



亚洲区域卤虫参考中心  
Asian Regional Artemia Reference Center



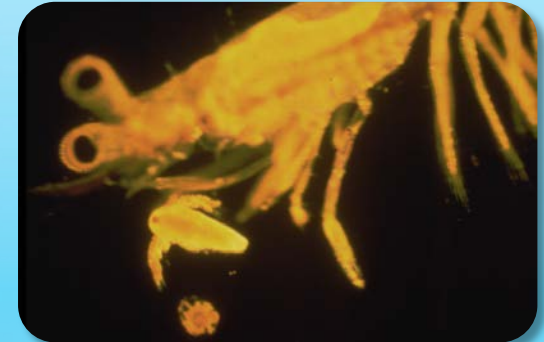
# Current Situation of *Artemia* Resources in Bohai Bay Solar Saltworks, China

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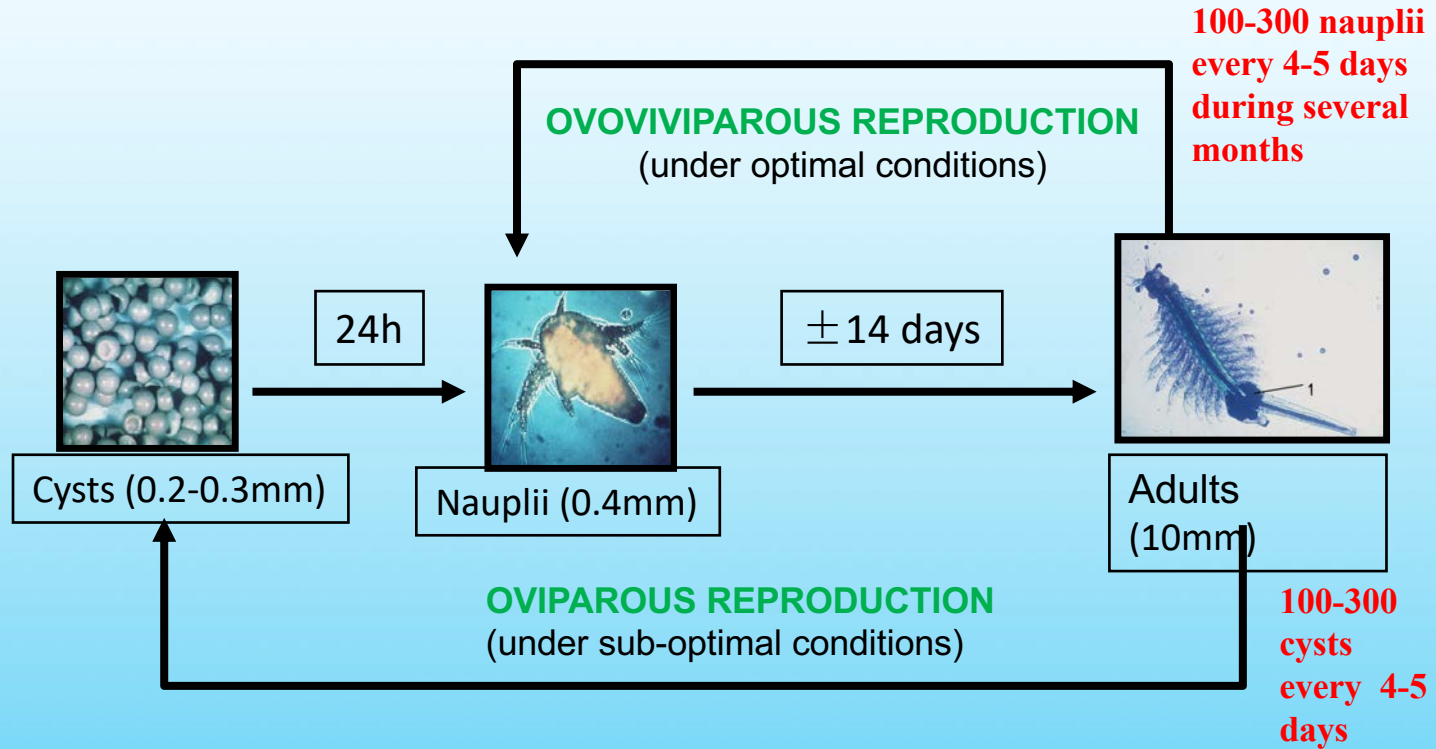
Asian Regional Artemia Reference Center  
Tianjin University of Science and Technology, China

