansu, Qinghai, Sichuan (including Chongqing), Guizhou, Hubei, Anhui, Jiangsu, Zhejiang, Jiangxi, Hunan, Fujian, Guangdong and Guangxi, where has large population of the wild *Andrias davidianus* species. However since the 1950s, especially the 1980s, the human activities have caused damage, loss and reduction of *Andrias davidianus*'s habitat. Additionally over-hunting and over-acquisition caused sharp reduction of wild *Andrias davidianus*'s population and shrinkage of its distribution. The existing distribution areas and points are also sharply decreased. In the 1960's, there are 10 counties of Xiangxi Autonomous Prefecture in Hunan Province where *Andrias davidianus* is distributed, but now there are only 5 counties having *Andrias davidianus* distributed (Liu and Liu 1993).

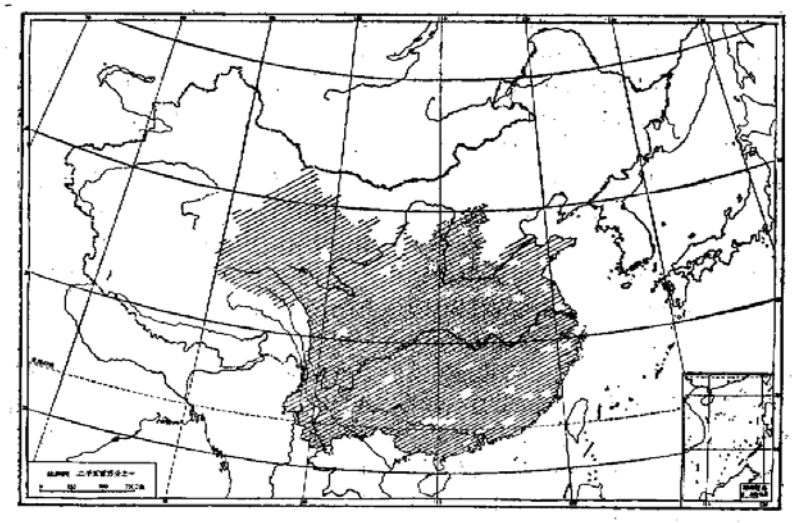

Fig. 1 Historical distribution of *Andrias davidianus* (Liu 1989)

Fig. 2 Distribution of *Andrias davidianus* in 2002 (Zhang et al., 2002)

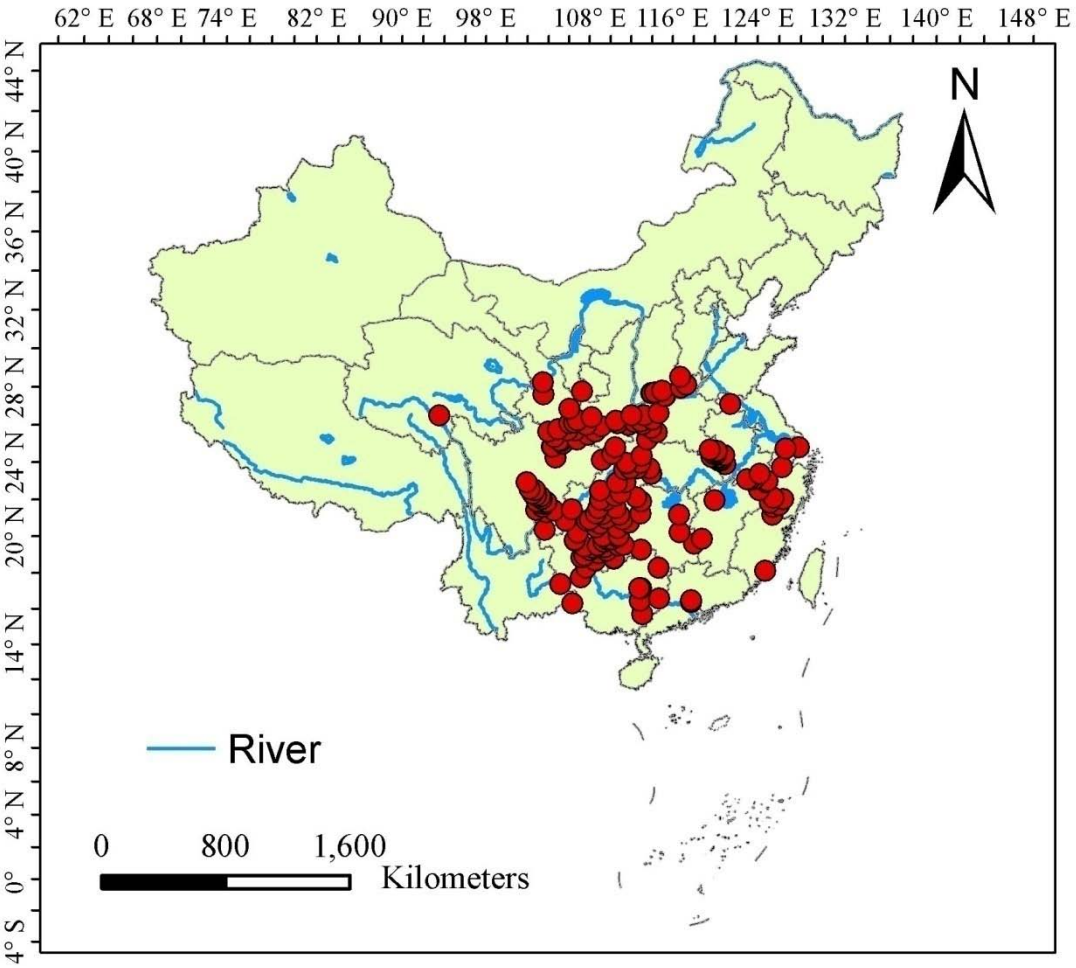

Fig. 3 Distribution record of *Andrias davidianus*

At present, *Andrias davidianus* is distributed in 17 provinces of China,

among which mountains in center China and Changjiang River are the major distribution of *Andrias davidianus*, forming 12 fragmented island-like distribution areas (Zhang et al. 2002). Among these 11 island-like distribution areas, the largest natural wild *Andrias davidianus* distribution areas are mainly concentrated in four regions, i.e. Qinba mountain area of Shaanxi Province (including Lushi County of Henan Province); Zhangjiajie and Xiangxi Autonomous Prefecture of Hunan Province; Fangxian County and Shenlongjia of Hubei Province; Zunyi of Guizhou Province and Yibin of Sichuan Province.

After analysis of complete sequence of mtDNA D-loop and Cyt*b* gene of five geographical species of *Andrias davidianus* and their genetic relation, Tao et al. (2005, 2006) believed that *Andrias davidianus* in China has divided into three geographical species: the Pearl River species (distributed in the Pearl River Basin such as Guangxi), the Yangtze River species (distributed in the Yangtze River Basin such as Hunan, Shaanxi and Sichuan) and the Yellow River species (distributed in the Yellow River Basin such as Henan). Among the above 3 geographical species of *Andrias davidianus*, genetic differentiation shows continuity in geographical areas. Minor genetic differences are observed between the Yangtze River species and the Yellow River species, and between the Yangtze River species and the Pearl River species. But considerable genetic differentiation is found between the Yellow River species and the Pearl River species. Among them, the Yangtze River species plays a bridge role between the Pearl River species and the Yellow River species.

2 Serious decreasing of wild population

Besides shrinkage of the distribution areas, population size of the wild *Andrias davidianus* also shows the trend of severe depression. The natural distribution areas and the population of *Andrias davidianus* have been lost 60-90% from 1950 to 2000 (Zhang et al. 2002). Before the 1980s, *Andrias davidianus* has been purchased as aquatic products. To a great extent, reduction of purchasing volume of the wild *Andrias davidianus* is due to reduction of its wild population. We found the historic records of 17 counties for catching or purchasing *Andrias davidianus*, among which 7 regions could provide the records for more than two years, and the data have certain historic comparability. Among these data, the earliest is the purchase record from the 1950s, and the latest is the catching record kept in 2008. The data show that all the records for catching and purchasing *Andrias davidianus* in the 7 regions indicate that *Andrias davidianus* catching and purchasing volume shows the trend of gradual decrease. And such decrease trend has already been common since the 1960s – the 1970s (Table 1).

