Asian Herpetological Research 2010, 1(2): 64-85
DOI: 10.3724/SP.J.1245.2010.00064

Progress and Prospects for Studies on Chinese Amphibians

FEI Liang, YE Changyuan and JIANG Jianping*

Chengdu Institute of Biology, Chinese Academy of Sciences, Chengdu 610041*, Sichuan, China*

Abstract This work summarizes the history and progress of the studies on Chinese amphibians since they first appeared in the Chinese literature. A wide range of research has been carried out, including the history of the definition of amphibians, faunal surveys, systematic research, ecological research, biochemical research (isozyme and other proteins or peptides, chromosomes, DNA), anatomical research, embryological research, phylogenetic and zoogeographical research, and many others such as ultrastructure of organs, crossbreeding test, regeneration of organs, abnormality survey, acoustics, fossils, sperm ultrastructure and parasites. In addition, the prospects for studies on Chinese amphibians in future are proposed in this paper.

Keywords progress, prospect, faunal survey, systematics, amphibian, China

1. Introduction

China is located in east Asia and covers a land area of approximately 9.6 million km^2. Due to the vast territory occupied by this country, extremely different landforms, complex environments, and diverse climates and vegetation, China is very rich in amphibians, not only containing extremely numerous rare and endemic species, but also preserving a large number of relic species. Presently, there are 386 species, and 10 subspecies, belonging to 76 genera, 13 families and 3 orders, of which three species are invasive aliens, and 242 species are endemic to China, accounting for 62.8% of the total amphibians of China (Jiang *et al*., in press). This work summarizes the history and progress of the studies on Chinese amphibians since they first appeared in the Chinese literature, and proposes the prospects of the studies on Chinese amphibians in the future.

2. Brief Historical Studies on Amphibians

References were found for the Chinese historical records on amphibian research for at least 3000 years: toads (maybe *Bufo gargarizans*) were equated to ugliness and wickedness in 'The Book of Songs' (-3000 years ago), but frog (*黽*, *鼃*) had been inscribed on bones or tortoise shell approximately 16th – 11th centuray B.C. (Guo *et al*., 1999). "*人鱼*" (Mermen, now called the Chinese giant salamander, *Andrias davidianus*), "*活师*" (meaning tadpoles), and "*黾*" (meaning frogs) were mentioned in 'The Classic of Mountains and Seas' (–2500 years ago). Amphibians were divided into two groups: the worms and the fishes in the 'Er Ya' (–2000 years ago), an ancient book containing commentaries on classics, names etc, and into three groups in the 'Origin of Chinese Characters' (A.D.100–121), that is, 1) group with the 'Fish' character including the Chinese giant salamander, 2) group with 'Worm' character including toads, and 3) the "*黾*" with "frog" characters including toads. TAO Hong Jing (A.D. 502–549) listed the Chinese giant salamander, toads, and frogs as medicinal animals. In the 'Compendium of Materia Medica' (Li, 1596), amphibians were divided into two sections: Chinese giant salamander belonging to the fishes without scales, and toads and frogs belong to worms of wet environment. These facts reflect a rudimentary understanding of amphibians in ancient China.

In other countries, Linnaeus (1758; 10th Edition) was the first scientist to establish the biological classifications (sometimes known as "Linnaean Taxonomy"): kingdom,

*Corresponding author: Prof. JIANG Jianping, from Chengdu Institute of Biology, Chinese Academy of Sciences, with his research focusing on systematics, evolutionary biology and conservation genetics of amphibians
E-mail: jiangjp@cib.ac.cn
Received: 12 June 2010 Accepted: 20 October 2010

phylum, class, order, family and genus, and the introduction of the idea for a binomial nomenclature for naming species. The Class Amphibia was first adopted by Linnaeus (1758; 10th Edition), including not only true amphibians but also reptiles and some fishes, and was divided into three orders: 1) Reptiles, a group with feet including *Testudo*, *Draco*, *Lacerta* (containing crocodiles, lizards, and salamanders), and *Rana*; 2) Serpentes, a group without feet, including snakes, slowworm, and caecilian; and 3) Nantes, a group with fins. Frogs were easy to be distinguished from other groups and assigned in the genus *Rana* (*sensus lato*), but salamanders were assigned to so called *Lacerta*, and caecilians were assigned to the order Serpentes.

Generally speaking, the Class Reptilia was formally used by Laurenti (1768), and it contained three orders: 1) Salientia, including *Pipa*, *Bufo*, *Rana* and *Hyla* of tailless amphibians, and *Proteus of* tailed amphibians; 2) Gradientia, including salamanders *Triton* (=*Triturus*, *Salamandra*, lizards (*Gekko*, *Chamaeleo*, *Iguana*), and crocodiles (*Crocodylus*); and 3) Serpentia, including caecilian (*Caecilia*) and snakes (*Amphisbaena*, *Anguis*, *Natrix*, *Coronella*, *Boa*, *Coluber*, *Vipera*).

On the basis of internal structures, reproductive modes, and development, Brongniart (1799) divided amphibians and reptiles into two groups: The first group was set up for reptiles, with caecilians assigned to the order Ophidii; and the second group was for Batrachia, i.e., Batraciens, including *Salamandra*, *Rana*, *Hyla*, and *Bufo*, of which salamanders were separated from lizards for the first time. Latreille (1804) further indicated that Batrachii was characterized by tips of toes without claw, juveniles with gills, and metamorphism present in individual developmental process. Duméril (1806) put forward two French terms, Anoures and Urodèles, the former means tailless amphibians, and the latter tailed amphibians. These two terms were Latinized as Anura and Urodela by Fischer van Waldheim in 1813 (Frost, 2010), which are two of the orders of living amphibians currently recognized. This was the first time to separate these taxonomic groups had been separated from reptiles. Oppel (1811) separated the group Apoda from the Class Reptilia and combined them with salamanders (Caudata) and frogs (Ecaudata) together as a larger group Nuda, of which the three groups correspond to the three orders of extant amphibians recognized. From then on, amphibians were distinguished from reptiles with scales. It is necessary to explain here that the term Apoda had been preoccupied by a group fish Apodes in Latreille (1804), and then the former is the junior synonym of the latter. So the Apoda had been replaced by Gymnophiona (Rafinesque-Schmaltz, 1814) in amphibians.

The opinion that the Class Amphibia should be separated from the Class Reptilia was widely adopted by herpetologists (Gray, 1825; Wagler, 1828, 1830; Fitzinger, 1826, 1843; Günther, 1858). Boulenger (1890) indicated that Amphibia was a transition group between Pisces and Reptilia. Dubois (1991) suggested Batrachology as a distinct scientific discipline to study amphibians.

3. Progress in Surveys and Studies of Chinese Amphibians

3.1 Surveys and studies of Chinese amphibians prior to 1950

3.1.1 By foreign scientists Linnaeus (1758) was the first foreign researcher to record Chinese amphibians identified from the specimens that had been brought to Europe by Marco Polo in the 13th Century. Swede Osbeck (1771) was the first person to collect specimens of amphibians in China in the 18th century and recorded the species *Rana chinensis* (= *Hoplobatrachus chinensis*) from Guangdong Province (= Canton in the literature) of China. Wiegmann (1835) recorded a new species *Rana rugulosa* (= *Hoplobatrachus chinensis*) embedded in specimens collected from Hong Kong, Macau, and Guangzhou by Meyen in 1831. In order to establish a museum, the Dutch in 1820 collected many amphibian specimens from Southern Asia, China, and Japan, and those specimens from China including the genera *Andrias*, *Hynobius*, *Onychodactylus*, *Cynops*, *Leptobrachium*, *Hylarana*, *Polypedates*, *Buergeria*, *Theloderma*, *Microhyla* and *Kalophrynus*, which were denominated by Tschudi, and the genera *Ichthyophis*, *Pelophylax* and *Limnonectes* denominated by Fitzinger. The creation of these genera provided an important basis for further taxonomic studies of Chinese amphibians.

From 1840 to 1949, herpetologists from Britain, Germany, Russia, France, Austria, USA, and Japan came to China in different periods to survey amphibians and collect specimens. 45 new species were published by the British herpetologists in 35 articles, 17 new species by the American in 50 articles, 9 new species by the German and French each in 32 articles, 7 new species by the Russian, and 3 new species by the Japanese. According to preliminary statistics, more than 80 new species published by them are now valid. Even though the type localities of the above new species are in China, the type

specimens are now preserved in various museums of different foreign countries. There were approximately 70 colleagues collecting and writing about 170 articles on Chinese amphibians. The following are the summaries of the major contributing countries and colleagues.

Cantor from England collected amphibians in Zhoushan (= Chusan) of Zhejiang Province from 1840 to 1842, from which a new species *Bufo gargarizans* was discovered, and *Rana nigromaculatus* was incorrectly named as *Rana esculenta* (Cantor, 1842). Hodgson collected amphibian specimens in Tibet, China from 1845 to 1859. Swinhoe surveyed some regions in China including Taiwan, Penghu and Xiamen in 1861, also in the Hainan Island and the Leizhou Peninsula of Guangdong, and along the Yangzi River in 1868 and 1869, and he published his survey results in his *List of reptiles and batrachians collected in the Island of Hainan* (Swinhoe, 1870a) and *Notes on reptiles and batrachians collected in various parts of China* (Swinhoe, 1870b). After that, Blyth, Gray, and Günther studied these specimens and published new species of amphibians and reptiles in the following several decades. From 1858 to 1896, Günther published 20 papers, discovering 11 new species of amphibians, of which four species with type localities in China include *Hynobius chinensis* and *Rana boulengeri* (=*Qusipaa boulengeri*) (Günther, 1889), collected in Yichang of Hubei Province by Pratt, *Bufo mammatus* (=*Aelurophryne mammatus*) (Günther, 1896), collected by Potanin, and *Nanorana pleskei* (Günther, 1896) by Berezowski. Günther (1896) published a new genus *Nanorana*. Gray published two new species, *Cynops chinensis* Gray 1859 (=*Paramesotriton chinensis)* and *Kaloula pulchra* Gray, 1831.

Hallowell from the USA (1860) published 47 new species and 10 new genera of amphibians and reptiles from the specimens collected in Japan, Ryukyu Islands, Hong Kong, and Java by John Rogers and his colleagues. China is the type locality for 10 of the species, of which 6 are amphibians, including *Rana multistriata* (=*Fejervarya multistriata*), *Rana trivittata* (=*Hylarana macroductyla*), *Rana nebulosa* (a nomen dubium, it's of incertae sedis in the genus *Odorrana*; Frost, 2010), *Bufo griseus* (=*Bufo gargarizans*), *Engystoma pulchrum* (=*Microhyla pulchra*) and *Polypedates megacephalus*, and they were all collected in Hong Kong.

Anderson from England went to Burma and southwestern Yunnan twice since 1868 and collected many specimens. From 1871 to 1879, several articles were published, including '*Mandalay to Momien: A Narrative of the Two Expeditions to Western China of 1868 and 1875*' (1876), and '*Anatomical and Zooll Researches: Comprising an Account of the Zooll Results of the Two Expeditions to Western Yunnan*' (1878), and 9 new species of amphibians and one new genus *Tylototriton* were published (1871).

From 1862 to 1873, French missionary David surveyed in Beijing, Hebei, Inner Mongolia, Shanxi, Shaanxi, Zhejiang, Fujian, Jiangxi, and Sichuan, and published 8 new species of amphibians, 6 are still valid, and 3 collected from Baoxing County of Sichuan (David, 1871): *Dermodactylus pinchonii* (= *Batrachuperus pinchonii*), *Polypedates mantzorum* (= *Amolops mantzorum*) and *Polypedates dugritei* (=*Rhacophorus dugritei*). In addition, he collected specimens of *Sieboldia davidiana* (=*Andrias davidianus*) denominated by Blanchard (1871) for memory of his contribution to this species.

From 1878 to 1920, Boulenger, a Belgian-British zoologist, examined many of the specimens of amphibians that were preserved in the British Museum and collected from northeastern China, Shandong, Fujian, Taiwan, Sichuan, Yunnan, and adjacent countries including Korea, Japan, Viet Nam, Burma, India and Nepal by Holst, Moltrecht, Berezowki, Sauter, Graham, Dymond and Tonche, and published more than 60 papers, of which '*Catalogue of the Batrachia Salientia s. Ecaudata in the Collection of British Museum*'(1882), '*A Revision of the Oriental Pelobatid Batrachians*(*Genus* Megalophrys)'(1908), '*A Monograph of the South Asian, Papuan, Melanesian and Australian Frogs of the Genus* Rana'(1920) narrated 36 new species and 5 new genera of amphibians. The type localities of more than 20 species are in China.

In 1911, Scottish zoologists Annandale and Hodgart surveyed amphibians in Abor (southern part of Medog, Tibet, China), the boundary between Southeastern Tibet of China and Northeastern India, and collected many amphibian specimens. 25 species, including 5 new species, were recorded in '*Zooll Results of Abor Expedition 1911–1912*' (Annandale, 1912) including the collection of Kemp.

Smith, from England, surveyed amphibians several times in Southeast Asia, and in 1923 he surveyed Hainan Island. He published seven new species pertaining to China, of which two new species were found on Hainan Island (Smith, 1923).

Russian explorer Przewalsky and his colleagues visited China four times in the Amur River region, Inner Mongolia, Xinjiang, Gansu, and Qinghai, and collected more than 8500 specimens of animals, belonging to 680

species, most of which were preserved in the Institute of Zoology, Russian Academy of Sciences. Bedriaga, a Russian herpetologist, studied the 1200 specimens of amphibians and reptiles, and published '*Wissenschaftliche Resultate der von N. M. Przewalski nach Central-Asien unternommenen Reisen. Zoologischer Theil. Amphibien und Reptilien* (Band 3，Abt.1)' in 1898–1912, of which 8 species and 6 new subspecies were recorded. From 1915 to 1930, Zarevsky studied the specimens collected from Inner Mongolia, Sichuan (in Batang and Kangding), Qinhai, and Tibet by Kozlov in 1899–1926, and discovered 5 new species of amphibians (Zarevsky, 1924, 1925a, 1925b, 1930).

From 1885 to1901, German zoologist Boettger studied many of the Chinese amphibian specimens preserved in Frankfurt, which were collected from Hubei, Anhui (in Wuhu), Zhejiang (in Ningbo), Shanghai, Hong Kong, Hainan Island, Guangdong and Guangxi, and published about 10 articles, of which '*Materialien zur Herpetologischen Fauna von China* (I, II, III)' were published in 1885, 1888, and 1894, respectively, and recorded 40 species of Chinese amphibians, including several new species.

Since 1894, many Japanese researchers traveled to China to survey bio-resources, from which several papers were published. Maki started collecting specimens from Taiwan, China in 1911, and published a paper '*Notes on the Salamanders Found in the Island of Formosa*' (1922), in which three new species of tailed amphibians were recorded, *Hynobius arisanensis*, *H. formosanus* and *H. sonani*. Mori published '*A Hand-list of the Manchurian and Eastern Mongolian Vertebrata, Amphibia*' (1927a) and '*On a New* Hynobius *from South Manchuria*' (1927b). Okada published '*The Tailless Batrachians of the Japanese Empire*' (1931), '*The Anuran Fauna of Formosa*' (1934) and '*Amphibia and Reptilia of Jehoh*' (1935).

From 1899 to 1910, Wilson (Wilson visited China four times, and the first two represented by UK and the last two by USA) and Zappey from USA visited China several times, and kept their collections of specimens at Harvard University. Jordon and Barbour studied these specimens together with those collected by Owston, and published several papers, in which two new species were recorded, *Bufo bankorensis* Barbour, 1908, and *Kaloula borealis* (Barbour, 1908).

For 10 years starting from 1916, Andrews from USA organized a group to survey Middle Asia, and explored most of China. Among them, from 1921 to 1926, Pope surveyed in Guangdong, Hainan Island, Hunan, Fujian, Anhui, Shandong, Hebei and Shanxi. Specifically, Pope investigated Fujian and Hainan Island, collecting a large number of specimens of amphibians while documenting their life history and ecology. Based on these data and specimens, Pope published several papers, of which '*Notes on Amphibians from Fukien, Hainan, and Other Parts of China* (1931)' recorded 2 orders, 9 families, 18 genera, and 67 species with morphological descriptions, life history, and biological data.

Stejneger from USA studied the amphibian specimens that were preserved in the American National Museum and also collected specimens from Japan and China, including Inner Mongolia, Hebei, Beijing, Sichuan, Tibet, Yunnan and Taiwan, and published several papers and/or monographs, '*Herpetology of Japan and Adjacent Territory*' (1907). In 1927, he created a new genus *Altirana* endemic to the Qinghai-Tibet Plateau, which was later synonymized with the genus *Nanorana* by Lu *et al.* (1995).

