International Journal of *Artemia* Biology

ISSN:2228-754X

2013, Vol 3, No 1: 20-50

Review of the biogeography of *Artemia* Leach, 1819 (Crustacea: Anostraca) in China

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Abstract

China is one of the countries the richest in *Artemia* locations and biodiversity. To date, at least 274 *Artemia* sites (excluding 39 ambiguous sites that may overlap with the determinate records) have been recorded from China, including 156 sites reported after the last review or omitted in previous review work. Among the 274 sites, 66 are coastal salterns and 208 are inland salt lakes/pools. Three bisexual species, *A. sinica*, *A. tibetiana* and *A. franciscana*, and the parthenogenetic populations of *Artemia* with ploidies of 2n, 3n, 4n, 5n and 9n have been documented for Chinese *Artemia*, whereas most of the Chinese populations have not been identified to species. The *Artemia* populations of coastal salterns are distributed from 18.5°N to 40.9°N, across the tropical, subtropical and temperate zones. They were almost exclusively parthenogenetic before 1989, but since then these habitats have been commonly invaded by the exotic bisexual species, *A. franciscana* or/and *A. sinica*. The inland populations are almost exclusively located in the subarid and arid areas such as Neimenggu (Inner Mongolia), Ningxia, Gansu, Xinjiang, Qinghai and northern Xizang (Tibet), and range vertically from as low as -154 m to as high as ~5040 m above the sea level. The distribution pattern of China inland *Artemia* can be roughly divided into four regions. The first region is composed of the northern Qinghai-Xizang Plateau, and *Artemia* of this region are characterized by consisting of alpine bisexual populations and are represented by the species *A. tibetiana*. The second region includes the Neimenggu Plateau and the Loess Plateau (Huangtu Gaoyuan), *Artemia* of this region is bisexual and is represented by *A. sinica*. The third region is located in the Junggar Basin, Turpan Basin and intermontane basins of Tian Shan area, which is characterized by inhabiting parthenogenetic populations. The fourth region is located in Qaidam Basin, which is geographically in between the above three regions. Containing both bisexual and parthenogenetic populations, the *Artemia* fauna of this region seems transitional.

Key Words: *Artemia*, China, biogeography, taxonomy, biological invasion

Introduction

Brine shrimp *Artemia* lives in the hypersaline waters, such as inland salt lakes, coastal lagoons and salterns, in all the continents except Antarctic. As *Artemia* (including their resting eggs and larvae) possess some well-known merits, it is widely used in fish and shellfish larviculture (Dhont and Sorgeloos, 2002) and in research such as toxicology, genetics, evolution, astrobiology, etc. (e.g., Bücker and Horneck, 1975；Abreu-Grobois, 1987; Lewan *et al*., 1992; Gajardo *et al*., 2002). These small creatures have drawn more attention of scientists than other similar taxa, and have been extensively studied during the recent decades. By the beginning of the century, more than 600 *Artemia* sites had been recorded in the world (Van Stappen, 2002).

China is one of the countries that are the richest in *Artemia* locations and biodiversity. The record of *Artemia* from Chinese saltworks may date back to the Ming Dynasty (Ben-Jun Tu, 1596; see Yang and Sun, 2013), whereas before 1980 the occurrence of *Artemia* in China was only mentioned in several papers (Xu and Huang, 1959; Huang and Huang, 1973; Chen *et al*., 1975; Qiu, 1977; Hua, 1979; Xu *et al*., 1979). Since then records of Chinese *Artemia* populations have explosively increased, mostly because their importance in aquaculture became well known. Searches with the Chinese word "luchong" (=brine shrimp) in CNKI China Periodical Full Text Database (http://www.cnki.net) showed that the number of Chinese papers mentioning *Artemia* has been continuously increasing (136 results during 1980 to 1989, 470 results during 1990 to 1999, and 727 results during 2000 to 2009). Several reviews on the distribution of Chinese *Artemia* have been published (Ma, 1993: 77 sites; Triantaphyllidis *et al*., 1994a: 27 sites; Xin *et al*., 1994: 75 sites; Triantaphyllidis *et al*., 1998: 71 sites; Van Stappen, 2002: 92 sites). Since the latest review by Van Stappen (2002), many previously unknown *Artemia* sites have been reported, particularly from Xizang (= Tibet) and Neimenggu (= Inner Mongolia) autonomous regions, and the species composition recorded in coastal salterns has markedly changed because of biological invasion. In the present paper, we will make an updated summary for the distribution of Chinese *Artemia* populations, which contains 274 sites, including 156 sites reported after the last review or omitted in the previous review works.

Natural geography and *Artemia* habitats of China

Salinity is the predominant abiotic factor determining the presence and limiting the geographical distribution of *Artemia*, which is rarely found in waters with salinity lower than 45 $g.l^{-1}$. Other factors (temperature, light intensity, primary food production) may have an influence on the quantitative aspects or may cause only a temporary absence of brine shrimp populations (Van Stappen, 2002). The dependence of *Artemia* on hyper saline habitats is often explained because the absence of predators in them (Persoone and Sorgeloos, 1980; Van Stappen, 2002). The presence of *Artemia* in some natural waters with quite low salinities in Qinghai-Xizang Plateau (e.g., Oma Co, 7.0 $g.l^{-1}$; Sekazi Hu I, 8.47 $g.l^{-1}$; Yanshan Hu III, 8.69 $g.l^{-1}$; Yanshan Hu II, 12.69 $g.l^{-1}$; Toson Hu, 15.9 $g.l^{-1}$; Yanshan Hu IV, 17.25 $g.l^{-1}$; Xiaoquan Hu, 18.63 $g.l^{-1}$. See Liu and Zheng, 1990; Yuan *et al*., 2007) may be also due to harsh alpine environments (except Toson Hu which is 2813 m above the sea level (m.a.s.l.), elevations of these lakes range from 4436 m to ~5040 m) have limited the occurrence of predators. A world-scope evaluation on the distribution of *Artemia* showed that 97 percent of the *Artemia* habitats were located in areas where annual evaporation exceeds annual precipitation (Vanhaecke *et al*., 1987). While aridity is a common climatic feature for natural areas inhabited by *Artemia,* the position and topography (besides the latitude and atmospheric circulation) are two major factors determining the climate type of a given inland area.

The topography of China is characterized by high altitudes in the west and lowlands in the east, while usually divided into three steps (Fig. 1). The

first step is represented by the Qinghai-Xizang (= Qinghai-Tibet) Plateau with an average elevation over 4000 m.a.s.l. The second step lies to the north of Kunlun Shan (in Chinese "shan" means "mountain/ mountains"), Altun Shan and Qilian Shan and (farther south) to the east of the Hengduan Shan, with the elevation descending to about 1000-2000 m.a.s.l. The third step extends from Da Hinggan Ling (Daxinganling) (in Chinese "ling" means "range") - Taihang Shan- Wu Shan - Wuling Shan- Xuefeng Shan to the Chinese seas. Most of this third area is made up of hills and plains lying below 500 m.a.s.l.

The climate of China can be classified into five main types: tropical monsoon climate (Leizhou Peninsula, southern Taiwan, Hainan and other islands of the South China Sea), subtropical monsoon climate (the area to the south of the Qin Ling and Huai He, and to the east of Hengduan Shan), temperate monsoon climate (the area to the north of Qin Ling - Huai He and to the east of Helan Shan - Yin Shan - Da Hinggan Ling), plateau climate (Qinghai-Xizang Plateau and Tian Shan), and temperate continental climate (the other areas in northern China).

Chinese salt lakes are mostly distributed in areas of the first and the second topographic steps, where the climate is of either plateau climate or temperate continental climate. Their distribution is controlled by the arid and semi-arid climate, and they are mainly located within the limits of annual mean precipitation < 500 mm (Zheng, 2010; also see Fig. 1). There are more than 1000 saline lakes (with salinities > 50 $g.l^{-1}$) embracing a total area of approximately 50,000 km^2 (Neimenggu, 375 and 1441 km^2; Xinjiang, 112 and 10790 km^2; Qinghai, 71 and 18986 km^2; Xizang, ~500 and ~8225 km^2; Jilin + Heibei + Ningxia + Gansu + Shanxi + Shaanxi, 21 and 335 km^2) in the so-called Chinese salt lake mega-region (Zheng *et al*., 2002), which was broadly divided into four regions, Qinghai-Xizang Plateau salt lake region (I), northwest salt lake region (II), northeast salt lake region (III) and east dispersed salt lake region (IV), each is further divided into different subregions (Fig. 1) (Zheng, 2001b, 2010).

In addition to the inland salt waters, man-made coastal salterns are another important type of *Artemia* habitat in China. Along the ~18000 km coastline there are numerous salterns that constitute a total area of 4,050 km^2 (Hu, 2011). The climate (temperature, precipitation, wind, evaporation, etc) of the different saltern areas varies greatly. For instance, annual precipitation around Bohai area is usually lower than 700 mm, that on the Yellow Sea coasts is about 700 - 1000 mm, and that on the coasts of the East China Sea and South China Sea may reach 1000 - 2000 mm (Fig. 1; Liu, 2010).

Taxonomic status of *Artemia* populations from China

Although many populations from China were reported as *Artemia* sp., nine species names have ever been used for Chinese *Artemia*. Except Xu and Huang (1959) who did not identify their populations to species level, earlier authors usually reported the Chinese brine shrimps as *Artemia salina* (L., 1819), including the *Artemia* populations from coastal salterns in almost all coastal provinces (Huang and Huang, 1973; Chen *et al*., 1975; Qiu, 1977; Hua, 1979; Huang *et al*., 1980) and several *Artemia* populations from Xizang (Jiang, 1983). Huang *et al*. (1980) first documented that males were rare in the population from Tanggu Saltern of Tianjin. This population and many other coastal saltern populations were confirmed to be parthenogenetic populations (see below) by many latter studies (Tab. 1). The Cam Co population (in Xizang) was re-identified as *Artemia tibetiana* Abatzopoulos *et al*., 1998 by Zheng and Sun (2008) and the other "*A. salina*" populations reported by Jiang (1983) may also belong to this species.

Qian *et al*. (1992) described three new species according to specimens from three salt lakes of Xinjiang, *Artemia barkolica* Qian and Wang in Qian *et al*., 1992, *Artemia urumuqinica* Qian and Wang in Qian *et al*., 1992 and *Artemia ebinurica* Qian and Wang in Qian *et al*., 1992, which were mentioned only by few subsequent works (Qian *et al*., 1993, 1994; Zhang *et al*., 1994a,b). Although male specimens were described for *A. barkolica* and *A. ebinurica*, the very biased sex ratio (♀/♂=189:1 and 625:1, respectively; and 2500:0 for *A. urumuqinica*)