# Brine shrimp *Artemia*

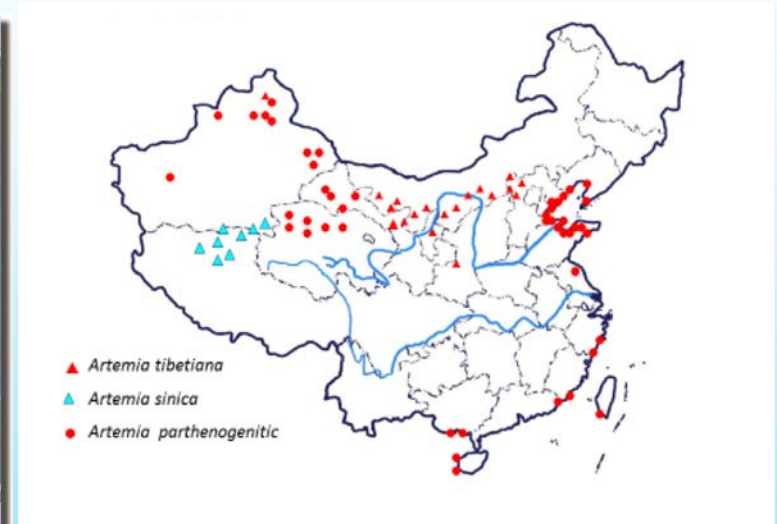
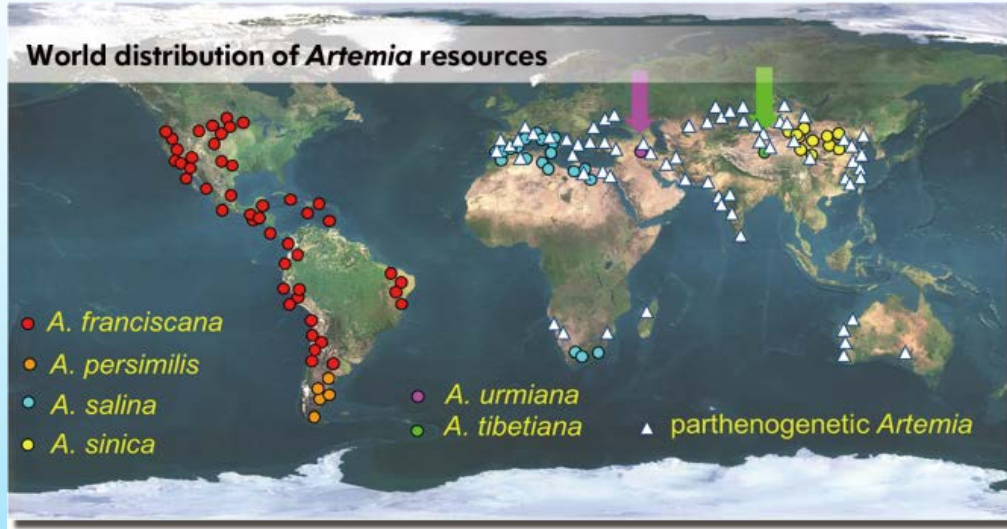
- *Artemia* is zooplanktonic crustaceans distributed in hypersaline environment , such as inland salt lakes and solar saltworks.
- *Artemia* plays an important role in hypersaline food chain as well as in the saltpond ecological system.
- *Artemia* it is an important test organism in a variety of life sciences.
- *Artemia* nauplii is the most commonly used live food in marine fish and crustacean larviculture.