Taylor, also from the USA, studied amphibians collected by Light from Fujian, Hainan Island and Jiangsu, and published a paper '*Notes on Chinese reptiles and amphibians*' (1934), in which a new species *Rana lighti*, a junior synonym of *Pelophylax fukiensis* (Pope, 1929) now, was recorded. From 1925 to 1956, Schmidt studied 1800 specimens preserved at the American Museum of Natural History, of which 1389 specimens were collected in the 3rd Asian Survey, and produced several publications. In them, Schmidt (1925a, b; 1927) recorded 40 species, belonging to 11 genera and 7 families, including two new species, *Batrachuperus tibetanus* (Schmidt, 1925) and *Bufo andrewsi* (Schmidt, 1925). In addition, some tailed amphibians of China were recorded in '*The Salamanders of the Family Hynobiidae*' (Dunn, 1923) and '*Les Salamandres d'Europe, d'Asie et d'Afrique du Nord*' (Thorn, 1968).

Of the foreign zoologists teaching at Chinese universities, Gee and Boring, from 1919 to 1930, collected a large quantity of data and literature on Chinese amphibians, and published '*A Check List of Chinese Amphibia with Notes on Geographical Distribution*' (1929), which recorded 131 species, belonging to 25 genera, 10 families and 2 orders, with original notes, type localities, distribution ranges, etc. From 1930 to 1945, Boring collaborated with Pope CH, Liu CC, Chang TK, and Xu XP and published ten more treatises, of which the book '*A Survey of Chinese Amphibia*' (Pope and Boring, 1940) was based on the Chinese amphibians preserved in more than ten

museums. This book recorded 87 species of Chinese amphibians with taxonomic discussion of each species and the preservation states of those specimens in museums. Following this, based on all the collected literature on taxonomic studies of Chinese amphibians, Boring (1945) wrote '*Chinese Amphibian: Living and Fossil Forms*' recording living and fossil species with a nomenclatural list and geographic distributions.

3.1.2 By Chinese scientists The earliest surveys and studies of Chinese amphibians by Chinese scientists began in the 1920's. When Ping Chi returned from the USA in 1920, he created the Biology Department in Nanjing University, and was one of the founders of 'Fan Memorial Institute of Biology' in Beijing. In addition, he started the "Journal of Biology". All these activities provided a basis for Chinese biological research, including herpetological research. From 1926, he, together with his students Chang MLY, Chang TK, Fang PW, Hsu XP, and Wu HW, carried out several field surveys in eastern China, southern China and Sichuan, with the subsequent discovery of new species. The work of Wu (1929) and Shaw (1929) opened the prelude to the researches of Chinese amphibians by Chinese scientists. After that, Wu (1930), Hsu (1930), Fang and Chang (1932), and Chang (1932) published many papers on Chinese amphibians. In addition, monographs including '*Study of Some Amphibians from Szechuan*' (Chang and Hsu, 1932), '*Amphibiens Urodèles de la Chine*' (Chang, 1936), '*Notes on Amphibia from Bohea Hill, Fukien*' (Ting, 1944) were also published.

In northern China, the main research group for Chinese amphibians consisted of Liu CC and Chang TK, and Professor Boring AM from USA. From 1929 to 1931, Liu CC worked in Shenyang, and then went to Beijing and conducted many surveys and research projects on the amphibians of northern China, particularly on the life history and secondary sex characteristics of frogs. From 1937, Liu CC worked at Union University of Western China in Chengdu. He, together with approximately ten colleagues, carried out several field surveys of amphibians in western Sichuan and Gansu, and collected a large amount of specimens and biological data, based on which 30 papers were published. The papers '*The Linea Masculina, a New Secondary Sex Character in Salientia*' (1935), and '*Types of Vocal Sac in Salientia*' (1935) attracted interest and notice from both inside and outside of China. He finished his first book '*Amphibians of Western China*' in 1950, in which 74 species of amphibians in western China were recorded. In addition, he discovered 27 new species and created one genus, *Vibrissaphora*. The rich content in this book is a continual source of inspiration for studying amphibians both in China and on a global scale.

3.2 Surveys and research of Chinese amphibians since 1950

3.2.1 Faunal surveys and sytematic research After 1950, a greater number of individuals and institutional Chinese scientists carried out surveys of Chinese amphibians. For example, Ting (1950) surveyed amphibians of Fujian, Chen (1956) studied amphibians of Chinese Taiwan, Huang (1958) wrote about the amphibians of Xishuangbanan in Yunnan, Mao (1959) about amphibians of Hangzhou of Zhejiang, Zhou and Shan (1961) about amphibians of Henan, Zhou (1962) about amphibians of Jiangsu, Xue (1963) about amphibians of Wuhan in Hubei, Zhou *et al*. (1963) about amphibians of Guangdong, Wang *et al*. (1964) about amphibians of Tianjing, Shen (1965) about amphibians of Hunan, and Guo (1966) about amphibians of Zhejiang.

From 1952 to 1970, Liu CC and Hu SQ organized for their colleagues from the Sichuan Medical College, and Chengdu Institute of Biology, Chinese Academy of Sciences (CIB), and carried out broad field surveys of Chinese amphibians in Sichuan, Yunnan, Guizhou, Shaanxi, Fujian, Guangxi, and the Hainan Island. Approximately 100 individuals took part in these surveys, collecting more than 30,000 specimens, and publishing several papers. For example, Liu and Hu (1959, 1962), Liu *et al.* (1960a, b; 1962), and Hu and Yang (1960), Hu *et al.* (1966) reported on amphibian diversity, including some new species and national new records, which discussed the amphibian fauna of the above mentioned regions. In addition, during this period in the 1950's, Liu *et al*. (1959) wrote the book '*Atlas of Chinese Animals: Amphibians*', which was the first atlas of Chinese amphibians, in which 42 species were recorded. Liu and Hu (1961) wrote the book '*Tailless Amphibians of China*', in which 120 species known then in China were recorded along with taxonomic status, morphological narratives, and biological data for each species, phylogenetic relationships of some genera and species, as well as issues worthy of further research were suggested also. Undoubtedly, the works above have played a significant role in promoting further research of Chinese amphibians and development of Batrachology. After that Zhou (1965) published the book '*Anatomy of the Frog Body*'.

The 1970's was the period in which surveys of Chi-

nese amphibians were conducted throughout China. A workshop on compiling '*Fauna Sinica*' was held in February, 1973 in Guangzhou, and then the workshop on compiling '*Fauna Sinica: Amphibia*' was organized in December, 1973 in Chengdu. These projects undoubtedly accelerated China's surveys and further research of amphibians, as well as compiling provincial fauna of Amphibia. During the 1970's, more than 100 papers were published, 70% of them were on taxonomic studies and fauna analyses. For example, Liu *et al*. (1973, 1979), Hu *et al*. (1973), Yang *et al*. (1976), Sichuan Institute of Biology (SIB, former name of CIB, Fei *et al*., 1976, 1977; Fei and Ye, 1976; Hu *et al*., 1974; Ye and Fei, 1974, 1976; Zhao and Wu, 1974) reported some new species and nes national new records. SIB (Hu *et al*., 1977) compiled the book '*Sytematic Key to Amphibians of China*', which recorded 204 species known then in China, belonging to 35 genera, 11 families and 3 orders. During that time, it was the most complete and useful reference book, and played an important role in the surveys and taxonomic research of Chinese amphibians. Yang *et al*. (1978) published '*Amphibians and Reptiles of the Gaoligong Mountains, Western Yunnan*', in which 27 species or subspecies of amphibians were recorded.

In the 1980's, Chinese batrachological research rapidly advanced, it not only included surveys, taxonomic studies and fauna analyses, but also developed ecological, embryonic, cellular-genetic, biochemical, anatomical, histological, acoustical and paleontological studies, as well as conservation biology. Special projects were carried out, for example, 'Ecological Studies of *Cynops cyanurus*' (1980–1984), 'Generic and specific taxonomic studies of Hynobiidae' (1982–1985), 'Taxonomic studies of Rhacophoridae' (1987) by CIB, 'Generic and specific taxonomic studies and phylogeny of Chinese Pelobatids' (1986-1990) by CIB collaborated with Yunnan University and Chongqing Museum, based on which series of papers were published. During this period, about 450 papers were published, 270 covered species diversity, taxonomy of amphibian fauna. This 2.6–2.7 times higher than those published in the passed 30 years. In addition, some provincial amphibian fauna, and reference books and monographs were published: '*Amphibians of Taiwan*' (Lue and Chen, 1982), '*Identification Manual of Chinese Amphibians and Reptiles*' (Tian and Jiang, 1986), '*Studies on Chinese Tailed Amphibians*' (Zhao and Hu, 1984), '*The Amphibian Fauna of Guizhou*' (Wu *et al*., 1988), '*Fauna Liaoningica: Amphibia Reptilia*' (Ji *et al*., 1987), '*Amphibia-Reptilia of Xizang*' (Hu *et al*., 1987), '*Hong Kong Amphibians and Reptiles*' (Karsen *et al*., 1988), and '*Economical Fauna of Qinghai: Amphibia*' (Huang, 1989).

In the 1990's, Chinese batrachological research achieved various results in many aspectes. During this decade, more than 470 papers and 20 monographs were published, some of them derived from the following special projects: 'Generic and specific taxonomic studies of the family Ranidae', 'Taxonomic studies of the genus *Rana*', 'Reproductive ecological studies of *Echinotriton chinhaiensis*', and 'Taxonomic studies of the genus *Odorrana*' carried out by CIB, 'Phylogenetic studies of torrent frogs' and 'Taxonomic studies of the family Bufonidae' done by Kunming Institute of Zoology, CAS (KIZ), 'Artificial breeding and conservation of *Ranodon sibiricus*' by Xinjiang Normal University, 'Reproductive ecology of *Cynops orientalis*' by Hunan Normal University, 'Reproductive ecology of *Tylototriton kweichowensis*' by Liupanshui Teacher's College. Six of the 20 monographies are national range: 1) '*Key to Chinese Amphibia*' (Fei *et al*., 1990), which recorded 279 species or subspecies known then in China, belonging to 58 genera or subgenera and 11 families or subfamilies; including one new subfamily Occidozyginae, five new genera (*Pseudorana, Rugosa, Tigrina, Glandirana*, and *Odorrana*), three new subgenera (*Paa* (*Quadrana*), *Paa* (*Unculuanus*), and *Hylarana* (*Tenuirana*)), and six new species; 2) '*Rare and Economic Amphibians of China*' (Ye *et al*., 1993); 3) '*Latin-Chinese-English Names of Amphibians and Reptiles*' (Zhao *et al*., 1993, with the names of amphibia written by Hu SQ, Fei L, and Ye CY); 4) '*Herpetology of China*' (Zhao and Adler, 1993); 5) '*China Red Data Book of Endangered Animals: Amphibia & Reptilia*' (Zhao, 1998); and 6) '*Atlas of Amphibians of China*' (Fei, 1999), which recorded 302 species known then in China, belonging to 59 genera or subgenera in 11 families of 3 orders. Eight of the monographs are on provincial faunas: 1) '*Fauna of Zhejiang: Amphibia/Reptilia*' (Huang *et al*., 1990); 2) '*The Amphibian and Reptilian Fauna of Anhui*' (Chen, 1991); 3) '*The Amphibia-Fauna of Yunan*' (Yang, 1991); 4) '*Vertebrata Fauna of Gansu: Amphibia*' (Song and Yao, 1991); 5) '*Amphibians and Reptiles of the Hengduan Mountains Region*' (Zhao and Yang, 1997); 6) '*Amphibians and Reptiles of Shanxi Province*' (Fan *et al*., 1998); 7) '*Atlas of Amphibians and Reptiles of Taiwan*' (Lu *et al*., 1999); and 8) '*Tadpoles of Taiwan*' (Chou *et al*., 1997). In addition, six books regarding the economic use and popular science of Chinese amphibians were published. The accomplishments above greatly enriched

the research content of Chinese amphibian taxonomy, fauna and conservation, and confirmed the solid achievements that the Chinese researchers attained in the 1990's.

For the first decade of the 21th century, Chinese herpetologists have made a satisfactory progress in amphibian research. During the first decade, the work of compiling '*Fauna Sinica: Amphibia*', which was started in 1973, was completed and was published in three volumes in 2006, January 2009 and August 2009, respectively (Fei *et al*., 2006, 2009a, 2009b). In all, it recorded 355 species or subspecies known in China then, belonging to 61 genera plus 9 subgenera and 11 families plus 10 subfamilies. This work is the first in China to record species with a list of synonyms, diagnoses, detailed descriptions of morphology for adults, tadpoles and eggs, biological data, secondary sexual characteristics, distributions with maps, characteristic figures, and taxonomic discussions where necessary. The book '*Colored Atlas of Chinese Amphibians*' (Fei *et al*., 2010a), as a sister work to '*Fauna Sinica: Amphibia*', recorded 355 species plus 11 subspecies and 4 introduced species with Chinese names, Latin names, English names, brief descriptions of morphological characters for adults, tadpoles, juveniles and eggs, biological data, population status, distribution, and color photos including dorsal and ventral views, color variation of males and females, tadpole or juvenile, eggs, and habitat. These two sister-works complement each other to help understand Chinese amphibians. In addition, '*An illustrated Key to Chinese Amphibians*' (Fei *et al*., 2005) is a field guide, and is useful in field surveys of Chinese amphibians; '*Cytotaxonomy of Amphibian in China*' (Li, 2007) recorded karyotype and/or chromosome banding patterns of 205 species of Chinese amphibians, and analyzed their evolution with relationships between them and speciation.

Some books or atlases of provincial fauna of amphibia were published in this decade too, including '*Amphibians in Guangxi*' (Zhang and Wen, 2000), '*The Colour Handbook of the Amphibians of Sichuan*' (Fei and Ye, 2001), '*Amphibia and Reptilia of Yunnan*' (Yang and Rao, 2008), '*Herpetologica Fauna of Heilongjiang*' (Zhao, 2008), and '*Amphibians and Reptiles of Tibet*' (Li *et al*., 2010), '*Field Guid to the Amphibians of Taiwan*' (Yang, 2008), '*Illustration to Amphibians and Reptiles of Taiwan*' (Xiang et al., 2009).

Since 2000, Chinese herpetologists have published more than 600 papers, approximately half of them were of surveys of amphibian diversity and systematics research, including description of 52 new species, 15 new tribes, and 8 new genera, and 5 new subfamilies.

3.2.2 Ecological research Ecological studies of Chinese amphibians were documented after 1940, for example, Liu CC reported the life history of more than 10 species of amphibians before 1950. From 1950 to 1979 only a few ecological studies were reported, but after 1980 the ecological studies of Chinese amphibians accelerated. More than 250 papers on ecological studies have been published since 1980. This number is 5 times that of all the publications in the previous 40 years, with a wide range of contents including individuals, populations, reproduction, behavior, physiological ecology, feeding, relationships between animal and environment and predators. These studies involved approximately 100 species, including *Andrias davidianus* (Hu, 1987; Li and Lan, 1997; Liu *et al*., 1991; Song and Wang, 1989; Zheng and Wang, 2010), *Batrachuperus tibetanus* (Xu and Chen, 1992), *Cynops cyanurus* (Fei and Ye, 1988), *C. orientalis* (Yang and Shen, 1993), *Echinotriton chinhaiensis* (Xie *et al*., 2000), *Tylototriton kweichowensis* (Tian *et al*., 1997), *T. wenxianensis* (Gong and Mu, 2008), *Ranodon sibiricus* (Miao and Chen, 1993; Yuan and Wang, 2009), *Oreolalax puxiongensis* (Fei and Ye, 1984), *Vibrissaphora liui* (Tang, 1990), *V. ailaonica* (Chen *et al*., 1984; Li and Chen, 1988), *V. boringii* (Zheng and Fu, 2007, Zheng *et al*., 2010), *Bufo raddei* (Yao, 1984; Zhou and Song, 1997, 1998; Zou, 1987), *Bufo gargarizans* (Li, 1987, 1988; Zhang *et al*., 2007; Liao and Lu, 2009a, 2009b), *Hyla annectans chuanxiensis* (Liao and Lu, 2010), *Rana dybowskii* (Ma, 1982, 1985), *R. chensinensis* (Lu, 2004; Lu *et al*., 2008, 2009, 2010; Ma *et al*., 2009), *Hylaran daunchina* (Dai *et al*., 2004), *Rana kukunoris* and *Nanorana pleskei* (Dai *et al*., 2005, 2007a, 2007b; Qi *et al*., 2007a, 2007b; Zhang *et al*., 2006; Lu *et al*., 2008), *Nanorana parkeri* (Ma and Lu, 2009, Ma *et al*., 2009), *Rhacophous dennysi* (Shen *et al*., 1986), *Rhacophorus taipeianus* (Lin and Yang, 1988), *Polypedates megacephalus* (Lin and Zhang, 1990), *Chirixalus idiootocus* (Lin and Zhang, 1990), *Buergeria japonica* and *B. robusta* (Huang *et al*., 2001), *Hoplobatrachus chinensis* (Chen, 1983; Geng and Cai, 1994), *Fejervarya multistriata* (Deng, 1992; Shen and Deng, 1985), *Quasipaa boulengeri* (Yuan and Wen, 1990), *Q. spinosa* (Liang and Huang, 1984; Lin and Yu, 1990; Yu and Tu, 1997; Zou and Zhong, 1986), and *Chirixalus eiffingeri* (Kam *et al*., 1996, 1997). Some of the species above and related studies had been recorded and illustrated by movies, e.g., *Ranodon sibirica*, *Echinotriton chinhaiensis*, *Rhacophorus taipeianus*, and *Kurixalus eifingeri*.

