



Preliminary study of temperature effect on life span and production potential of a tropical parthenogenetic *Artemia* form Yinggehai Saltern (Hainan, China)

Bo Yuan¹, Yuemin Liu¹, Xiaojuan Xu¹, Chunwei Liu², Ying Cao², Lian Ming Wang¹, Farnaz Mahmoudi Shikhsarmast^{1*}

¹ College of Marine Science and Technology, Hainan Tropical Ocean University, Sanya, China

² College of Fisheries and Life Sciences, Hainan Tropical Ocean University, Sanya, China

Abstract

Yinggehai Saltern is located in a tropical area and it is the habitat of a rare pentaploid parthenogenetic *Artemia*. This study was assayed under laboratory condition where effect of temperature was evaluated on life span and production potential. Our results documented that increasing temperature to 28 °C had negative influence on life span of Yinggehai population, while the highest production was recorded at 28 °C. Although high temperature could significantly decrease the life span of Yinggehai population, it represented the high reproductive performance at this condition.

Keywords: brine shrimp, tropic, age, reproductive characters

Introduction

The brine shrimp *Artemia* is a zooplankton with a wide distribution on the five continents which colonizing hypersaline habitats (Van Stappen, 2002; Shen *et al.*, 2021) [13, 9]. The genus *Artemia* includes seven bisexual species and large number of parthenogenetic populations consisting different ploidy degrees (Asem *et al.*, 2010, Asem *et al.*, 2016) [5, 4]. Obligate parthenogenetic populations containing di-, tri-, tetra-, pentaploids dispersed in the Old World and Oceania (Sun *et al.*, 1999; Asem *et al.*, 2016) [11, 4].

The life span and reproductive potential of *Artemia* populations are firmly impacted by environmental parameters and genetic components (Browne and Wanigasekera, 2000; Browne *et al.*, 2002) [6, 7]. Therefore *Artemia* has been suggested to be a model organism, for study on the influence of temperature and salinity on biological characters (Browne and Wanigasekera, 2000; Abatzopoulos *et al.*, 2003) [6, 1].

While diploid asexual *Artemia* is characterized by automixis, polyploid asexual populations are apomictic and generally monoclonal (Abatzopoulos *et al.*, 2003) [1]. Many studies have investigated on effect of environmental conditions on biology of parthenogenetic populations without considering ploidy level. In present study, we aimed to investigate the influence of temperature changes on life span and production potential of a pentaploid parthenogenetic *Artemia* from Yinggehai Saltern,

Hainan Province (China) to understand compatibility process in tropical habitats.

Material and Methods

The cysts of *Artemia* were collected from Yinggehai Saltern (YGH), Hainan (18°31'N, 108°44'E) (Fig 1). The natural sea water (35 ppt) was used to incubate cysts for hatching under standard conditions (Sorgeloos *et al.*, 1986). After hatching, newly hatched nauplii were removed to cylindroconical flasks. The salinity in each medium was gradually increased to reach 80 ppt (Triantaphyllidis *et al.*, 1995) [12]. Specimens divided to three treatments with different temperature (22 °C, 25 °C and 28 °C). The specimens of each treatments were fed on a mixed diet of the *Dunaliella* sp. and LANSY ZM (INVE, Thailand) following Triantaphyllidis *et al.* (1995) [12]. Second generation (only first brood) was used for experiment, (Fig. 2). Individuals of each treatment were transferred into 50-ml falcon tubes containing 35-40 ml of 80 ppt medium before maturation and checked daily. Approximately 15 females were examined for each treatment. The falcons were considered daily at the same period to determine life span and offspring production until death of the female. Significant differences between means of treatments were determined by One-Way ANOVA (Tukey, $p < 0.05$). The program SPSS 16 was used for statistical analysis.



Fig 1: sampling area, Yinggehai Saltern (Ledong, Hainan; 18°31'N, 108°44'E).



Fig 2: incubator to set culture of *Artemia* in different temperature.

Results and Discussion

Results of life span and reproductive potential of YGH population cultured at three different temperatures were summarized in Table 1 and Figure 3. Life span shows high values at 22 °C (82.60 ± 9.51) and 25 °C (81.40 ± 13.91), respectively that there is no significant difference between these two treatments. The short life span was observed at 28 °C (61.00 ± 8.92). Although there is no significant difference between the number of nauplii and number of cysts among different temperatures, the high values of nauplii (145.06 ± 93.00) and cysts production (134.46 ± 114.43) at 28 °C and 22 °C were considerable. With regard to our results, the highest and lowest production was obtained at 28 °C (257.66 ± 73.34) and 25 °C (232.80 ± 60.10), respectively.

Table 1: Mean (SD) of life span and production potential (No. nauplii, No. cyst and Total production) for Yinggehai population examined under different temperatures (n = 15, same letter shows nonsignificant difference, p.0.05).