Table 1 Historic record of purchasing/catching *Andrias davidianus* in various regions

Region	Year	Annual Production
Huoshan County, Anhui Province	1967	550 (kg)
	1968	170 (kg)
Manshuihe Township, Huoshan County, Anhui Province	1967	500 (kg)
	1968	500 (kg)
	1970	30 (kg)
Sangzhi County, Hunan Province	1954	7500 (kg)
	1978	1000 (kg)
Taibai County, Shaanxi Province	1973	3813 (kg)
	1974	3884.5 (kg)
	1975	80.5 (kg)
	1976	1041.5 (kg)
	1978	1588 (kg)
	1979	1300 (kg)
	1974	40 (kg)
Suichang County, Zhejiang Province	1970s	45 (Nr.)
	1985	19 (Nr.)
	1986	7 (Nr.)
	1987	3 (Nr.)
Youyang County, Chongqing	1966	5500 (kg)
	1974	2000 (kg)
Xingwen County, Sichuan Province	2004	3200 (larvae)
	2005	2800 (larvae)
	2006	2400 (larvae)
	2007	1000 (larvae)
	2008	50 (larvae)
	2009	0 (larvae)

At present, *Andrias davidianus* reserve in China is less optimistic. According to our investigation and the literature recordation, population of the wild *Andrias davidianus* in China has sharply decreased. During less than 50 years, *Andrias davidianus* has experienced the change that giant panda experienced during 3 million years (Hu and Wei 1990). However, genetic diversity of *Andrias davidianus* populations is still very high (Murphy, *et al*., 2000). Its population depression is mainly caused by external factors such as human activities. It is promising to recover the population of *Andrias davidianus* quickly once the habitat and wild population is well protected.

Table 2 *Andrias davidianus* reserve in certain regions of China after 1990

Location	Survey Year	Population Size		References
		Weight (kg)	Count	
Mountains in south of Anhui and Dabieshan Mountain	1994	13200-22000		Wang Yuan, 1996
Gucheng County, Shanxi	1991	18291-19100	22778-23786	Liu Shifeng,

Province				etc., 1991
Taibai County, Shaanxi Province	1997		6976	Yang Deguo, etc., 1997
Shanxi Province	1994	2000		Lian Jin, etc., 2000
Lushi County, Henan Province	1991	3000		Zheng Hexun, etc., 1992
Zhangjiajie Reserve, Hunan Province	2006-2008		2000	Luo Qinghua, etc. 2009

3 River pollution and ground habitat loss

Andrias davidianus is originally widespread in mountain streams and valleys. The *Andrias davidianus* specimen collection record kept in Amphibian and Reptilian Animal Specimens Museum of Chengdu Institute of Biology, Chinese Academy of Sciences also indicates that a large number of specimens were collected from mountain streams, rivers and surrounding land. However, we have found during survey in recent years in Xingwen, Jiangyou, Zhangjiajie, Wuxi, Yangxian and Qinba mountain area that almost all the existing *Andrias davidianus* living in underground rivers. The original surface habitat has already become non-viable due to human activities. Except in the Zhangjiajie Reserve, the track of *Andrias davidianus* almost could not be seen in the surface water in other regions.

Fig. 4 Current status of Zhongba Town, Jiangyou City as type locality of *Andrias davidianus*

Urbanization, industrial and agricultural development caused great destruction to the original habitat of *Andrias davidianus*. Zhongba Town, Jiangyou City is originally the type locality of *Andrias davidianus*, but now it has become a highly developed town center with turbid river water and quite serious industrial pollution. And the natural habitat of *Andrias davidianus* in Mabian, Xingwen and Wuxi, etc. has also become the developed agricultural regions. In these regions, industrial and agricultural pollution is serious; natural vegetation around rivers is lacking; and water quality is far from satisfaction of demands for *Andrias davidianus*'s living. Besides degradation of water quality, on the rivers at Mabian, Xingwen and Wuxi, etc. where there was *Andrias davidianus* distributed, the small dams under cascade development could be found everywhere. Most of the small dams have serious silting, causing large-scale destruction of the preferred microhabitat of *Andrias davidianus* such as swallet and rock cavity.

Although surface habitat is seriously destructed, there are still individual reports regarding occasional finding of *Andrias davidianus* in the surface rivers in Pingwu, Xingwen, Hanzhong, Zhouzhi, Lantian and Liuba counties in recent years. But there have never been the records about propagation of *Andrias davidianus* or its larvae. It indicates that these rivers could not be the breeding place and habitat of *Andrias davidianus*. The *Andrias davidianus* in the river is more likely migrating down the river from underground river or stream.

Fig. 5 Surface river water deterioration and seriously silted small dams

Fig. 6 Habitat at Huoshaodian Township, Liuba County, Shaanxi Province where wild *Andrias davidianus* was ever caught

Most of the researchers (Cheng 1993; Gao 1998; Liu and Liu 1993; Feng and Jin 1993; Song 1986; Hu 1987) regarded the catching by human as the main reason causing decrease of wild *Andrias davidianus* population. But it is also considered (Gao 1988) that wide application of fertilizer and pesticide is an important threatening to the wild *Andrias davidianus* population. No matter how great threats catching ever brings to the wild *Andrias davidianus* population, but you have to agree that even no any catching by human, according to the current severe ecological state of the surface habitat, the *Andrias davidianus* population still could not escape its destiny of distribution shrinkage and population depression.

4. Poaching is rampant driven by the huge economic benefits

According to the price survey of purchase market of *Andrias davidianus* over the years, in 1970s when *Andrias davidianus* was not listed in Animals under National First-class Protection, its purchase price was 0.2 yuan/500g. The purchased *Andrias davidianus* was mainly used for foreign trade export (Hong Kong, Japan). The price of *Andrias davidianus* has been soaring since 1980s, and its price began to drop slightly until 2007, when it was six years after the artificial propagation *Andrias davidianus* was successfully realized throughout the country in 2001. For example, the price of *Andrias davidianus*

in 1981 was 5 yuan/500g, the price in 1988 was 20-30 yuan/500g, the price in 1995 was 100-120 yuan/500g, the price in 1997 was 200 yuan/500g, the price in 2002 was 500 yuan/500g, and the price reached the ceiling price in 2007, i.e. about 4,000 yuan/500g, the price in the first half year of 2008 was 1,500 yuan/500g, the price in the second half year of 2008 was 400 yuan/500g, and the price in the first half year of 2009 was 700 yuan/500g. Driven by the huge economic benefits, crazy catching of *Andrias davidianus* by law-breakers was common in Qinba Mountain Area. Those law-breakers caught *Andrias davidianus* by hands in the river course firstly, and when it came to the late of 1980s, they placed the self made "hook" in the natural river course of original distribution area of *Andrias davidianus* to catch *Andrias davidianus*. In the late of 1990s when the quantity of wide *Andrias davidianus* was sharply reduced, the law-breakers began to spread poison into the river course at the upper reaches of rive course and directly picked up the poisoned *Andrias davidianus* in the river course. Spreading poison into the river course caused the water quality in the river course seriously polluted, the balance of aquatic ecosystem badly damaged and the aquatic animals in the river course such as wide *Andrias davidianus* basically extinct. Because wide *Andrias davidianus* was extremely rare in quantity after 2004, the event of using "hook" or spreading poison into the river course gradually became reduced.

