Influence of seawater salinity on the survival, growth, development, and neonate production of *Scapholeberis mucronata* (O. F. Müler) (Crustacea: Cladocera)

Lei Wang ¹, Wen Zhao ² Corresp., ³, Yuanzi Huo ³, Xuwang Yin ², Jie Wei ², Shan Wang ²

¹ Lab of Marine Biology and Ecology, Third Institute of Oceanography, State Oceanic Administration, Xiamen, Fujian, China
² Key Laboratory of Hydrobiology in Liaoning Province, College of Fisheries and Life Science, Dalian Ocean University, Dalian, Liaoning, China
³ Institute of Marine Science, College of Fisheries and Life Sciences, Shanghai Ocean University, Shanghai, China

Corresponding Author: Wen Zhao
Email address: zhaowen@dlou.edu.cn

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² Third Institute of Oceanography, State Oceanic Administration, Xiamen, Fujian, China
³ College of Fisheries and Life Sciences, Shanghai Ocean University, Shanghai, China

Corresponding Author:
Wen Zhao¹
Heishijiao Street #52, Shahekou District, Dalian, Liaoning Province, 116023, China
Email address: zhaowen@dlou.edu.cn

Abstract
In order to determine the influence of salinity on the survival, growth, development, and neonate production of the cladoceran *Scapholeberis mucronata* (O. F. Müler), long-term experiments were carried out at four salinity gradients (1, 2, 3, and 4) and a control (freshwater) using *Chlorella pyrenoidesa* as feed. The acute effect of salinity on this species indicated that salinity gradients 4 and 4.5 were its upper tolerance limits for reproduction and survival. The survival and growth rates of individuals reared in salinity gradients 1 and 2 were higher than those reared in other salinity gradients. The mean size of the female adults decreased from 820 to 743 μm when the salinity increased from salinity gradients 1 to 4. For individuals reared in salinity gradients 1 and 2, the $r_m$ of population was 1.021 and 0.903, respectively; the rate of egg production was 1.281 and 1.390, respectively; the cumulative egg production was 83.2 and 106.0 and mean life span was 16.05 and 17.30, respectively. These values of life-history parameters were higher than those of individuals reared in salinity gradient 3. No eggs were produced by females reared in gradient 4 during the entire experiment. Furthermore, individuals reared at gradients 1 and 2 had faster embryonic development. The above results imply that *S. mucronata* prefer an environment with lower salinity (1-2). Resting egg formation and sexual reproduction did not occur in any of the tested salinity gradients.

Introduction
Cladocera constitute a vital component of most zooplankton communities in the freshwater ecosystem (Dodson and Frey, 1991). Studies have implied the importance of Cladocera in
utilizing primary resources which, in turn, influences the turnover of higher trophic levels (Selvakumar, 1970). The functional roles of Cladocerans have been well documented in lakes and seas for their secondary production and energetic associations (Lemly and Dimmick, 1982; Mengestou and Fernando, 1991; Mavuti, 1994; Puelles et al, 2003). The effects of certain environmental factors on Cladocera have been studied extensively because of their importance to the aquatic system. These factors include temperature, salinity, light, and the photoperiod..


The present study focuses on the effect of salinity on Scapholeberis mucronata, which is a cosmopolitan eurythermal cladoceran. Compared with other species, few quantitative studies have been made (Rammner, 1927; Kawabata, 1998; De Meester, 1993). Lemke and Benke (2003) and Huang (1985) studied the biology of S. mucronata. Experiments were designed to evaluate the effect of different salinity gradients on parthenogenetic reproduction, growth rates, and the ecological development of this species in the aquatic system in order to learn more about its growth and reproductive behavior and to determine whether it can be used as a live aquaculture food source..