3.2.3 Anatomical research Morphology has and continues to be the primary way of studying and describing taxa. The anatomical studies are part of morphology, so the anatomical studies of amphibians have been playing an important role in morphological taxonomy, particularly the skeletal characteristics are essential on the validation of the generic taxonomy or its upper levels. More than 40 papers on anatomical studies were published after 1980, approximately 10 times that of the 30 years prior to 1980, with contents including skeleton, muscle, digestive system, reproductive system, and the nervous system of adults and tadpoles of several decades of amphibian species. More studies were carried out on *Andrias davidianus*, including its skeleton (Wu, 1982; Qiu and Yang, 1986), skin and muscular system (Wu and Gao, 1982), nervous system (Wu, 1988), digestive system (Wu, 1990), and reproductive system (Luo *et al.*, 2002). Most of the other anatomical studies were done for a group of species rather than a single species, particularly the skeleton, including a report on 12 species of the genus *Scutiger* (Fei and Ye, 1987), Chinese Ranidae (Fei *et al*., 1990), *Amolops* (Yang, 1991), 14 species of Rhacophoridae (Jiang *et al*., 1987), and the genus *Paramesotriton* (Pang *et al*., 1992), etc. In addition, Huang *et al*. (1991) reported the internal oral structure of the tadpoles of 17 species, belonging to 7 genera of Megophyidae, and Chou and Lin (1997) reported the structure of tadpoles of amphibians distributed in Taiwan. Besides the studies above, there are anatomic studies on osteology of some species such as *Hynobius keyserlingii* (Ma, 1964), *Hyla tsinlingensis* (Feng, Liu, 1985), *Pachyhynobius shangchengensis* (Li and Qu, 1986) and *Scutiger sikimmensis* (Fei and Ye, 1986).

3.2.4 Embryological research The study of embryology is one of the most important parts of Chinese amphibian research. More than 58 papers in this field were published after 1980, which is 5 times as many as those published before 1979, and involved ~40 species, including *Cynops orientalis* (Geng *et al.*, 1960; Cai, 1978), *Cynops cyanurus* (Wang *et al*., 1984), *Hynobius chinensis* (Cai *et al*., 1985), *H. guabangshanensis* (Mi *et al*., 2007), *Paramesotriton hongkongensis* (Kong and Tong, 1986), *Vibrissaphora leishanensis* (Fei *et al*., 1985), *V. boringii* (Fei *et al*., 1987), *Kaloula rugifera* (Fei and Ye, 1983), *K. borealis* (Li *et al.*, 1998), *Quasipaa spinosa* (Yu and Lin, 1995; Geng *et al*., 2000), *Q. boulengeri* (Li and Li, 1955), *Odorrana versabilis* (Geng *et al*., 1997), *O. tormota* (Xiong *et al*., 2010), *Hyla chinensis* (Geng *et al*., 1999), *Hyla immaculate* (Wu, 1987), *Hynobius leechii* (Jiang, 1985), *Bombina orientalis* (Li *et al.*, 1991), *Andrias davidianus* (Yang *et al*., 1983; Liu *et al*., 1994), *Microhyla ornate* (Liu *et al*., 1996), *Rana chensinensis* (Shen, 1983), *R. zhenhaiensis* (Zhang, 1989), *Scutiger boulengeri* (Song and Ouyang, 1985), *Bufo raddei* (Ge *et al*., 1982), *Bufo gargarizans* (Wang *et al*., 1984), *B. melanostictus* (Ye *et al*., 1986), *Pelophylax nigromaculatus* (Wang, 1958), *Fejervarya multstriata* (Wu, 1981), *Echinotriton chinhaiensis* (Xie *et al*., 2001), *Batrachuperus tibetanus* (Xu and Cui, 1993), *Hylarana guentheri* (Zou *et al*., 2001), *Polypedates megacephalus* (Xu *et al.*, 2007), *Chirixalus eiffingeri* (Kam *et al.*, 1998), *Hoplobatrachus chinensis* (Pang and Liang, 1990), and *Torrentophryne aspinia* (Rao and Yang, 1994). All the above studies summarized the special features and patterns in embryological development of various amphibian families and assisted in accumulating abundant data on the developmental studies of animals.

3.2.5 Biochemical research Chinese scholars began to adopt biochemical methods to study Chinese amphibians by the end of of the 1970's, mainly on the use of isozymes and other proteins (or peptide), chromosomes and DNA.

Studies on isozyme and other proteins (or peptide) Studies on isozymes were mainly done for lactate dehydrogenase (Chen and Chen, 1988; Feng *et al*., 1995; Gu and Tian, 1997; Liu and Liu, 1986; Wei *et al*., 1991; Yang, 1983; Yuan *et al*., 2000; Zeng *et al*., 1993; Li *et al.,* 1992; Du *et al.*, 1990; Yu *et al*., 1992; Xu and Ma, 1996), and few reports were made on esterases and peroxidases (Chen *et al*., 2000), and malic acid dehydogenase (Yu *et al*., 1992). Studies on proteins were mainly conducted for lens proteins (E and Chen, 1984a, 1984b; Ye *et al.*, 1994; Fei *et al*., 1986, 1989, 1995), and few reports on blood albumin (Yang, 1983). Most studies aimed to elucidate the relationships between and among taxa, some to test the differences among different tissues. Studies on peptides were mainly done to elucidate diversity of skin peptides, and to separate and purify bioactive molecules (Tian *et al*., 2008).

Studies on chromosomes Studies on chromosomes for amphibians in China began at the end of the 1970s when Wu (1978a, 1978b) reported the cultivation of tissues and cells from amphibians (*Bufo gargarizans* and *Pelophylax plancyi*), and the study on chromosomes of cultured amphibian somatic cells *in vitro*. After that, the studies on chromosomes of the amphibians in China gradually developed all over China. Different methods were developed to study chromosomes of amphibians, including cultivation of tissues and lymphocyte (Wu, 1978a, 1978b),

slide press of tail of embryo with tail bud (Gao and Ye, 1985), or cells of bone marrow (Wen *et al*., 1981; Wu, 1982), and chromosome banding (Sichuan University, 1984). Since 1980, more than 200 papers on the studies of chromosomes of Chinese amphibians have been published, involving more than 200 species of Chinese amphibians. Most of them reported basic data of karyotypes and (or) chromosomal banding pattern, and a few further discussed the phylogenetic relationships between taxa based on the comparative data. Information from chromosomal studies has played an important role in elucidating taxonomic and phylogenetic issues.

Although Li (2007) systematically summarized the studies on chromosomes of Chinese amphibians in the book '*Cytotaxonomy of Amphibian in China*', it is worthy to mention here some representative studies: 1) the Chinese species that were first reported on their karyotype in each family included *Ichthyophis bannanicus,* the only representative of the family Ichthyophidae in China (Wen and Pang, 1990), *Salamandrella keyserlingii* of the family Hynobiidae (Wang *et al.*, 1983), *Andrias davidianus* of the family Cryptobranchidae (Morsecalchi *et al.*, 1977), *Bombina orientalis* of the family Bombinatoridae (Jiang *et al.*, 1984), *Vibrissaphora liui liui* of the family Megophryidae (Wu *et al*., 1981), *Bufo gargarizans* of the family Bufonidae (Wu, 1978b), *Hyla gongshanensis gongshanensis* of the family Hylidae (Li *et al*., 1981), *Pelophylax fujiensis* and *Boulengerana guentheri* of the family Ranidae (Lin and Huang, 1979), *Fejervarya multistriata*, *Hoplobatrachus chinensis*, and *Limnonectes fujianensis* of the family Dicroglossidae (Lin and Huang, 1979), *Occidozyga lima* and *Phrynoglossus martensii* of the family Occidozygidae (Zhao *et al*., 1987), *Buergeria robusta* of the family Rhacophoridae (Kuramoto, 1977), and *Kaloula borealis* (Wu and Yang, 1981; Jiang *et al.*, 1981); and 2) Sexual differentiation of chromosomes has been discovered in ten species of Chinese amphibians. The ZW type was found in the species *Tylototriton kweichowensis* by Gu and Tian (2000), *Bufo gararizans* from Shanghai by Wen *et al*. (1981, 1983) and from Beijing by Shang and Deng (1983), while the XY type was found in *Paramesotriton chinensis* by Zhang *et al*. (1985), *Pseudepidalea raddei* by Deng and Shang (1984), *Pelophylax nigromaculatus* from Beijing by Wu and Zhang (1985), and from Chengdu by Heng *et al*. (1984), *Rugosa tientaiensis* by Guo (1994), *Rugosa emeljianovi* by Zhao *et al.* (2004), *Odorrana swinhoana* by Kuramoto (1996), *Amolops mantzorum* by Wu and Zhao (1985) and Wu *et al*. (1987). In addition, Wu and Zhao (1984) and Liu and Zan (1984) independently discovered that all chromosomes of *Gynandropaa sichuanensis* and *Gynandropaa phrynoides*, respectively, were T type, the same as found in *Unculuana unculuana* by Liu *et al*. (1993) and Li and Hu (1994). Wu and Zeng (1994) nominated a super-species based on karyotype of *Rhacophorus dugritei*.

Studies using DNA Approaches applied for the study of DNA sequences include fingerprinting, RFLP, RAPD, SSR and sequencing. Most of the studies on DNA of Chinese amphibians were done by sequencing, few by SSR, and few by fingerprinting (Xie *et al*., 2005). Almost all the studies on DNA aimed to elucidate phylogenic relationships between taxa, based on which their phylogenetic systematics and zoogeographical issues were discussed, besides some sequenced complete mtDNA genomes (ref. Chen *et al*., 2008). For a detail summary on the studies on DNA of Chinese amphibians, see the section below.

3.2.6 Phylogenetic and zoogeographic research Phylogenetic research of Chinese amphibians was first reported in '*Tailless Amphibians of China*' by Liu and Hu (1961), showing the relationships among 34 species of the genus *Rana* (*sensu lato*). Subsequently, phylogenetic research on Chinese amphibians surfaced again after the mid 1980's, including phylogenetic relationships among tailed amphibians of China (Zhao and Hu, 1984), Chinese tree frogs (Jiang *et al*., 1987), species of the genus *Oreolalax* (Xu *et al*., 1992; Fu and Murphy, 1997; Wei *et al*., 2009), species of the genus *Scutiger* (Ye *et al*., 1992; Fu *et al*., 1997), species of the genus *Odorrana* (Ye and Fei, 2001), *Amolops* (Yang, 1991), and *Rana japonica* group (Xie *et al*., 2000). Fei *et al*. (1984) discussed the geographical distribution and differentiation center of the family Hynobiidae, as well as the phylogenetic relationships among its members. Fei and Ye (1989, 1990) studied the geographical distribution, origin, evolution, and differentiation center of the high-altitude megophryid toads (the genera *Scutiger* and *Oreolalax*) with their relation to the formation of the Qinghai-Xizang Plateau. Almost all of these studies were done based on the skeletons and external morphological characters of the animals, with combination of the data derived from biochemical and ecological studies.

On entering the 21st century, most of phylogenetic studies were inferred from the sequences of mtDNA and some combined with nuclear DNA, including the phylogenetic relationships among hynobids (Fu *et al*., 2001, 2003; Fu and Zeng, 2008; Zeng and Fu, 2004;

Zeng *et al.*, 2006; Zhang *et al*., 2006; Xiong *et al*., 2007; Nishkawa *et al*., 2010; Peng *et al*., 2009), Chinese Giant Salamander *Andrias davidianus* (Murphy *et al*., 2000; Tao *et al*., 2005), salamandrids (Lu et al., 2004; Weisrock *et al*., 2006; Zhang *et al*., 2008; Wu *et al*., 2009, 2010), bell toads (Yu *et al.*, 2007; Zheng *et al*., 2009), megophrids (Jiang *et al*., 2003; Zheng *et al.*, 2004a, 2004b, 2008; Fu *et al.*, 2007; Rao and Wilkinson, 2008; Matsui *et al*., 2010), bufonids (Liu *et al*., 2000; Fu *et al*., 2005), ranids (Jiang and Zhou, 2001, 2005; Jiang *et al*., 2002, 2005; Chen *et al*., 2005; Zhang *et al*., 2005; Ngo *et al*., 2006; Cai *et al*., 2007; Che *et al.*, 2007a, 2007b, 2009, 2010; Zhao *et al.*, 2009; Wang *et al*., 2009; Matsui *et al*., 2010), Rhacophorids (Li *et al*., 2008, 2009; Yu *et al*., 2009), and microhylids (Meijden *et al*., 2007). Recently, the studies of phylogeography, demographic history, and population genetic structure of Chinese amphibians based on DNA sequences or microsatellites were initiated, including *Bufo gargarizans* (Hu *et al*., 2007), *Sylvirana latouchii* (Jang-Liaw *et al.*, 2008), *Pelophylax nigromaculatus* (Zhang *et al*., 2008), *Quasipaa spinosa* (Zheng *et al*., 2009), *Fejervarya multistriata* (Zhong *et al*., 2008), and *Gynandropaa* (Zhang *et al*., 2010). These studies are very important and helpful for the understanding of Chinese amphibians' diversity, and their differentiation mechanism and formation of modern distribution patterns, as well as for modification of classification system of taxa, for example, Fei *et al*. (2010b)'s phylogenetic systematics of the family Ranidae.

3.2.7 Other research Besides the scientific disciplines mentioned above to study the amphibian fauna of China, scholars are beginning to use various methods from different fields to carry out more integrative studies, including the ultrastructures of organs (Zheng *et al*., 1984), cross breeding tests (Ding *et al*., 1965; Liu *et al*., 1990; Jiang *et al*., 1995), regeneration of organs (Chen and Wu, 1957; Fei *et al*., 1987), abnormality surveys (Fei and Ye, 1987a), studies on acoustics (Huang *et al*., 1982; Mu and Zhao, 1992; Jiang *et al*., 1995; Jiang *et al*., 2002; Xu *et al*., 2005; Feng *et al*., 2006; Cui *et al*., 2010), on fossils (Wang and Evans, 2006), on sperms (Liang, 1994; Zheng *et al*., 2000, 2002, 2004, 2006, 2010; Qin *et al*., 2008, 2010), and on diseases (Bai *et al*., 2010). In addition, more than 100 popular science papers and books were published then.

All the above studies contributed extensively to the accumulation of a large amount of basic biological data for Batrachology, and also contributed greatly to the conservation of Chinese amphibians and biology in general.

4. Prospect of Surveys and Studies of Chinese Amphibians

The advances in the research of Chinese amphibians summarized above show that Chinese scholars, at times in collaboration with international colleagues, have amassed a large amount of information on amphibians, indicated not only by the quantity and quality of papers, books and monographs, but also by their depth on the subjects, as a great contribution towards the further advancement of batrachology in China, and perhaps on a global scale.

The '*Fauna Sinica: Amphibia*' was published in three volumes in 2006, January 2009 and August 2009, respectively, increasing the number of known species or subspecies to 355, which is 4.1 times those recorded by Boring (1945), and of which tailless amphibians are approximately 2.6 times as those recorded by Liu CC and Hu SQ (1961). However, the increasing trends of new species discovered in these decades (Table 1) lead us to hypothesize that additional new forms of amphibians in China will be possibly discovered with further faunal surveys. In addition, national, provincial, and local new records of species have been reported at times. So it's suggested that more detailed field surveys are necessary for the discovery of new taxa, and their distribution, as well as their population data, based on which living status of species can be measured more accurate rather than assessed by experiences of herpetologists (Xie *et al.*, 2007). According to the topography of China and the richness in species of Chinese amphibians in each subregion (Figure 1), the regions most likely to harbor undescribed species to increase the amphibian species diversity of China include the areas around the Sichuan Basin, southern slope of Himalayas, southern and western Yunnan, Guangxi, western and northern Guangdong, Hainan Island and Wuyi Mountains.