# Life cycle of *Artemia*



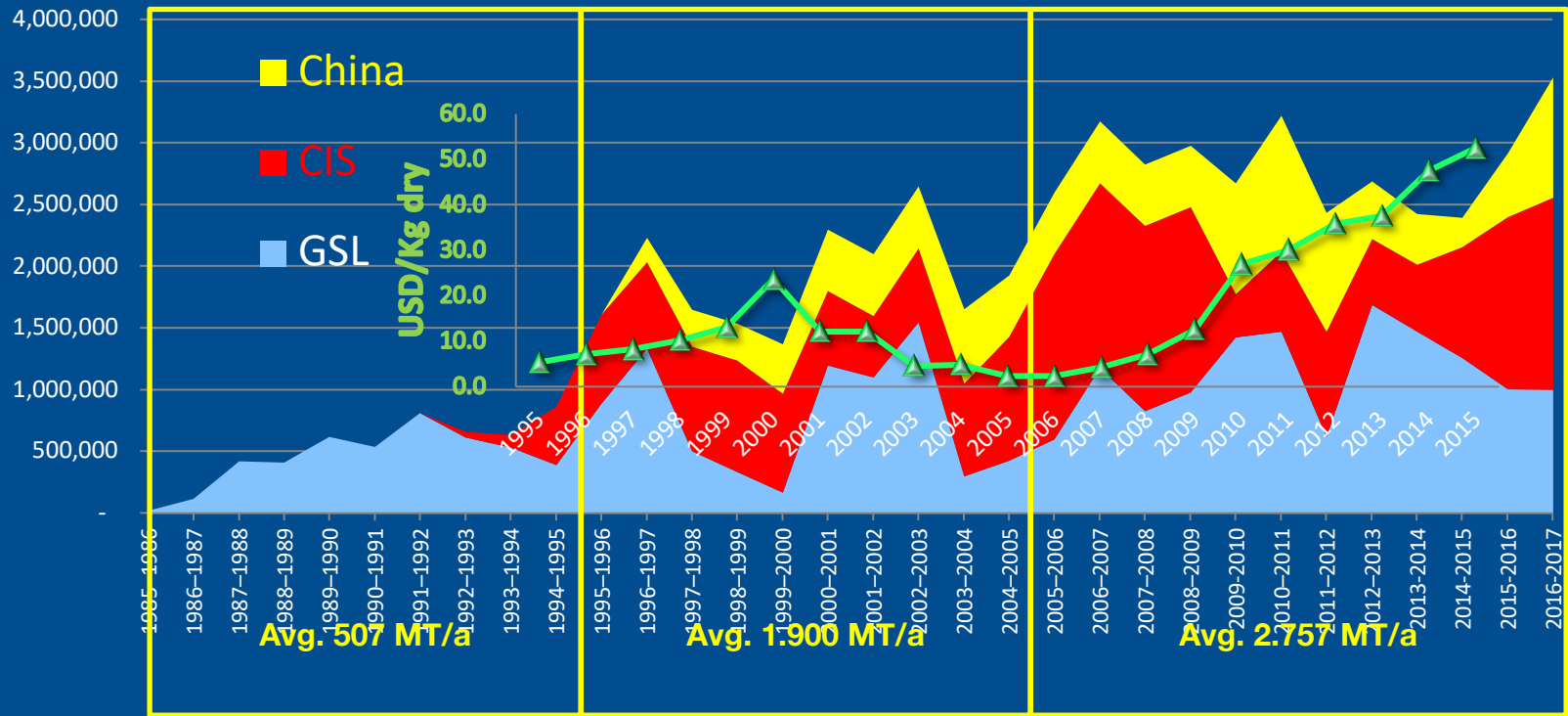
# Artemia resources distribution



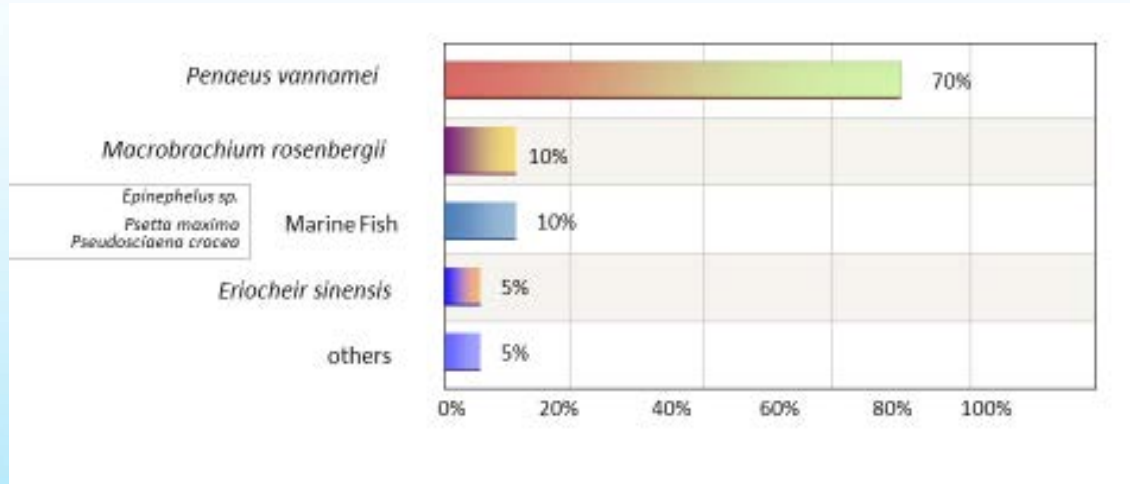
- Average annual *Artemia* cysts consumption in China: 1000-1500 ton (40-50% of total world consumption).
- Abundance of *Artemia* resources and biodiversity in China.

# NEED FOR MORE PRODUCTION ... AT A BETTER PRICE

## Historical Data Global *Artemia* Harvest



# Main species consuming *Artemia* nauplii at hatchery stage





# Sea salt production in Bohai Bay saltworks

- Bohai Sea coastal area is the major sea salt production site: 1500 Km<sup>2</sup> of salt evaporation ponds are in operation



# *Artemia* production in Bohai Bay Salt ponds

- The cysts production is 100-300 ton DW/y.
- Are known as higher hatchability (>85%) and higher nutritional value (e.g. HUFA content), thus it is highly demanded in market, though its price is double of cysts from inland salt lakes.
- Harvest of *Artemia* biomass is a few hundred tons/y, used as a supplemental feed for local shrimp and crab hatchery.