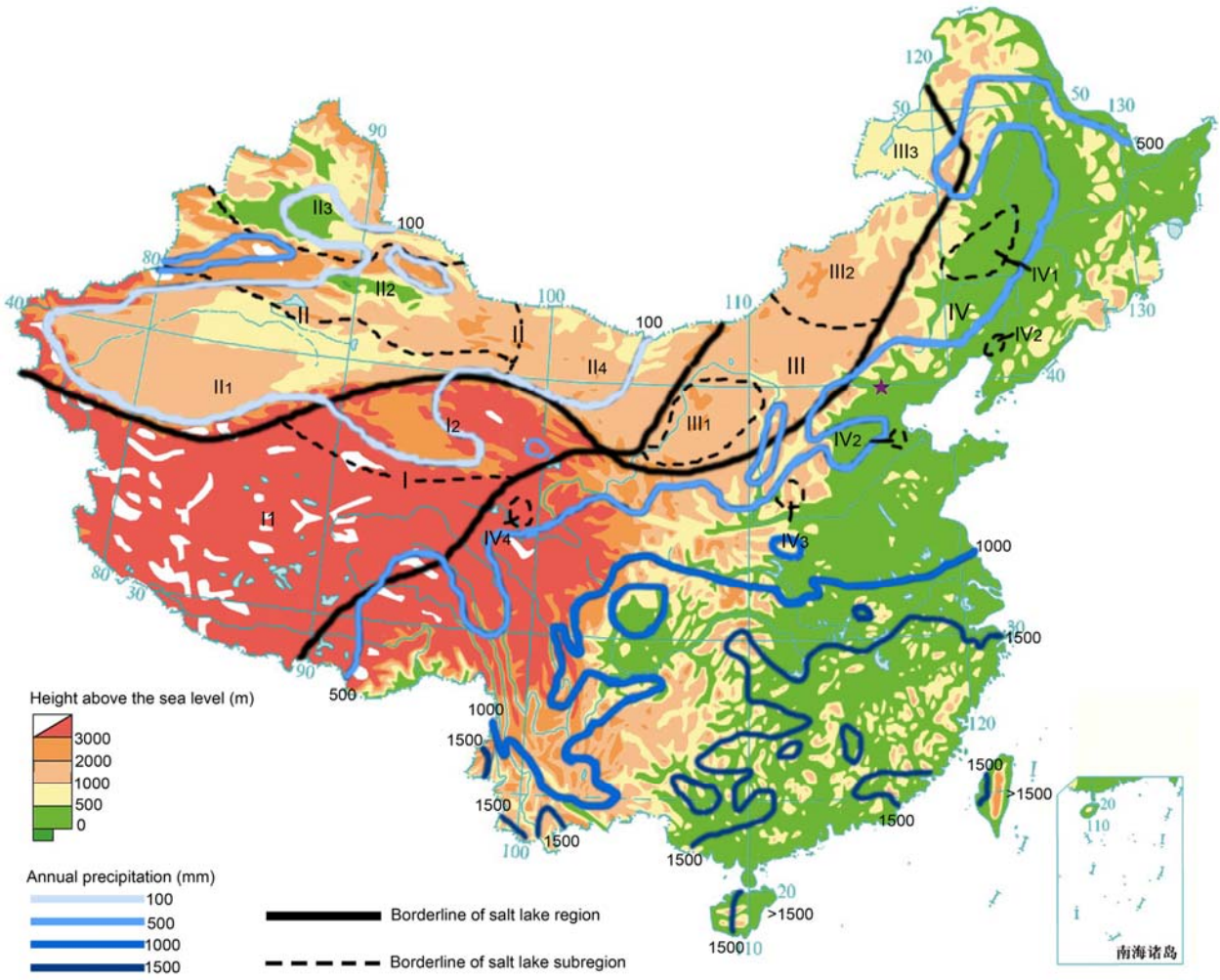

Fig. 1: China map showing the 3-step topography, the annual precipitation and the quaternary saline lake regions. I. Qinghai-Xizang Plateau salt lake region: I_1. Xizang salt lake subregion; I_2. Kunlun-Qilian salt lake subregion. II. Northwest salt lake region: II_1. Tarim salt lake subregion; II_2. Tianshan salt lake subregion; II_3. Junggar salt lake subregion; II_4. Alxa salt lake subregion. III. Northeast salt lake region: III_1. Ordos salt lake subregion; III_2. Eastern Neimenggu salt lake subregion; III_3. Hulun Buir salt lake subregion. IV. East dispersed salt lake region: IV_1. Nenjiang River salt lake subregion; IV_2. Coastal underground brine lake subregion; IV_3. Yuncheng salt lake subregion; IV_4. Yellow River Source local salt lake subregion (Boderlines of saline lake regions/subregions after Zheng, 2010. Some minor deviations in precipitation lines and borderlines of saline lake regions/subregions might have been caused while superimposing them to the topography map).

(Qian *et al*., 1992) and results of many other studies (see Tab. 1) have showed that all the three populations should be parthenogenetic. Therefore the validity of these three nominal species is questionable according to the modern consensus on *Artemia* taxonomy. In addition, there were inadequate holotype designations for these species – multiple specimens (rather than single specimen) were designated as holotypes in the original description (Qian *et al*., 1992). In the present paper, these populations are considered as parthenogenetic populations of *Artemia* though the name *Artemia parthenogenetica* was proposed for parthenogenetic *Artemia* (see Bowen and Sterling, 1978) and used by many latter studies (It might be an unavailable name; see Asem *et al*., 2010).

Artemia sinica Cai, 1989 is a bisexual species described by Cai (1989) using the material collected from Xie Chi, Yuncheng, Shanxi. The validity of this species is seldom questioned. At least 27 additional bisexual populations, which were collected from Jilin (1site), Neimenggu (21 sites), Hebei (3 sites; i.e. Shangyi, Zhangbei and Kangbao counties, which are not included in the present site list following our criterion, see Tab. 1) and Qinghai (2 sites; i.e. Da Qaidam Hu and Xiao Qaidam Hu; see futher), were reported to be *A. sinica* (Hou *et al*., 1997a, b; Hou, 1998; Triantaphyllidis *et al*., 1997a,b, 1998; Sun *et al*., 2000; Xin *et al*., 2000; Van Stappen, 2002; Zhou *et al*., 2003a, b). Although the population from Xiao Qaidam Hu was reported to be *A. sinica* (Hou *et al*., 1997a, b; Hou, 1998; Xin *et al*., 2000), no comparisons were conducted with the sibling Tibetan populations (*A. tibetiana*) in these studies. Zhou *et al*. (2003b) found that the Xiao Qaidam Hu population is morphologically intermediate between *A. sinica* and *A. tibetiana*, but ascribed this population to the subspecies *A. sinica tibetiana*. Recent results of 16S rDNA analysis showed that Xiao Qaidam Hu population is genetically closer to *A. sinica* than to *A. tibetiana* (Yin *et al*., 2011). Therefore the Xiao Qaidam Hu population is more likely to be *A. sinica* than *A. tibetiana*, whereas no cross-breeding tests have ever been conducted for this population. Another geographically close population, Da Qaidam Hu population (see Tab. 1), which was also reported to be *A. sinica* by Hou *et al*. (1997a), might be of the similar condition.

Another bisexual species, *A. tibetiana*, was described according to the material collected from Lagkor Co, Xizang (Abatzopoulos *et al*., 1998). The taxonomic status of *A. tibetiana* has been controversial since it was established. It has been suggested to be a subspecies of *A. sinica* by Zhou *et al*. (2003b), while Hou *et al*. (2006) argued that it should be a junior synonym of *Artemia urmiana* Günther, 1899 (see Asem and Rogers, 2012). Following the discussion of Zheng and Sun (2008), *A. tibetiana* is considered as a valid species in the present paper. Four additional populations from Qinghai-Xizang Plateau (Cam Co, Jibu Caka, Dagdong Co and Jingyu Hu) were identified as *A. tibetiana* by Zheng and Sun (2008). Two other populations (Goulu Co and Kyêbxang Co), which were considered as *A. sinica tibetiana* by Zhou *et al*. (2003 b), can also be assigned to *A. tibetiana*.

Parthenogenetic *Artemia* populations, which had been assigned to the so-called *Artemia parthenogenetica* for years (see above), have been found in both coastal salterns and inland salt lakes, and ploidies of 2n, 3n, 4n, 5n and 9n have been reported (Tab. 1; see further).

The last species reported from China is the cosmopolitan invasive species *Artemia franciscana*, which has occurred in many coastal salt pans since ~1989. We will make further discussion for this species in a latter section.

Distribution of Chinese *Artemia*

There are hundreds of publications that have provided information of *Artemia* localities in China and more than 310 sites were mentioned in these references. The geographic names of these *Artemia* sites are from different languages, including Chinese, Mongolian and Tibetan, whereas they are reported with either Chinese or English in the *Artemia* references. When translated to English, the names might have been romanized from Chinese to English, or from Mongolian/Tibetan to English, or first from Mongolian/Tibetan to Chinese then to English. Thus synonyms, either from original languages or from different translations, are not uncommon.

Localities of *Artemia* so far reported from China as well as the synonymous geographic names appearing in *Artemia* references, their geographical coordinates, reproduction modes, ploidies (parthenogenetic populations), and specific designations are summarized in Tab. 1. Some of the sites were reported from a relatively big area (a district, a county, etc), and a few others, such as Leguantai, Beidaba, Wudao, Yueya Hu, Maduo Hu, Erdaogou and Dagdong Cuo (see Table 1), were failed to re-locate on the local map even after inquiring the original authors. Excluding the ambiguous localities (those reported from big regions) that may be overlapped with determinate sites, a total of 274 *Artemia* sites have been recorded from China,

including 66 sites from coastal salt pans and 208 sites from inland hypersaline waters (Tab. 1). These sites are distributed horizontally from 18.5°N (Yinggehai, Hainan) (Zhang and Liu, 1989; *et al*.) to 47.7°N (Kekesu Yanhu, Xinjiang) (Ren *et al*., 1996; *et al*.) and vertically from as low as –154 m.a.s.l. (Aydingkol Hu, Xinjiang, the lowest place of China) (Ma, 1993) to as high as ~5040 m.a.s.l. (Yanshan Hu II, III and IV, Xizang) (Yuan *et al*., 2007) (Tab. 1).

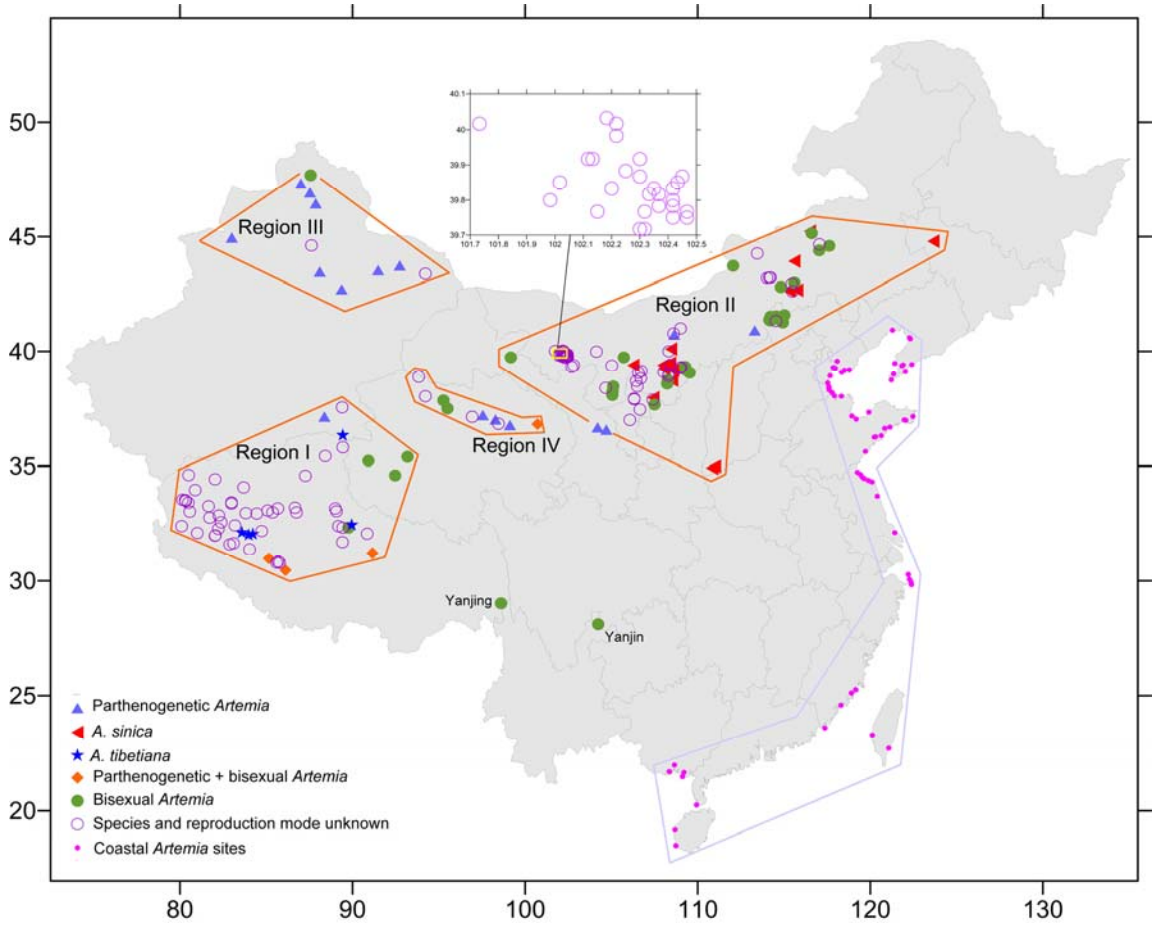

Fig. 2: Geographic distribution of Chinese *Artemia* populations showing only sites whose geographic coordinates are available (see Table 1). Species and/or reproduction mode are only shown for inland *Artemia* populations. Those of coastal saltern sites are specified in Fig. 3. Four major inland *Artemia* distribution regions (Region I, II, III and IV) are encircled.