Table 1 New species discovered in China in different decades by Chinese herpetologists, excluding national new records

Years	–1949	1950–1959	1960–1969	1970–1979	1980–1989	1990–1999	2000–2009
New species discovered	12	14	27	32	38	39	52

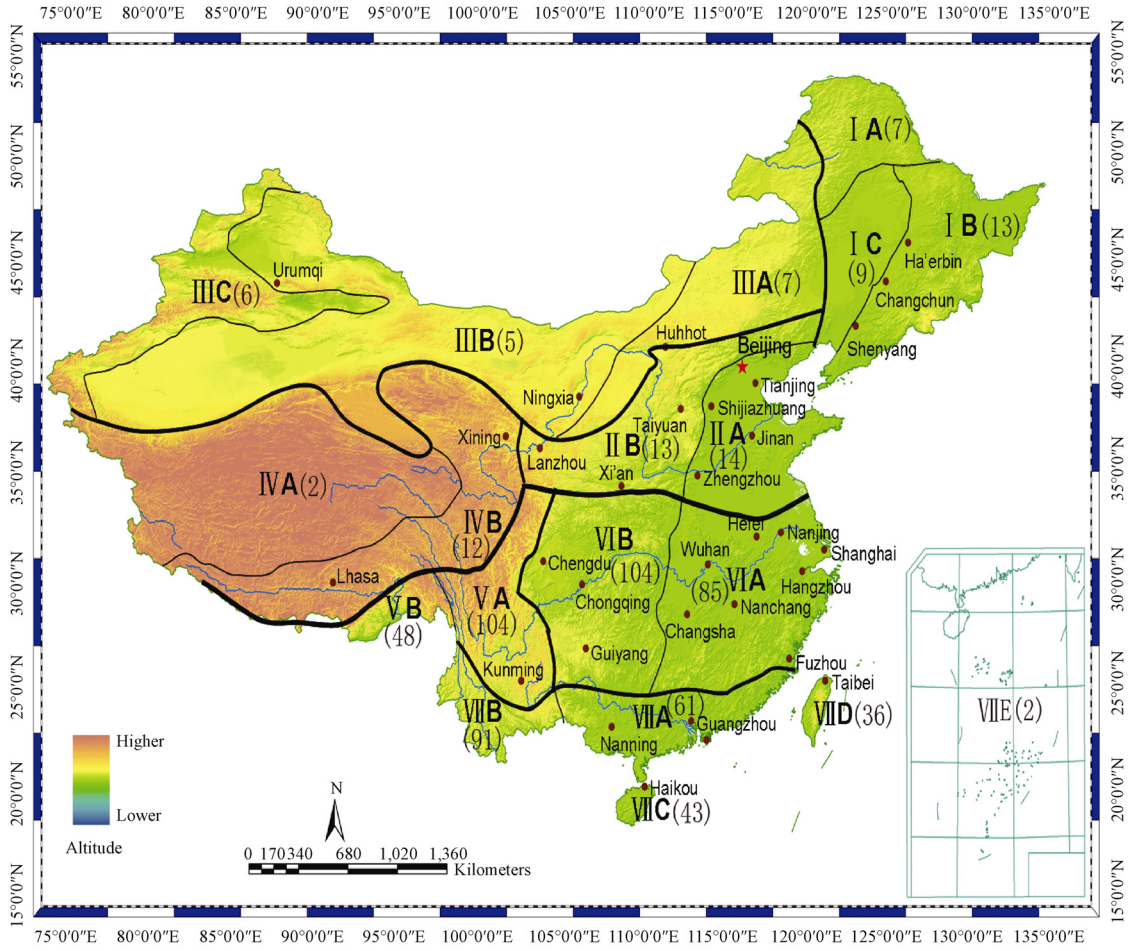

Figure 1 Zoogeographic regions and subregions of China with species number of amphibians in each subregion present in parentheses. The regions and subregions were redrawed from Zhang (1999). The A – E after I – VII mean subregions.
The palaearctic realm:
I. Northeastern China Region: A=Daxing'an Mountains; B=Changbai Mountains; C=Songliao Plain;
II. Northern China Region: A=Yellow River-Huai River Plain; B=Loess Plateau;
III. Inner Mongolia-Xinjiang Region: A=Eastern Grass Land; B=Western Arid; C=Tianshan Mountains;
IV. Qinhai-Xizang Region: A=Qiangtang Plateau; B=Qinghai-Southern Xizang.
The oriental realm:
V. Southwestern China Region: A=Southwest China Mountains; B=Himalaya Mountains;
VI. Central China Region: A=Eastern Plain and Upland; B=Western Mountains and Plateau;
VII. Southern China Region: A=Coastal areas of Fujian, Guangxi and Guangdong; B=Southern Yunnan; C=Hainan Island; D=Taiwan Island; E=Islands in South China Sea.

With the accomplishment of the new compilation of amphibian fauna of China, researches of phylogeny, phylogeography, demographic history, and population genetic structure of Chinese amphibians will proceed faster, wider and more profound. These will be greatly helpful in promoting systematics, particularly, classification system being modified scientifically in time, e.g., Fei *et al.* (2010b). However, the issue from a phylogenetic tree to the classification system is worth further study.

As noted above, the researches on amphibian ecology, acoustics, conservation biology, functional biology, etc., are weaker than those on amphibian diversity and phylogeny, but are well on their way to becoming more widely studied.

Acknowledgements We are grateful to Prof. WANG Yuezhao and Prof. ZHONG Shengxian for their suggestions to improve this manuscript. Also, thanks go to Mr.

QIAO Yongkang for his help in preparing the map of China shown by Figure 1, to Profs. LI Yiming, LU Xin, RAO Dingqi and ZENG Xiaomao, and Dr. DAI Qiang for providing literature, to Prof. FU Jinzhong for his help in improving the language and reviewing this manuscript, and to Dr. Leo Yang and Dr. Raul E. Diaz for their help in polishing the language. This work was supported partially by the National Natural Science Foundation of China (31071906, 30730029), the international collaborate project of the Chinese Academy of Sciences (GJHZ0954), and the Field Front Project of the Knowledge Innovation Program of the Chinese Academy of Sciences.

References

Anderson J. 1871. Description of a new genus of newts from Western Yunnan. Proc Zool Soc, London, 423–425

Anderson J. 1876. Mandalay to Momien: A narrative of the two expeditions to Western China of 1868 and 1875, under Colonel Edward B. Sladen and Colonel Horace Browne. London: MacMillan, 1–479

Anderson J. 1878. Reptiles and Amphibians, 703–869. In: Anatomical and Zooll Researches: Comprising an account of the Zooll results of the two expeditions to Western Yunnan in 1868 and 1875. London: Quaritch, 1–985

Annandale N. 1912. Zooll results of the Abor Expedition, 1911–1912. I. Batrachia Rec Indian Mus, 8: 7–36

Bai C. M., Garner T. W. J., Li Y. M. 2010. First Evidence of *Batrachochytrium dendrobatidis* in China: Discovery of *Chytridiomycosis* in introduced American bullfrogs and native amphibians in the Yunnan Province, China. EcoHealth, 7(1): 127–134

Barbour T. 1908. Some new reptiles and amphibians. Bull Mus Comp Zool, 51(12): 315–325

Bedriaga J. von. 1898. Wissenschaftliche Resultate der von N. M. Przewalski nach Central-Asien unternommenen Reisen. Zool. Theil., Band III, Abth 1: Amphibien und Reptilien. St. Petersburg, 1–69 (In Russian and German)

Blanchard E. 1871. On a new gigantic salamander (*Sieboldia davidiana* Blanchard) from Western China. Ann Mag Nat Hist, 8(4): 212–214

Boettger O. 1885. Materialien zur Herpetologischen Fauna von China. I. Ehr. Offenb Ver Naturk, 24–25: 115–170 (In German)

Boettger O. 1888. Materialien zur Herpetologischen Fauna von China. II. Ehr. Offenb Ver Naturk, 26–28: 53–191 (In German)

Boettger O. 1894. Materialien Zur Herpetologischen Fauna von China. III. Ehr. Offenb Ver Naturk Ges, 129–152 (In German)

Boring A. M. 1945. Chinese Amphibians: Living and Fossil Forms. Peking: Inst Geobiol, 1–151

Boulenger G. A. 1882. Catalogue of the Batrachia Salientia: S. Ecaudata in the Collection of the British Museum. London: Order of the Trustees, 1–503

Boulenger G. A. 1890. The fauna of British India, including Ceylon and Burma, Reptilia and Batrachia. London: Taylor and Francis, 1–541

Boulenger G. A. 1908. A revision of the Oriental pelobatid batrachians (Genus *Megalophrys*). Proc Zool Sol London, 1908: 407–430

Boulenger G. A. 1920. A monograph of the South Asian, Papuan, Melanesian and Australian frogs of the genus *Rana.* Rec Indian Mus, 20: 1–226

Brongniart A. 1799. Essai d'une classification naturelle des Reptiles. Mag. Encycl. J Sci Lett Art, 5(6): 184–201 (In French)

Cai B. 1978. Atlas of Embryonic Development of *Cynops orientalis* (David). Beijing: Science Press, iii+77 pp, 4 plates (In Chinese)

Cai H. X., Che J., Pang J. F., Zhao E. M., Zhang Y. P. 2007. Paraphyly of Chinese *Amolops* (Anura, Ranidae) and phylogenetic position of the rare Chinese frog, *Amolops tormotus*. Zootaxa, 1531: 49–55

Cai M. Z., Zhang J., Lin D. J. 1985. Preliminary observation on the embryonic development of *Hynobius chinensis* Günther. Acta Herpetol Sinica (New ser), 4(3): 177–180 (In Chinese with English abstract)

Cai M. Z. 1979. Observations on reproductive habits of thirty-two anuran species of Fujiam Province. J Fujian Normal Univ (Nat Sci), (1): 71–79 (In Chinese)

Cantor T. 1842. General features of Chusan, with remarks on the flora and fauna of that Island. Ann Mag Nat Hist, 9: 481–493

Chang M. L. Y., Hsu H. F. 1932. Study of some amphibians from Szechwan. Contr Biol Lab Sci Soc (Z. S.), 8(5): 137–181

Chang M. L. Y. 1932. Notes on two salamanders from Chekiang, *Tylototriton chinhaiensis* sp. nov. and *Triturus sinensis* (Gray). Contr Biol Lab Sci Soc. China (Ser Zool), 8(7): 201–202

Chang M. L. Y. 1936. Contribution à l'etude morphologique, biologique et systematique des amphibiens uroděles de la Chine. Paris: Librairie Picart, 1–156 (In French)

Che J., Hu J. S., Zhou W. W., Murphy R. W., Papenfuss T. T., Chen M. Y., Rao D. Q., Li P. P., Zhang Y. P. 2009. Phylogeny of the Asian spiny frog tribe Paini (Family Dicroglossidae) sensu Dubois. Mol Phyl Evol, 50: 59–73

Che J., Pang J. F., Zhao E. M., Matsui M., Zhang Y. P. 2007b. Phylogenetic relationships of the Chinese brown frogs (genus *Rana*) inferred from partial mitochondrial 12S and 16S rRNA gene sequences. Zool Sci, 24: 71–80

Che J., Pang J. F., Zhao H., Wu G. F., Zhao E. M., Zhang Y. P. 2007a. Phylogeny of Raninae (Anura: Ranidae) inferred from mitochondrial and nuclear sequences. Mol Phyl Evol, 43: 1–13

Che J., Zhou W. W., Hu J. S., Yan F., Papenfuss T. J., Wake D. B., Zhang Y. P. 2010. Spiny frogs (Paini) illuminate the history of the Himalayan region and Southeast Asia. PNAS, 107(31): 13765–13770

Chen B. H. 1983. Studies on the autoecology of *Rana tigrina rugulosa*. J Anhui Normal Univ (Nat Sci), (2): 86–95 (In Chinese)

Chen B. H. 1991. The Amphibian and Reptilian Fauna of Anhui. Hefei: Anhui Publishing House of Science and Technology, 408 pp, 4 plates (In Chinese)

Chen G. Y., Jiang J. P., Xie F., Liu J. Y., Zheng Z. H. 2008. Characteristics of the amphibian mitochondrial genome. Acta Zool Sinica, 33 (2): 307–311 (In Chinese)

Chen H. J., Li F. L., Xiao H. 1984. Preliminary observations on ecology of *Vibrissaphora ailaonica*. Acta Herpetol Sinica (New ser.), 3(1): 41–45 (In Chinese)

Chen J. S. 1956. Fanua of Taiwan: Vertebreta. Taibei: Taiwan Commercial Press, 293–306

Chen L. Q., Murphy R. W., Lathrop A., Ngo A., Orlov N. L., Ho C. T., Somorjai I. L. M. 2005. Taxonomic chaos in Asian ranid frogs: An initial phylogenetic resolution. Herpetol J, 15: 231–243

Chen S. M., Wu R. M. 1957. The effection of living conditions on the regeneration of hind limbs of tadpoles of *Rana guentheri*. Chin J Zool, 1(3): 150–153

Chen W., Chen J. 1988. Comparison of LDH isoenzyme analyses among three species of amphibian. J South Chin Nor Univ (Nat Sci), (1): 60–67 (In Chinese)

Chen X. H., Wang L. S., Qu W. Y. 2000. Study on esterase and peroxidase isozyme in *Pachyhynobius shangchengensis* (Hynobiidae). Sichuan J Zool, 19(1): 13–15 (In Chinese)

Chou W. H., Lin J. Y. 1997. Tadpoles of Taiwan. Nat Mus Nat Sci, No. 7. iv+1–98.

Cui J. G., Wang Y. S., Brauth S., Tang Y. Z. 2010. A novel female call incites male-female interaction and male-male competition in the Emei music frog, *Babina daunchina*. Anim Behav, 82: 181–187

Dai Q., Dai J. H., Li C., Liu Z. J., Wang Y. Z. 2004. Anti-predator behavior of tadpoles of *Rana daunchina* to a novel craw fish (*Procambarus clarkia*). Biodivers Sci, 12(5): 481–487 (In Chinese)

Dai Q., Dai J. H., Zhang J. D., Yang Y., Zhang M., Li C., Liu Z. J., Gu H. J., Wang Y. Z. 2005. Terrestrial core habitat of three anurans in Zoige Wetland Nature Reserve. Acta Ecol Sinica, 25(9): 2256–2262

David A. 1871. Rapport adresse a MM. Les Professeurs Administrateurs du Museum d'Histoire Naturelle par M. I'abbe Armand David. Nouv. Arch Mus Hist Nat (Bull), 7: 75–100

Deng C. X., Shang K. G. 1984. A cytogenetic demonstration of XY sex determination in *Bufo raddei*. Acta Gene Sinica, 11(5): 395–399 (In Chinese)

Deng X. J., He S. H., Hu Z. H. 1992. Studies on the population ecology of *Rana limnocharis*. Nat Sci J Human Nor Univ, 15(3): 285–288 (In Chinese)

Ding H. B. 1950. A survey of the amphibian fauna of Fujian with the geographical distribution. Science, 32(12): 371–377 (In Chinese)

Du C. H., Jiang T., Huang R. X. 1990. Determination of lactic dehydrogenase isoenzyme in *Ranodon sibiricus* Kessler. Sichuan J Zool, 9(4): 14–15 (In Chinese)

Dubois A. 1991. Batrachology as a distinct scientific discipline. Alytes, 9(1): 1–14

Duméril A. M. C. 1806. Zoologie Analytique, ou Méthode Naturelle de Classification des Animaux. Paris: Perronneau, 1–344.

Dunn E. R. 1923. The salamanders of the family Hynobiidae. Proc Am Acad Arts Sci, 58(13): 445–523

E W. Y., Chen S. W. 1984a. Studies on cytotaxonomy of some species of Chinese anurans by electrophoresis of their lens proteins. I. Comparative analyses on lens proteins of some species in Ranidae, Rhacophoridae and Microhylidae by isoelectric focusing and SDS polyacrylamide gel electrophoreses. Acta Herpetol Sinica (New ser.), 3(2): 25–32 (In Chinese)

E W. Y., Chen S. W. 1984b. Studies on cytotaxonomy of some species of Chinese anurans by electrophoresis of their lens proteins. II. Comparative analyses on lens proteins of some species in Discoglossidae, Pelobatidae and Bufonidae by electric focusing and SDS polyacrylamide gel electrophoreses. Acta Herpetol Sinica (New ser.), 3(3): 1–4 (In Chinese)

Fan L. S., Guo C. W., Liu H. Z. 1998 Amphibians and Reptiles of Shanxi Province. Beijing: China Forestry Press, 1–206 (In Chinese)

Fang P. W., Chang M. L. Y. 1932. Notes on *Tylototriton kweichowensis* sp. nov. and *asperrimus* Unterstein with synopsis to species. Sinensis, 2(9): 111–122

Fei L., Hu S. Q., Ye C. Y., Huang Y. Z. 2006. Fauna Sinica Amphibia (Vol. 1). Beijing: Science Press, 1–471 + plates XVI

Fei L., Hu S. Q., Ye C. Y., Huang Y. Z. 2009a. Fauna Sinica Amphibia (Vol. 2). Beijing: Science Press, 1–957

Fei L., Hu S. Q., Ye C. Y., Huang Y. Z. 2009b. Fauna Sinica.Amphibia (Vol. 3). Beijing: Science Press, 959–1847 + plates XVI

Fei L., Wang C. F., Ye C. Y. 1985. Early embryonic development and adaptability of *Vibrissaphora leishanensis*. La Animala Mondo, 2(3 & 4): 189–198 (In Chinese)

Fei L., Ye C. Y., Chen S. W. 1986. Polymorphism in some pelobatid toads of the genus *Scutiger*. Acta Zool Sinica, 32(2): 168–179 (In Chinese)

Fei L., Ye C. Y., Huang Y. Z., Jiang J. P., Xie F. 2005. An illustrated key to Chinese Amphibians. Chengdu: Sichuan Publishing House of Science and Technology, 1–340 + plates XII (In Chinese)

Fei L., Ye C. Y., Huang Y. Z. 1990. Key to Chinese Amphibia. Chongqing: Chongqing Branch, Science and Techonology Literature Publishing House, 1–364 (In Chinese)