Treatment	Life span	No. nauplii	No. cyst	Total production*
22 °C	82.60 ^a (9.51)	98.33 ^a (74.91)	134.46 ^a (114.43)	232.80 ^{ab} (60.10)
25 °C	81.40 ^a (13.91)	89.26 ^a (67.59)	92.80 ^a (110.41)	182.06 ^a (82.78)
28 °C	61.00 ^b (8.92)	145.06 ^a (93.00)	112.60 ^a (84.66)	257.66 ^b (73.34)

* Total production = No. nauplii + No. cyst

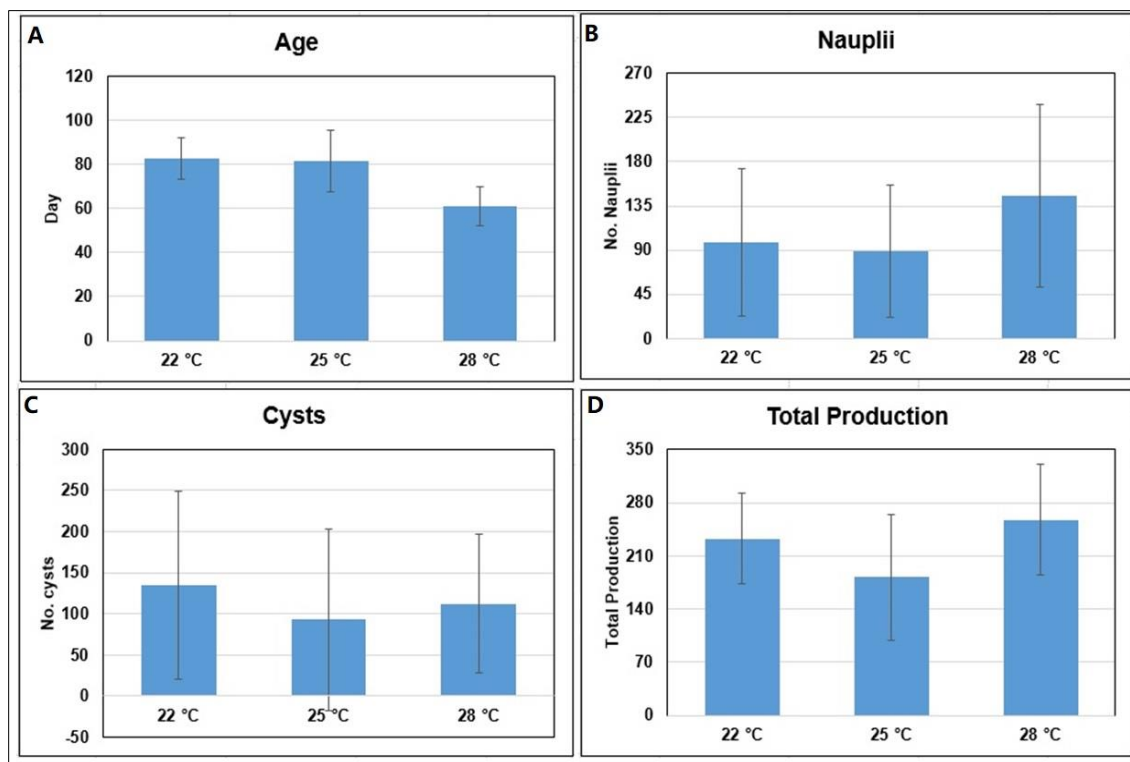


Fig 3: Mean (SD) of A) life span, B) No. nauplii, C) No. cyst and D) Total production under different temperatures.

Many studies have been reported influences of salinity on life span and reproductive characters of *Artemia*, but there is few investigation have focused on effects of temperature. Generally, *Artemia franciscana* shows high adaptation ability to the wild range of environmental parameters. It gained fastest growth at 20 °C to 28 °C in 100 ppt to 170 ppt salinity (Wear and Haslett, 1986) and represented optimal reproductive potential at the temperature range 20 °C to 28 °C in 120 ppt to 200 ppt salinity (Wear *et al.*, 1986). Even so, different parthenogenetic populations display different results. Kuruppu and Ekaratne

(1995) [8] showed that tropical parthenogenetic *Artemia* from Sri Lanka could not mature at 21 °C. They reported 100 to 120 ppt and 25 °C to 30 °C as the best condition for Sri Lankan *Artemia*. Abatzopoulos *et al.* (2003) [1] evidenced that life span and reproductive characters show significantly relationship with variation of salinity and temperature. They documented that temperature had a major effect, so that tetraploid population from Embolon (Thessaloniki, Greece) represented the highest reproductive potential as total number of offspring per female at

22 °C. Additionally their results showed that life span could decreased with increasing temperature.

YGH population is a rare pentaploid parthenogenetic population from tropical habitat (Asem and Sun 2014, 2016) ^[2, 4]. According to our results, YGH population lived significantly longer at 22 °C and 25 °C which contrasts with the observations of Kuruppu and Ekaratne (1995) ^[8] that tropical parthenogenetic population from Sri Lanka could not mature in 21 °C. Additionally, tetraploid parthenogenetic from Embolon displayed high reproductive performance in low temperature while YGH represented the maximum value of total number of offspring per female at high temperature.