Fig. 7 Scene of Larvae of Wide Andrias davidianus Catching in Yuehe Township, Zhen'an County, Shaanxi

Moreover, the market price of *Andrias davidianus* was soaring and the

quantity of wide *Andrias davidianus* was sharply reduced, the cost of catching wide *Andrias davidianus* was continuously improved, thus, more and more persons wished to obtain larvae of *Andrias davidianus* by means of artificial propagation. However, because artificial propagation of *Andrias davidianus* was not broken through before 2000 and the price of larvae of *Andrias davidianus* was soaring, which caused white-hot poaching of larvae of *Andrias davidianus*. For example, the larvae of *Andrias davidianus* were purchased by no one before 1987, and one of larvae of *Andrias davidianus* were sold for 50 yuan in 1998, 100 yuan in 2000, 300 yuan in 2002, 400 yuan in 2005, 600-800 yuan at the end of 2006, 1,300-1,500 yuan in the first half year of 2007 (which was the ceiling price), 50-120 yuan in 2008 and 150 yuan in the first half year of 2009 respectively. Driven by the huge economic benefits, serious criminal cases were occurred in Shaanxi caused by *Andrias davidianus*. Reported by Huashang Daily on November 13, 2009, on October 27, 2009, Mr./Ms. Tang who was the villager of Huangnibao Village, Yuhuangmiao Township, Liuba County killed Mr./Ms. Yang who guarded *Andrias davidianus* and stole 1,692 larvae of *Andrias davidianus* which were propagated this year.

5. The populations of underground river present the metapopulation characteristics, the communication among populations is reduced, and the extinction risk is increased

Andrias davidianus was once the widely distributed breed of Chinese Mainland, however, only the underground river is still the “harbor of refuge” of *Andrias davidianus* at present. All of the populations of *Andrias davidianus* in Xinwen, Jiangyou of Sichuan, Fengjie of Chongqing, Sangzhi of Hunan and Guiding of Guizhou are living in the underground river. In one hand, *Andrias davidianus* can escape from capture in the underground river, and in the other hand, the water quality of underground river is generally better than that of surface river. There is common phenomenon of underground rivers in Xinwen, Jiangyou of Sichuan and Fengjie of Chongqing etc.: the river water is very crystal and clean when it just leaves the cave mouth and reaches the ground, however, the water quality becomes sharply deteriorated after just a few kilometers or even just a few hundred meters due to the agricultural, industrial and domestic pollution.

Even so, not all the populations of *Andrias davidianus* can escape from death. The quantity of larvae of *Andrias davidianus* flown from underground river of small fishing hole of Xingwen every year presents the declining trend since 2004 when the records began to be made (refer to Figure below). When it comes to 2009, no larva is flown out, and the breeding activity of *Andrias davidianus* seems to stop in this section of underground river. We have no

idea about the reason: whether it is exactly caused by the water body pollution or the natural fluctuation of local populations. The quantity of wide *Andrias davidianus* in the underground river of National Natural Reserve Area for *Andrias davidianus* in Zhangjiajie is also decreased, and at present, there are only 2000 wide *Andrias davidianus* remained in the whole reserve area, which presents the discontinuous punctated distribution (Luo Qinghua et al., 2009).

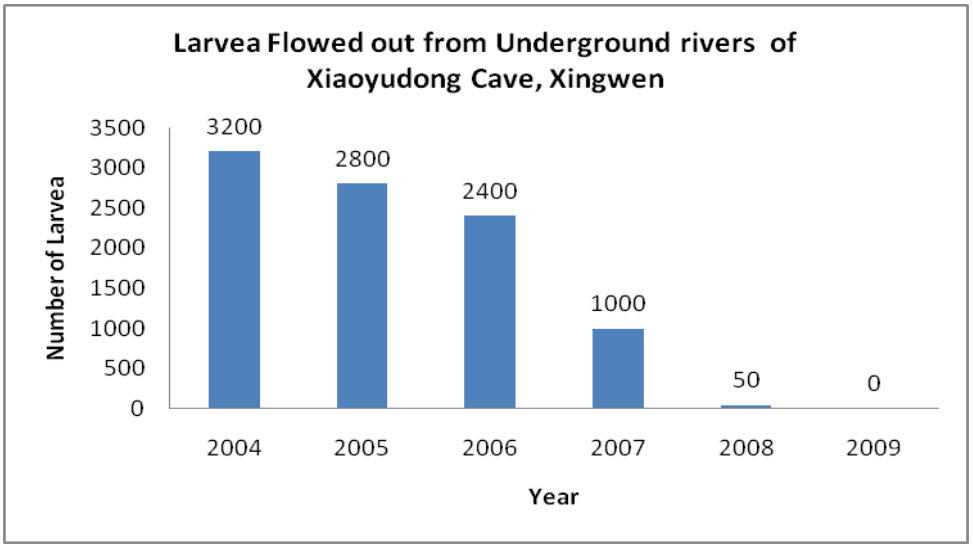

Fig. 8 Annual Variation of Quantity of Flown Larvae of Andrias davidianus from Small Fishing Hole of Xinwen

Due to the extinction of ground habitat, wide *Andrias davidianus* in China have become isolated groups of "underground populations". There is no direct connection among the underground rivers, and the migration communication among the underground populations only can be realized by means of ground habitat. However, the ground habitat is seriously polluted, the ground habitat is lacking, and the ecological function is seriously lost, thus, the population communication among the underground local populations is less.

Fig. 9 Outlet of Underground River of Xinwen is Located in the Center of Daba Town

The environment of underground river is not stable and unchanged, and the hydrological change of underground river will have a impact on the inhabited *Andrias davidianus* populations. The change of seasonal precipitation will impact the water level change of the underground river. The underground river of karst terrain will even change the course of underground river due to the limestone corrosion caused by rive stream. The water level change of underground river and the course change will directly impact the underground habitat of *Andrias davidianus* and even cause it impossible for *Andrias davidianus* to live and propagate, which may cause the population depression or extinction of *Andrias davidianus* in the underground river. *Andrias davidianus* will no longer exist in those habitats if no other populations of *Andrias davidianus* immigrated into those habitats. The hydrological change may also crease some new underground river habitats, but the newly formed habitats will face the difficult situation that no natural population can be immigrated due to the loss of ground habitat.

Even the secluded underground river is affected by the surface pollution. In fact, the underground river is connected with the surface river, and the water of surface river can also flow into the underground river, which is also the main source of organic nutrients of underground river. Besides, the surface pollutants may be also penetrated into the underground water body. It can be found in the studies of recent years that many underground rivers are polluted by many pollutants such as chemical fertilizer, agricultural chemical, heavy metal and organic carcinogen (Yang Mei et al., 2009, Yu Xiaoying et al., 2009), and even the underground river has become the “sewer” (Yuan Daoxian, Xue Yuqun, 2007). It can be seen from above that the habitat of underground river cannot protect *Andrias davidianus* against pollution at

present.

The present distribution pattern of *Andrias davidianus* presents the metapopulation characteristics, and the extinction risk of all populations is increased. There are two important parameters that decide the existence ability of metapopulation: the rebuilding rate of migration and extinction rate among various local populations. When the rebuilding rate is low while the extinction rate is high, even the widely distributed breed will face the risk of extinction. With regard to *Andrias davidianus*, the extinction risk of all populations of *Andrias davidianus* is extremely high due to the loss of ground habitat, decreased immigration communication among various underground local populations and pollution of underground river which increases the extinction probability of local populations.

III. Protection Management Status

1. Current *Andrias davidianus* Nature Reserves Distribution and Management Status in China

Incomplete statistics shows that China has already set up 22 natural *Andrias davidianus* nature reserves to protect the endangered species (shown in Table 3). These *Andrias davidianus* nature reserves are province- or county-level nature reserves, except Hunan Zhangjiajie Nature Reserve, which is a state-level nature reserve. Although *Andrias davidianus* is under second class protection and under ban of fishing, conventional fishing activity without focus on *Andrias davidianus* will also harm *Andrias davidianus*. Nature Reserves may prohibit fishing activities in the area in terms of system. The protection and restoration of *Andrias davidianus* habitats in the nature reserves can have law to follow, laying a good foundation for boosting sustainable development of wild *Andrias davidianus* species protection and germplasm resources.