Fei L., Ye C. Y., Jiang J. P. 2010a. Colored Atlas of Chinese Amphibians. Chengdu: Sichuan Publishing House of Science and Technology, 1–519 (In Chinese)

Fei L., Ye C. Y., Jiang J. P. 2010b. Phylogenetic systematics of Ranidae. Herpetol Sinica, 12: 1–43

Fei L., Ye C. Y., Li S. S. 1989. On the generic classification of Asian high altitude pelobatid toads (Amphibia: Pelobatidae). Acta Zool Sinica, 35(4): 381–389 (In Chinese)

Fei L., Ye C. Y., Wang C. F. 1987. Preliminary observation on the early embryonic development of *Vibrissaphora boringii* (Liu). Chin J Zool, 22(6): 18–22 (In Chinese)

Fei L., Ye C. Y. 1983. Preliminary observations on the early development of *Kaloula rugifera* Stejneger. Acta herpetol Sinica (New ser.), 2(1): 41–48 (In Chinese)

Fei L., Ye C. Y. 1984. Ecological studies of the pelobatid toad, *Oreolalax puxiongensis*. Acta Zool Sinica, 30(3): 270–277 (In Chinese)

Fei L., Ye C. Y. 1986. Osteological studies of pelobatid toad, *Scutiger sikkimensis* (Blyth) (Anura: Pelobatidae). La Animala Mondo, 3(4): 35–48 (In Chinese)

Fei L., Ye C. Y. 1987a. Two cases of abnormality on supernumerary limbs in pelobatid toads (*Vibrissaphora boringii*). Chin J Zool,

22(3): 7–11 (In Chinese)

Fei L., Ye C. Y. 1987. Comparative studies on skeleton of twelve species of pelobatid toad (Genus *Scutiger*, Anura: Pelobatidae) from Qinghai-Xizang Plateau. Acta Biol Plateau Sinica, 7: 155–170 (In Chinese)

Fei L., Ye C. Y. 1988. Studies on the breeding ecology of *Cynops cyanurus chuxiongensis* Fei et Ye. Acta Ecol Sinica, 8(3): 233–241 (In Chinese)

Fei L., Ye C. Y. 2000. A new hynobiid subfamily with a new genus and new species of hynobiidae from west China. Cultum Herpetol Sinica (Guiyang), 8: 64–70 (In Chinese)

Fei L., Ye C. Y. 2001. The Colour Handbook of the Amphibians of Sichuan. Beijing: Chinese Forestry Press, 1–263

Fei L., Ye C. Y., Xia Y. 1987. A study on the limb regeneration of *Cynops cyanurus chuxiongensis*. Chin J Zool, 25(2): 14–18 (In Chinese)

Fei L. 1999. Atlas of Amphibians of China. Zhengzhou: Henan Publishing House of Sciecne and Technology, 1–432

Feng A. S., Narins P. M., Xu C. H., Lin W. Y., Yu Z. L., Qiu Q., Xu Z. M., Shen J. X. 2006. Ultrasonic communication in frogs. Nature, 440: 333–336

Feng X. Y., Liu Z. X. 1985. Studies on the skeleton of *Hyla tsinlingensis*. Acta Herpetol Sinica (new ser.), 4(4): 308–312 (In Chinese)

Feng Z. J., Yang K. H., Ji L. P., Jiang Z. H. 1995. Comparative studies on the isozyme patterns of LDH in some tissues of six species of amphibian. Acta Herpetol Sinica (Guiyang), 4–5: 238-244 (In Chinese)

Fitzinger L. J. 1826. Neue Classification der Reptilien, nach ihren Natürlichen Verwandtschaften nebst einer Verwandtschafts-Tafel und einem Verzeichnisse der Reptilien-Sammlung des k.k. Zoologischen Museum zu Wien. Wien: Hübner Verlagen J. G., 1–66 (In German)

Fitzinger L. J. 1843. Systema Reptilium. Fasc. Primus: Amblyglossae. Vindobonae: Braumüller & Seidel, 1–106 (In German)

Frost D. R. 2010. Amphibian Species of the World: An Online Reference. Version 5.4 (8 April, 2010). Electronic Database accessible at http://research.amnh.org/vz/herpetology/amphibia/ Am Mus Nat Hist, New York, USA

Fu J. Z., Lathrop A., Murphy R. W. 1997. Phylogeny of genus *Scutiger* (Amphibia: Megophyidae): A re-evaluation. Asia Herpetol Res, 7: 32–37

Fu J. Z., Murphy R. W. 1997. Phylogeny of Chinese *Oreolalax* and the use of functional outgroups to select among multiple equally parsimonious trees. Asia Herpetol Res, 7: 38–43

Fu J. Z., Hayes M., Liu Z. J., Zeng X. M. 2003. Genetic divergence of the southeastern Chinese salamanders of the genus *Hynobius*, Acta Zool Sinica, 49(5): 581–591

Fu J. Z., Wang Y. Z., Zeng X. M., Liu Z. J. 2001. Genetic diversity of eastern *Batrachuperus* (Caudata: Hynobiidae). Copeia, 2001: 1100–1107

Fu J. Z., Weadick C. J., Bi K. 2007. A phylogeny of the high-elevation Tibetan megophrid frogs and evidence for the multiple origins of reversed sexual size dimorphism. J Zool, 273: 315–325

Fu J. Z., Weadick C. J., Zeng X. M., Wang Y. Z., Liu Z. J., Zheng Y. C., Li C., Hu Y. 2005. Phylogeographic anglysis of the *Bufo gargarizans* species complex: A revisit. Mol Phyl Evol, 37: 202–213

Fu J. Z., Zeng X. M. 2008. How many species are in the genus *Batrachuperus*? A phylogeographic analysis of the stream salamanders (Family Hynobiidae) from southwestern China. Mol Ecol, 17: 1469–1488

Gao J. M., Ye R. Q. 1985. A simple technique for chromosome preparations from amphibian embryonic cell in early phases of development. Heriditas, **7**(1): 39–40 (In Chinese)

Ge R. C., Feng B. S., Tong Y. X. 1982. The early embryonic development and stages of the toad, *Bufo raddei* Strauch. J Lanzhou Univ (Nat Sci), 18(4): 125–136 (In Chinese)

Gee N. G., Boring A. M. 1929 (1930). A check list of Chinese Amphibia with notes on geographical distribution. Peking Nat Hist Bull, 4(2): 15–51

Geng B. R., Cai M. Z., Chen R., Fu Q. X. 2000. Early embyonic development of *Paa* (*Paa*) *spinosa*. Cultum Herpetol Sinica (Guiyang), 8: 193–198 (In Chinese)

Geng B. R., Cai M. Z., Wen Q. 1997. The early embryonic development of *Rana versabilis*. J Fujian Nor Univ (Nat Sci), 13(1): 81–85 (In Chinese)

Geng B. R., Cai M. Z. 1994. A study of the feeling and breeding habits of *Rana tigerina rugulosa*. J Fujian Nor Univ (Nat Sci), 11(4): 78–81 (In Chinese)

Geng B. R., Chen Y. L., Zhang Q. J. 1999. The early embryonic development of Hyla chinensis. 878–883. In Zooll Studies in China. Beijing: Chinese Forest Press (In Chinese)

Geng J. J., Zhang J. M., Cai B. 1960. Observations on the early development of *Cynops orientalis* (David). Acta Zool Sinica, 12(2): 175–184, 2 plates (In Chinese)

Gong D. J., Mu M. 2008. Behavioral observation and descriptions of the endangered knobby newt *Tylototriton wenxianensis* and their application in conservation. Asia Herpetol Res, 11: 31–38

Gray J. E. 1825. A synopsis of the genera of reptiles and amphibia, with a description of some new species. Annu Philos, (2)10: 193–217

Gray J. E. 1831. The Zooll Miscellany. London: Treuttel, Wurtz & Co, 1–40

Gray J. E. 1859. Descriptions of new species of salamanders from China and Siam. Proc Zool Soc, 1859: 229–230

Gu X. M., Tian Y. Z. 1997. LDH isozyme comparative studies of various tissues in *Tylototriton kweichowensis* and *T. asperrimus*. Cultum Herpetol Sinica (Guiyang), 6–7: 189–192

Gu X. M., Tian Y. Z. 2000. A comparative study on karyotypes, C-bands of four species of Salamandridae from Guizhou. Acta Zool Sinica, 26(1): 108–112 (In Chinese)

Günther A. 1858. Catalogue of the Batrachia Salientia in the collection of the British Museum. London: Taylor and Francis, 1–160

Günther A. 1889. Third contribution to our knowledge of reptiles and fishes from the Upper Yangtsze-kiang. Ann Mag Nat Hist, (6)4: 218–229

Günther A. 1896. Report on the collections of reptiles, batrachians and fishes made by Messrs Potanin and Berezowski in the Chinese provinces Kansu and Szechwan. Ann Mus Zool Acad Imper Sci, 1896: 199–219

Guo C. W. 1994. A preliminary analysis of high-resolution G-bands in *Rana tientaiensis* chromosomes. Acta Herpetol Sinica (Guiyang), 3: 99–103 (In Chinese)

Guo F., Needham J., Cheng Q. T. 1999. the History of Zoology in China. Beijing: Science Press, 1-639. (In Chinese)

Guo H. S., Zhang J X., Zhu F X., Geng J. J., Cai B., Pan Y. C., Zhang J. M. 1966. Surveys of amphibians of Zhejiang Province. Chin J Zool, 8(1): 31–34 (In Chinese)

Hallowell E. 1860. Report upon the Reptilia of the North Pacific Exploring Expedition, under command of Capton John Rogers, Proc Acad Nat Sci, 12: 480–510

Heng H. Q., Zhao X. L., Xie B. 1984. Preliminary analysis of high resolution banding pattern of the *Rana nigromaculata*. Zooll Res, 5(1, suppl.): 30–32 (In Chiniese)

Hsu H. F. 1930. A new giant frog of Amoy. Contr Biol Lab Sci Soc (z. s.), 6(3): 19–23

Hu S. Q., Yang F. H. 1960. Preliminary survey of amphibians in Mt. Jinfo, southern Sichuan. Chine J Zool, 4(6): 256–263 (In Chinese)

Hu S. Q., Zhao E. M., Jiang Y. M., Fei L., Ye C. Y., Hu Q. X., Huang Q. Y., Huang Y. Z., Tian W. S. 1987. Amphibia-Reptilia of Xizang. Beijing: Science Press, 1–153

Hu S. Q., Zhao E. M., Liu C. C. 1966. A herpetological suevey of Tsining and Ta-Pa Shan region. Acta Zool Sinica, 18(1): 57–89 (In Chinese)

Hu S. Q., Zhao E. M., Liu C. C. 1973. A survey of amphibians and reptiles in Kweichow Province, including a herpetofaunal analysis. Acta Zool Sinica, 19(2): 149–178, 3 plates (In Chinese)

Hu X. L. 1987 Ecological studies of *Andrias davidianus* in Mt. Dabieshan, Anhui. J Anhui Univ (Nat Sci), 1987(1): 69–73 (In Chinese)

Hu Y. L., Wu X. B., Jiang Z. G., Yan P., Su X., Cao S. Y. 2007. Population genetics and phylogeography of *Bufo gargarizans* in China. Biochem Gene, 45: 697–711

Huang M. H., Jin Y. L., Cai C. M. 1990. Fauna of Zhejiang: Amphibia/Reptilia. Hangzhou: Zhejiang Science and Technology Publishing House, 306 pp, 4 colored plates (In Chinese)

Huang W. S.，Lee J. K., Ho C. H. 2001. Reproductive pattern of two sympatric rhacophorid frogs, *Buergeria japonica* and *B. robusta,* with comments on anuran breeding seasons in Taiwan. Zool Sci, 18: 63–70

Huang Y. Z., Fei L., Ye C. Y. 1991. Studies on internal oral structures of tadpoles of Chinese Pelobatidae. Acta Biol Plateau Sinica, 10: 71–99 (In Chinese)

Huang Y. Z. 1989. Amphibia. 173-202, in Nortwestern Plateaue Institute of Biology, Chinese Academy of Sciences Ed.: Economical Fauna of Qinghai. Xining: Qinghai People's Press, 1–735

Huang Z. J. 1958. A preliminary survey of amphibians and reptiles of Xishuang banna, Yunnan Bull Biol, (10): 6–13, 1 plate (In Chinese)

Huang Z. J., Shang E. C., Wang Y. Y. 1982. Acoustic analysis of frog vocalization. News Biol Sci, (2): 9–11 (In Chinese)

Jang-Liaw N. H., Lee T. H., Chou W. H. 2008. Phylogeography of *Sylvirana latouchii* (Anura, Ranidae) in Taiwan. Zool Sci, 25: 68–79

Ji D. M., Liu M. Y., Liu Z. Y., Zhou Y. F., Huang K. C., Wen S. S, Zou B. Z. 1987. Fauna Liaoningica: Amphibia Reptilia. Shenyang: Liaoning Science and Technology Press, 1–170

Jiang J. 1985. Prelimilary observations on embryonic development of *Hynobius leechii*. J Dalian Med Coll, 7(3): 1–7 (In Chinese)

Jiang J. P., Dubois A., Ohler A., Tillier A., Chen X. H., Xie F., Stöck M. 2005 Phylogenetic relationships of the tribe Paini (Amphibia, Anura, Ranidae) based on partial sequences of mitochondrial 12S and 16S rRNA genes. Zool Sci, 22(3): 353–362

Jiang J. P., Xie F., Zheng Z. H. 2002. Phylogentic relationships of Chinese brown frogs with discussion on the karyotype evolution. J Sichuan Univ (Nat Sci), 39 (supl.): 85–89 (In Chinese)

Jiang J. P., Yuan F. R., Xie F., Zheng Z. H. 2003. Phylogenetic relationships of some species and genera in Megophryids inferred from partial sequences of mitochondrial 12 S and 16 S rRNA genes. Zool Res, 24 (4): 241–248 (In Chinese)

Jiang J. P., Zhou K. Y. 2001. Evolutionary relationships among Chinese ranid frogs Inferred from mitochondrial DNA sequences of 12s rRNA gene. Acta Zool Sinica, 47 (1): 38–44 (In Chinese)

Jiang J. P., Zhou K. Y. 2005. Phylogenetic relationships among Chinese ranids inferred from sequence data set of 12S and 16S rDNA. Herpetol J, 15: 1–8

Jiang J. P., Xie F., Fei L., Ye C. Y., Zheng M. Q. 2002. Mating calls of six forms of pelobatid in Wawu Mountain National Park, Sichuan, China (Anura: Pelobatidae). Zool Res, 23(1): 89–94

Jiang J. P., Xie F., Li C. 2010. Diversity and Conservation Status of Chinese Amphibians. In: Harold Heatwole, Indraneil Das, John Wilkinson (eds.): Amphibian Biol (Vol. 8 C) (In press)

Jiang J. P., Ye C. Y., Fei L., Wang C. F. 1997. Crossing test of 10 species (populations) of *Rana* produced in China. Cultum Herpetol Sinica (Guiyang), 6–7: 59–66 (In Chinese)

Jiang S. P., Hu S. Q., Zhao E. M. 1987. The approach of the phylogenetic relationship and the supraspecific classification of 14 Chinese species of tree frogs (Rhacophoridae). Acta Herpetol Sinica (New ser) , 6(1): 27–42 (In Chinese)

Jiang S. T., Wen C. X., Shen C. R., Meng Y. 1984. Preliminary observations on karyotypes *Bombina orientalis*. Acta Herpetol Sinica (New ser), **3**(1): 25–27 (In Chinese)

Jiang S. R., Ding P., Zhu G. Y. 1995. The comparative study on the characteristics of calling songs of three frog species. Zool Res, 16(1): 75–81 (In Chinese)

Jiang S. T., Wen C. X., Shen C. R. 1981. The chromosomal karyotype of *Kaloula borealis*. Acta Acad Med Bengbu, 6(3): 181–183 (In Chinese)

Kam Y. C., Chuang Z. S., Yen C. F. 1996. Reproduction, ovipositionsite selection, and tadpole oophagy of an arboreal nester, *Chirixalus eiffingeri* (Rhacophoridae), from Taiwan. J Herpetol, 30(1): 52–55

Kam Y. C., Huang Y. H., Huang Z. S., Huang T. S. 1997. Growth and development of oophagous tadpoles in relation to brood care of an arboreal breeder, *Chirixalus eiffingeri* (Rhacophoridae). Zool Studies, 36(3): 186–193

Kam Y. C., Yen C. F., Hsu C. L. 1998. Water balance, growth, development, and survival of arboreal frog eggs (*Chirixalus eiffingeri* Rhacophoridae): Importance of egg distribution in bamboo stumps. Physiol Zool, 71(5): 534–540

Karsen S. J., Lau M. W. N., Bogadek A. 1998. Hong Kong Amphibians and Reptiles. Hong Kong: Urban Council, 1–186

Kong Y. C., Tong T. M. 1986. The developmental stages of *Paramesotriton hongkongensis* (Myers *et* Leviton). Acta Herpetol Sinica (New ser), 5(2): 106–118