# Information of the solar saltworks

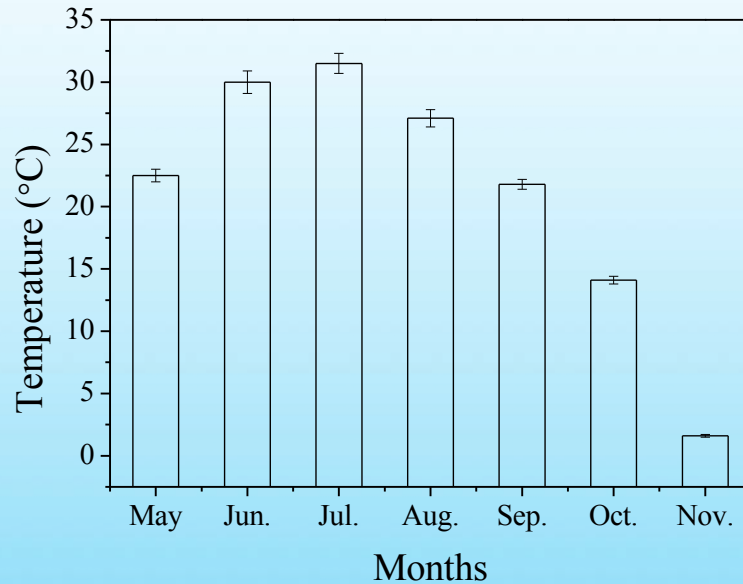
No.	Name	Covering area (km <sup>2</sup> )	Annual salt yield in 2017 (×10 <sup>4</sup> ton)
1	Yangkou Saltworks	300	160
2	Wangdao Saltworks	-	<10
3	Chenghou Saltworks (Huitai Group)	200	120
4	Wudi Second Saltworks (Fengyuan Salt Chemicals)	43	<10
5	Tanggu Saltworks	170	110
6	Hangu Saltworks	100	75
7	Nanpu Saltworks	270	140
8	Luannan Saltworks	-	<10
9	Yingkou Saltworks	80	28
10	Fuzhouwan Saltworks	140	60



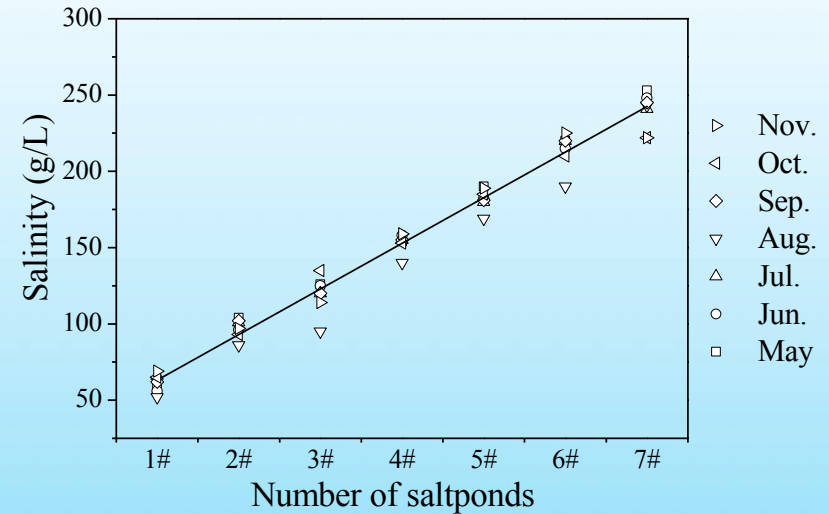
# Characterization of *Artemia* population in ten solar saltworks

No.	Name of saltworks	Salinity (%)	Number of observation	Female / male	Oviparous/viviparous	Cyst diameter (μm)	Chorion thickness (μm )	Species composition
1	Yangkou	11.0	333	2.0	6.5	233.3±10.7	5.6±0.3	<i>A. parthenogenetica</i> <i>A. franciscana</i>
2	Wangdao	11.2	306	1.2	3.2	237.2±9.8	6.4±0.3	<i>A. parthenogenetica</i> <i>A. franciscana</i>
3	Chengkou	10.0	603	1.2	0.7	242.5±16.3	9.8±0.7	<i>A. parthenogenetica</i> <i>A. franciscana/A. sinica</i>
4	Wudi Second	11.5	305	1.2	0.8	236.0±10.7	5.8±0.4	<i>A. parthenogenetica</i> <i>A. franciscana</i>
5	Tanggu	12.0	621	4.4	1.4	-	-	-
6	Hangu	12.3	598	1.6	1.7	-	-	
7	Nanpu	11.5	315	1.5	4.2	225.1±11.8	5.4±0.5	<i>A. parthenogenetica</i> <i>A. franciscana</i>
8	Luannan	11.0	657	1.6	2.3	230.5±11.2	6.7±0.4	<i>A. parthenogenetica</i> <i>A. franciscana</i>
9	Yingkou	11.5	495	1.5	3.9	229.8±11.4	6. 9±0.6	<i>A. parthenogenetica</i> <i>A. franciscana</i>
10	Fuzhouwan	11.0	540	1.8	2.2	229.3±10.9	5.5±0.3	<i>A. parthenogenetica</i> <i>A. franciscana</i>