Table 3 Current Established *Andrias Davidianus* Nature Reserves in China

S/N	Name of Nature Reserve	Level	Time of Establishment
1	Hunan Zhangjiajie *Andrias davidianus* Nature Reserve	State level	1995
2	Shaanxi Taibai Xushuihe Aquatic Wildlife Nature Reserve	Provincial level	2001
3	Shaanxi Lueyang *Andrias Davidianus* Aquatic Wildlife Nature Reserve	Provincial level	2007
4	Shaanxi Luonan *Andrias Davidianus* Aquatic Wildlife Nature Reserve	Provincial level	1998
5	Henan Xixia *Andrias Davidianus* Nature Reserve	Provincial	1982

		level	
6	Hubei Zhuxi Wanjianghe *Andrias Davidianus* Nature Reserve	Provincial level	1986
7	Henan Xin'an Qingyaoshan *Andrias Davidianus* Nature Reserve	Provincial level	1987
8	Hubei Xianfeng Zhongjianhe *Andrias Davidianus* Reserve	Provincial level	1994
9	Henan Luanchuan *Andrias Davidianus* Nature Reserve	Provincial level	1996
10	Henan Songxian *Andrias Davidianus* Nature Reserve	Provincial level	1998
11	Sichuan Tongjiang Nuoshuihe *Andrias Davidianus* Nature Reserve	Provincial level	1998
12	Gansu Wenxian *Andrias Davidianus* Nature Reserve	Provincial level	2004
13	Henan Lushi *Andrias Davidianus* Nature Reserve	City level	1983
14	Guangdong Heyuan Guishan *Andrias Davidianus* Nature Reserve	City level	2001
15	Jiangxi Jing'an Laohe *Andrias Davidianus* Nature Reserve	County level	1980
16	Hunan Sangzhi *Andrias Davidianus* Nature Reserve	County level	1983
17	Hunan Chenxi Longmen *Andrias Davidianus* Nature Reserve	County level	1984
18	Guizhou Qianxi *Andrias Davidianus* Nature Reserve	County level	1986
19	Hunan Loudi Dachengshan *Andrias Davidianus* Nature Reserve	County level	1987
20	Hunan Yongshun Liangcha *Andrias Davidianus* Nature Reserve	County level	1988
21	Chongqing Youyang *Andrias Davidianus* Nature Reserve	County level	1989
22	Sichuan Dayi Chuanxihe *Andrias Davidianus* Nature Reserve	County level	2004

Except special *Andrias davidianus* nature reserves, China also have 38 reserves (involving 13 provinces) that focus mainly on *Andrias davidianus.* Beijing has two reserves that focus mainly on *Andrias davidianus*, but whether it has *Andrias davidianus* distribution or not is open to discussion. There are five state-level reserves, fifteen province-level, seven city-level and ten county level reserves that focus mainly on *Andrias davidianus.* The competent authorities are complex considering the specialty of the living history and environment of *Andrias davidianus*. The 38 reserves are mainly under five departments, which partly causes inter-department management inconvenience.

Table 4 *Andrias Davidianus*-focused Reserves in China

Province	**Name of Reserve**	**Administrative Area**	**Area /hm^2**	**Protection Focus**	**Type**	**Level**	**Starting Time of Construction**
Beijing	Jumahe	Fangshan District, Beijing City	1125	*Andrias davidianus* and other aquatic wildlife	Wildlife	Provincial level	1996
Beijing	Huaishahe Huaijiuhe	Huairou District, Beijing	111	*Andrias davidianus*, Pungitius pungitius, mandarin duck and other wildlife	Wildlife	Provincial level	1996
Fujian	Kengdi *Andrias Davidianus*	Shouning County	19610	*Andrias davidianus* and its habitat	Wildlife	County level	2001
Gansu	Wenxian *Andrias Davidianus*	Wenxian County	13579	*Andrias davidianus* and its habitat	Wildlife	Provincial level	2004
Guangxi	Sijiansha n *Andrias Davidianus*	Rongshui Miaozu Autonomous County	10384	*Andrias davidianus* and its habitat	Wildlife	Provincial level	2004
Guangxi	Guangxi Qianjiandong	Guanyang	12231	Gingko, Abiesziyuanensis, yew, Chinese yew, Tragopan caboti, *Andrias davidianus*, Hoplobatrachus tigerinus, pangolin, macaque, Moschus berezovskii and so forth	Forest ecology	State level	1982
Guangxi	Guangxi Daping shan	Guiping City	1867	Rare plants including spinulose tree fern, and Apterosperma oblate and rare animals including Shinisaurus crocodilurus, *Andrias davidianus* and so forth	Forest ecology	Provincial level	1982
Guangzhou	Wanshishan *Andrias Davidianus*	Shaoguan City	850	*Andrias davidianus* and its habitat	Wildlife	County level	2006

Guangzhou	Huanghuajiang	Xinyi City	1000	*Andrias davidianus* and other aquatic resources	Wildlife	County level	1996
Guangzhou	Luhe Nanwan *Andrias Davidianus*	Shanwei City	500	*Andrias davidianus* and its habitat	Wildlife	City level	2006
Guangzhou	Guishan *Andrias Davidianus*	Heyuan City	133	*Andrias davidianus* and its habitat	Wildlife	City level	2001
Guangzhou	Paidu *Andrias Davidianus*	Liannan Yaozu Autonomous County	1046.6	*Andrias davidianus* and its habitat	Wildlife	City level	2004
Guangzhou	Binjiang Hydrobios	Qingxin County	1400	*Andrias davidianus*, Mystus guttatus, Pelteobayrus vachelli and other aquatic life	Wildlife	City level	2004
Guangzhou	Sanshui Aquatic Wildlife	Lianzhou City	210	Pelochelys bibroni, *Andrias davidianu*, golden coin turtle and other aquatic wildlife	Wildlife	City level	2004
Henan	Qingyaoshan	Xin'an County	4000	*Andrias davidianus* and its habitat	Wildlife	Provincial level	1988
Henan	Luanchuan *Andrias Davidianus*	Luanchuan County	800	*Andrias davidianus* and its habitat	Wildlife	County level	1996
Henan	Songxian *Andrias Davidianus*	Songxian County	600	*Andrias davidianus* and its habitat	Wildlife	County level	1998
Henan	Lushi Dayu	Lushi County	1000	*Andrias davidianus* and its habitat	Wildlife	Provincial level	1983
Henan	Xixia *Andrias Davidianus*	Xixia County	1000	*Andrias davidianus* and its habitat	Wildlife	Provincial level	1982
Hubei	Wanjianghe *Andrias*	Zhuxi County	780	*Andrias davidianus* and its habitat	Wildlife	Provincial level	1989

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Hubei	Zhongjianhe *Andrias Davidianus*	Xianfeng County	264	*Andrias davidianus* and its habitat	Wildlife	Provincial level	1994
Hunan	Huangsang	Suining County	12590	Forest ecology, hemlock, *Andrias davidianus* and other rare animals and plants	Forest ecology	State level	1982
Hunan	Zhangjiajie *Andrias Davidianus*	Wulingyuan District, Zhangjiajie	14285	*Andrias davidianus* and its habitat	Wildlife	State level	1996
Hunan	Longmenxi Giant Salamander	Chenxi County	3607	*Andrias davidianus* and its habitat	Wildlife	County level	1984
Hunan	Hunan Qiyanquan	Sangzhi County	484	Black bear, pangolin and *Andrias davidianus*	Forest ecology	City level	2001
Hunan	Hunan Piduhe	Longshan County	2162	Golden pheasant, *Andrias davidianus*, orchid and other wildlife under special state protection	Forest ecology	County level	2002
Jiangxi	Jing'an *Andrias Davidianus*	Jing'an County	100	*Andrias davidianus* and its habitat	Wildlife	County level	1980
Shanxi	Yangcheng Manghe Macaque	Yangcheng County	5600	Macaque, *Andrias davidianus* and warm temperate zone forest vegetation	Wildlife	State level	1983
Shanxi	Shanxi Lishan	Yuanqu, Yangcheng, Qinshui, Yicheng	24200	Warm temperate zone forest vegetation and Pucrasia macrolopha, macaque, *Andrias davidianus*	Forest ecology	State level	1983
Shaanxi	Taibai Xushuihe	Taibai County	5343	*Andrias davidianus*, Brachymystax lenok, Hucho taimen and other aquatic	Wildlife	Provincial level	1990