Kuramoto M. 1977. A comparative study of karyotype in the tree-frogs (Family Rhacophoridae) from Japan and Taiwan. Caryologica, 30(3): 333–342

Kuramoto M. 1996. Karyotypes of *Rana narina* complex (Anura: Ranidae) from Japan and Taiwan. Bull Fukuoka Univ Educ, 45: 27–35

Latreille P. A. 1804. Tableau methodique des poissons. In: Nouveau dictionnaire d'histoire naturelle (Tome 24). Paris: Deterville: 71–105

Laurenti J. N. 1768. Specimen medicum, exhibens synopsin Reptilium emendatam cum experimentis circa venena et antidota Reptilium austriacorum. Viennae: Joan. Thom Nob de Trattnern: i-ii +1–215

Li D. F., Lan S. C. 1997. Analysis of the sonograms of *Andrias davidianus*. J Northeast Nor Univ (Nat Sci), 20(2): 55–57 (In Chinese)

Li D. H. 1987. A preliminary study on the migration and hibernation of adult *Bufo gargarizans* Cantor in the suburbs of Guiyang. Acta Herpetol Sinica (New ser), 6(4): 51–55 (In Chinese)

Li D. H. 1988. A preliminary observation on the reproduction of *Bufo bufo gargarizans* in the suburbs of Guiyang. Chin J Zool, 23(3): 17–20 (In Chinese)

Li F. L., Chen H. J. 1988. A study on the biology of *Vibrissaphora ailaonica*. Acta Herpetol Sinica (New ser), 7(2): 141–147 (In Chinese)

Li J. T., Che J., Bain R. H., Zhao E. M., Zhang Y. P. 2008. Molecular phylogeny of Rhacophoridae (Anura): A framework of taxonomic reassignment of species within the genera *Aquixalus, Chiromantis, Rhacophorus*, and *Philautus*. Mol Phyl Evol, 48: 302–312

Li J. T., Che J., Murphy R. W., Zhao H., Zhao E. M., Rao D. Q., Zhang Y. P. 2009. New insights to the molecular phylogenetics and generic assessment in the Rhacophoridae (Amphibia: Anura) based on five nuclear and three mitochondrial genes, with comments on the evolution of reproduction. Mol Phyl Evol, 53: 509–522

Li P. P., Zhao E. M., Dong B. J. 2010. Amphibians and Reptiles of Tibet. Beijing: Science Press, 1–251

Li R. Q., Li X. Z. 1955. The adaptation of the early embryonic development of *Rana boulengeri*. Acta Scientiarum Naturalium Universitatis Pekinensis, 1955(1): 111–130 (In Chinese)

Li S. S., Hu J. S. 1994. On the karyotypes and Ag-NORs of three sympatrically *Paa* frogs in Yunnan Province. Acta Zool Sinica, 40(3): 317–323 (In Chinese)

Li S. S., Wang Y. X., Li C. Y., Wang R. F., Liu G. Z. 1981. A comparative investigation of karyotype from four amphibian species. Zool Res, 2(1): 17–24 (In Chinese)

Li S. S. 2007. Cytotaxonomy of Amphibian in China. Beijing: Science Press. 1–252

Li Y. T., Xiang Y. H., Yang Y. Q. 1992. Comparative studie on LDH isozymes of various tissues in *Andrias davidianus* and *Trionyx sinensis*. Chin J Zool, 27(1): 28–31 (In Chinese)

Li Z. H., Qu W. Y. 1986. Studies on the skeleton of *Pachyhynobius shangchengensis* Fei et Qu. La Animala Mondo, Xi'an, 3(2–3): 49–56 (In Chinese)

Li Z. Y., Feng Z. J., Zou S. C. 1991. Preliminary observations on the early embryonic development of *Bombina orientalis* (Boulenger). Chin J Zool, 26(5): 14–18 (In Chinese)

Li Z. Y., Sun J. M., Hu B., Wang J. M. 1998. Preliminary observations on early embryonic development of *Kaloula borealis*. Chin J Zool, 33(5): 4–8 (In Chinese)

Liang R. Q., Dong Y. W. 1984. Ecological surveys of *Rana spinosa*. J Anhui Nor Univ (Nat Sci), 1984(1): 30–38 (In Chinese)

Liang R. Q. 1994. Morphologies of spermatozoa in 24 Chinese anuran species. Chin J Zool, 29(1): 20–23 (In Chinese)

Liao W. B., Lu X. 2009. Male mate choice in the Andrew's toad *Bufo andrewsi*: A preference for larger females. J Ethol, 27: 413–417

Liao W. B., Lu X. 2009. Sex recognition by male Andrew's toad *Bufo andrewsi* in a subtropical montane region. Behav Processes, 82: 100–103.

Liao W. B., Lu X. 2010. Age structure and body size of the Chuanxi Tree Frog *Hyla annectans chuanxiensis* from two different elevations in Sichuan (China). Zoologischer Anzeiger, 248: 255–263

Lin F. Y., Huang C. C. 1979. Karyological studies of five *Rana* species in Taiwan (Amphibia: Salientia). Proc Nat Sci Counc ROC, 3(4): 429–436.

Lin G. H., Yu P. C. 1990. A biological investigation of the reproduction of the frog (*Rana spinosa*). J Nanchang Univ (Nat Sci), 14(4): 64–70 (In Chinese)

Lin Y. S., Yang Y. R. 1988. Social behavior of *Rhacophorus taipeianus* during the breeding season. Chin Biosci, 31(2): 7–16 (In Chinese)

Lin Y. S., Zhang S. M. 1990. The reproductive behavior of *Polypedates megacephalus*. Chin Biosci, 33(1): 35–47 (In Chinese)

Lin Y. S., Zhang Y. W. 1990. The reproductive behavior of *Chirixalus idiootocus*. Chin Biosci, 33(1): 49–57 (In Chinese)

Linnaeus C. 1758. Systema Naturae per regna tria naturae, secundum classes, ordines, genera, species, cum characteribus. differentiis, synonymis, locus. Editio decima, reformata. Tomus I. Holmiae, 1–824

Liu C. C., Hu S. Q., Ding H. B. 1959. Atlas of Chinese Animals: Amphibia. Beijing: Science Press, 1–29

Liu C. C., Hu S. Q., Fei L., Huang Z. J. 1973. On collections of amphibians from Hainan Island. Acta Zool Sinica, 19(4): 385–404 (In Chinese)

Liu C. C., Hu S. Q., Fei L. 1979. Five new pelobatid toads from China. Acta zoot Sinica, 4(1): 83–92, 2 plates (In Chinese)

Liu C. C., Hu S. Q., Yang F. H. 1960a. Amphibia of Yunnan collected in 1958. Acta Zool Sinica, 12(2): 149–174 (In Chinese)

Liu C. C., Hu S. Q., Yang F. H. 1960b. Amphibians from Wushan, Szechwan. Acta Zool Sinica, 12(2): 278–292 (In Chinese)

Liu C. C., Hu S. Q., Yang F. H. 1962. Preliminary report of amphibian from western Kweichow. Acta Zool Sinica, 14(3): 381–392, 2 plates (In Chinese)

Liu C. C., Hu S. Q. 1959. Preliminary report of Amphibia from southern Yunnan. Acta Zool Sinica, 11(4): 509–532 (In Chinese)

Liu C. C., Hu S. Q. 1961. Tailless Amphibians of China. Beijing:

Science Press, Xiv+364 pages, 34 plates (In Chinese)

Liu C. C., Hu S. Q. A herpetological report of Kwangsi. Acta Zool Sinice, 14(Suppl.): 73–104 (In Chinese)

Liu C. C. 1935a. "The Linea Masculina"，a new secondary sex character in Salientia. J Morph, 57(1): 131–145

Liu C. C. 1935b. Types of vocal sac in the Salientia. Proc Boston Soc Nat Hist, 14(3): 19–40

Liu C. C. 1950. Amphibians of Western China. Chicago: Fieldiana: Zool Mem, 2: 1–400

Liu C. W., Liu J. 1986. Comparative studies on karyotypes and LDH isozymes among *Rana catesbeiana, R. nigromaculata* and *R. tigrina rugulosa.* Nat Sci J Hunan Nor Univ, 9: 66–72, 65 (In Chinese)

Liu C. W., Luo S., Chen X. C. 1990. Hybridization experiments of four species of frogs. J Nat Sci Hunan Nor Univ, 13(3): 286–288 (In Chinese)

Liu J. Y., Lin X. Z., Yang Y. Q., Xiao H. B. 1994. Observation of early embryonic development of *Andrias davidianus*. Chin J Zool, 29(4): 42–46 (In Chinese)

Liu S. F., Yang X. Z., Tian Y. X. 1991. *Andrias davidianus* population and its statistic method in Xushui River, a branch of Han River. Chin J Zool, 26(6): 35–40 (In Chinese)

Liu S. L., Song Z. M., Zhang J. Y., He M. Y., Zhu Q., Li Y. 1996. Study on early embryonic development in *Microhyla ornata*. J Sichuan Univ (Nat Sci), 33(3): 323–329 (In Chinese)

Liu W. G., Zan R. G. 1984. A special karyotype in the genus Rana – An investigation of the karyotype, C-banding and Ag-stained NORs of *Rana phynoides* Boulenger. Acta Genet Sinica, 11(1): 61–64 (In Chinese)

Liu W. Z., Lathrop Av, Fu J. Z., Yang D. T., Murphy R. W. 2000. Phylogeny of East Asian Bufonids inferred from mitochondrial DNA sequences (Anura: Amphibia). Mol Phyl Evol, 14(3): 423–435

Liu W. Z., Yang D. T., Kuramoto M. 1993. Karyological studies on six anuran species from Yunnan Province, China. Jpn J Herpetol, 15(1): 22–28

Lu S. Q., Yang D. T. 1995. A study of relationships among ranid frogs of the genera *Nanorana* and *Altirana* in the Transhimalaya Mountains of China. Asia Herpetol Res, 6: 73–77

Lu S. Q., Yuan Z. G., Pang J. F., Yang D. T., Yu F. H., McGuire P., Xie F., Zhang Y. P. 2004. Molecular phylogeny of the genus *Paramesotriton* (Caudata: Salamandridae). Biochem Genet, 42(5/6): 139–148

Lu X., Li B., Li Y., Ma X. Y., Fellers G. M. 2008. Pre-hibernation energy reserves in a temperate anuran, *Rana chensinensis*, along a relatively fine elevational gradient. Herpetol J, 18: 97–102

Lu X., Ma X. Y., Fan L. Q., Yu T. L. 2010. Opportunity for sexual selection arises at moderate densities in the frog *Rana chensinensis*: An experimental approach. J Ethol, 28: 257–262

Lu X., Ma X. Y., Li Y., Fan L. Q. 2009. Breeding behavior and mating system in relation to body size in *Rana chensinensis*, a temperate frog endemic to northern China. J Ethol, 27: 391–400

Lu X. 2004. Annual cycle of nutritional organ mass in a temperate-zone anuran, *Rana chensinensis*, from northern China. Herpetol J, 14: 9–12

Lu X., Zeng X. H., Du B., Nie C. 2008. Reproductive ecology of *Rana kukunoris* Nikolskii, 1918, a high-altitude frog native to the Tibetan Plateau (Anura: Ranidae). Herpetozoa, 21 (1/2): 67–77

Lue G. Y., Chen S. H. 1982. Amphibians of Taiwan. Chang C. H, ed. Taibei: Natural Press, 1–190

Lue G. Y., Du M. Z., Xiang G. S. 1999. Atlas of Amphibian and Reptiles of Taiwan. Taibei: Natural Press, 1–343

Ma C. F. 1982. Studies on reproductive biology of *Rana temporaria chensinensis*. Acta Herpetol Sinica, (Nat Sci), 8(3): 48–62, 3 plates (In Chinese)

Ma C. F. 1985. Preliminary studies of age determination and the population construction on *Rana temporaria chensinensis*. J Northeast Nor Univ, 1985(1): 81–89 (In Chinese)

Ma K. Q. 1964. Studies on skeleton system of *Hynobius keyserlingii*. J Jilin Nor Univ, 1964(1): 79-88 (In Chinese)

Ma X. Y., Lu X., Merilä J. 2009. Altitudinal decline of body size in a Tibetan frog. J Zool, 279: 364–371

Ma X. Y., Lu X. 2009. Sexual size dimorphism in relation to age and growth based onskeletochronological analysis in a Tibetan frog. Amphibia-Reptilia, 30: 351–359

Ma X. Y., Tong L., Lu X. 2009. Variation of body size, age structure and growth of a temperate frog, *Rana chensinensis*, over an elevational gradient in Northern China. Amphibia-Reptilia, 30: 111–117

Maki M. 1922. Notes on salamanders found in the Island of Formosa. Zool Mag, 34: 635–639 (In Japanese with English abstract)

Mao J. R., Zhang Z. H. 1959. Surveys of Huangzhou amphibians. J Hangzhou Univ, 2: 17–24 (In Chinese)

Matsui M., Hamidy A., Murphy R. W., Khonsue W., Yambun P., Shimada T., Ahmad N., Belabut D. M., Jiang J. P. 2010. Phylogenetic relationships of megophryid frogs of the genus *Leptobrachium* (Amphibia, Anura) as revealed by mtDNA gene sequences. Mol Phyl. Evol, doi:10.1016/j.ympev.2010.03.014

Matsui M., Kuraishi N., Jiang J. P., Ota H., Hamidy A., Orlov N. L., Nishikawa K. 2010. Systematic reassessments of fanged frogs from China and adjacent regions (Anura: Dicroglossidae). Zootaxa, 2345: 33–42

Meijden Avd., Vences M., Hoegg S., Boistel R., Channing A., Meyer A. 2007. Nuclear gene phylogeny of narrow-mouthed toads (Family: Microhylidae) and a discussion of competing hypotheses concerning their biogeographical origins. Mol Phyl Evol, 44: 1017–1030

Miao L. T., Chen G. Z. 1993. An ecological observation on *Ranodon sibiricus*. Chin J Zool, 28(3): 13–14 (In Chinese)

Mori T. 1927a. A hand-list of the Manchurian and Eastern Mongolian Vertebrata, Amphibia. Seoul: Keijo Imp Univ, 144–147

Mori T. 1927b. On a new *Hynobius* from South Manchuria. Chin J Sci Art, 6(9): 205–206

Morsecalchi A., Odeirna G., Olmo E. 1977. Karyological relationships between the Cryptobranchid salamanders. Experientia, 33: 1579–1581

Mou Y., Zhao E. M. 1992. A study on vocalization of thirteen anuran species from China. In: Jiang Y. M. Collected Papers on Herpetology. Chengdu: Sichuan Publishing House of Science and Technology, 15–26 (In Chinese)

Murphy R. W., Fu J., Upton D. E., Lemas Tde., Zhao E. M. 2000. Genetic variability among endangered Chinese Giant

Salamanders, *Andrias davidianus*. Mol Ecol, 9: 1539–1547

Ngo A., Murphy R. W., Liu W. Z., Lathrop A., Orlov N. L. 2006. The phylogenetic relationships of the Chinese and Vietnamese waterfall frogs of the genus *Amolops*. Amphibia-Reptilia, 27: 81–92

Nishikawa K., Jiang J. P., Matsui M., Mo Y. M., Chen X. H., Kim J. B., Tominaga A., Yoshikawa N. 2010. Invalidity of *Hynobius yunanicus* and molecular phylogeny of *Hynobius* salamander from continental China (Urodela, Hynobiidae). Zootaxa, 2426: 65–67

Okada Y. 1931. The Tailless Batrachians of the Japanese Empire. Tokyo: Imperial Agricult Exper Station, 1–215

Okada Y. 1934. The anuran fauna of Formosa. Copeia, (1): 19–20

Okada Y. 1935. Amphibia and Reptilia of Jehoh. In: Report of the First Scientific Expedition to Manchoukuo, 1933. Tokyo. 1–76

Oppel M. 1811. Die Ordnungen, Familien und Gattungen der Reptilien als Prodrom einer Naturgeschichte derselben. Munich: Lindauer, 1–87

Pan J. H., Liang D. Y. 1990. Studies of the early embrynoic development of *Rana rugulosa* Wiegmann. Asia Herpetol Res, 3: 85–100

Pang J. Q., Jiang Y. M., Hu Q. X. 1992. A systematic study on Chinese newt genus *Paramestoriton* (Caudata; Salamandridae). In Jiang Y. M. (ed.): Collected Papers on Herpetology. Chengdu: Sichuan Publihshing House of Science and Technology, 89–100 (In Chinese)

Peng R., Zhang P., Xiong J. L., Gu H. J., Zeng X. M., Zou F. D. 2009. Rediscovery of *Protohynobius puxiongensis* (Caudata: Hynobiidae) and its phylogenetic position based on complete mitochondrial genomes. Mol Phyl Evol, doi: 10.1016/j.ympev. 2009.12.011

Pope C. H., Boring A. M. 1940. A survey of Chinese amphibia. Peking Nat Hist Bull, 15(1): 13–86

Pope C. H. 1931. Notes on amphibians from Fukien, Hainan, and other parts of China. Bull Am Mus Nat Hist, 61(8): 397–611