# Brine water temperature and pH in Hangu Saltworks

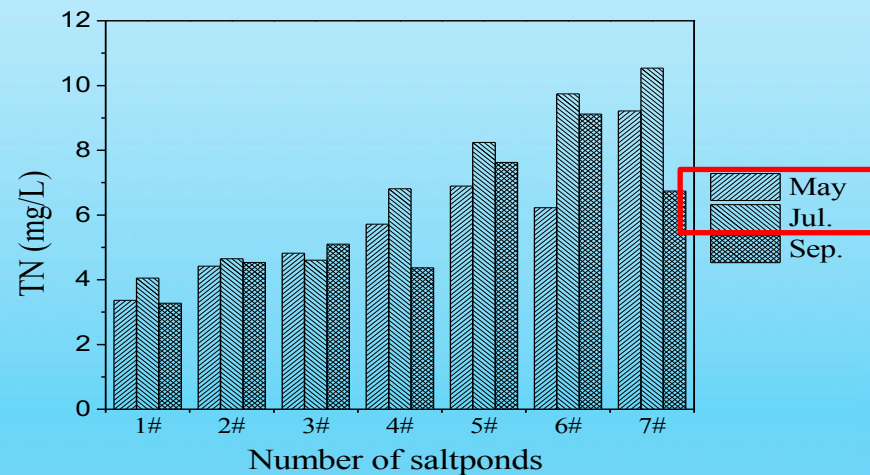
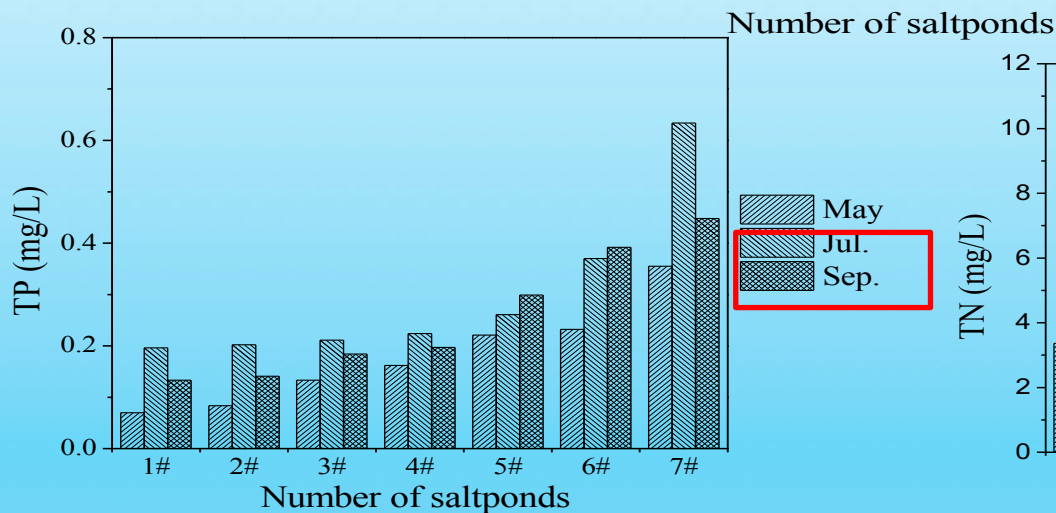
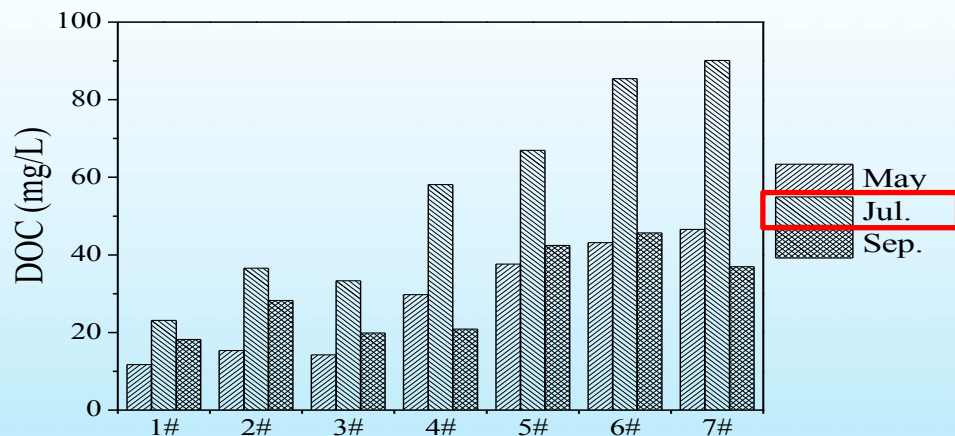


