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ORIGINAL ARTICLE

Combined effect of temperature and salinity on hatching characteristics of three fairy shrimp species (Crustacea: Anostraca)

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ABSTRACT

The combined effects of temperature and salinity on hatching performance of three anostracan species, Phallocryptus spinosa*,* Branchinecta orientalis *and* Streptocephalus torvicornis *from East and West Azerbaijan, Iran, were studied. The cysts were kept for 10 days at seven different temperatures (12, 15, 18, 21, 24, 27 and 30°C) and four salinity conditions (0, 5, 10, and 15 gL^{-1}), and the effects of the resulting 28 experimental conditions on hatching patterns (duration of pre-hatching period, hatching percentage at first day of hatching, cumulative hatching success) were examined. Results were tested by ANOVA and multiple regression was applied to generate contour models by polynomial equation. The hatching performance in all species was significantly affected by temperature and salinity. Based on contour plot analysis, maximum hatching for* P. spinosa*,* B. orientalis *and* S. torvicornis *cysts was registered at temperatures 19-25ºC, 18-23ºC and 16-20ºC, respectively, within the same salinity range of 0-1 gL^{-1}. The highest cumulative hatching success among the species was observed in* P. spinosa *at the combination of 24°C and 0gL^{-1} (88. 98%). No hatching was observed for eggs of* S. torvicornis *and* B. orientalis *incubated at lower (<15ºC) and higher (>27ºC) temperature, respectively. The pre-hatching period was prolonged with increase in salinity and decrease in temperature and was highest in* P. spinosa *(7.7 days at 12°C and 15 gL^{-1} salinity). High hatching success was observed over wide ranges of temperature and salinity in* P. spinosa *eggs which demonstrates one of the possible mechanisms responsible for the wide distribution of this species.*

Key words: Anostraca, Phallocryptus spinosa*,* Branchinecta orientalis*,* Streptocephalus torvicornis*, cumulative hatch.*

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INTRODUCTION

Fairy shrimp (Branchiopoda: Anostraca) are often the most conspicuous invertebrates associated with the temporary aquatic habitats that are typically characterized by variation in timing, frequency and duration of inundations; a number of variables that together shape the hydrological regime (*i.e*., hydroregime) of the habitat (Hulsmans *et al.*, 2008). Like many other diapausing crustaceans, anostracans produce encysted embryos that can remain viable in the sediments for years (Marcus, 1996), providing a significant source of recruitment to the water column (Viitasalo, 1992) and of *dispersal in time* (Hairston and Cáceres, 1996). For most of the year, anostracan cysts are far more accessible than the corresponding adult or juvenile forms due to the much longer dry season when compared to the length of the inundated phase (Simovich and Hathaway, 1997).

The distribution of large branchiopods is affected by their drought-resistant cysts, which are efficient agents of passive dispersal, so that populations occur on remote islands, and are apparently found wherever there are suitable habitats (Longhurst, 1955). The diapausing cysts may be dispersed by wind, water or birds, which regularly visit seasonal water bodies (Proctor, 1964; Proctor *et al.*, 1967; Figuerola *et al.*, 2003; Green and Figuerola, 2005; Green *et al.*, 2005). Furthermore the extremely sticky eggs could also disperse presumably by adhering to land animals (Longhurst, 1955; Frank, 1988; Gottwald and Eder, 1999; Bohonak and Roderick, 2001; Coulson *et al.*, 2002). Dormancy ends when the appropriate environmental cues (*e.g.*, light, temperature) occur with hydration (Brendonck, 1996; Brendonck *et al.*, 1996, 1998; Hathaway and Simovich, 1996). A certain fraction of the eggs resumes metabolism when favourable environmental conditions are restored, while others remain paused until one or more seasonal cycles have passed. This observed delay in cyst hatching is supposed to be an adaptation to overcome unpredictable seasonal changes that could be fatal for the adult life-phase. In this sense, the existence of a marked inter- and intraspecific variation observed in the hatching pattern of fairy shrimps (Merta, 2003; Zarattini, 2004; Zarattini and Mura, 2007), has provided evidence that a different cyst reactiveness exists, and this is related to the degree of environmental unpredictability (Belk and Cole, 1975).

Little is known regarding the environmental conditions