**Materials & Methods**

**Animal incubation and preparation**

S. mucronata were collected from fish ponds at the Biliuhe Reservoir Fisheries Co. and were cultured at the Key Laboratory of Hydrobiology in Liaoning Province. Laboratory-reared parthenogenetic females of S. mucronata whose juvenile age was less than 2 hours old (h) were used for the experiment. A monoculture of Chlorella pyrenoidesa, taken from Key Laboratory of Hydrobiology in Liaoning Province during the exponential phase of growth, and was offered as food. This source was supplied in sufficient quantity to maintain a slight green hue in the water. Desired salinity gradients were prepared by diluting autoclaved, aerated, and nucleopore-filtered (Millipore, 0.22 μm) sea water (FSW) of salinity at 32 [insert relevant unit of measure] with the required volume of distilled water. The cultured water was changed every other day. All of the experiments were conducted at 25±0.5°C. A photoperiod of light:dark (14 h L:10 h D) was maintained for culturing and testing.

**Median lethal concentration (LC₅₀) experiment**

In order to assess the acute effect of salinity on S. mucronata, the bioassay consisted of ten newborn juveniles grouped in 6 different salinity gradients (3.79, 4.15, 4.55, 4.99, 5.47, 6.00).
The experiment was conducted in 60 ml glass-stoppered bottles, each containing 50 ml of cultured water. The experimental setup consisted of 5 such bottles for each salinity treatment. Juveniles were monitored for mortality over 96 hours periods. Survival data was used to calculate LC$_{50}$, the salinity resulting in 50% mortality over a given time. LC$_{50}$s were calculated for 1, 2, 4, 8, 16, 24, 48, 72, and 96 hours using the Probit Method (Zhou and Zhang, 1989). NOAEL (No Observed Adverse Effect Level, which is the highest concentration producing no adverse effects significantly different from the control) can be assessed according to the results.

**Chronic toxicity studies**

One hundred newborn juveniles were reared in a 1000 ml beaker under salinity 1. Seawater was added to the cultured water every day to elevate salinity by 0.125 units. When juveniles were released from the brood chamber of adult $S. mucronata$, they were collected to continue the study using the method mentioned above. After 7 to 8 days of increasing salinity, adults did not produce offspring and the noted value of salinity was deemed the upper limit for the reproduction of $S. mucronata$. The experiment was continued until about 50% specimens died and this value of salinity was determined to be the upper limit of survival for $S. mucronata$.

**Life table analysis and reproduction**

To determine the influence of salinity on growth, life span, and neonate production, long-term experiments were carried out at four salinity gradients (designated as 1, 2, 3, and 4) and a control (freshwater). 325 neonates (< 2 h) were transferred to each 50 ml bottle and 15 such bottles were maintained for each salinity treatment. Concurrently, ten juveniles were introduced into one bottle and 5 such bottles were prepared for each salinity treatment, which were used to compute the intrinsic increasing rate ($r_m$) of $S. mucronata$. Survival, growth, maturity instars, and neonate production in each bottle were recorded three times daily and fresh algae liquid bait was supplemented into the freshwater to maintain the stability of salinity. The increase in length ($\mu$m) of each live specimen was measured daily with an ocular scale under an Olympus microscope at 40×. The experiment lasted until the death of all the animals.

From the results, life expectancy data under every salinity gradient were tabled and $r_m$, and other parameters were calculated based on equation $\sum(l_i b_x e^{-r_m x}) = 1$. This equation was solved iteratively to obtain a more precise solution for $r_m$ (Gotelli, 1995), where $x$ is the age in days, $l_i$ is the proportion of surviving individuals at the onset of each interval ($x$), and $b_x$ is the number of juveniles produced per females during interval $x$.

About four hundred parthenogenetic females were reared individually in 24-well cell plates in order to study the different embryonic stages under various salinity treatments. It was not possible to clearly observe the details of embryonic development in the brood chamber itself due to its dark color and opacity of the carapace. Therefore, a few parthenogenetic females were killed at fixed time intervals and their brood chamber carefully dissected out to release the developing eggs, revealing the distinct stages of development.
Results
Survival
During the experiment on the acute effect of salinity on *S. mucronata*, individuals did not die within the first two hours. However, four hours after the onset of the experiment, deaths were observed. The LC$_{50}$s of juveniles exposed to salinity exhibited at 4, 8, 16, 24, 48, and 72 hours were 13.43, 7.47, 5.60, 4.88, 4.45, and 3.91, respectively. According to the Fig. 1a, it can be assessed that the most vitally protective salinity gradient for *S. mucronata* was less than 4.00. The upper limit for the reproduction and survival of *S. mucronata* were 4 and 4.5, respectively. Under all salinity treatments, the curve of survival rate of *S. mucronata* corresponded with Deevey I’s pattern, namely a low death rate in the population at the prophase of the culture and a high death rate at anaphase.