Average brine temperature in the saltponds

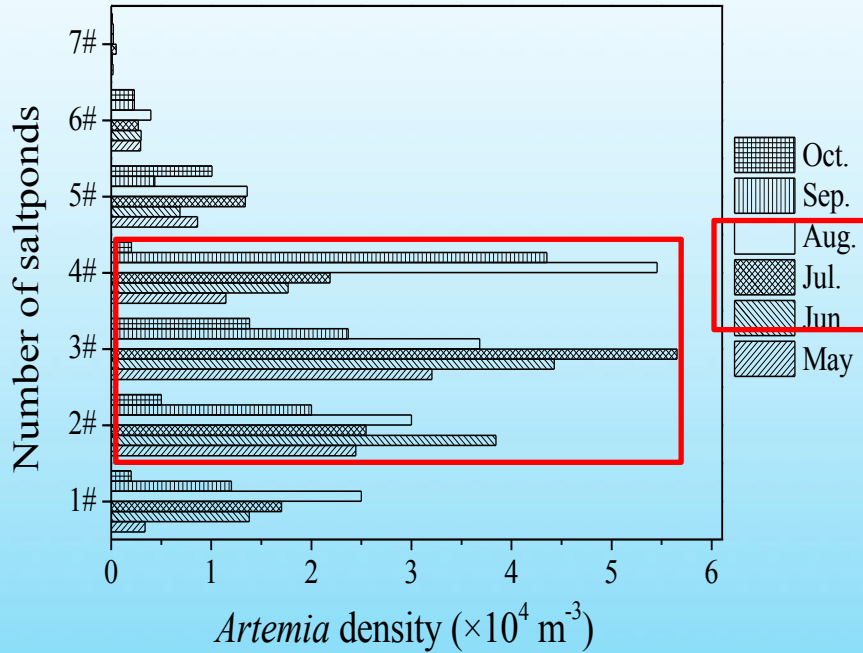


Salinity variation in the saltponds

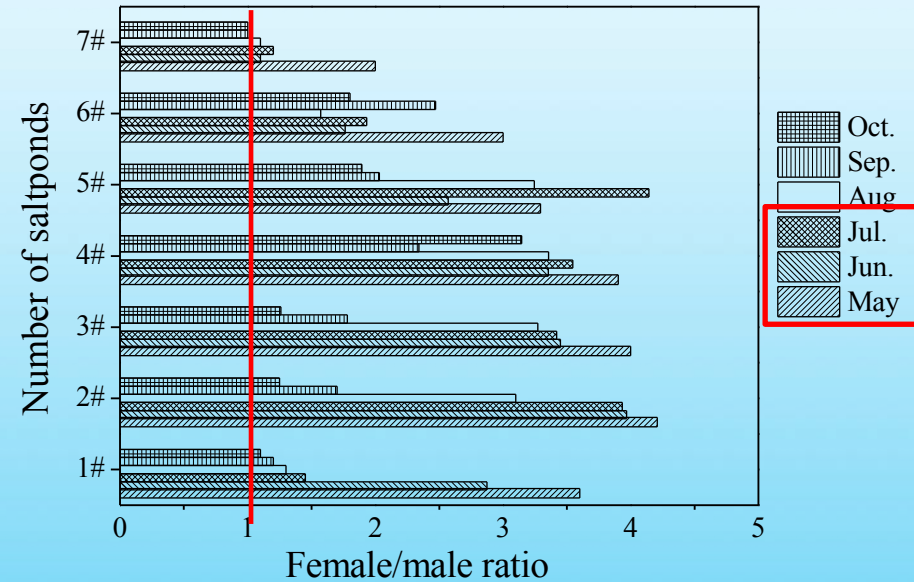
# DOC, TN and TP content in Hangu Saltworks