In conclusion, there is a lack of information about reproductive potential and life span of parthenogenetic population regarding to ploidy degree and ecological condition of residence. Our results documented even if the life span of YGH pentaploid population significantly decreased in 28 °C, this temperature had a major influence on increasing reproductive potential.

Acknowledgements

This study was carried out at HTOU, College of Marine Science and Technology. It was supported by 2020 Provincial Undergraduate Innovation and Entrepreneurship Program (S202011100013) and Annual opening experiment students project (2020). We would like to express our appreciations to Prof. S.-C. Sun from Ocean University of China (China) for providing *Artemia* samples to this research project.

References

1. Abatzopoulos TJ, El-Bermawi N, Vasdekis C, Baxevanis AD, Sorgeloos P. Effects of salinity and temperature on reproductive and life span characteristics of clonal *Artemia*. (International Study on *Artemia*. LXVI). *Hydrobiologia*, 2003;492:191-199.
2. Asem A, Sun S-C. Morphological differentiation of seven parthenogenetic *Artemia* (Crustacea: Branchiopoda) populations from China, with special emphasis on ploidy degrees. *Microscopy research and technique*, 2016;79:258-266.
3. Asem A, Sun S-C. Biometric characterization of Chinese parthenogenetic *Artemia* (Crustacea: Anostraca) cysts, focusing on its relationship with ploidy and habitat altitude. *North-Western journal of zoology*, 2014;10:149-157.
4. Asem A, Eimanifar A, Sun SC. Genetic variation and evolutionary origins of parthenogenetic *Artemia* (Crustacea: Anostraca) with different ploidies. *Zoologica Scripta*, 2016;45:421-436.
5. Asem A, Rastegar-Pouyani N, De los Rios P. The genus *Artemia* Leach. 1819 (Crustacea: Branchiopoda): true and false taxonomical descriptions. *Latin American Journal of Aquatic Research*, 2010;38:501-506.
6. Browne RA, Wanigasekera G. Combined effects of salinity and temperature on survival and reproduction of five species of *Artemia*. *Journal of Experimental Marine Biology and Ecology*, 2000;244:29-44.
7. Browne RA, Moller V, Forbes VE, Depledge MH. Estimating genetic and environmental components of variance using sexual and clonal *Artemia*. *Journal of Experimental Marine Biology and Ecology*, 2002;267:107-119.
8. Kuruppu MM, Ekaratne SUK. Effects of temperature and salinity on Survival, Growth and Fecundity of the brine shrimp *Artemia parthenogenetica* form Sri Lanka. *Journal of the National Science Foundation of Sri Lanka*, 1995;23:161-169.
9. Shen Ch, Liu Ch, Wu X, Yao L, Meng X, Xia L *et al*. First record of the invasive American *Artemia franciscana* Kellogg, 1906 (Crustacea: Anostraca) at the South China Sea coast of China. *Crustacean*, 2021. 10.1163/15685403-bja10113.
10. Sorgeloos P, Lavens P, Leger P, Tackaert W, Versichele D. Manual for the culture and use of brine shrimp *Artemia* in aquaculture. Belgium: Ghent University Press, 1986.
11. Sun Y, Zhong Y-C, Song W-Q, Zhang R-S, Chen R-Y. Detection of genetic relationships among four *Artemia* species using randomly amplified polymorphic DNA (RAPD). *International Journal of Salt Lake Research*, 1999;8:139-147.
12. Triantaphyllidis GV, Pouloupoulou K, Abatzopoulos TJ, Perez CAP, Sorgeloos P. International study on *Artemia*. XLIX. Salinity effects on survival, maturity, growth, biometrics, reproductive and lifespan characteristics of a bisexual and a parthenogenetic population of *Artemia*. *Hydrobiologia*, 1995;302:215-227.
13. Van Stappen G. Zoogeography. In *Artemia: Basic and Applied Biology*. (Eds T. J. Abatzopoulos, J. A. Beardmore, J. S. Clegg, and P. Sorgeloos.) Kluwer Academic Publishers, Dordrecht, the Netherlands, 2002, 171-224.
14. Wear GRJ, Haslett SH. Effects of temperature and salinity on the biology of *Artemia franciscana* Kellogg from Lake Grassmere, New Zealand. 1. Growth and Mortality. *Journal of Experimental Marine Biology and Ecology*, 1986;98:153-166.
15. Wear GW, Haslett JH, Alexander NL. Effects of temperature and salinity on the biology of *Artemia franciscana* Kellogg from Lake Grassmere, New Zealand. 2. Maturation, Fecundity, and Generation times. *Journal of Experimental Marine Biology and Ecology*, 1986;98:167-183.
16. Ammar I, Raya R. First record of marbled shrimp *Saron marmoratus* (Olivier, 1811) from Syrian marine waters. *International Journal of Zoology Studies*. 2019(1).