In the maritime areas, *Artemia* populations were reported from all the coastal provinces except Shanghai, Xianggang (= Hong Kong) and Aomen (= Macao).The area surrounding Bohai Sea, which includes the coasts of Liaoning, Hebei, Tianjin and Shandong provinces, constitutes the major habitat for coastal *Artemia*. *Artemia* cysts and biomass harvested from this area was estimated to attain 50

percent of total production of the whole country (He, 2000). In the southern areas (Jiangsu, Zhejiang, Fujian, Guangdong, Taiwan, Hainan and Guangxi), the environment of salt pans is not so favorable for *Artemia*, mostly because of the warm and rainy climate and different salt production methods. For example, evaporation ponds in salterns of Jiangsu are only about 5 cm deep (Li *et al*., 2000). Stable hydro-conditions are scarce and *Artemia* populations are usually restricted to the deep salt pools, brine channels and brine wells (Luo, 1989; Wang, 2001). These may be the reasons of low biomass and rare cyst productions in the southern coastal salterns.

Although the environmental conditions vary greatly from the north to the south, the *Artemia* species composition shows a homogeneous pattern among the salterns of different areas. Except the Beimen Saltern of Tainan County (containing both parthenogenetic and bisexual populations; see Huang and Huang, 1973; Qiu, 1977; explaination see Tab. 1 note 11), all China coastal salterns were occupied by parthenogenetic populations before 1989 (Tab. 1). After that, however, allochthonous bisexual species (probably also allochthonous parthenogenetic populations) became to occur in almost all coastal salterns that have been examined (Triantaphyllidis *et al*., 1994b; Guan *et al*., 2003; Zheng *et al*., 2004; Guan *et al*., 2005; Zhou *et al*., 2006; Van Stappen *et al*., 2007; Zhao *et al*., 2007; and our personal observations).

Inland *Artemia* populations were found in 11 provinces / autonomous regions (Tab. 1; Fig. 2). Most of them are located in Neimenggu, Xinjiang, Qinghai and Xizang. In Neimenggu 91 *Artemia* sites have been reported (Tab. 1), which mainly locate on Xilinguole-Wulanchabu Plateau, Ordos Plateau and Alxa Plateau, most of them are small salt lakes. Reproductive mode of the Neimenggu populations is bisexual except the Wangliuhao Hu and the Huangqi Hai populations (the latter was established by introduction of coastal parthenogentic *Artemia* in 1987 (Ma, 1993; Ren *et al*., 1996)). In Xinjiang 15 *Artemia* sites have been recorded (Tab. 1), which mainly locate in the Junggar Basin, Turpan Basin, intermontane basins of Tianshan Mountains, and intermontane basins of/between Kunlun Mountains and Altun Mountains (Fig. 2). *Artemia* in this autonomous region is mostly parthenogenetic, but populations of Kekesu Yanhu and Jingyu Hu are bisexual. Fifteen *Artemia* habitats have been reported from Qinghai Province (Tab. 1), which mainly locate in Qaidam Basin and Hoh Xil region. Reproduction modes of these populations include parthenogenetic (3 sites), bisexual (5 sites) and parthenogenetic + bisexual (1site). There are 57 *Artemia* sites reported from the Xizang Autonomous Region (Tab. 1), mostly locating in the northern high altitude areas. Reproductive mode is only known for 10 populations (Tab. 1; Fig. 2). *Artemia* from Lagkor Co, Kyêbxang Co，Cam Co, Jibu Caka, Dagdong Co and Yanjing (Naxi Township) is bisexual (Zhang and Liu, 1989; Yin *et al*., 2001; Zhou *et al*., 2003a; Hou *et al*., 2006b; Zheng and Sun, 2008), but co-occurrence of bisexual and parthenogenetic *Artemia* was reported in 3 other sites (Bong Co, Bozi Co and Co Qen Co) (Van Stappen *et al*., 2003). In addition to the above four provinces/ autonomous regions, *Artemia* was also reported from Jilin (1 site), Hebei (10 sites), Shanxi (3 sites), Shaanxi (1 site), Ningxia (10 sites), Gansu (4 sites) and Yunnan (1 site).

Except the two ambiguously reported sites, Yanjin (County), Yunnan (Li *et al*., 1991; see note of Tab. 1) and Yanjing, Xizang, all Chinese inland *Artemia* populations are distributed in the arid or subarid areas. They show a marked distribution pattern (Fig. 2), which is related to topography and climate and is characterized by having four major distribution regions.

The first region (Region I) is located on the northern Qinghai-Xizang Plateau (the Xizang Salt Lake Subregion (I_1; Zheng, 2010)) excluding the Qaidam Basin (Figs 1 and 2). There are 63 alpine *Artemia* sites recorded from this region. All except Ayakkum Hu (3885 m) are higher than 4200 m.a.s.l. Except the Aqqikkol Hu population, which is parthenogenetic and located at the northern edge of the region (Fig. 2), known reproduction mode of these populations is bisexual (Tab. 1; Fig. 2) with a few sites coexistence of both bisexual and parthenogenetic populations (Van Stappen *et al*., 2003). All bisexual populations so far identified to species can be assigned to *A. tibetiana*

Tab. 1: *Artemia* sites in China.

Locality: (1) Some sites were reported by names of administrative districts (counties, towns/townships, etc.) rather than specific waterbodies (salterns, lakes *et al.*). To avoid potential overlaps we ignored such records if any determinate site or lower-level district within certain district is already listed, e.g, the site "Canton (=Guangdong Province)" appearing in previous reviews is excluded from the present checklist because the more accurate location "Xuwen Saltern" was known from this province (Tang, 1997). *Artemia* sites reported by misused/unexisting geographic names, like Gaize Hu, Nyima Hu (Wang, 2002) and Dangnuo Co (Zheng *et al*. 2007), are not listed as distinct sites, but if any report was afterwards verified to belong to a determinate site it will be cited and explained in table note. (2) Each site is followed by the name of a county-level administrative district (Xian, Shi, Qu, or Qi) where the *Artemia* site is located in. If the district is a "Qu" of a prefecture city (an administrative district between province and county), the city (Shi) name is also given. (3) Romanized geographic names are preferentially taken from China Gazetteer — A Geographical Index for Maps of the People's Republic of China (Department of Toponomy, Institute of Surveying and Mapping, National Administration of Surveying and Mapping, 1983). For names not embodied in this gazetteer, we romanized them after the criteria used in this gazetteer. Different romanized names and potential synonyms are separated by the slash " / ". (4) Explanation for commonly used words in Chinese geographic names: xian – county; shi – city; qu – district; qi – county-level administrative district used in Inner Mongolia; meng – prefecture-level administrative district used in Inner Mongolia; hu – lake; yanhu – salt lake; chi – pool / lake; yanchi – salt lake / salt pool; hai / haizi – sea / lake / pool, used to name lakes / pools in both Chinese and Mongolian; nur / nor – lake, from Mongolian, also appearing as "nao" or "naoer" in some references (different romanization from Chinese); co – lake, from Tibetan; caka – salt lake, from Tibetan, also appearing as "chaka" in some *Artemia* references (different romanization from Chinese).

Geographic coordinates: Coordinates are cited from original references, Zheng *et al*. (2002), Mu (2001), Wang and Dou (1998), or estimated using the Google Earth. Data not from original *Artemia* literature are shown in parentheses.

Reproduction mode: P = parthenogenetic; B = bisexual.

Species: Par. = parthenogenetic population*; A. sin. = A. sinica; A. tib. = A. tibetiana; A. fra. = A. franciscana; A. bar = Artemia barkolica; A. uru. = Artemia urumuqinica; A. ebi. = Artemia ebinurica.*

Locality	Geographic coordinates	Survey/ Sampling year	Reproduction mode	Species	Ref.
Coastal *Artemia* habitats					
Liaoning Province					
Pikou Saltern, Jinzhou Qu, Dalian Shi	(39°25′N, 122°24′E)		P	Par.	34, 42
Dongjiagou, Jinzhou Qu, Dalian Shi	(39°07′N, 122°02′E)		P	Par.	86, 100
Lüshun Saltern, Lüshunkou Qu, Dalian Shi	(38°45′N, 121°13′E)	1986-1988	P (2n, 4n, 5n, 9n)	Par.	12, 13, 31, 33, 81, 20
Yingchengzi Branch of Lüshun Saltern, Ganjingzi Qu, Dalian Shi	(39°00′N, 121°21′E)	1987	?	?	44
Jinzhou Saltern, Jinzhou Qu, Dalian Shi	(39°22′N, 121°50′E)[1]		P (2n, 4n, 5n)	Par.	12
		2005	P B	Par. *A. fra.*	130
Pulandian Saltern, Pulandian Shi	(39°24′N, 121°54′E)	1986-1988	P (2n, 4n, 5n)	Par	13, 86, 100
		2005-2006	P B	Par. *A. fra.*	130
Fuzhou Wan Saltern, Wafangdian Shi	(39°28′N, 121°25′E)	1986-1988	P (2n, 3n, 4n, 5n)	Par	12, 13, 31, 33, 130
		2005-2006	P B	Par. *A. fra.*	130
Yingkou Saltern, Yingkou Shi	(40°33′N, 122°19′E)	1985-1988	P (2n, 4n, 5n)	Par.	12, 13, 31, 33, 34, 53, 74, 75, 76, 81, 93, 100, 120
Erdaogou Saltern, Laobian Qu, Yingkou Shi	(40°36′N, 122°16′E)	2005-2006	P B	Par. *A. fra.*	130
Jinzhou Saltern, Linghai Shi	40°56′N, 121°17′E		P (2n, 4n, 5n)	Par.	12
		2008	B P?	? Par.?	78

Tab. 1: Continued

Locality	Geographic coordinates	Survey/ Sampling year	Reproduction mode	Species	Ref.
Hebei Province					
Daqing He Saltern, Leting (Laoting) Xian	(39°11′N, 118°47′E)	1985	P (2n, 5n)	Par.	53, 61, 75, 76, 93, 100
Nanpu Saltern, Nanpu Qu, Tangshan Shi	39°05′N, 118°20′E	1988	P	Par.	31, 33, 53, 61, 100
		1991	P B B	Par. *A. sin.* *A. fra.*	90
Luannan Saltern, Luannan Xian	39°10′N, 118°30′E		P	Par.	61, 100
		1992	P B B	Par. *A. fra.* *A. sin.*	90, 95, 112
Fengnan Qu, Tangshan	(39°34′N, 118°05′E)		?	?	61
Huanghua Saltern, Huanghua Shi	(38°18′N, 117°37′E)	1985	P (2n, 5n)	Par.	33, 34, 53, 61, 82, 86, 93
		1991	P B	Par. *A. sin.*	90
Nandagang Saltern, Huanghua Shi	(38°27′N, 117°36′E)		?	?	61
Zhongjie Saltern, Huanghua Shi	(38°23′N, 117°36′E)		?	?	61
Haifeng Saltern, Haixing Xian[2]	38°11′N, 117°47′E	1999-	P B	Par. *A. fra.*	21, 22, 108, 140
Wangfengyu Saltern, Haixing Xian[2]	38°11′N, 117°47′E	1999	P B	Par. ?	140
Tianjin City					
Third Branch of Hangu Saltern (Dawopeng Saltern), Tianjin Binhai New Area[3]	(39°17′N, 117°51′E)		?	?	16
Hangu Saltern, Tianjin Binhai New Area	(39°15′N, 117°58′E)	1985, 1991	P (2n, 5n)	Par.	53, 54, 86, 93, 100
		1990-	P B B	Par. *A. sin.* *A. fra.*	90, 95, 112
Tanggu Saltern, Tianjin Binhai New Area	(38°56′N, 117°40′E)	1959-1988	P (2n, 3n, 4n, 5n)	Par.	31, 33, 34, 37, 53, 72, 76, 83, 99, 100, 104, 105, 122, 123, 124
		1989-	P B B	Par. *A. sin.* ?	90, 95, 112, 120
Mapengkou Saltern, Tianjin Binhai New Area	(38°37′N, 117°32′E)	2008	B P?	? ?	78
Shandong Province					
Chengkou Saltern, Wudi Xian	38°03′N, 117°55′E	1984-1988	P (2n, 4n, 5n)	Par.	10, 31, 33, 34, 53, 60, 86, 94, 100, 102, 103
		1991-2008	P B	Par. *A. fra.*	95, 132