# Artemia population dynamics in Hangu Saltworks

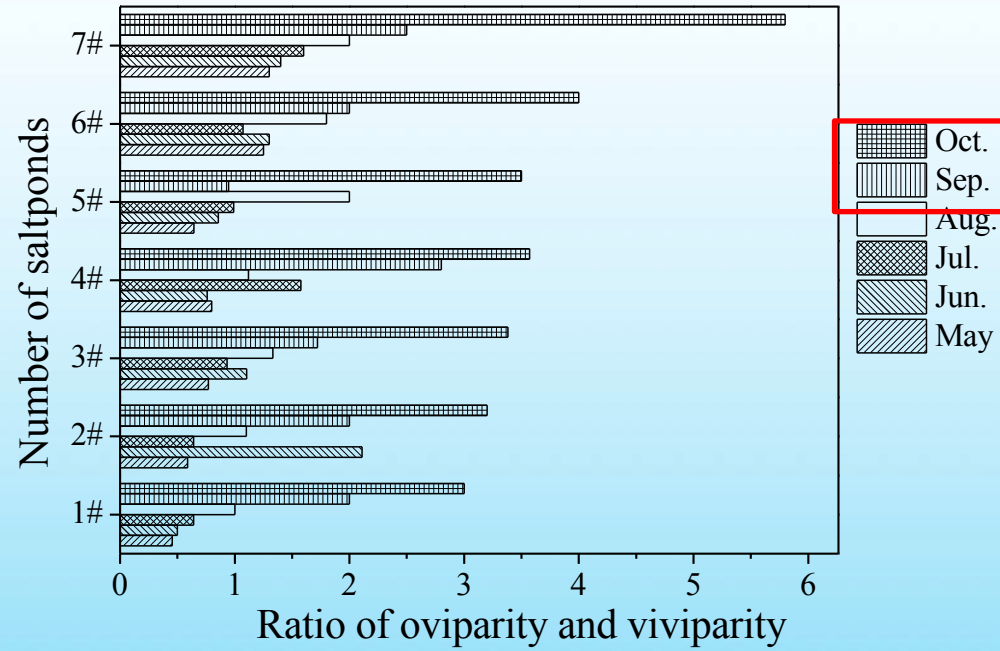


Artemia density in the saltponds



Ratio of Female and male *Artemia* in the saltponds





**The ratio of oviparity and viviparity of female adult *Artemia* in the saltponds**

# Conclusions

- The *Artemia* population in Bohai Bay saltworks are mostly **mixed with *A. parthenogenetica* and *A. franciscana***, except for the Chengkou Saltworks where *A. sinica* was also detected.
- The differentiation on **dominant reproductive mode** (oviparity vs viviparity), **ratio of female/male** (parthenogenetic population vs bisexual species), **cyst diameter** and **chorion thickness** of *Artemia* in different saltworks should relate to the local pond conditions, such as **food availability and change of salinity**.
- In Hangu saltworks, *Artemia* population were mostly condensed in salinity range of 90 g/L to 150 g/L and in summer. Both parthenogenetic and bisexual *Artemia* coexisted in the saltponds with local parthenogenetic population dominating in summer and lower salinity range. Female *Artemia* tended to produce cysts in autumn and higher salinity range in order to secure their population.
- Further study is needed in aspect of physiochemical and biological diversity in the brine and to provide more information for better biological management in saltworks.

# Asian Regional Artemia Reference Center

- The establishment of **AR-ARC** is recommended by **FAO** in 2016, at Tianjin University of Science and Technology.
- AR-ARC has the first Artemia Gene Bank in China and Asia (>150 Artemia cysts samples):
  - Characterization of *Artemia* species/strains (e.g. biometrics, hatching performance, nutritional quality, genetic fingerprint)
  - Analyze and input the data into gene bank database.

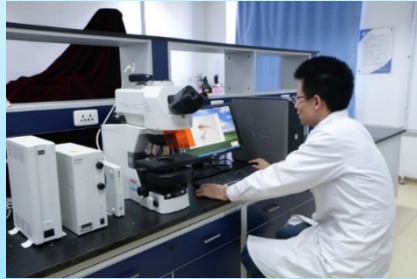


卤虫种质数据库  
Artemia Gene Bank Database

# Laboratories and Facilities at AR-ARC



**Artemia Hatching Room**



**Equipment Room**



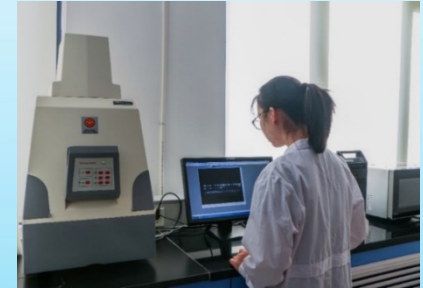
**Lab of Nutrition and Chemical Analysis**



**Recirculating Aquaculture Systems**



**Lab of Microbiology**



**Lab of Molecular Biology**

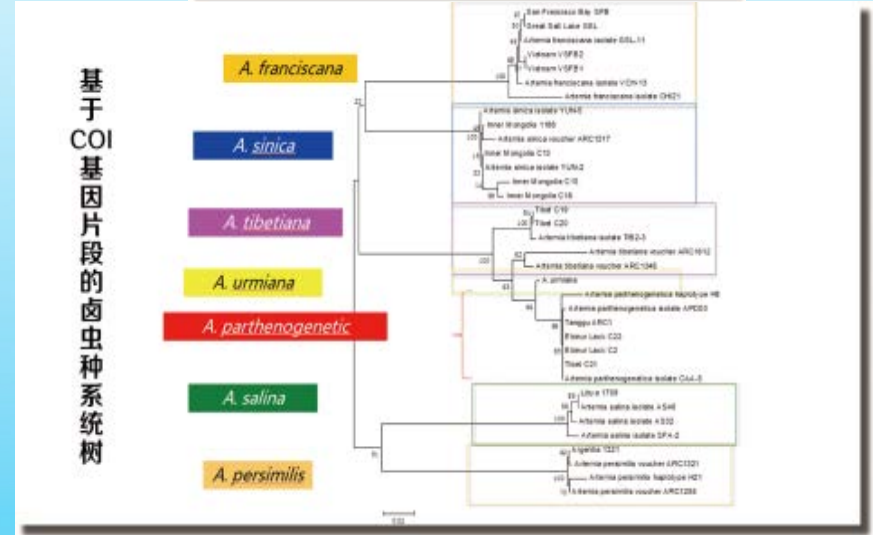
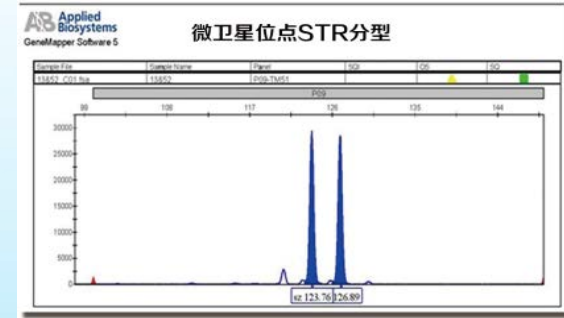