				animals			
Shaanxi	Lueyang *Andrias Davidianus*	Lueyang County	5600	*Andrias davidianus* and its habitat	Wildlife	Provincial level	2006
Shaanxi	Luonan *Andrias Davidianus*	Luonan County	5715	*Andrias davidianus* and its habitat	Wildlife	Provincial level	1999
Shaanxi	Shaanxi Yinghu Wetland	Hanbin District	19800	*Andrias davidianus*, Ciconia nigra, Accipiter soloensis and so forth	Wetland ecology	Provincial level	2001
Sichuan	Nuoshui he *Andrias Davidianus*	Tongjiang County	9480	*Andrias davidianus* and its habitat	Wildlife	Provincial level	2002
Sichuan	Quhe	Seda County	4300	*Andrias davidianus*, flowerfish and other aquatic animals	Wildlife	City level	2002
Sichuan	Sichuan Sima	Pingchang County, Bazhong City	12162	Egret, macaque, and *Andrias davidianus*	Forest ecology	County level	2000
Chongqing	Sandaigou	Youyang Dujiazu & Miaozu Autonomous County	9400	*Andrias davidianus* and its habitat	Wildlife	County level	1989

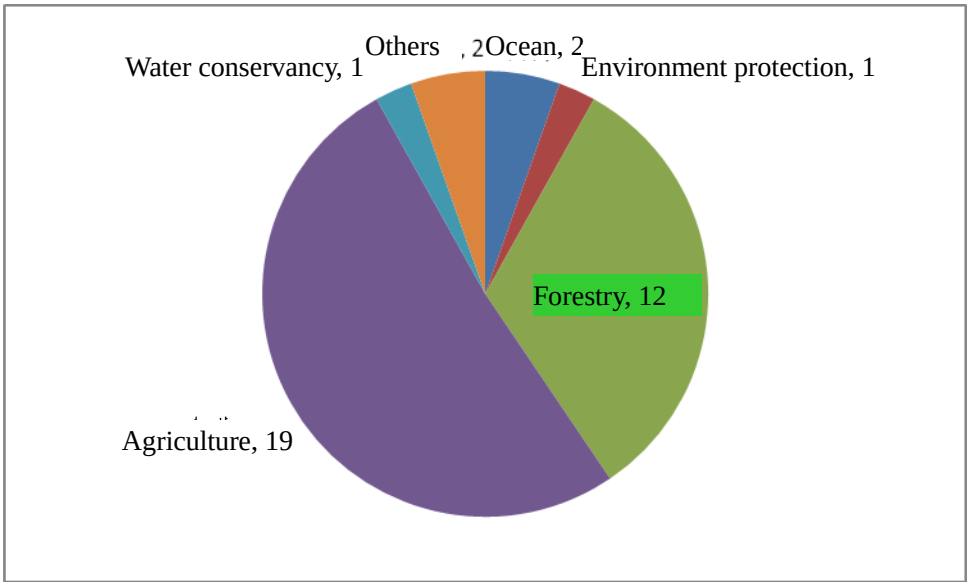

Fig. 10 Distribution of Competent Departments of *Andrias Davidianus* Reserves in China

The 22 *Andrias davidianus* reserves that have been established in China are province- or county-level reserves, except Zhangjiajie Reserve, which is a state-level reserve. As provincial level or county level reserves are restricted by staffing, highly inadequate fund and other problems, the majority of province- or county-level reserves exist only in name, rendering *Andrias davidianus* and its natural ecosystems under inadequate effective protection. Even if a few reserves obtain some fund support, but the infrastructure construction and scientific management is not in place, and limited funds are mainly used to build houses and ponds, showing a lack of awareness of protecting the entire *Andrias davidianus* original habitat natural ecosystem, which seriously departs from the scientific intention of local protection.

2. Disorderly Trading Market

Andrias davidianus of China has massive economic value. *Andrias davidianus* is tasty, and is said to have effects in strengthening immunity and slowing aging process, and is therefore passionately adored. Before 1980s, *Andrias davidianus* had always been an aquatic product that can be utilized. Up to date, the operational utilization of *Andrias davidianus* is eating. The market of *Andrias davidianus* eating was originally distributed in Guangdong, Hunan, Guangxi and other provinces, but it has been spread nationwide to many big cities and economically strong middle and small cities.

Andrias davidianus was, in 1988, listed among the wildlife under national second class special protection and listed in Annex I of CITES. Relevant laws and regulations provide that it is prohibited to hunt, kill, sell, buy, transport or carry wildlife under national special protection or their products, and hunting, killing, selling, buying, transporting or carrying wildlife under national

second class protection or their products that required in special conditions such as scientific research, taming/breeding and display must be approved by the wildlife competent administration of provinces, autonomous regions, or municipality directly under the Central Government to obtain Capture Permit, Operational Utilization Permit or Transport Permit. Taming and breeding of animals under national second class protection shall be approved by Province-level fishing competent administration to obtain Taming and Breeding Permit.

Any operational utilization of *Andrias davidianus* without approval from governmental competent administration before 2007 is illegal operational utilization of *Andrias davidianus.* Office of Aquatic Wild Fauna and Flora Conservation, Ministry of Agriculture, has since 2007, organized experts of State Endangered Aquatic Wildlife Science Committee to evaluate the *Feasibility Study Report on Operational Utilization of Andrias davidianus* submitted by nine *Andrias davidianus* breeding enterprises including one from Zhejiang Province (Yotrio Group Co., Ltd), two from Hunan Province (Hunan Ruff Biotech Co., Ltd., Zhangjiajie Jinni Biological Technology Co., Ltd.), five from Shaanxi Province (Shaanxi Hanshui *Andrias Davidianus* Development Co., Ltd., Shaanxi Nanzhen Qinling *Andrias Davidianus* Cultivation Co., Ltd., Shaanxi Xushui Biological Development Co., Ltd., Shaanxi Ningshan Longquan *Andrias Davidianus* Breeding Yard, Shaanxi Hanzhong Tiancheng *Andrias Davidianus* Breeding Co., Ltd.), one from Guizhou Province, the aquatic wildlife competent administrations of Zhejiang, Hunan, Shaanxi and Guizhou issued the *Andrias davidianus* operational utilization permits to them respectively to allow them to perform operational utilization of *Andrias davidianus.* In addition, Shaanxi Aquatic Wildlife Competent Administration also issued an *Andrias davidianus* operational utilization permit to one *Andrias davidianus* breeding enterprise (Shaanxi Hanyuan Biotech Co., Ltd.) to allow the enterprise to perform operational utilization of *Andrias davidianus* in Shaanxi Province.

The main *Andrias davidianus* production areas at present remain Shaanxi, Hunan and Hubei; other provinces has *Andrias davidianus* breeding but is small in size. The *Andrias davidianus* trading at present mainly falls into two categories: one being larvae trading and the other being trading in adult ones. The traded larvae primarily come from Shaanxi, which is followed by Hunan and Hubei. Larvae bred in Sichuan and other provinces are to a large extent from field capturing and to a small extent from artificial breeding in Shaanxi, Hunan and Hubei in addition to some local capturing of naturally bred larvae. The high end consumption of local catering of Shaanxi, Hunan, Hubei, Sichuan and other provinces will consume a part of adult *Andrias davidianus* and a large part is sold to Guangdong.