Qi Y., Felix Z., Dai Q., Wang Y., Liu L., Zhang Q., Wang Y. Z. 2007a. Activities of *Rana kukunoris* in summer and autumn around the seasonal pond in Zoige alpine peat land. Chin J Zool, 28 (5): 526–530 (In Chinese)

Qi Y., Felix Z., Dai Q., Wang Y., Yang Y., Wang B., Wang Y. Z. 2007b. Post-breeding movements, home range, and microhabitat use of plateau brown frogs *Rana kukunoris* in Zoige alpine wetland. Acta Zool Sinica, 53 (6): 974–981 (In Chinese)

Qin L. M., Zheng Z. H., Jiang J. P., Xie F., Mo Y. M. 2008. Sperm morphology of five *Rhacophorus* (Amphibia: Anura: Rhacophoridae) species from China. Asiatic Herptol Res, 11: 105-109

Qin L. M., Zheng Z. H., Xie F., Jiang J. P. 2010. Sperm morphology of tribe Paini. Herpetol Sinica (Nanjing), 12: 128–134 (In Chinese)

Qiu Y. X., Yang A. F. 1986. A study on osteology of *Andrias davidianus*. Acta Sci Nat Univ Pekinensis, (6): 69–82 (In Chinese)

Rafinesque-Schmaltz C. S. 1814. Fine del Prodromo d'Erpetologia Siciliana. Specchio Sci, 2: 102–104

Rao D. Q., Wilkinson J. A. 2008. Phylogenetic relationships of the mustache toads inferred from mtDNA sequences. Mol Phyl Evol, 46: 61–73

Rao D. Q., Yang D. T. 1994. The study of early development and evolution of *Torrentophryne aspinia*. Zool Res, 15(suppl.): 142–157

Schmidt K. P. 1925a. New Chinese amphibians and reptiles. Am Mu. Novit, 175: 1–3

Schmidt K. P. 1925b. New reptiles and a new salamander from China. Am Mus Novit, 157: 1–5

Schmidt K. P. 1927. Notes on Chinese amphibians. Bull Am Mus Nat Hist, 54(5): 553–575

Shang K. G., Deng C. X. 1983. A cytogenetic demonstration of ZW sex determination in *Bufo bufo garharizans*. Acta Genet Sinica, 10(4): 298–305

Shaw T. H. 1929. The amphibians of Peiping. Bull Fan Mem Inst Biol (Z. S.), 1(5): 77–97

Shen Q. Z. 1983. Stages in the normal development of *Rana temporaria chensinensis* David. Acta Sci Nat Univ Intramongolicae, (2): 42–48 (In Chinese)

Shen Y. H., Deng X. J., Zhao A. M. 1986. A study of the breeding ecology of the *Rhacophorus dennysi*. Acta Ecol Sinica, 6(2): 178–185 (In Chinese)

Shen Y. H., Deng X. J. 1985. Preliminary study of feeding habit of *Rana limnocharis*. J Hunan Nor Univ (Nat Sci), 1985(1): 36–40 (In Chinese)

Shen Y. H. 1965. Preliminary studies on anurans from Mt. Nanyue, Hunan Province. Chin J Zool, 7(2): 76–79 (In Chinese)

Sichuan Institute of Biology (Fei L., Hu S. Q., Ye C. Y., Wu G. F.). 1977. A survey of amphibians in Xizang (Tibet). Acta Zool Sinica, 23(1): 54–63, 2 plates (In Chinese)

Sichuan Institute of Biology (Fei L., Ye C. Y.). 1976. A survey of amphibians in western Hubei Province. Materials for Herpetol Res, 3: 18–23 (In Chinese)

Sichuan Institute of Biology (Fei L., Ye C. Y., Hu S. Q.) and Sichuan Medical College (Liu C. C.). 1976. Amphibian fauna of Sichuan. Materials for Herpetol Res, 3: 1–17 (In Chinese)

Sichuan Institute of Biology (Hu S. Q., Ye C. Y., Fei L.). 1974. A herpetological survey of Er'lang Shan. Materials for Herpetol Res, 2: 58–65 (In Chinese)

Sichuan Institute of Biology (Hu S. Q., Ye C. Y., Fei L.). 1977. Systematic Key to Amphibians of China. Beijing: Science Press, v+93 pages, 17 plates (In Chinese)

Sichuan Institute of Biology (Ye C. Y., Fei L.). 1974. Check list of Chinese amphibians and their distribution. Materials for Herpetol Res, 2: 2–16 (In Chinese)

Sichuan Institute of Biology (Ye C. Y., Fei L.). 1976. A survey of Mang Shan, Yizhang Country, Hunan Province. Materials for Herpetol Res, 3: 24–29 (In Chinese)

Sichuan Institute of Biology (Zhao E. M., Wu G. F.). 1974. A herpetological survey of Anhui Province. Materials for Herpetol Res, 3: 48–5 (In Chinese)

Sichuan University (Lab of Cytology, Department of Biology). 1984. Techniques for studying karyotypes and chromosome banding in amphibians. Zool Res, 5(1 Suppl.): 23–28 (In Chinese)

Smith M. A. 1923. On a collection of reptiles and batrachians from the Island of Hainan. J Nat Hist Soc, 6(2): 195–212

Song M. T., Wang Q. 1989. The growth of *Andrias davadianus*

(Blanchard) (Cryptobranchidae) in wild. Zool Res, 10(1): 64, 70, 78 (In Chinese)

Song Z. M., Ouyang F. 1985. Early embryonic development in *Scutiger boulengri*. Acta Herpetol Sinica (New ser), 4(3): 181–186 (In Chinese)

Song Z. M., Yao C. Y. 1991. Amphibia. 142–190 pp. In Wang X. T. (ed): Vertebrata Fauna of Gansu. Lanzhou: Gansu Publishing House of Science and Technology, 1–1362 (In Chinese)

Stejneger L. 1907. Herpetology of Japan and adjacent territory. Bull US Nat Mus, 58: 1–577

Stejneger L. 1927. A new genus and species of frog from Tibet. J Washington Acad Sci, 17(12): 317–319

Swinhoe R. 1870a. List of reptiles and batrachians collected in the Island of Hainan. Proc Zool Soc, London, 239–241

Swinhoe R. 1870b. Notes on reptiles and batrachians collected in various parts of China. Proc Zool Soc, London, 409–412

Tang Z. J. 1990. Study on the ecology and habit of *Vibrissaphora yaoshanensis*. Chin J Zool, 25(5): 10–13 (In Chinese)

Tao F. Y., Wang X. M., Zheng H. X., Fang S. G. 2005. Genetic structure and geographic subdivision of four population of Chinese Giant Salamander, *Andrias davidianus*. Zool Res, 26(2): 162–167 (In Chinese)

Taylor E. H. 1934. Notes on Chinese reptiles and amphibians. Lingnan Sci J, 13(2): 297–310

Thorn R. 1968. Les Salamandres d'Europe, d'Asie et d'Afrique du Nord. Encyclo. Pratique Nat. xxxv. Eds. Paul Lechevalier, Paris, 1–376

Tian W. J., Liu J. Y., Jiang J. P., Xie F. 2008. Studies on the progress of amphibian skin antimicrobial peptides. J Sichuan Univ (Nat Sci), 45(Supl.): 268–273 (In Chinese)

Tian W. S., Jiang Y. M. 1986. Identification Manual of Chinese Amphibians and Reptiles. Beijing: Science Press, 1–164

Tian Y. Z., Sun A. Q., Li S. 1997. Observation of reproductive habits of *Tylototriton kweichowensis*. Chin J Zool, 32(1): 20–23 (In Chinese)

Ting H. P. 1944. Notes on amphibia from Bohea Hill, Fukien. Biol Bull, Fukien Christian Univ, 4: 151–160

Ting H. P., Ts'ai M. Z., Liu J. R. 1965. Studies on hybridization of sixteen anuran species from Fukien. J Fukien Teachers Coll, (1): 65–114 (In Chinese)

Wagler J. 1828. Conspec Systematic Amphibiorum. Isis Von Oken, 21: 742–743 (In German)

Wagler J. 1830. Natürliches System der Amphibien, mit vorangehender classification der Säugethiere und Vögel. München, Stuttgart & Tübingen, Cotta, 1–354 (In German)

Wang B., Jiang J. P., Xie F., Chen X. H., Dubois A., Liang G., Wagner S. 2009. Molecular phylogeny and genetic identification of populations of two species of *Feirana* frogs (Amphibia: Anura, Ranidae, Dicroglossinae, Paini) endemic to China. Zool Sci, 26(7): 500–509

Wang C., Jia X. Z., Li Y., Wang Y. 1984. Preliminary observations on embryonic development of *Bufo bufo gargarizans* Cantor. Acta Herpetol Sinica (Nat Sci), 3(2): 39–48 (In Chinese)

Wang C. F., Fei L., Ye C. Y. 1984 Preliminary observations on the early development of *Cynops cyanurus chuxiongensis*. Chin J Zool, 19(6): 4–7, 1 plate (In Chinese)

Wang S. A., Liu Q. Y., Liu D. J. 1964. The amphibian species and their distribution in Tianjin. J Hebei Univ (Nat Sci), 1964(3): 229–235 (In Chinese)

Wang Y., Evans S. E. 2006. Advances in the study of fossil amphibians and squamates from China: The past fifteen years. Vertebrata Palasiatica, 44(1): 60–73

Wang Y. B., Fang J. J., Tang X. R. 1983. Preliminary observations on karyotype of *Salamandrella keyserlingii*. Acta Herpetol Sinica (new ser), 2(2): 19–22 (In Chinese)

Wang Y. T. 1958. The early development of the common frog, *Rana nigromaculata*. Acta Scientiarium Naturalium University Pekinensis, (1): 95–108, 10 plates (In Chinese)

Wei G., Li D. J., Xu N. 1991. A comparative study of LDH isoenzyme of four subspecies of *Rana chensinensis*. Acta Acad Med Zunyi, 14(4): 45–46 (In Chinese)

Wei G., Wang B., Xu N., Li Z. Z., Jiang J. P. 2009. Morphological evolution from aquatic to terrestrial in the genus *Oreolalax* (Amphibia: Megophryidae, Anura). Prog Nat Sci, 19: 1403–1408

Weisrock D. W., Papenfuss T. J., Macey J. R., Litvinchuk S. N., Polymeni R., Ugurtas I. H., Zhao E. M., Jowkar H., Larson A. 2006. A molecular assessment of phylogenetic relationships and lineageaccumulation rates within the family Salamandridae (Amphibia, Caudata). Mol Phyl Evol, 41: 368–383

Wen C. X., Shen J. C., Jiang S. T. 1981. Chromosome sample preparation and karyotype analysis of marrow cell of *Bufo gargarizans*. Acta Acad Med Bengbu, 6(1): 26–29 (In Chinese)

Wen C. X., Lu Q., Wei X. 1983. Studies of chromosome banding and sister chromatid exchange in *Bufo bufo gargarizans*. Acta Genet Sinica, 10(4): 291–297 (In Chinese)

Wen Y. T., Pang Q. P. 1990. The karyotype of *Ichthyophis bannanica* and comparison with *I. glutinosus*. Zool Res, 11(2): 121–125 (In Chinese)

Wiegmann A. F. A. 1835. Beiträge zur Zoologie, Gesammelt auf einer Reise um die Erde. In: von Dr. Meyer FJF. Amphibien. Nova Acta Caesar. Acad Leop Carol, 17: 183–268

Wu C. H., Gao W. 1983. The anatomy of the integumental and muscular systems of *Andrias Andrianus*. Acta Herpetol Sinica (New ser), 2(4): 13–24, 1 plate (In Chinese)

Wu C. H. 1982. External morphology and skeletal anatomy of *Andrias davidianus*. Chin J Zool, 17(1): 11–16 (In Chinese)

Wu C. H. 1988. The anatomy of the nervous system of *Andrias davidianus*. Acta Herpetol Sinica (New ser), 7(2): 93–102 (In Chinese)

Wu C. H. 1990 Studies on the morphology of digestive system of *Andrias davidianus* (Blanchard). In Zhao Er-mi (ed.): From Water onto Land. Beijing: China Forestry Press, 46–52, 2 plates (In Chinese)

Wu G. F., Yang W. M., Zhao E. M. 1981. Studies on genus *Vibrissaphora* (Amphibia: Pelobatidae). 3. A preliminary observation on karyotype of *Vibrissaphora liui* (Pope). Acta Herpetol Sinica (Old ser), 5: 139–142 (In Chinese)

Wu G. F., Zeng X. M. 1994. The karyotypic differentiation of *Polypedates dugritei* with description of a superspecies (Rhacophoridae, Anura). Sichuan J Zool, 13(4): 156–161 (In Chinese)

Wu G. F., Zhao E. M. 1984. A rare karyotype of anurans, the karyotype of *Rana phrynoides*. Acta Herpetol Sinica (New ser),

3(1): 29–32 (In Chinese)

Wu G. F., Zhao E. M. 1985. Preliminary studies on karyotypes of the genus *Amolops* of the Hengduan Mountains. Acta Herpetol Sinica (New ser.), 4(4): 276–282 (In Chinese)

Wu H. L, Zhang R. P. 1985. A study of sex chromosome in *Rana nigromaculata* by BrdU-Hoechst 33258-Giemsa technique. Acta Genet Sinica, 12(6): 462–469 (In Chinese)

Wu H. W. 1929. *Osteosternum amoyense*, a new frog from Amoy. Contr Biol Lab Sci Soc, 5(2): 1–9

Wu HW. 1930. Herpetological notes from Hangchow. Nat Cent Univ Sci Rept, B(1): 51–58

Wu L., Dong Q., Xu R. H. 1988. The Amphibian Fauna of Guizhou. Guiyang: Guizhou People's Press, 1–144 (In Chinese)

Wu Y. K., wang Y. Z., Jiang K., Chen X., Hanken J. 2009. Homoplastic evolution of external colouration in Asian stout newts (*Pachytriton*) inferred from molecular phylogeny. Zool Scripta, 39: 9–22

Wu Y. K., Wang Y. Z., Jiang K., Hanken J. 2010. A new newt of the genus *Cynops* (Caudata: Salamandridae) from Fujian Province, southeastern China. Zootaxa, 2346: 42–52

Wu Y. L., Sun Y. C. 1981. Preliminary observation on early embryonic development of *Rana limnochairs*. Chin J Zool, 16(3): 28–30, 1 plate (In Chinese)

Wu Y. L. 1987. Observation of early embryonic development of *Hyla immaculata*. Bull Biol, (2): 41–43 (In Chinese)

Wu Z. A., Tan A. M., Zhao E. M. 1987. Cytogenetic studies on four species of *Amolops* in the Hengduan Range. Acta Genetica Sinica, 14(1): 63–68 (In Chinese)

Wu Z. A., Yang H. Y. 1981. The karyotype of *Kaloula borealis*. Acta Zool Sinica, 27(1): 106 (In Chinese)

Wu Z. A. 1978a. Cultivation of tissues and cells from amphibian. Acta Zool Sinica, 24(2): 107–116 (In Chinese)

Wu Z. A. 1978b. Chromosomes studies on cultured amphibian somatic cells in vitro. Acta Zool Sinica, 24(2): 117–126 (In Chinese)

Wu Z. A. 1982. A simple method for chromosome preparation from amphibian bone marrow cells. Hereditas, 4(1): 38–39 (In Chinese)

Xiang G. S., Li P. X., Yang Y. R. 2009. Illustration to Amphibians and Reptiles of Taiwan. Taibei: Eagle Press. 1–336 (In Chinese)

Xie F., Fei L., Li C., Ye C. Y. 2001. The preliminary studies on the early development of the Chinhai Salamander, *Echinotriton chinhaiensis*. Chin J Zool, 36(4): 21–25 (In Chinese)

Xie F., Fei L., Ye C. Y., Cai C. M., Wang Z. W., Sparreboom M. 2000. Breeding migration and oviposition of the Chinhai salamander, *Echinotriton chinhaiensis.* Herpetol J, 10: 111–118

Xie F., Fei L., Ye C. Y., Zheng Z. H., Jiang J. P. 2005. Study on the systematics of the genus *Tylototriton* inferred from DNA fingerprinting. J Sichuan Univ (Nat Sci Edi), 42(sup): 106-112.