**Cell Culture Room**

# Main Researches

## 1. Exploitation and Utilization of *Artemia* Resources

- *Artemia* biology and population genetic diversity study.
- Selective breeding and germplasm improvement of specific *Artemia* strains.
- *Artemia* cysts processing techniques improvement.
- Efficient utilization of *Artemia* in aquaculture.





# Main Researches

## 2. Assessment and Bio-remediation of Hypersaline Environment

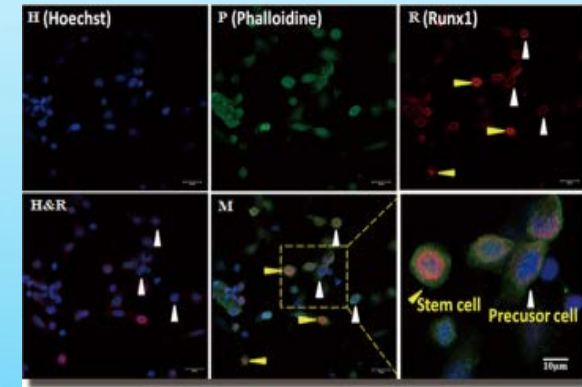
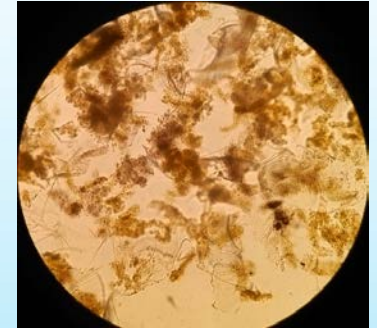
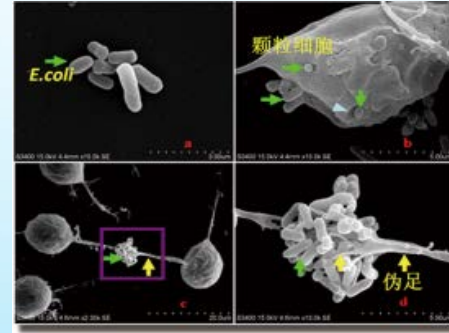
- Use of *Artemia* as an test organism in environment science study.
- Ecological investigation on solar saltworks and salt lakes.
- Improvement of salt production and quality through biological management (*Artemia* inoculation).



# Main Researches

## 3. Mechanism and Techniques for Aquaculture Health Management

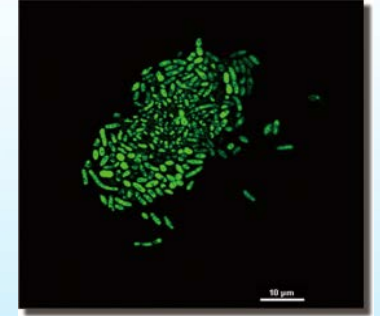
- Cellular immune response strategy and mechanism in crustacean.
- Key factor and signaling pathway on immunity homeostasis and its regulation mechanism in crustacean.
- Application of biofloc techniques and in *Artemia* pond culture.
- Application of bio-control agent (PHB) in aquaculture health management.



# Main Researches

## 4. Exploration and Application of Bioactive Substances from Halophilic Microorganisms

- Halophilic Microorganism Gene Bank (>30 strains) and selection of bioactive compounds produced by halophilic bacteria and archaea.
- PHB production thorough *Halomonas* fermentation and its application in aquaculture.
- Accumulation of carotenoids (e.g. bacterioruberins) in halophilic archaea, pigment composition and bioactivity study.



# International collaborations

**AR-ARC has close corporations with:**

- International organizations: **FAO, ASEAN-FEN (+ member)**, European Salt Association, International Salt Lake Society, etc.
- Oversea universities: Ghent University (Belgium), Can Tho University (Vietnam) , University Malaysia Terengganu (Malaysia), Urmia University (Iran), etc.
- Local enterprises, research institutes and universities, and local organizations (**CAA, CAPPMA**), etc.



Food and Agriculture  
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Thank you very much

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