Tab. 1: Continued

Locality	Geographic coordinates	Survey/ Sampling year	Reproduction mode	Species	Ref.
Xinhu Saltern, Hekou Qu, Dongying Shi	38°02′N, 118°19′E	2000	B P?	? ?	77
Yangkou Saltern, Shouguang Shi	(37°10′N, 118°56′E)	1985	P (2n, 4n, 5n)	Par.	53, 60, 93, 100
		2001	P B	Par. *A. fra.*	132
Shandong Frontier Corps Saltern (Wuzhi), Hanting Qu, Weifang Shi[4]	(37°02′N, 119°11′E)[4]		P	Par.	34
Dongfanghong Saltern, Laizhou Shi	37°20′N, 119°55′E	1985	P (2n, 4n, 5n)	Par.	60, 116, 117
		2008	B P?	? ?	78
Gaodao Saltern, Wendeng Shi	(36°59′N, 122°03′E)	1985	P (2n, 4n, 5n)	Par.	60
Huashan Saltern, Wendeng Shi	(37°00′N, 121°58′E)	1985	P	Par.	15
Jiangjia Saltern, Rongcheng Shi[5]	(37°09′N, 122°28′ E)		P	Par.	53
Xiaotan Saltern, Haiyang Shi	(36°41′N, 121°08′E)	1985	P (2n, 4n)	Par.	60
Laiyang Saltern, Laiyang Shi	36°38′N, 120°50′E	1988	P	Par.	73
Daqiao Saltern, Jimo Shi	(36°19′N, 120°38′E)	1985	P (2n, 5n)	Par.	93
Nanwan Saltern, Chengyang Qu, Qingdao Shi	(36°16′N, 120°18′E)	1983-1985	P (2n, 5n)	Par.	53, 60, 93
Dongfeng Saltern, Chengyang Qu, Qingdao Shi	(36°15′N, 120°14′E)	1983	P (2n, 4n, 5n)	Par.	53, 93, 100
Xiaochang Saltern, Jiaonan Shi	(35°38′N, 119°43′E)		?	?	16
Huangnigou, Weihai Shi?[6]		2002	?	?	95
Beidaba[6]		2002	?	?	95
Leguantai[6]		2002	?	?	95
Wudao[6]		2002	?	?	95
Jiangsu Province					
Taibei Saltern, Jingji Jishu Kaifa Qu, Lianyungang Shi	(34°44′N, 119°15′E)	1981	P	Par.	42, 43, 53
Tainan[7] Saltern, Lianyun Qu, Lianyungang Shi	(34°38′N, 119°26′E)	1998	P? B[7]	Par.? *A. fra.*	134
Xuwei[7] Saltern (Xuyu)[8], Lianyun Qu, Lianyungang Shi	(34°32′N, 119°32′E)		P	Par.	86, 88, 100
		1990-1998	P? B[7]	Par.? *A. fra.*	134
Guanxi Saltern, Guanyun Xian[7]	(34°28′N, 119°38′E)	1990-1998	?	?	134
Guandong Saltern, Xiangshui Xian	(34°23′N, 119°53′E)		P	Par.	40, 91
Xintan Saltern, Binhai Xian[7]	(34°19′N, 120°06′E)	1990-1998	?	?	134
Sheyang Saltern, Sheyang Xian	(33°42′N, 120°24′E)	1981	P	Par.	42
Nantong Saltern, Tongzhou Qu, Nantong Shi	(32°07′N, 121°25′E)	1981	P	Par.	42
Zhejiang Province					
Daishan Xian (Is.)	(30°17′N, 122°12′E)		P	Par.	53
Zhanmao Saltern, Dinghai Qu, Zhoushan Shi	(30°04′N, 122°16′E)		P	Par.	100
Shunmu Saltern, (Zhujiajian Is.), Putuo Qu, Zhoushan Shi	29°57′N, 122°21′E		P	Par.	100
Zhujiajian Saltern, (Zhujiajian Is.), Putuo Qu, Zhoushan Shi	29°50′N, 122°23′E		P	Par.	100

Tab. 1: Continued

Locality	Geographic coordinates	Survey/ Sampling year	Reproduction mode	Species	Ref.
Fujian Province					
Putian Saltern, Xiuyu Qu, Putian Shi	(25°16′N, 119°09′E)	1987	P	Par.	10
		2010	B P?	? Par.?	77
Shanyao Saltern, Quangang Qu, Quanzhou Shi	(25°07′N, 118°54′E)	1990	P	Par.	100
Dongyuan Saltern, Xiang'an Qu, Xiamen Shi[9]	(24°35′N, 118°18′E)	1989-1990	B	*A. fra.*[9]	79, 80
Xigang Saltern, Dongshan Xian	(23°35′N, 117°22′E)		P	Par.	100
Guangdong Province					
Xuwen Saltern, Xuwen Xian	(20°15′N, 109°56′E)	1991	P	Par.	79
Guangxi Autonomous Region					
Hepu Xian	(21°39′N, 109°12′E)		P	Par.	23
Beihai Shi (prefecture level)	(21°28′N, 109°07′E)		P	Par.	23
Qinzhou Shi (prefecture level)	(21°58′N, 108°39′E)		P	Par.	23
Fangcheng Shi (prefecture level)	(21°41′N, 108°21′E)		P	Par.	23
Hainan Province					
Dongfang Saltern, Dongfang Shi	(19°11′N, 108°41′E)[10]	1986	P	Par.	9, 10
		2010	B P?		77
Yinggehai Saltern, Ledong Xian	(18°31′N, 108°44′E)		P	Par.	9, 10, 102, 103, 122, 123, 124
Taiwan Province					
Beimen (Peimen) Saltern, Tainan Xian	23°16′N, 120°07′E	1973-1974	P B[11]	Par. ?	36, 68
Peinan (salina), Taidong Xian	(22°42′N, 121°04′E)		?	?	87
Inland *Artemia* habitats					
Shanxi Province					
Yan Chi / Yuncheng Yanhu / Xie Chi / Hedong Yanchi, Yanhu Qu, Yuncheng Shi[12]	(34°59′N, 111°00′E)	1982-2005	B	*A. sin.*	2, 7, 8, 11, 19, 26, 27, 30, 31, 32, 33, 35, 47, 53, 54, 56, 57, 63, 74, 76, 84, 85, 94, 100, 101, 105, 106, 107, 113, 120, 123, 124, 128, 131, 138
Xiao Chi, Yanhu Qu, Yuncheng Shi[12]	34°55′N, 110°49′ E	1982-1990	B	*A. sin.*	27, 28
Beimentan, Yanhu Qu, Yuncheng Shi[12]	(34°55′N, 110°51'E)	1982-1990	B	*A. sin.*	29
Hebei Province					
Yan Nur, Kangbao Xian			B		121
Xiaoyan Nur, Kangbao Xian	(41°32′N,114°32′E)	1990-1991	B		121, 126, 127
Dayan Nur, Kangbao Xian	(41°31′N, 114°36′E)		B		121
Jiuliancheng Nur, Guyuan Xian	(41°35′N, 115°01′E)	1990-1991	B		121, 127

Tab. 1: Continued

Locality	Geographic coordinates	Survey/ Sampling year	Reproduction mode	Species	Ref.
Kushui Nur, Shangyi Xian	(41°23′N, 114°09′E)		B		121
Hulunfangzi Nur, Shangyi Xian	(41°21′N, 114°12′E)		B		121
Nanhao Cun (village), Zhangbei Xian	(41°16′N, 114°56′E)		B		121
Xianyan Nur / Erquanjing Yan Nur, Zhangbei Xian	(41°25′N, 114°40′E)	1990-1991	B		121, 127
Xiyan Nur, Zhangbei Xian	(41°30′N, 114°14′E)		B		121
Shitou Nur, Zhangbei Xian	(41°20′N, 114°32′E)	1990-1991			126, 127
Jilin Province					
Dabusu Pao / Gongnong Hu, Qian'an Xian	(44°48′N, 123°39′ E)	1989-1991	B	*A. sin.*	30, 31, 32, 33, 106
Neimenggu (=Inner Mongolia) Autonomous Region					
Yabrai Yanhu, Alxa Youqi	(39°23′N, 102°49′E)	1991			6, 1
Zhongquanzi Xiaohu, Alxa Youqi	(39°19′N, 102°42′E)				6
Tamayin Hu, Alxa Youqi	(39°46′N, 102°19′E)	2003			18
Xi Barunyikeer Hu, Alxa Youqi	(39°43′N, 102°18′E)	2003			18
Dong Barunyikeer Hu, Alxa Youqi	(39°43′N, 102°19′E)	2003			18
Xiao Shazao Hai / Bagajigede Hu, Alxa Youqi	(39°48′N, 101°59′E)	2003			18
Barun shanggenjilin Hu / Xi Shanggejilin Hu, Alxa Youqi	(39°51′N, 102°1′E)	2003			18
Dong Shanggejilin Hu, Alxa Youqi		2003			18
Xi Naoertu Hu, Alxa Youqi	(40°01′N, 101°44′E)	2003			18
Ekenjilin Hu, Alxa Youqi		2003			18
Wuertabulage Hu / Wuritubulage Hu / Changquan Hu, Alxa Youqi	(40°02′N, 102°11′E)	2003			18
Ayaga Nur / Wanwan Hai, Alxa Youqi		2003			18
Chahannaohaitu Hu / Baigou Wanzi Hu, Alxa Youqi	(39°50′N, 102°12′E)	2003			18
Da Shazao Hai / Yihe Jigede Hu, Alxa Youqi	(39°46′N, 102°09′E)	2003			18
Buerte Hu / Buritu Hu, Alxa Youqi		2003			18
Zhalatu Hu, Alxa Youqi	(39°47′N, 102°22′E)	2003-2004			18, 115
Hudugejilin Hu, Alxa Youqi	(39°49′N, 102°22′E)	2003			18
Balunjiren Hu / Nan Miao Haizi, Alxa Youqi	(39°47′N, 102°25′E)	2003			18
Suminjilin Hu / Bei MiaoHaizi, Alxa Youqi	(39°48′N, 102°25′E)	2003			18
Bagajilin Hu / Xiao Haizi, Alxa Youqi	(39°50′N, 102°25′E)	2003			18
Inde'ertu Hu / Jianshe Haizi, Alxa Youqi	(39°51′N, 102°26′E)	2003			18
Dong Gelike Hu, Alxa Youqi	(39°55′N, 102°08′E)	2003			18
Xi Gelike Hu / Barun Gelike Hu, Alxa Youqi	(39°55′N, 102°07′E)	2003			18
Bayan Nur, Alxa Youqi	(39°52′N, 102°28′E)	2003			18
Saihan'aile Hu / Saiheng'ailitu Hu/ Haorenjia Hu, Alxa Youqi	(39°59′N, 102°13′E)	2003			18
Baoerzengtu Hu / Baorijingtu Hu, Alxa Youqi		2003			18
Sharilejitu Hu / Sharijiletu Hu, Alxa Youqi	(39°55′N, 102°18′E)	2003			18
Dabusitu Hu, Alxa Youqi		2003			18
Celegeer Hu /Celigeri Hu, Alxa Youqi	(39°53′N, 102°15′E)	2003			18
Dong Shazao Hai / Zhun Jigede Hu, Alxa Youqi	(39°52′N, 102°18′E)	2003			18
Emengjilin Hu, Alxa Youqi		2003			18
Alatetu Hu / Alatatu Hu, Alxa Youqi	(39°50′N, 102°21′E)	2003			18
Dagetu Hu, Alxa Youqi	(39°49′N, 102°20′E)	2003			18
Huhejilin Hu / Qing Haizi, Alxa Youqi	(39°52′N, 102°27′E)	2003			18