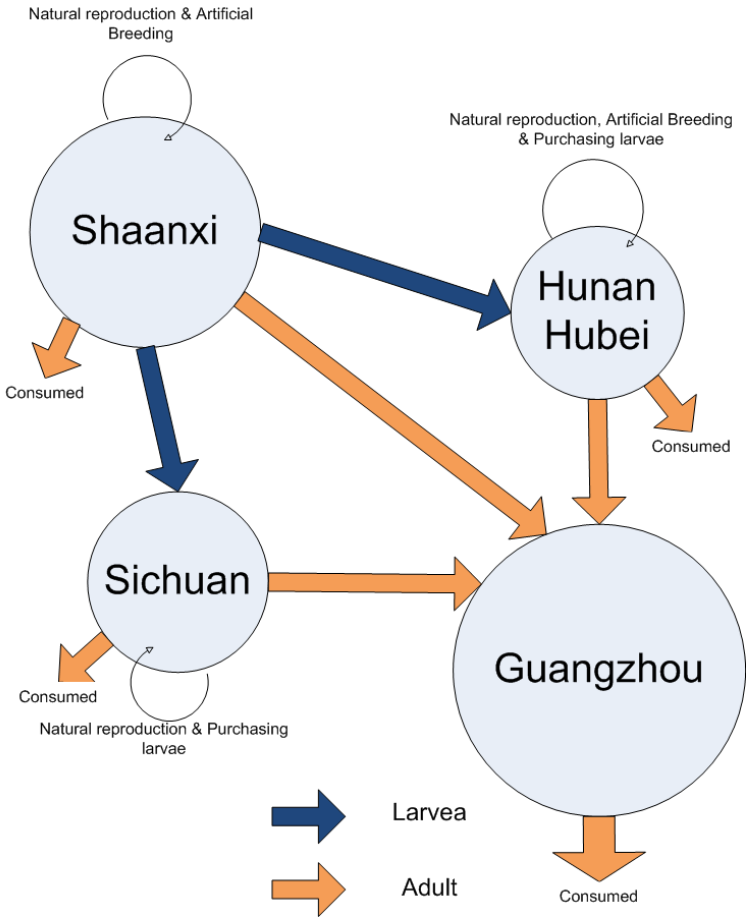

Fig. 11 *Andrias davidianus* Trading Flow Direction Diagram Between Shaanxi, Hunan, Bubei, Sichuan and Guangzhou

There remain a number of farmers breeding *Andrias davidianus* without permit, and it is very difficult to evaluate and regulate these small size farmers. In addition, the same problem also exists as in management of other artificial breeding of wildlife. Even if the seller has complete permits, it is difficult with current technology to determine whether the *Andrias davidianus* sold is genuine artificially bred ones or is wild one in the name of artificial breeding. This brings about great difficulty to management of *Andrias davidianus* protection.

IV. Current Situation of Artificial Breeding

1. A growing number of *Andrias davidianus* is artificially bred nationwide.

Artificial breeding of *Andrias davidianus* has become a hot industry throughout China since it has high dietary value, medicinal value and visual value. In 2007, there were 32,100 artificially bred *Andrias davidianus* in Zhang Jiajie, while there were only 2,000 wild *Andrias davidianus in* Zhang

Jiajie *Andrias Davidianus* Natural Reserve in the same period. (Luo et al. 2009) *Andrias davidianus* grow very fast if artificially bred, the production of which in one year can reach that of wild ones in five years (Jin & Wang 1997). Due to the huge economic value of *Andrias davidianus*, all funds for breeding are private capitals, and mated giant salamanders for propagation derived from wild *Andrias davidianus* before 2006. Since 2006, artificially bred *Andrias davidianus* have been sold to cultivation companies as mated giant salamanders because wild *Andrias davidianus* are too hard to catch, the breeding market expands dramatically, culturists are increasing, the market has huge demands for mated giant salamanders, the cost is very high, and artificially bred first artificially bred filial generation grew to be in the latency period (usually 5 years old). Now there is little *Andrias davidianus* for food or medicine.

Artificial breeding of *Andrias davidianus* has been widespread in 12 provinces or regions of our country (Shanxi, Shaanxi, Gansu, Sichuan, Guizhou, Yunnan, Henan, Hubei, Hunan, Jiangxi, Zhejiang, Guangdong) Before 2007, companies of breeding *Andrias davidianus* are: 3 companies in Shanxi with around 600 mated giant salamanders; 1 in Gansu with around 150 mated giant salamanders; 4 in Sichuan with around 600 mated giant salamanders; 5 in Guizhou with around 1000 mated giant salamanders (5,000 larvae in annual production); 1 in Yunnan with around 200 mated giant salamanders; 3 in Henan with around 500 mated giant salamanders; it is widespread in Fangxian County and Shiyan Region, Hubei Province, mainly breeding commercial mature giant salamanders; 13 in Hunan with around 6,000 mated giant salamanders (20,000 larvae in annual production); 3 in Jiangxi with 560 mated giant salamanders; 2 in Zhejiang with around 1,100 mated giant salamanders (30,000 larvae in annual production); and 5 in Guangdong with around 7,000 mated giant salamanders (20,000 larvae in annual production). So far, all the companies adopt the “Total Artificial Breeding Mode of *Andrias Davidianus*” to propagate larvae except those in Shaanxi Province.

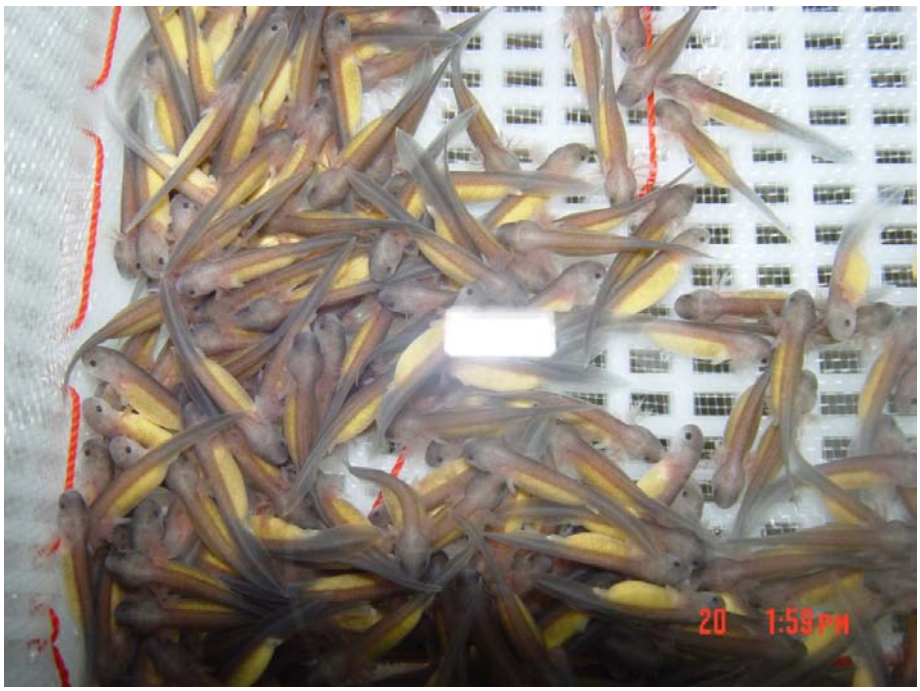

Fig. 12 Larvae Bred in Natural Habitats

(Retrieved zygotes have been incubated)

Fig. 13 Larvae Bred in Artificial Habitats

(Bred larvae in the dark cave)

Fig. 14 Total Artificial Breeding Mode of *Andrias Davidianus* (Indoor)

Fig. 15 Mode of Breeding in Natural Habitats

Fig. 16 Mode of Breeding in Artificial Habitats

In Shaanxi Province, there are 67 authorized propagation farms since 2000 when the first group of artificial breeding farms was approved. However, in Qinba Mountain Area of Shaanxi Province, especially Hanzhong City, there are more than ten thousand culturists that haven't applied for the Aritificial Breeding Certificate. The scale of *Andrias davidianus* breeding companies in Shaanxi Province range from 300 mated giant salamanders with annual production of 20,000-50,000 larvae to 10 or 20 mated giant salamanders with annual production of 1,000-3,000 larvae. The number of bred *Andrias davidianus* in Shaanxi Province was over 300,000 in 2007, over 400,000 in 2008, and over 600,000 in 2009. Since the technology of natural habit breeding and artificial habit breeding succeeded in 2001 and 2004 respectively, many culturists has bred large quantity of larvae by making use of this technology (see Fig. 4 & 5). The number of bred larvae just in Hanzhong City was 25,000 in 2005, 40,000 in 2006, 100,000 in 2007, over 350,000 in 2008, and over 500,000 in 2009. Due to rapid growth in recent years, Hanzhong City tops the four major origins in the breeding quantity of *Andrias davidianus*. In the beginning of 2008, Hanzhong Municipal Government issued "*Andrias Davidianus* Breeding and Protection in the Eleventh Five-year Plan of Hanzhong City", in which the government intends to accelerate the establishment of natural habits, artificial habits, and total artificial breeding bases during the Eleventh Five-year Plan, so as to form a structure of standardized management, mass production, and socialized service, providing adequate supports for proliferation of *Andrias davidianus* larvae and industrial development.