Xie F., Lau M. W. N., Stuart S. N., Chanson J. S., Cox N. A., Fischman D. L. 2007. Conservation needs of amphibians in China: A review. Sciences in China C, 50(2): 265–272

Xiong J. L., Chen Q., Zeng X. M., Zhao E. M., Qing L. Y. 2007. Karyotypic, morphological, and molecular evidence for *Hynobius yunanicus* as a synonym of *Pachyhynobius shangchengensis* (Urodela: Hynobiidae), J Herpetol 41(4): 663–670

Xiong R. C., Jiang J. P., Fei L., Wang B., Ye C. Y. 2010. Embryonic development of the concave-eared torrent frog with its significance on taxonomy. Zool Res, 31(5): 490–498

Xu J., Chen J. C. 1992. A preliminary study on the reproductive ecology of the *Batrachuperus tibetanus*. Chin J Zool, 27(5): 33–36 (In Chinese)

Xu J., Cui J. H. 1993. The preliminary observations on the embryonic development of *Batrachuperus tibetanus*. J Lanzhou Univ (Nat Sci), 29(2): 131–134 (In Chinese)

Xu J. L., Ma X. H. 1996. LDH isozymes patterns of *Xenobius melanonychus*. Acta Zool Sinica, 42(2): 182–188 (In Chinese)

Xu J. X., Xie F., Jiang J. P., Mo Y. M., Zheng Z. H. 2005. The acoustic features of the mating call of 12 anuran species. Chin J Zool, 40(3): 12–l (In Chinese)

Xu N., Wei G., Li D. J., Fei L., Ye C. Y. 1992. Study on the phylogenetic relationship between species of genus *Oreolalax* (Amphibia: Pelobatidae). Acta Herpetol Sinica (Guiyang), 1 & 2: 40–49 (In Chinese)

Xue M. G. 1963. Economical Animal of Wuhan, Hubei: Mahphibians and Reptiles. Zool Soc Hubei Province and Wuhan City, 1–90 (In Chinese)

Yang D. D., Shen Y. H. 1993. Studies on the breeding ecology of *Cynops orientalis*. Zool Res, 14(3): 215–220 (In Chinese)

Yang D. T., Rao D. Q. 2008. Amphibia and Reptilia of Yunnan. Kunming: Yunnan Science and Technology Press, 1–411 (In Chinese)

Yang D. T., Su C. Y., Li S. M. 1978. Amphibians and Reptiles of the Gaoligong Mountains, Western Yunnan. Kunming: Scientific Report of the Yunnan Institute of Zoology, Acad Sinica, (8): 1–94 + plates 6 (In Chinese)

Yang D. T., Su C. Y. 1976. *Ichthyophis glutinosus* found from Xishuangbanna of Yunnan. Acta Zool Sinica, 22(1): 115 (In Chinese)

Yang D. T. 1991. Phylogenetic systematics of the *Amolops* group of ranid frogs of southeastern Asia and the Greater Sunda Islands. Fieldiana: Zool, Chicago, n. s. 63: 1–42

Yang D. T. 1991a. The Amphibia-Fauna of Yunan. Beijing: China Forestry Publishing House, iv+259 pp (In Chinese)

Yang Y. H. 1983. A comparative study on three subspecies of *Bufo bufo* from China using techniques of C-Banding, Ag-NORs and electrophoresis of sera and of lactate dehydrogenase (LDH) isozymes. Acta Herpetol Sinica (New ser), 2(2): 1–9, 2 plates (In Chinese)

Yang Z. G., Tian C. L., Hu Q. P. 2000. Comparative studies on the LDH isozymes of several tissues in *Paramesotriton fuzhongensis* and *P. guangxiensis*. Cultum Herpetol Sinica (Guiyang), 8: 269–272 (In Chinese)

Yang A. S., Bian W., Liu Y. Q., Liu G. J. 1983. Preliminary studies on the embryonic development of *Megalobatrachus davidianus* (Blanchard). Acta Zool Sinica, 29(1): 42–47, 2 plates (In Chinese)

Yang Y. R. 2008. Field Guide to Amphibians of Taiwan. Taibei: Forest Department of Agricultural Committee in Taiwan, 1–133 (In Chinese)

Yao S. Y. 1984. Preliminary observations on reproductive habit of *Bufo raddei* Stauch of suburbs of Xuzhou. Acta Herpetl Sinica (New ser), 3(3): 21–22 (In Chinese)

Ye C. Y., Fei L., Chen S. W. 1994. Polymorphism and geographic distribution of skin texture of six species amphibians in Heng-

duan Mountains. Zool Res, 15(1): 33–45 (In Chinese)

Ye C. Y., Fei L., Hu S. Q. 1993. Rare and Economic Amphibians of China. Chengdu: Sichuan Publishing House of Science and Technology, 1–412 (In Chinese)

Ye C. Y., Fei L., Wei G., Xu N. 1992. Study on the phylogenetic relationship between species of *Scutiger* genus in Qinghai-Xizang Plateau (Amphibia: Pelbatidae). Acta Herpetol Sinica (Guiyang), 1 & 2: 27–39 (In Chinese)

Ye R. Q., Hong X. F., Chen X. D. 1986. Early stages of the embryonic development in *Bufo melanostictus*. Acta Herpetol Sinica (New ser.), 5(3): 185–188 (In Chinese)

Yu G. H., Rao D. Q., Zhang M. W., Yang J. X. 2009. Re-examination of the phylogeny of Rhacophoridae (Anura) based on mitochondrial and nuclear DNA. Mol Phyl Evol, doi:10.1016/j. ympev.2008.11.023

Yu G. H., Yang J. X., Zhang M. W., Rao D. Q. 2007. Phylogenetic and systematic study of the genus *Bombina* (Amphibia: Anura: Bombinatoridae): New insights from molecular data. J Herpetol, 41(3): 365–377

Yu P., Pang J. Q., Liu Z. J., Hu Q. X. 1992. A comparison on LDH and MDH between two species of salamanders. Acta Herpetol Sinica (Guiyang), 1 & 2: 150–153 (In Chinese)

Yu P. C., Lin G. H. 1995. Preliminary observations on the early embryonic development of *Rana spinosa*. Acta Hydrobiol Sinica, 19(3): 216–222 (In Chinese)

Yu P. C., Tu X. G. 1997. *Rana spinosa* feeding habits preliminary research. Cultum Herpetol Sinica (Guiyang), 6–7: 128–132 (In Chinese)

Yuan F. X., Wen X. B. 1990. A preliminary study on living and feeding habits of *Rana boulengeri* in wentern Hubei Province. Chin J Zool, 25(2): 17–21 (In Chinese)

Yuan L., Wang X. L. 2009. Reason analysis on decreasing number of *Ranodon sibiricus* and conserving strategies. J Xinjiang Nor Univ (Nat. Sci), (3): 15–18, 32 (In Chinese)

Zarevsky S. 1924. On a new species of *Bufo* from South Monglia. Ann Mus Zool Acad Sci, 25: 152–154

Zarevsky S. 1925a. Notes on some batrachians from the Palaearctic region. Ann Mus Zool Acad Sci, 26: 74–78

Zarevsky S. 1925b. The reptiles and amphibians of P. K. Kozlov's Expedition in Mongolia and Szechwan in 1907–1909. Ann Mus Zool Acad Sci, 26: 79–86

Zarevsky S. 1930. Zooll results of the expedition to Mongolia made by P. K. Kozlov in the years 1924–1926. II. Reptilia and Amphibia. Ann Mus Zool Acad Sci, 31: 213–217

Zeng K. W., Che F. Y., Li X. F., Pan X. F., Zhou D. L. 1993. A study on LDH isoenzyme of 8 species of amphibia in Heilongjiang Province. Chin Wildl, 6: 36–41 (In Chinese)

Zeng X. M., Fu J. Z., Chen L. Q., Tian Y. Z., Chen X. H. 2006. Cryptic species and systematics of the hynobiid salamanders of the *Liua* - *Pseudohynobius* complex: Molecular and phylogenetic perspectives. Biochem Syst Ecol, 34: 467–477

Zeng X. M., Fu J. Z. 2004. Low genetic diversity in Chinese *Hynobius leechii*, with comments on the validity of *Hynobius mantchuricus*. Amphibia-Reptilia, 25: 119–122

Zhan J. D., Dai J. H., Dai Q., Zhang M., Xiong Y., Li C., Liu Z. J., Wang Y. Z. 2006. Niche breadths of three anurans at different ontogenetic stages in Zoige Wetland. Chin J Appl Environ Biol, 12 (5): 665–668 (In Chinese)

Zhang D. R., Chen M. Y., Murphy R. W., Che J., Pang J. F., Hu J. S., Luo J., Wu S. J., Ye H., Zhang Y. P. 2010. Genealogy and palaeodrainage basins in Yunnan Province: Phylogeography of the Yunnan spiny frog, *Nanorana yunnanensis* (Dicroglossidae). Mol Ecol, 19: 3406–3420

Zhang H., Yan J., Zhang G. Q., Zhou K. Y. 2008. Phylogeography and demographic history of Chinese black-spotted frog populations (*Pelophylax nigromaculata*): Evidence for independent refugia expansion and secondary contact. BMC Evol Biol, 8:21 doi:10.1186/1471-2148-8-21

Zhang J. D., Fu Z. P., Li Y. J., Dai Q., Wang B., Wang Y. Z. 2007. Daily activity rhythm of *Rana kukunoris* and *Bufo minshanicus* in Zoige Wetland. Sichuan J Zool, 26(2): 312–315 (In Chinese)

Zhang J. F., Nie L. W., Peng Q. L., Ge Y. D., Wang Y., Xu J. C., Tang X. S. 2005. Relationships among the Chinese group of *Limnonectes* based on mitochondrial 12S and 16S rRNA sequences. Acta Zool Sinica, 51 (2): 354–359 (In Chinese)

Zhang J. M., Wang A. H., Guo P. 1985. Investigation on the karyotypes of salamanders *Triturides chinensis* and *Pachytriton brevipes*. J Wenzhou Med Coll, 15(1): 26–31 (In Chinese)

Zhang P., Chen Y. Q., Zhou H., Liu Y. F., Wang X. L., Papenfuss T. T., Wake D. B., Qu L. H. 2006. Phylogeny, evolution, and biogeography of Asiatic salamanders (Hynobiidae). PNAS, 103(19): 7360–7365

Zhang P., Papenfuss T. J., Wake M. H., Qu L. H., Wake D. B. 2008. Phylogeny and biogeography of the family Salamandridae (Amphibia: Caudata) inferred from complete mitochondrial genomes. Mol Phyl Evol, 49: 586–597

Zhang R. Z. 1999. Zoogeography of China. Beijing: Science Press, 1–502 (In Chinese)

Zhang Y. G. 1989. Studies on the early embryonic development of *Rana japonica japonica* Guenther. J Southwest Teachers Univ, 14(1): 58–66 (In Chinese)

Zhang Y. X., Wen Y. T. 2000. Amphibians in Guangxi. Guilin: Guangxi Normal University Press, 1–183 (In Chinese)

Zhao E. M., Adler K. 1993. Herpetology of China. Oxford, Ohio: Society for the Amphibians and Reptiles, 1–522 (In Chinese)

Zhao E. M., Hu Q. X. 1984. Studies on Chinese Tailed Amphibians. Chengdu: Sichuan Scientific and Technique Publishing House, 1–68 (In Chinese)

Zhao E. M., Jiang Y. M., Huang Q. Y., Hu S. Q., Fei L., Ye C. Y. 1993. Latin-Chinese-English names of Amphibians and Reptiles. Beijing: Science Press, 1–329 (In Chinese)

Zhao E. M., Tan A. M., Wu G. F. 1987. Karyotypes of Chinese species of *Occidozyga* (Family Ranidae), with discussion on the taxonomic status of *O. laevis martensi*. Chin Herpetol Res, 1: 7–11 (In Chinese)

Zhao E. M., Yang D. T. 1995. Amphibians and Reptiles of the Hengduan Mountains Region. Beijing: Science Press, 1–303 + plates VIII

Zhao E. M. 1998 China Red Data Book of Endangered Animals: Amphibia & Reptilia. Beijing: Sciences Press, 1–330 +plates IV

Zhao S., Dai Q., Fu J. Z. 2009. Do rivers function as genetic barriers for the plateau wood frog at high elevations? J Zool, 279: 270–276.

Zhao W. G., Liu P., Xia Y. G. 2004. Karyotype of *Rana rugosa* from Liaoning Province. Sichuan J Zool, 23(3): 185–187 (In Chinese)

Zhao W. G. 2009. Herpetol Fauna of Heilongjiang. Beijing: Science Press, 1–249 + plates I-VI

Zheng H. X., Wang X. M. 2010. Telemetric data reveals ecologically adaptive behavior of captive raised Chinese giant salamanders when reintroduced into their native habitat. Asian Herpetol Res, 1(1): 31–35

Zheng R. Q., Ye R. H., Yu Y. Y., Yang G. 2009. Fifteen polymorphic microsatellite markers for the giant spiny frog, *Paa spinosa*. Mol Ecol Resour, 9: 336–338

Zheng Y. C., Deng D. C., Li S. Q., Fu J. Z. 2010. Aspects of the breeding biology of the Omei mustache toad (*Leptobrachium boringii*): Polygamy and paternal care. Amphibia-Reptilia, 31: 183–194

Zheng Y. C., Fu J. Z., Li S. Q. 2009. Toward understanding the distribution of Laurasian frogs: A test of Savage's biogeographical hypothesis using the genus *Bombina.* Mol Phyl Evol, 52: 70–83

Zheng Y. C., Fu J. Z. 2007. Making a doughnut-shaped egg mass: Oviposition behaviour of *Vibrissaphora boringiae* (Anura: Megophryidae). Amphibia-Reptilia, 28: 309–311

Zheng Y. C., Li S. Q., Fu J. Z. 2008. A phylogenetic analysis of the frog genera *Vibrissaphora* and *Leptobrachium,* and the correlated evolution of nuptial spine and reversed sexual size dimorphism. Mol Phyl Evol, 46: 695–707

Zheng Y. C., Mo B. H., Liu Z. J., Zeng X. M. 2004. Phylogenetic relationships of megophryid genera (Anura: Megophryidae) based on partial sequences of mitochondrial 16S rRNA gene. Zool Res, 25 (3): 205–213 (In Chinese)

Zheng Y. C., Zeng X. M., Yuan Y. Z., Liu Z. J. 2004. Phylogenetic positions of *Ophryophryne* and four *Leptobrachium* group genera in Megophryidae (Anura). Sichuan J Zool 23(3): 290–295 (In Chinese)

Zheng Z. H., E W. Y., Li S. Q. 1984. Ultrastructure of the oviduct of *Rana temporaria chensinensis* David. Acta Herpetol Sinica (New ser), 3(2): 15–19 (In Chinese)

Zheng Z. H., Fei L., Ye C. Y. 2000. Study on morphology of spermatozoa of *Megophrys* (Amphibia: Pelobatidae) from China. Chin J Appl Environ Biol, 6(2): 161–165 (In Chinese)

Zheng Z. H., Fei L., Ye C. Y., Xie F., Jiang J. P. 2002. Comparative study on sperm morphology of Chinese Megophryinae and its taxonomical sense (Amphibia: Pelobatidae). Acta Zoot Sinica, 27(1): 167–172 (In Chinese)

Zheng Z. H., Xie F., Jiang J. P., Fei L. 2004. Spermatozoa structure of the Chinhai salamander *Echinotriton chinhaiensis* (Caudata: Salamandridae). Acta Zool Sinica, 50(4): 622–629 (In Chinese)

Zheng Z. H., Xie F., Jiang J. P., Fei L. 2006. Ultrastructure and morphology of the spermatozoa in *Vibrissaphora boringii* and its taxonomical sense (Anura: Megophryidae). Zool Res, 27(3): 291–298 (In Chinese)

Zheng Z. H., Jiang J. P., Xie F., Liu J. Y. 2010. Sperm morphology of Microhylidae from China. Herpetol Sinica (Nanjing), 12: 146–152 (In Chinese)

Zhong J., Liu Z. Q., Wang Y. Q. 2008. Phylogeography of the rice frog, *Fejervarya multistriata* (Anura: Ranidae), from China based on mtDNA D-loop sequence. Zool Sci, 25: 811–820

Zhou B. X. 1965. Anatomy of the Frog Body. Beijing: Science Press, 1–239 (In Chinese)

Zhou J. X., Shan Y. X. 1961. A catalogue of amphibians and reptiles of Henan Province. Joint J Xinxiang Teachers Coll Henan Chem Ind Coll, 2: 39–44 (In Chinese)

Zhou K. Y. 1962. A preliminary study on geographical distribution of amphibians of Kiangsu Province. J Nanking Teachers Coll (Nat Sci), 1962(2): 45–51 (In Chinese)

Zhou L. Z., Song Y. J. 1997. A study of feeding ecology of *Bufo raddei*. Chin J Ecology, 16(4): 29–34 (In Chinese)

Zhou L. Z., Song Y. J. 1998. Food diversity and trophic niche of the breeding population of *Bufo raddei*. Chin J Zool, 33(2): 7–11 (In Chinese)

Zhou Y. H., Qin Y. L., Xu L. H. 1963. Report on survey of tailless amphibians in mailand of Guangdong, In Abstracts of Conference on Animal Ecology and Fauna. Beijing: Science Press, 148 pp (In Chinese)

Zou M. Q., Zhong Y. G. 1986. Ecological surveys and observations on the breeding of *Rana spinosa* in northwestern Fujian. Chin J Zool, 21(3): 4–8 (In Chinese)

Zou P. Z., Wen C. X., Xu J., Chen J. R. 2001. The primary research for the early embryonic development of *Hylarana guentheri.* Chin J Zool, 36(6): 15–19 (In Chinese)

Zou S. C. 1987. Studies on the ecology of *Bufo raddei* in autumn and winter. Acta Herpetol Sinica, 6(3): 4–8 (In Chinese with English abstract)