Tab. 1: Continued

Locality	Geographic coordinates	Survey/ Sampling year	Reproduction mode	Species	Ref.
Dong Naoertu Hu, Alxa Youqi	(39°46′N, 102°28′E)	2003			18
Chaohaoer Maoritu Hu / Maoritu Hu, Alxa Youqi	(39°45′N, 102°25′E)	2003			18
Wutongtu Hu, Alxa Youqi	(39°45′N, 102°28′E)	2003			18
Baixinggaole Hu / Bashenggaole Hu, Alxa Youqi	(39°59′N, 104°08′E)	2003			18
Tamige Haizi / Tahilt Nur, Alxa Youqi	(39°52′N, 101°59′E)	2004			115
Qagan Bulag Hu, Alxa Zuoqi	(38°24′N, 104°40′E)				6
Hut Chi, Alxa Zuoqi	(39°22′N, 105°01′E)				6
Hong Yanhu Saltern, Alxa Zuoqi	(38°05′N, 105°03′E)	2010	B		133
Naoerte Hu, Alxa Zuoqi	(38°15′N, 105°04′E)	2001-2002	B		3, 49
Wenzi Hu, Alxa Zuoqi	(38°28′N, 105°06′E)	2001-2002	B		3, 49
Jartai Yanhu, Alxa Zuoqi	(39°44′N, 105°43′E)		B	*A. sin.*	6, 47, 100
Wangliuhao Hu, Urad Qianqi	(40°40′N, 108°38′E)	2001-2002	P	Par.	4, 114
Chagan Nur, Urad Qianqi	41°00′N, 108°42′E	1993	B		100, 113
Yan Haizi, Urad Qianqi	(40°47′N, 108°36′E)				59
Beida Chi, Otog Qianqi	37°58′N, 107°26′E	1983	B	*A. sin.*	33, 39, 56, 69, 71, 75, 76, 100, 125, 138
Bayan Nur, Otog Qi	39°23′N, 108°00′E	1991	B	*A. sin.*	30, 32, 33, 71, 101
Hamatai Nur, Otog Qi	39°06′N, 108°02′E				58
Qagan Nur, Otog Qi	39°14′N, 108°04′E	1991	B	*A. sin.*	30, 32, 33, 71
Ulan Nur, Otog Qi	38°35′N, 108°14′E		B		56, 58, 125
Narin Nur, Otog Qi	39°23′N, 108°16′E	1991	B	*A. sin.*	30, 32, 33, 71
Taohaotu Nur, Otog Qi	38°45′N, 108°16′E		B		56, 71, 125
Nuhetu Nur / Niugetu Nur, Otog Qi	(39°21′N, 108°18′E)	1991	B	*A. sin.*	30, 32, 33
Wudu Nur, Otog Qi	38°55′N, 108°18′E				58
Hadat Nur, Otog Qi	39°00′N, 108°19′E				71
Shuiquanzi Hu, Otog Qi	(39°29′N,108°24′ E)	1991	B	*A. sin.*	30, 32, 33, 35
Dalatu Nur, Otog Qi	39°24′N, 108°24′E				71
Changhan Nur, Hanggin Qi	40°00′N, 108°19′E				59
Yan Haizi / Hangginqi Saltern, Hanggin Qi	40°06′N, 108°27′E	1990-1991	B	*A. sin.*	30, 32, 33, 56, 59, 69, 106, 107, 125, 138
Haolebaoqing Nur / Sijian Hu, Uxin Qi	38°44′N, 108°31′E	1992-1994	B	*A. sin.*	56, 67, 69, 71, 84, 85, 100, 101, 125, 138
Hoh Tolgoi Nur, Uxin Qi	(39°11′N, 108°35′E)	1991-1993	B	*A. sin.*	56, 69, 71, 125, 138
Xi Subei Nur, Uxin Qi	39°16′N, 108°58′E				71
Haotongyin Chagan Nur, Uxin Qi	39°12′N, 109°00′E	1993-1994	B	*A. sin.*	39, 56, 71, 100, 101, 125

Tab. 1: Continued

Locality	Geographic coordinates	Survey/ Sampling year	Reproduction mode	Species	Ref.
Subei Nur, Uxin Qi	39°18′N, 109°02′E	1991		*A. sin.*	71
Bag Nur, Uxin Qi	39°19′N, 109°16′E		B		39, 56, 71, 125
Bayan Nur, Uxin Qi	39°11′N, 109°19′E	1993-1994	B		71
Taigemiao Chagan Nur, Ejin Horo Qi	39°04′N, 109°32′E		B	*A. sin.*	5, 71, 100
Huangqi Hai, Qahar Youyi Qianqi[13]	40°51′N, 113°18′E	1992	P (2n, 4n, 5n)	Par.[13]	53, 54, 55, 56, 69, 71
Nandawudeng Nur, Shangdu Xian	(41°31′N, 114°13′E)		B		56, 71, 125, 141
Erendabusen Nur / Erlian Yanchi, Erenhot Shi	43°44′N, 112°03′E	1993	B	*A. sin.*	56, 69, 71, 141
Bayian (Baiyin) Nur, Sonid Zuoqi	(44°16′N, 113°27′E)				59
Shang Matala Hu, Sonid Zuoqi	(43°12′N, 114°01′E)				59
Zhong Matala Hu, Sonid Zuoqi	(43°13′N, 114°09′E)				59
Xia Matala Hu, Sonid Zuoqi	(43°13′N, 114°13′E)				59
Alateng Nur, Zhengxiangbai Qi	42°48′N, 114°49′E		B		56, 59, 69, 125
Ih Nur, Zhengxiangbai Qi	42°39′N, 115°16′E	1993	B	*A. sin.*	69, 71, 138
Zhagesitai Nur, Zhenglan Qi	(42°56′N, 115°27′E)	2001-2002			38
Xiari Nur, Zhenglan Qi	(42°37′N, 115°29′E)	2001-2002			38, 71
Zhunsaihan Nur, Zhenglan Qi	(43°00′N, 115°36′E)		B	*A. sin.*	56, 125
Sanggin Dalai Nur, Zhenglan Qi	42°40′N, 115°46′E	1992-2002	B	*A. sin.*	38, 39, 56, 67, 69, 71, 101, 125, 138
Dage Nur, Zhenglan Qi	42°41′N, 115°51′E	1992-2002	B	*A. sin.*	38, 56, 69, 71, 125, 138
Bayan Nur, Xilin Hot Shi	43°56′N, 115°36′E	1990-1993	B	*A. sin.*	71, 138
Eji Nur, Dong Ujimqin Qi	45°13′-45°16′N, 116°27′-116°33′E	1991-1992	B	*A. sin.*	39, 47, 53, 54, 55, 56, 69, 71, 75, 76, 100, 101, 113, 138
Bagaeji Nur / Xiao Paozi, Dong Ujimqin Qi	45°09′N, 116°36′E	1990	B		56, 71, 125
Jiren Gaole (or Jilin Gaole) Lakes, Xi Ujimqin Qi[14]	(44°24′N, 117°02′E)[14]	1991	B		56, 71, 125
Balun Nur, Xi Ujimqin Qi	44°40′N, 117°03′E				59
Bale Nur, Xi Ujimqin Qi	(44°36′N, 117°37′E)		B		56, 125
Dahan Hu, Xili Gol Meng			B	*A. sin.*	101
Shaaxi Province					
Dingbian Yanhu (Qun) (Dingbian Salt Lake(s)), Dingbian Xian[15]	37°40′N, 107°30′E[15]		B		47, 100
Ningxia Autonomous Reigion					
Wangjiazhuang (village), (Yanzidun Township), Huinong Qu, Shizuishan Shi	(39°04′N, 106°34′E)	1989-			20

Tab. 1: Continued

Locality	Geographic coordinates	Survey/ Sampling year	Reproduction mode	Species	Ref.
Xigoutan, (Tuanjie Village, Weizha Town), Huinong Qu, Shizuishan Shi	(39°08′N, 106°44′E)	1989-			20
Yu'andian (village), (Mataigou Township), PingluoXian[16]	38°49′N, 106°42′ E[16]	1989-			20
Shaqu (village), (Yaofu Town), PingluoXian	(38°42′N, 106°26′ E)	1989-?			20
Daojianggou Zhuang (village), (Tonggui Township), Xingqing Qu, Yinchuan Shi	(38°28′N, 106°30′E)	1989-?			20
Guaerqu Sidui (village), (Shangqiao Jiedao), Litong Qu, Wuzhong Shi	(37°56′N, 106°19′ E)	1989-?			20
Chaoyang (village), (Jinyintan Town), Litong Qu, Wuzhong Shi	(37°54′N, 106°19′ E)	1989-			20
Hui'anpu Saltern, Yanchi Xian	(37°27′N, 106°39′ E)	1989-			20
Liuyangpu Xiaochang, Yanchi Xian	(37°53′N, 107°24′ E)	1989-			20
Huangjiashuigou, Tongxin Xian	(37°00′N, 106°04′ E)	1989-?			20
Gansu Province					
Da Suhai Hu, Akesai Autonomous Xian[17]	38°53′N, 93°50′E				47, 135
Gaotai Xian	39°44′N, 99°10′ E		B	-	100
Bayin (Baiyin) Shi (prefecture level city)	36°36′N, 104°12′ E		P	Par.	53, 56
Jingyuan Xian	36°30′N, 104°42′ E		P	Par.	53, 56
Qinghai Province					
Haiding Nur, Golmud Shi	(35°34′N, 93°11′E)		B		109
Balunma Hai, Delingha Shi	38°02′N, 94°13′E	1994			71
Da Qaidam Hu, Delingha Shi	37°51N, 95°16′E	1991-1992	B	*A. sin.*?	32, 47, 71, 100, 135
Xiao Qaidam Hu, Delingha Shi	37°30′N, 95°30′E	1991-1994	B	*A. sin.*?	30, 33, 47, 53, 54, 55, 56, 69, 71, 98, 100, 101, 109, 113, 135, 138
Toson Hu, Delingha Shi	37°08′N, 96°56′E				47, 135
Ga Hai, Delingha Shi	37°08′N, 97°33′E	1991-2001	P (2n, 4n)	Par.	17, 33, 34, 47, 50, 51, 52, 53, 54, 55, 56, 69, 71, 75, 94, 98, 100, 106, 108, 109, 113, 120, 135
Hoh Yanhu, Ulan Xian	(36°57′N, 98°17′E)	1986	P (4n)	Par.	9, 10, 56, 98, 109, 102
Ulan Hu / Xiligou Hu, Ulan Xian	(36°50′N, 98°27′E)				33
Caka Yanhu, Ulan Xian	36°42′N, 99°07′E		P	Par.	9
Yishan Yanhu, Zhidoi Xian	(35°14′N, 90°55′E)		B		98, 109