In Hunan Province, there are 5 or 6 large-scale breeding farms with annual

production of 10,000 pieces or so. It is reported that artificial propagation has been realized and the second artificially bred filial generation is still growing well, some individuals even being able to breed the next generation. However, we are not sure they are the true second filial generation totally artificially bred. Collection of natural bred larvae for artificial breeding also exists in Sangzhi and Wudaoshui. Other breeding farms are small and numerous, most of which are operated by common farmers, so the exact number is hard to count. Larvae in small breeding farms and families are mainly from large breeding farms, however, it is not impossible to catch or buy wild sources as there is large demand for larvae and the cost is very high.

In Jiangyou City, Xingwen County, etc. of Sichuan Province, there are artificial breeding farms for *Andrias davidianus*, but there has no report on successful artificial propagation yet. The larvae are mainly from juvenile flowing out from natural breeding farms or purchased from Shaanxi Province. Due to unfavorable artificial propagation and small demands, some breeding farms visited by us that are used to be prosperous now have small breeding quantity, some even hard to survive. Two companies in Zhejiang Province succeeded in commercial propagation. It is reported that the annual propagation can reach 3,000,000 to 6,000,000 larvae. It is strange that the two companies still buy larvae from Shaanxi, Sichuan, Hunan, Hubei, etc. The reason is unknown. (Wang Xiaoming, personal communication)

In general, most breeding farms have not completely mastered the technology of artificial propagation yet. In our survey, although not a few breeding farms claimed they have mastered the technology of artificial propagation for *Andrias davidianus*, most of them just succeeded in some individuals but not broke through the difficulty to realize artificial propagation in mass.

At present, artificial breeding of *Andrias davidianus* has become a hot industry throughout China, but the order is in a mess.

1) Lack of mated giant salamanders, the breeding companies have to buy *Andrias davidianus* especially wild *Andrias davidianus* in the original distribution areas at high prices, which makes the three *Andrias davidianus* populations disordered nationwide, so it causes difficulties of protection for genetic diversity and idioplasm resources of different *Andrias davidianus* populations.

2) Some mated giant salamanders distributed in remote mountain areas are just from the local places. Under artificial conditions, they may be inbred for long which can cause the loss of genetic diversity and degeneration of idioplasm resources. Therefore, works on off site conservation of *Andrias davidianus* require breeding companies to create true and reliable files for the sources and propagation of *Andrias davidianus* Furthermore, we should strengthen the establishment and study of genetic pedigree of artificially bred *Andrias davidianus*, so as to help breeding companies avoid

inbreeding which can cause the loss of genetic diversity and degeneration of idioplasm resources.

3)Application for Artificial Breeding Certificate of *Andrias Davidianus* must be examined and approved by the provincial fishery administration, and the procedures are complex and expensive, so many culturists are not certified, which causes tremendous difficulties for the governmental agencies to regulate their illegal actions and loss of their ideology and social responsibilities for protection of *Andrias davidianus*.

Fig. 17 Artificially Bred Andrias Davidianus in Jiangyou City

2. Artificial breeding has not play an obviously positive role in protecting wild *Andrias davidianus*.

Artificial breeding and propagation is a way of off site conservation to breed and propagate wild *Andrias davidianus* artificially, thus protecting idioplasm resources. Off site conservation is an effective way of protecting gene pools of rare and endangered species. According to Liang Gang's survey (personal communication), it is preliminarily estimated that the quantity of bred *Andrias davidianus* in our country is about 1,000,000, which is a trustable figure, so to speak more than 90 percent of the total number of *Andrias davidianus* is artificially bred. It was thought that successful artificial breeding of *Andrias davidianus* may bring less catching of wild *Andrias davidianus* and be good for protecting wild *Andrias davidianus*. Although artificial breeding of *Andrias davidianus* has developed rapidly, the protection for wild *Andrias davidianus* is very limited so far.

First, artificial breeding does not cause less catching at all. As the technology of artificial breeding has not broken through greatly, the price of *Andrias davidianus* is always high; mature *Andrias davidianus* are sold 1500-2000

Yuan per 500g on the market, and larvae are increased to 500-800 Yuan per one due to the demand of culturing. Therefore, some individuals catch wild *Andrias davidianus* and sell at once or after a period of culturing for huge benefits.

In many places, *Andrias davidianus* are bred on small scales by numerous farmers, so it is hard to register and confirm their sources. The way of current regulations is not severe enough to stop catching activities driven by sudden huge profits. Furthermore, the large-scale breeding farms are possible to purchase wild *Andrias davidianus* from catchers for huge profits. Even though the technology of artificial breeding is broken through in the future and the price reduced as 10 times as the current price, catching wild *Andrias davidianus* is still profitable as the *Andrias davidianus* grow slowly that requiring a long period and high cost. It is hard to eliminate catching activities by just depending on artificial breeding.

Second, there is little achievement in artificial releasing of larvae. Statistic shows that, from December 2002 to May 2008, 11 Propagation and Releasing Activities (as shown below in Table 2) have been conducted under the guidance of the fishery administrations in Shaanxi, Hunan, Jiangxi, Guangdong, Hubei, Guizhou, Anhui, Chongqing, and Sichuan and with the support of artificial breeding companies, totally 9,376 *Andrias davidianus* being released. The *Andrias davidianus* propagation and releasing activities raised the wild animal protectors and media's concerns and brought clear social benefits. To provide adequate resources for the releasing activities, in 2009, the Ministry of Agriculture confirmed 28 *Andrias davidianus* breeding companies through biddings in 13 provinces as the providers for propagation and releasing activities. It is known that the Ministry of Agriculture will buy *Andrias davidianus* from these 28 *Andrias davidianus* breeding companies for propagation and releasing.

However, the habits for wild *Andrias davidianus* are seriously contaminated. Rivers are polluted and ecological environment around the river is getting worse, the survival rate of released *Andrias davidianus* is unsatisfactory. In fact, there is no report that wild larvae of *Andrias davidianus* swimming out from underground rivers in Xingwen, Mabian, Jiangyou, etc. are nearly seen survived, as the surface of rivers is rather bad. Therefore, artificial releasing of larvae is little helpful for the conservation of wild population before the environment for them to habit is effectively improved. The price of *Andrias davidianus* is quite high and ground habits for them are densely populated with people, the released larvae may be caught soon.

Table 5 *Andrias Davidianus* Artificial Releasing Activities in China

Date	Releasing Place	Releasing Quantity (Nr.)

Dec.18, 2002	Zhang Jiajie City, Hunan Province	150
Sep.16, 2003	Heyuan City, Guangdong Province	250
Dec.22, 2004	Zhang Jiajie City, Hunan Province	350
May 23, 2005	Jing'an County, Jiangxi Province	1,000
Dec.10, 2005	Zhang Jiajie City, Hunan Province	120
May 14, 2006	Hanzhong City, Shaanxi Province	130
Jul.19, 2006	Jing'an County, Jiangxi Province	126
Apr.17, 2007	Huairou County, Beijing	200
May 10, 2007	Xinhua County, Hunan Province	160
Jul.23, 2007	Hanzhong City, Shaanxi Province	280
Apr.22, 2008	Hunan, Guangdong, Hubei, Shaanxi, Guizhou, Anhui, Chongqing, Sichuan	6,610
Total	Throughout the country	9,376

Fig. 18 Main Site for Propagation and Releasing Activity

Fig. 19 Propagation and Releasing Activity Site, Jiangxi

Fig. 20 *Andrias Davidianus* Released to Nature

V. Protection recommendations

The distribution shrinking and population declining are the main problems faced by *Andrias davidianus*, of which the causes are mainly due to habitat loss, and human fishing activities. We recommend that for protecting *Andrias davidianus*, its habitat shall be mainly protected, and its raising/breeding and trade management shall be strengthened.