Tab. 1: Continued

Locality	Geographic coordinates	Survey/ Sampling year	Reproduction mode	Species	Ref.
Goulu Co, Zhidoi Xian	(34°36′N, 92°28′E)		B	*A. tib.*	62, 98, 109, 138
Haiyan Hu, Gonghe Xian	36°03′N, 100°11′E		B P	Par.	89
Maduo Hu, Madoi Xian?					33
Erdaogou[18]					92
Salt pool(s)/lagoon(s) around Qinghai Hu[19]					92
	Xinjiang Autonomous Reigion				
Kekesu Yanhu / Alagake Yanchi, Altay Shi	(47°41′N, 87°34′E)	1993	B		25, 69, 71
Bai Yanchi, Fuhai Xian	(47°15′N, 87°00′E)	1992	P	Par.	25, 71
Dingshan Yanchi, Fuhai Xian	46°23′N, 87°52′E	1992	P	Par.	25, 71
Lü Yanchi, Fuhai Xian	46°51′-46°55′N, 87°30′-87°33′E	1993	P (4n, 5n)	Par.	25, 69, 71
Ebinur Hu, Jinghe Xian	(44°53′N, 83°00′E)	1985-2000	P (2n, 3n, 4n)	Par. [*A. ebi.*]	2, 10, 24, 25, 31, 33, 47, 52, 53, 55, 56, 60, 64, 69, 70, 71, 72, 75, 76, 84, 86, 100, 105, 106, 107, 108, 113, 120, 122, 123, 124, 127, 137
Beishawo Yanhu, Fukang Shi	(44°37′N, 87°37′E)				45
Dabancheng Dong Yanhu / Dabancheng Yanhu / Wulumuqi Yanhu / (Wulumuqi) Caiwopu Yanhu, Dabancheng Qu, Wulumuqi Shi[20]	(43°24′N, 88°06′E)	1985-1993	P (2n, 3n, 4n, 5n)	Par. [*A. uru.*]	10, 24, 25, 53, 56, 60, 64, 65, 69, 71, 86, 100, 113
Aydingkol Hu, Turtpan Shi	(42°38′N, 89°22′E)		P	Par.	53
Barkol Hu, Barkol (Autonomous) Xian	43°40′N, 92°44′E	1986-1993	P (2n, 3n, 4n, 5n)	Par. [*A. bar.*]	10, 14, 24, 25, 31, 33, 34, 46, 47, 53, 54, 55, 56, 64, 66, 69, 71, 75, 76, 86, 100, 106, 107, 113, 118, 119
Qijiaojing Yanchi, Hami Shi	(43°28′N, 91°29′E)	1993	P	Par.	25, 71
Tuolekule Hu / Yiwu Hu / Yanchi / Yiwu Yanchi / Tochari Hu, Yiwu Xian	(43°23′N, 94°13′E)				25, 45, 71
Aqqikkol Hu, Ruoqiang Xian	37°04′N, 88°22′E	1984-2005	P (2, 3n, 4n)	Par.	25, 51, 70, 94, 96, 97, 109

Tab. 1: Continued

Locality	Geographic coordinates	Survey/ Sampling year	Reproduction mode	Species	Ref.
Ayakkum Hu, Ruoqiang Xian	(37°33′N, 89°24′E)				25, 109
Jingyu Hu, Ruoqiang Xian	36°20′N, 89°26′E	1980-2001	B	*A. tib.*	25, 52, 71, 89, 94, 95, 96, 97, 109, 131, 138
Yueya Hu[18]					92
Yunnan Province					
Yanjin Xian[21]	(28°06′N, 104°14′E)		?[21]		42, 53, 56
Xizang (= Tibet) Autonomous Region					
Kayi Co, Rutog Xian	33°33′N, 80°09′ E	2001-2011			129, 136
Nitan Hu / Nitan Co, Rutog Xian	(33°30′N, 80°20′E)	2001			129, 136
Cangmu Co, Rutog Xian	33°32′N, 80°18′E	2006			111
Ayongbu Co, Rutog Xian	33°25′N, 80°29′E	2001			129
Lungmu Co, Rutog Xian	(34°37′N, 80°30′E)				109
Rabang Co, Rutog Xian	33°02′N, 80°34′E	2001			129
A'ong Co, Rutog Xian	(32°46′N, 81°43′E)				109
Gyêrzê Caka, Rutog Xian	33°58′N, 80°53′E	2001			129
Yanshan Hu II / Salt mountain L2, Rutog Xian		2006			111
Yanshan Hu III / Salt mountain L3, Rutog Xian	34°26′N, 82°02′E	2006			111
Yanshan Hu IV/ Salt mountain L4, Rutog Xian	34°26′N, 82°02′E	2006			111
Bozi Co, Ngamring Xian	30°28′N, 86°07′E		B P	Par.	88, 89
Anglicaga, Gêrzê Xian	31°36′N, 82°53′E	2006			111
Bala Co/ Bala Hu, Gêrzê Xian	33°26′N, 82°59′ E	2001			129, 136
Kahu Co, Gêrzê Xian	33°23′N, 82°59′E	2001			129, 136
Ruijiangmi Co, Gêrzê Xian	31°39′N, 83°06′E	2006			111
Oma Co, Gêrzê Xian	32°26′N, 83°11′E				47, 135
Cam Co / Marmê Co, Gêrzê Xian	32°07′N, 83°35′E	1976-2006	B	*A. tib.*	41, 56, 109, 111, 131, 135, 136
Xiaoquan Hu, Gêrzê Xian	(34°05′N, 83°41′E)	2006			111
Bula Co / Labu Co, Gêrzê Xian	(32°58′N, 83°49′E)	1997-1999			136
Jibu Caka, Gêrzê Xian	(32°01′N, 83°59′E)		B	*A. tib.*	47, 131, 135, 136
Lagkor Co, Gêrzê Xian[22]	32°03′N, 84°13′E	1995-2001	B	*A. tib.*	1, 2, 7, 8, 48, 57, 89, 94, 95, 109, 110, 131, 135, 136, 138
Domar Co, Gêrzê Xian	32°57′N, 84°27′E	1997-2006			111, 136
Dong Co, Gêrzê Xian	32°11′N, 84°44′E	1997-2006			47, 53, 56, 109, 111, 136
Zougangyou Caka / Zougouyou Co, Gêrzê Xian	(33°05′N, 85°05′E)	1997-1999			136
Zuoqing Co, Gêrzê Xian	(33°00′N, 85°22′E)	1997-1999			136
Guping Co, Gêrzê Xian	(33°10′N, 85°40′E)	1997-1999			136

Tab. 1: Continued

Locality	Geographic coordinates	Survey/ Sampling year	Reproduction mode	Species	Ref.
Shiquanhe, Gê'gyai Xian[23]	32°24′N, 81°06′ E				41, 56
Rabang Co, Gê'gyai Xian and Rutog Xian[24]	33°16′N, 81°39′ E	2001			136
Sêkazhig Hu I, Gê'gyai Xian	31°59′N, 82°02′E	2006			111, 135
Sêkazhig Hu II, Gê'gyai Xian	32°00′N, 82°03′E	2006			111, 135
Nyêr Co, Gê'gyai Xian	32°17'N 82°13'E	1997-2001			129, 136
Nau Co, Gê'gyai Xian	32°52′N, 82°15′E				47, 135
Chagcam Caka II, Gê'gyai Xian[25]	32°34′N, 82°23′E	1993-1996			47, 109, 135, 136
Shiquanhe, Gar Xian	32°30′N, 80°00′E				135
Co qen Co, Co qen Xian	30°59′N, 85°09′E	2001	B P	Par.	89, 92, 95
Dabi Co, Co qen Xian	(30°48′N, 85°36′E)	1997-1999			136
Da duo Co, Co qen Xian	(30°51′N, 85°41′E)				136
Duoqiong Co, Co qen Xian	(30°48′N, 85°46′E)	1997-1999			136
Rigen Co, Nyima Xian[22]	(32°39'N, 86°20'E)				110
Gangtang Co, Nyima Xian	(33°12'N, 86°40'E)				109
Yibug Caka, Nyima Xian	(33°00'N, 86°45'E)				109
Co Nyi / Shuang Hu[26], Nyima Xian	34°35′N, 87°16′E	2002			41, 56, 109, 135, 136, 92?, 142?, 143?
Gogen Co, Shuanghu (Special) District	(32°24′N, 89°11′ E)	1997-1999			136
Rola Co, Shuanghu (Special) District	35°26′N, 88°25′ E	2002			136
Xiangyang Hu, Shuanghu (Special) District	(35°49′N, 89°26′ E)				92
Yangnapen Co, Shuanghu (Special) District	(32°20'N, 89°46'E)	1997-2002	B		95, 110, 136
Bobsêr Co, Shuanghu (Special) District	(32°20'N, 89°26'E)	1997-1999			136
Têrang Punco, Shuanghu (Special) District	(33°03'N, 89°04'E)	1993-1996			136
Kyêbxang Co, Shuanghu Special District[22, 26]	(32°27'N, 89°57'E)	1997-2002	B	*A. tib.*	35, 95, 109, 110, 136, 138
Cêdo Caka, Shuanghu (Special) District	33°10′N, 89°00′E				41, 56, 109, 135
Zigê Tang Co, Amdo Xian	(32°04'N, 90°51'E)	1997-1999			136
Bangkog Co III, Bangkog Xian[27]	(31°42'N, 89°25'E) [27]	1980-1982			47, 53, 135, 136
Bong Co, Bangkog Xian and Nagqu Xian[28]	31°13′N, 91°09′E		B P	Par.	88, 89
Chabyêr Caka, Zhongba Xian	(31°23′N, 84°02′E)				109
Dagdong Co, Zhongba Xian?[29]			B	*A. tib.*	131
Yanjing (Yanjing Naxi Nationality Township), Mangkang Xian	(29°01′N, 98°36′E)		B		120

Notes:
1. Geographic coordinates of Shihe Branch of Jinzhou Saltern.
2. The two sites, Haifeng Saltern and Wangfengyu Saltern are adjacent and share the identical coordinates at 1′ resolution.
3. Formerly belonging to Hebei Province, and reported as Dawopeng Saltern (former name of the saltern) by Chen *et al*. (1975).
4. Reported as "Wuzhi" in Hou *et al*. (2006a), who clarified to be located near Yangzi Town (Lin Hou, personal communication). The coordinates given here are those of Yangzi Town.
5. The original site of the saltern became Rongcheng Jingji Kaifaqu (Rongcheng Economic Development Area) in 1993. This saltern was re-constructed at Laoshan Town, Rongcheng and renamed as Donghai Saltern in the same year. The coordinates given here are those of Jiangjia.
6. Wang *et al*. (2008) reported these four sites from Shandong Province. These sites were failed to re-locate with certainty on the local map, even after inquiring the original authors (probably because their research samples were provided by other people) (Nai-Hong Xin, personal communication).

7. Zheng (2001a) reported that *Artemia* had been cultured at Xuwei Saltern, Guanxi Saltern and Xintan Saltern since 1990 and *A. franciscana* was introduced to Xuwei Saltern in 1992 and to Tainan Saltern in 1998. Zheng (2001a) also mentioned that *Artemia sinica* was introduced to experimental pans in 1991, but did not specify at which saltern. Xin *et al*. (1994) documented that the *Artemia* from Xuwei and Lianyungang were parthenogenetic. Therefore, the *Artemia* of these areas might be mix of *A. sinica, A. franciscana* and parthenogenetic populations at the end of 1990s.
8. Xin *et al*. (1994) and Triantaphyllidis *et al*. (1997c) reported the site "Xuyu", and Van Stappen (2002) listed "Xuyu" and "Xuwei" as two different sites, whereas the "Xuyu" is most likely coming from the incorrect pronunciation of the Chinese "Xuwei".
9. The exotic *A. franciscana* was introduced to this site for culture during 1989 to 1990 (Tang and Lin, 1993).
10. Coordinates of Maling Work Area. Dongfang Saltern has various work areas distributed from 18°51′N to 19°18′N along the coast of Dongfang.
11. This population was listed as a bisexual population in previous review papers (e.g., Ma, 1993; Van Stappen, 2002), whereas Huang and Huang (1973) reported that >94% adult individuals are females and Qiu (1977) reported the mean sex ratio was 3.53:1 (♀:♂), which suggested that the population might be a mix of both parthenogenetic and bisexual populations.
12. Yuncheng Yanhu is usually the general designation for a series of salt lakes and salt flats, including Yanchi, Xiaochi, Beimengtan, Yazi Chi, Tanglitan, etc. *Artemia* has been reported to occur in Yanchi, Xiaochi and Beimengtan (He *et al*., 1993; He *et al*., 1995; Zhao *et al*., 1996, 1998). However, many other reports did not clearly specify in which of these waters the *Artemia* occurred. Those references are listed under the biggest waters "Yan Chi" in this table.
13. This *Artemia* population was a descendant from a coastal parthenogentic *Artemia* that had been introduced in 1987 (Ma, 1993; Ren *et al*., 1996).
14. Including four salt lakes each about 1 km^2 in area (Ren *et al*., 1996). The geographic coordinates are that of the middle larger one.
15. This site appeared as Dingbian Lake or Dingbian in *Artemia* references. The Dingbian Yanhu (salt lakes) is a general designation for 14 salt lakes (Gou Chi, Lanni Chi, Huama Chi, etc) locating in Dingbian County. The coordinates (from Xin *et al*., 1994) are those of Huama Chi (Yanchang Pu).
16. The geographic coordinate is that of Mataigou Township.
17. This lake locates across the boundary between Qinghai Province and Gansu Province.
18. The exact positions of the two sites, Erdaogou and Yueya Hu, which were reported by Wang (2002), could not be relocated with certainty. Yueya Hu is probably a lake near the western part of the boundary of Xizang and Xinjiang (Ji-Lin Wang, personal communication). There are more than one places with the name of Erdaogou, the one listed by Wang (2002) may be a small nameless lake near a village called Erdaogou (Ji-Lin Wang, personal communication).
19. This site is listed as Qinghai Hu in Table 3 of Wang (2002), whereas the author indicated in text that it should be a/some small lake(s) near the Qinghai Hu (Wang, 2002: 12).
20. There are three lakes in Dabancheng District that are easily confused. The west one is Chaiwopu Hu (brackish; S=4.01 g.l^{-1}). The middle one is Xiao Yanhu (also Dabancheng Xi Yanhu; Maliantan Hu). The east one is Dabancheng Dong Yanhu (also Yanhu; Pochengzi Yanhu; Wulumuqi Yanhu) (Wang and Dou, 1998; Zheng *et al*., 2002). The "(Wulumuqi) Caiwopu Yanhu" mentioned in Qian *et al*. (1992) also refers to this salt lake (Yi Qian, personal communication). Related information (coordinates, size) suggests that the "Dabancheng (Yanhu)" appearing in several *Artemia* literatures refers to Dabancheng Dong Yanhu, too.
21. The "Yanjin" population (reproduction mode unknown) was reported by Li *et al*. (1991). Ma (1993) mistakenly listed that this population was bisexual and first recorded by Zhang and Liu (1989). This error might be caused by the misreading of "Yanjing (in Xizang)" (an *Artemia* site reported by Zhang and Liu, 1989) for "Yanjin (in Yunnan)". To our knowledge, there is not any modern salt lake in this area. We guess that this *Artemia* habitat may be temporary salt pools managed for rock salt production.
22. Yu and Xin (2006) reported the three ambiguous *Artemia* sites, "Gaize Lake", "Nima Lake" and "Shuanghu Lake", which also appeared in Wang (2002). Dr. Nai-Hong Xin (personal communication) has clearified for the present paper that the accurate locality of their "Gaize Lake" should be Lagkor Co, that of "Nima Lake" should be Rigen Co, and that of "Shuanghu Lake" should be Kyêbxang Co (for this site, see also note 26). Whether the sites in Wang (2002) are the same lakes could not be determined.
23. This site is 0.15 m deep riparian marsh of Shiquanhe River (Jiang, 1983).
24. This lake locates across the boundary between Gê'gyai Xian and Rutog Xian.
25. This site includes three closely located salt lakes, Chagcam Caka I, II and III lakes. Only Chagcam Caca II has been reported to have *Artemia*. The coordinates and altitude given here are those of Chagcam Caka II.
26. The lake name "Co Nyi" was incorrectly written as "Nyi Co (Ni Co)" in some references (e.g., Ma *et al*., 1996; Zhang and Chen, 2009). The site "Shuanghu" (twin lakes) have been reported by several *Artemia* references, but this name may represent different lakes/districts of Xizang Autonomous Region such as Co Nyi (also Shuang Hu; a salt lake in Nyima Xian), Shuang Hu (a salt lake in Shuanghu Special District; 34°41′N, 89°14′E), Shuang Hu (a salt lake in Gêrzê Xian; 34°27′N, 83°10′E), or Shuanghu Special District. As explained in note 22, the "Shuanghu Lake" of Yu and Xin (2006) is actually the Kyêbxang Co in Shuanghu Special District (Nai-Hong Xin, personal communictioan). Unfortunately, we could not determine the locations of the "Shuanghu" appearing in the other refernces (e.g., Wang, 2002; Ning and Zhang, 2007; Zhang and Chen, 2009).
27. This site includes three closely located salt lakes, Bangkog Co I, II and III. Zheng *et al*. (2007) specified *Artemia* occurrence in Bangkog Co III, while the other reports were ambiguous. The coordinates and altitude given here are those of Bangkog III.
28. This lake locates across the boundary between Bangkog County and Nagqu County.
29. Using the sample provided by Mr Shao-Qing Lin we reported this site in an earlier paper (Zheng and Sun, 2008). A small lake named Dagdong Co (Dadong Cuo; ~30°09′N, ~84°23′E) can be found on the map (http://www.mapbar.com/search/). However, this site could not be ascertained by the sample collector and no data of this lake can be used to clue whether it is a salt lake suitable for *Artemia*. Thus we regard this site as a questionable site.

Ref.: 1. Abatzopoulos *et al*. (1998); 2. Abatzopoulos *et al*. (2002); 3. An *et al*. (2003a); 4. An *et al*. (2003b); 5. An *et al*. (2004); 6. Bai (2005); 7. Baxevanis *et al*. (2005); 8. Baxevanis *et al*. (2006); 9. Bian (1990); 10. Bian and Li (1989); 11. Cai (1989); 12. Cai and Hou (1991); 13. Cai *et al*. (1988); 14. Cai *et al*. (1994); 15. Charles *et al*. (1988); 16. Chen *et al*. (1975); 17. Du (2001); 18. En *et al*. (2004); 19. Gao *et al*. (1995); 20. Gao *et al*. (1996); 21. Guan *et al*. (2003); 22. Guan *et al*. (2005); 23. Guangxi Salt Bureau in Ma (1993); 24. Guo and Yang (1991); 25. Guo and Li (1997); 26. Guo *et al*. (1990); 27. He *et al*. (1989); 28. He *et al*. (1993); 29. He *et al*. (1995); 30. Hou (1998); 31. Hou *et al*. (1993); 32. Hou *et al*. (1997a); 33. Hou *et al*. (2000); 34. Hou *et al*. (2006a); 35. Hou *et al*. (2006b); 36. Huang and Huang (1973); 37. Huang *et al*. (1980); 38. Huo *et al*. (2005); 39. Ji and Meng (2003); 40. Jia *et al*. (1999); 41. Jiang (1983); 42. Li *et al*. (1991); 43. Li and Peng (2004); 44. Liu (1990); 45. Liu (1996); 46. Liu and Deng (1992); 47. Liu and Zheng (1990); 48. Liu *et al*. (1998); 49. Liu *et al*. (2004); 50. Liu *et al*. (2005); 51. Ma and Wang (2003); 52. Ma *et al*. (2003); 53. Ma (1993); 54. Ma *et al*. (1994a); 55. Ma *et al*. (1994b); 56. Ma *et al*. (1996); 57. Mura and Brecciaroli (2004); 58. Na S. in Ren *et al*. (1996); 59. NMG Salt, in Ren *et al*. (1996); 60. Pan *et al*. (1991); 61. Pang (2000); 62. Pang *et al*. (2010); 63. Pilla and Beardmore (1994); 64. Qian *et al*. (1992); 65. Qian *et al*. (1993); 66. Qian *et al*. (1994); 67. Qiao *et al*. (1996); 68. Qiu (1977); 69. Ren and Yao (1997); 70. Ren *et al*. (1992); 71. Ren *et al*. (1996); 72. Sorgeloos (1988); 73. Sun and Wang (1991); 74. Sun *et al*. (1999a); 75. Sun *et al*. (1999b); 76. Sun *et al*. (2000); 77. Sun S.-C., personal observation; 78. Sun S.-C., Okazaki R. K. and Liu J.-B., unpublished; 79. Tang (1997); 80. Tang and Lin (1993); 81. Triantaphyllidis *et al*. (1994a); 82. Triantaphyllidis *et al*. (1994b); 83. Triantaphyllidis *et al*. (1995); 84. Triantaphyllidis *et al*. (1997a); 85. Triantaphyllidis *et al*. (1997b); 86. Triantaphyllidis *et al*. (1997c); 87. Vanhaecke *et al*. (1987); 88.

Van Stappen (2002); 89. Van Stappen *et al*. (2003); 90. Van Stappen *et al*. (2007); 91. Wang (2001); 92. Wang (2002); 93. Wang *et al*. (1991); 94. Wang and Sun (2007); 95. Wang *et al*. (2008); 96. Wu and Wu (1990); 97. Wu and Wu (1992); 98. Xie *et al*. (2006); 99. Xie *et al*. (1998); 100. Xin *et al*. (1994); 101. Xin *et al*. (2000); 102. Xu (1996); 103. Xu *et al*. (1993); 104. Xu and Huang (1959); 105. Xu and Hu (1993); 106. Yang *et al*. (1995); 107. Yang *et al*. (1996); 108. Yang *et al*. (2005); 109. Yin *et al*. (2001); 110. Yu and Xin (2006); 111. Yuan *et al*. (2007); 112. Zhang *et al*. (1993); 113. Zhang *et al*. (1998); 114. Zhang *et al*. (2003); 115. Zhang (2005); 116. Zhang and King (1992); 117. Zhang and Lefort (1991); 118. Zhang *et al*. (1994a); 119. Zhang *et al*. (1994b); 120. Zhang and Liu (1989); 121. Zhang and Liu (1990a); 122. Zhang and Liu (1990b); 123. Zhang *et al*. (1989); 124. Zhang *et al*. (1990); 125. Zhang K.-W. in Ma (1993); 126. Zhao and He (1999); 127. Zhao *et al*. (1996); 128. Zhao *et al*. (1998); 129. Zhao *et al*. (2005); 130. Zhao *et al*. (2007); 131. Zheng and Sun (2008); 132. Zheng *et al*. (2004); 133. Zheng B., personal observation; 134. Zheng (2001a); 135. Zheng (1997); 136. Zheng *et al*. (2007); 137. Zheng (1990); 138. Zhou *et al*. (2003a); 139. Zhou *et al*. (2003b); 140. Zhou *et al*. (2006); 141. NMG Salt, in Ma (1993); 142. Ning and Zhang (2007); 143. Zhang and Chen (2009).

(Abatzopoulos *et al*., 1998; Zhou *et al*., 2003a, b; Zheng and Sun, 2008). This region has a frigid or sub-frigid high mountain/plateau climate, and the frost-free period is usually not more than 75 days (Liu, 2010). In addition, this area is also characterized by having low oxygen (about 60%~65% of that at the sea level) and very high solar radiation (>7000 MJ/m^2; Liu, 2010). *Artemia* populations from this region share some features quite different from those of the other areas in the world, including larger size of adults, resting eggs and nauplii (e.g., Zhou *et al*., 2003a, b), deep colored egg shells (Zhou *et al*., 2003a), hypoplastic outer cuticular membrane (without a well-developed multi-layered structure) and better permeability of egg shells (Wang and Sun, 2007; Wang *et al*., 2010), etc. These are most likely adaptive characters to the harsh environments of the plateau.

The second *Artemia* distribution region (Region II) is located on Neimenggu Plateau and the Loess Plateau (Huangtu Gaoyuan) (Fig. 2), and includes the Alxa Salt Lake Subregion (II_4), the Northeast Salt Lake Region (III) and the East Dispersed Salt Lake Region (IV) (Zheng, 2010). There are 119 *Artemia* sites recorded in this region. Elevations of these sites are mostly 800 m to 1400 m.a.s.l. (Table 1), and annual frost-free period is normally 100~200 days (Liu, 2010). This region is likely to be mainly inhabited by the bisexual *A. sinica* (though not identified to species for many populations). Exceptions are the populations of Baiyin (City) and Jingyuan (County), Gansu Province, Wangliuhao Hu and Huangqi Hai, Neimenggu, which are parthenogenetic. As previously indicated, the Huangqi Hai population is not indigenous. The sites Baiyin and Jingyuan are located near the southwestern edge of the region. Because *Artemia* culture had been conducted in these areas (Wang, 2002; Zhi-Zhen Ma, personal communication) whether these parthenogenetic populations were indigenous or established from human inoculation awaits further studies.

The third inland *Artemia* distribution region (Region III) is located in Junggar Basin, Turpan Basin and in the intermontane basins of Tian Shan (Fig. 2). *Artemia* sites of this region belong to the Tianshan Salt Lake Subregion (II_2) and Junggar Salt Lake Subregion (II_3). There are 11 sites recorded in this region. With the lowest place of China locating in this area, the *Artemia* sites of this region have elevations ranging from –154 m to 1890 m.a.s.l. and frost-free period usually not shorter than 150 days (Liu, 2010). The *Artemia* distribution in this region is characterized by harbouring parthenogenetic populations. Only the population of Kekesu Yanhu (at the north edge of the region) is bisexual (Ren *et al*., 1996; Guo and Li, 1997; Ren and Yao, 1997), which is similar to the nearby population in Davsan Nur, Mongolia (Van Stappen, 2002).