1. To protect and restore ground habitat, strengthen pollution control, and restore ecological environment of rivers

Loss of habitat, especially ground surface habitat, is the main cause for distribution shrinking and population declining, thus to protect *Andrias davidianus*, its habitat shall be protected firstly. Otherwise, *Andrias davidianus* may become a second alligator sinensis: raising and breeding are very successful, but wild population is almost zero, thus it would contribute nothing for the natural ecosystem. In order to make the protection work to be conducted systematically, it is required to establish natural reserves in the main distribution and breeding areas of *Andrias davidianus*. In the absence of the conditions for the establishment of natural reserve, its wild germplasm resource protection can be carried out from the perspective of the industry.

Since the breeding of *Andrias davidiani* requires high quality of water, for protecting and restoring its habitat, water quality shall be protected firstly. It is required to control the pollution of rivers and streams, particularly the common agricultural non-point source pollution in rural mountainous areas and mining pollution. Secondly, the surrounding vegetation of rivers and streams shall be restored, soil erosion shall be controlled, and sediment content in water shall be reduced.

2. To strengthen the protection of underground-river habitat for wild *Andrias davidianus*

The underground river is currently the most important habitat for wild *Andrias davidianus*, and the main source of larvae of *Andias Davidianus* for artificial feeding. However, the population in underground river is facing with the problems of degeneration or even extinction, and the environmental problems of underground rivers can not be ignored. Thus, it is required to control various non-point source pollutions and industrial pollutions in the catchment area of underground river. In fact, due to complex conditions of underground river, this kind of pollution management is not much easier than that for ground habitat. However, in view of that the protection of underground habitat for *Andias Davidianus* is very important not only for the protection for *Andias Davidianus*, but also for the *Andias Davidianus* breeding industry. Thus, it is worthwhile to carry out underground river habitat protection.

Since the current ground habitat has been basically destroyed, the larvae of *Andrias davidianus* from underground river is difficult to survive on the ground surface. In our view, it is better to collect this part of larvae for artificial feeding rather than let them naturally die. But, since *Andrias*

davidianus is the wildlife under national second class protection, the capture of larvae of wild *Andrias davidianus* shall be conducted according to the requirements of management regulations from fisheries or wildlife protection departments. In addition, since there is a huge profit for artificial feeding, for the underground rivers that have not been included in the scope of natural reserve management, the breeding sites can also be protected from the perspective of germplasm resources.

3. To establish the migration channel between breeding sites in underground river

If there are few exchanges between various local populations, even widely distributed species would be extinct. This problem is being faced by *Andrias davidianus*. The ground surface habitat is shrinking, and populations are limited in various isolated underground rivers. For an isolated population, the genetic diversity may easily be lost, and the possibility of reconstruction of population may be reduced, thus the overall risk of extinction is increased. Therefore, for protecting *Andrias davidianus*, it is required not only to protecting several underground rivers, but also to establish the migration channel between underground river distribution sites. If it is temporarily difficult to establish the migration channel, the migration can be made manually to strengthen the artificial rejuvenation work of various local populations.

In addition, if the habitat near the exit of underground river is restored firstly, it means that the breeding habitat area and population size are increased, and the risk of extinction of local population is decreased, thus it is more conductive to increase the existence ability of whole metapopulation.

4. To further refine and improve breeding and releasing work

With some technical difficulties, under the huge economic benefits, the artificial breeding for *Andrias davidianus* is expected to be successful to a large scale level, and one or more huge artificial populations can be established. The breeding and releasing of wild animals is a system engineering involving very wide scope of subjects, which depends on in-depth study of ecology. The Proliferating and Releasing Program for *Catreus Wallichii* (to release the artificially propagated population in Britain to the origin in Pakistan) launched by World Pheasant Association has been carried out for 10 years since 1978, under which more than a hundred chicks were released per year, but as of 1991, only a couple of *Catreus Wallichii* recorded were survival, thus this program is basically unsuccessful. The reasons for failure are mainly related to the insufficient study for the habitat environment of the origin and the ecological research on wild

populations.

The above description has mentioned that 11 large-scale *Andrias davidianu* proliferating and releasing activities have been carried out, with a total 9,376 Nr. released. But the releasing effect shall be researched, monitored, and evaluated by use of scientific approaches. Luo et al (2009) conduct a survey and evaluation for the effect of 11 *Andrias davidianus* proliferating and releasing activities in National Natural Reserve Area for *Andrias Davidianu*s in Zhangjiajie, Hunan, for the period from 2002 to 2008. Luo et al (2009) believed that in these 11 times of releasing activities for totally releasing 995 numbers of *Andrias davidianu*, 4 times are successful, and 8 times are failed. All successful activities were provided with perfect safety management at later stage. But the judgment standard for success of releasing is not clear. In fact, reviewing from the situation of the *Andrias Davidianu*s releasing activity in Hanzhong city of Shaanxi Province, when releasing, the government departments only knew to propagandize and report this releasing activity through media, but they forgot that there are huge economic values of *Andrias davidianus*, thus, together with lack of safety management after releasing, resulting that some lawless persons captured *Andrias Davidianu*s shortly after this activity. In addition, the government departments did not fully consider whether the various ecological factors were suitable for *Andrias davidianus* to survive and multiply.

Based on the above mentioned reality for releasing *Andrias davidianus* in our country, it is recommended that the following aspects shall be considered by the government departments when conducting *Andrias davidianus* releasing activities: 1) Pre-preparation before project determination. Including establishment of artificial feeding population; study for wild population status of existing *Andrias davidianus* and ecological research, such as, selection of habitat, area of live zone, intraspecific variation, species composition, social behavior, feeding habits, predators, disease and so on; selection of releasing site. 2) Evaluation of releasing site. Including identification of risk factors, and elimination of these factors; restoration and reconstruction of living environment. 3) Selection, quarantine and adaptability training for released individuals. 4) Preparation and releasing. Including determination of short-team and long-team goals; determination of releasing strategies; studies on adaptability of released individuals for water and soil, trainings for feeding behaviors, and determination of releasing site and time. 5) Work to be conducted after releasing. Including continuously tracking and monitoring (the most important measure is the radio telemetering); statistics of the number of released individuals, and ecological and behavior researches; adaptive process of released individuals, and investigation for the cause of death; manual intervention when necessary (such as: supplementary feeding and disease control); and evaluation of releasing effect.

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Appendix Public Education on Chinese Giant Salamander Protection

Public education on protection of Chinese Giant Salamander was carried out in 16 Dec, 2009 in Ande primary school, Pixian County by members of project team and volunteers. We advocated the information about Chinese Giant Salamander and the importance of the protection to Students, parents and teachers. We distributed pamphlets about Chinese Giant Salamander protection to Students, their parents and teachers. A lecture on Chinese Giant Salamander protection was given to more than 600 students. We introduced the information about habits, characteristics and importance of protection of the Chinese Giant Salamander to students through stories, photos and games. We suggested students to take the pamphlets back their home and share the stories they learned in the education with their parents. Students learned the life history of Chinese Giant Salamander and understudied the importance of its conservation through the education. Besides, we also believe that most of their parents will understand the importance of conservation.

Distributing pamphlets

Reading pamphlets

Reading pamphlets and waiting for lecture

Parents of students

Teachers are interesting in Chinese Giant Slammer

Leture

Leture

Students asking questions

Students asking questions

Learning the information about Chinese Giant Slammers through game

There was something funny

Pamphlet on Chinese Giant Salamander conservation