The fourth inland *Artemia* distribution region (Region IV) is Qaidam Basin (Fig. 2), which belongs to the Kunlun-Qilian Salt Lake Subregion (I_2) (Fig. 1; Zheng, 2010). This region contains both parthenogentic and bisexual *Artemia* populations, and the 10 known sites are distributed along the north edge of Qaidam Basin (Fig. 2). Though data of comparative studies are still limited, the *Artemia* fauna of this region seems transitional. In addition to

the occurence of both bisexual and parthenogenetic populations, the cysts size of the bisexual Xiao Qaidam Hu population is intermediate between those of *A. tibetiana* and *A. sinica* species populations (Zhang *et al*., 1998; Zhou *et al*., 2003a). This region is geographically located in between the above three regions (Fig. 2). *Artemia* sites of this region are high (some 2700 to 3200 m.a.s.l.) but apparently lower than those of the northern Qinghai-Xizang Plateau region (>4200 m), and the climate (plateau temperate climate; frost-free period > 150 days, see Liu, 2010) is different from the northern Qinghai-Xizang Plateau region (plateau sub-frigid or plateau frigid climate). In addition to the difference in elevations (2700–3200 *vs* <1400 m), the differences of *Artemia* composition between this region and the Nemenggu Plateau - Loess Plateau region might also be related to the geographical isolation by the Qilian Shan (usually 4000 – 5000 m high).

Therefore, the distribution pattern of Chinese inland *Artemia* populations is closely related to topography and climate. The inland *Artemia* sites are almost exclusively located in arid and subarid areas (Figs 1, 2), whereas no records have been documented from extremely dry areas (aridity index > 30) such as hinterland of Tarim Basin. Temperature is apparently not a limiting factor for occurrence of *Artemia*, but may play a significant role in determining which type of *Artemia* could appear in a certain area.

With regard to the zoogeographical regionalization, China is usually known for bestriding Palearctic and Oriental biogeographic realms, which are further divided into four and three zoogeographic regions (within the China territory), respectively, mainly according to the distribution pattern of vertebrates (Zhang, 1999). The *Artemia* distribution pattern is not contradicted with such a zoogeographical regionalization. All the four major *Artemia* distribution regions are located in the Palearctic biogeographic realm. The *A. tibetiana* region roughly matches the Qinghai-Xizang zoogeographic region; the other three *Artemia* distribution regions are mainly located in the Mongolia-Xinjiang zoogeographic region. The only two inland *Artemia* sites that are located in the Oriental biogeographic realm are Yanjin (in Yunnan Province) and Yanjing (in Xizang Autonomous Region) (Table 1; Fig. 2). To our knowledge, there are not any salt lakes, but there is well/rock salt production in these areas. We suppose that these *Artemia* habitats may be (temporary) salt pools managed for salt production.

Biological invasion and extinction of *Artemia* in China

The invasive *Artemia franciscana* has been documented all over the world (e.g., Persoone and Sorgeloos, 1980; Geddes, 1980; Triantaphyllidis *et al*., 1998; Amat *et al*., 2005). This is also the case in China. Before 1989, all *Artemia* populations living in salterns along the coastline of China (except Beimen, Taiwan, which contains both bisexual and parthenogenetic populations (see Table 1 note 11), and might be the first site that was settled by exotic bisexual *Artemia* in China) were parthenogenetic (Tab. 1). Recently *A. franciscana* and/or *A. sinica* have been reported to co-occur with indigenous parthenogenetic *Artemia* in at least 15 sites (salterns) (Liaoning, 4sites; Hebei, 5 sites; Tianjin, 2 sites; Shandong, 2 sites; Jiangsu, 2 sites) (Fig. 3; Triantaphyllidis *et al*., 1994b; Zheng, 2001a; Guan *et al*., 2003; Zheng *et al*., 2004; Guan *et al*., 2005; Zhou *et al*., 2006; Van Stappen *et al*., 2007; Zhao *et al*., 2007). And unidentified bisexual *Artemia* has been known to occur at another 7 maritime sites (Liaoning: 1 site; Tianjin: 1 site; Shandong: 2 sites; Fujian: 2 sites; Hainan: 1 site) (Fig. 3; Tang and Lin, 1993; Tang, 1997; Shi-Chun Sun, Robert K. Okazaki and Jian-Bao Liu, personal observations). They are allochthonous species entering in these areas by deliberate or undeliberate introduction activity. It can be expected that more cases will be found by future intensive survey work. In the co-occurred sites, *A. sinica* is usually the minority, and *A. franciscana* and parthenogenetic *Artemia* are dominant species (Zhou *et al*., 2006; Van Stappen *et al*., 2007). The results of field surveys indicated that the ratio of parthenogenetic to *A. franciscana* populations was affected by some environmental factors. Zhou *et al*.

(2006) found that in the same salterns parthenogenetic *Artemia* usually prevails in low salinity ponds while *A. franciscana* dominates in high salinity ponds. Guan *et al*. (2003) reported that from August to October the dominant species was *A. franciscana*, while in the other months *A. franciscana* and parthenogenetic *Artemia* keep similar proportions at Haifeng Saltern.

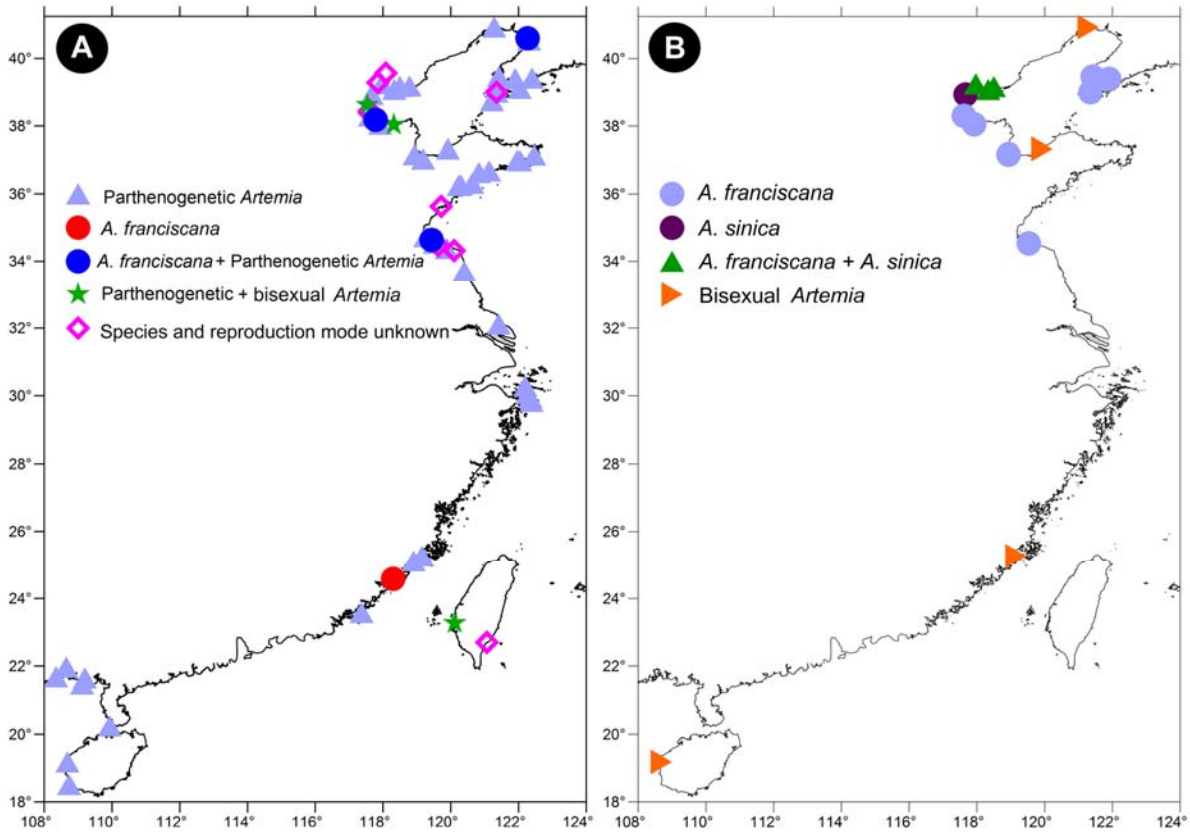

Fig. 3: Coastal saltern *Artemia* sites in China. (A) *Artemia* sites and their species composition / reproduction mode. For some sites, parthenogenetic *Artemia* was reported first but exotic bisexual *Artemia* was found by latter studies. In this case, the populations are shown as of parthenogenetic *Artemia*. Further information see part B of this figure. (B) *Artemia* sites that were reported to be occupied by parthenogenetic *Artemia* in earlier literature but were reported to be invaded by bisexual species latterly. Only the exotic bisexual species are shown, whereas parthenogenetic populations may co-occur at these sites.

Although there is no sound evidence that invasion of exotic species has caused extinction of indigenous populations, the invasive *A. franciscana* has been found to overwhelm the indigenous parthenogenetic populations in several coastal salterns (Zheng *et al*., 2004; Zhou *et al*., 2006; Zhao *et al*., 2007; Van Stappen *et al*., 2007). Since *A. franciscana* displays competitive advances over parthenogenetic populations (Browne, 1980; Browne and Halanych, 1989), the disappearance of the local parthenogenetic populations in large parts of their original distribution area, if not already a fact, is at least a short-term possibility (Van Stappen *et al*., 2007).

In addition to biological invasion, extinction of *Artemia* populations may be caused by the loss of

habitats and changes in environment, which have already become a fact for the disappearance of some populations in China. During the last two decades, some saltworks in the coastal areas of China (e.g., Pikou and Pulandian salterns in Liaoning Province; Jiangjia, Dongfeng and Nanwan salterns in Shandong Province) became the victims of rapid urbanization and economic development. Although similar human activities might have directly induced disappearance of inland salt waters, particularly those at the edge of cities, the main factors that may endanger inland *Artemia* populations might be the climate change. Global warming has been causing different changes of salt lake environments in different areas of China. During the last two decades, the climate in the Northwest Salt Lake Region and the Qinghai-Xizang Plateau Salt Lake Region (Fig. 1) have turned warm-and-wet and the lakes have had a tendency for surface expansion, water level rise and salinity reduction, which is to some extent because of glacier melting (Zheng，2010). *Artemia* is no longer found in some lakes of these regions recently (Qin-Xian Jia, personal communication). In contrast, in the Northeast Salt Lake Region (and in the eastern part of the Northwest Salt Lake Region) (Fig. 1), the climate has been still in a warm-and-dry stage，the surface level has lowered and some salt lakes have been desertified (Zheng，2010). Some *Artemia* populations might be endangered if the dried-up salt lakes could not be replenished within advisable time.

Acknowledgements

This work is supported by: 1) The Key Laboratory of Mariculture of Ministry of Education, Ocean University of China (201103); 2) the Fundamental Research Funds for the Central Universities (201122005).

We are grateful to Professor Robert K. Okazaki, Profersor Qin-Xian Jia, Mr. Ke En and Mr. Jian-Bo Liu for permission to cite their unpublished data, to Mr. Zeng-Guang Li for assistance in mapping *Artemia* sites. The following authors are acknowledged for providing further information /explanations for *Artemia* localities reported in their publications: Professors/Drs. Yi Qian, Nai-Hong Xin, Wen Zhao, Lin Hou, Ji-Lin Wang, Jun Yu, Gilbert Van Stappen, Li-Ying Sui, Yue-Qiang Guan, Feng-Qi Liu, Zhi-Zhen Ma and Yan Guo. Our thanks are also to Professors/Drs. Xiang Ji, De-Jian Yang, Pei-Li Wu, Fu-Yi Bai, Feng-Qi Liu, Qin-Xian Jia, and Alireza Asem and Chun-Hui Cao for explaining some geographic names and/or providing literature help.

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