The survival rate of *S. mucronata* reared in salinity gradients 1 and 2 was sustained above 90% 14 to 15 days after the onset of the experiment, which was obviously higher than those reared in other treatments. However, after days 16 to 17, the survival rate of *S. mucronata* reared in all salinity gradients rapidly declined, ultimately until death (Fig. 1b).

Growth and reproduction
Mean initial body length (0.28±0.01 mm) did not vary significantly among salinity gradients for *S. mucronata* juveniles. The initial body length increased at a rate that did not correspond with salinity (Fig. 2a). Length was noted to increase more quickly in the initial stages of the experiment at all treatments and slowed more noticeably at higher salinity treatments. The juveniles in salinity gradient 1 grew faster than those in other gradients. There was a significant inverse relationship in the size attained by female adults (p<0.05) with salinity (mean size: 820 μm at 1 and 743 μm at 4). Females reared in gradient 3 reproduced significantly later than those reared at a salinity ≤2 (p<0.05), although the age at first reproduction ($A_R$) did not differ significantly between the control and salinity gradients 1 and 2 (Tab. 1). Mean intervals between clutches appeared to follow a similar trend. *S. mucronata* individuals reared in salinity gradient 3 produced significantly fewer clutches per female, number of eggs per female, and number of eggs per clutch than those reared in other treatments (Tab. 1). These parameters of reproduction were not different among the control, and gradients 1 and 2 (Tab. 1). Egg production was initially high for females reared in salinity gradient 1 but began to level off at 72.3 eggs per female after the 8th maturity instars (Fig. 2b). Females reared at salinity gradient 2 continued to produce eggs and reached a maximum of 106.0 eggs per female. Cumulative egg production corresponded to a maximum of 83.2, 73.1 and 31.7 eggs per female at gradient 1, control, and gradient 3, respectively. The maximum number of eggs per female for individuals reared in salinity gradient 1 was reached at the 5th adult instars, whereas at gradient 2 and control, the maximum value was reached at the 6th. Interestingly, after reaching the maximum value, the number of eggs per female for individuals reared in all treatments presented a wave change until death (Fig. 2c). The cumulative egg production of this species was plotted against adult instar
numbers showing the rates of egg production, which was the angle of the slope of the regression line (Murugan and Sivaramakrishnan, 1976).

The rates of egg production exhibited 1.281, 1.390, 1.324 and 0.921 of salinity gradients 1, 2, control and 3, respectively (Tab. 1, Fig. 2b). The reproductive value ($V_X$) is important to determine the contribution to the future population that an individual female will make (Krebs, 1994). The maximum reproductive value of $S. \text{mucronata}$ at all treatments was reached 5 to 7 days from onset of production. The $V_X$ of specimens reared at gradient 2 was significantly greater than those reared in other treatments (Fig. 2d).

**Life table**

Instar indicates the time of desquamating, while the duration of instar refers to the interval of desquamation. Under all treatments, $S. \text{mucronata}$ had three consistent pre-adult instars, but had a different number of adult instars. At 2, there were thirteen adult instars, where other treatments had eleven adult instars. The duration of each instar and the cumulative duration of each instar were significantly longer for individuals reared at control compared with those reared at salinity $\geq 1$ (p<0.05), while specimens reared in salinity gradients 1, 2, 3, and 4 did not differ and corresponded to the cumulative duration of each instar of 24.5, 18.4, 23.3, 18.0 and 18.6 days per female for individuals reared at control, and gradients 1, 2, 3, and 4, respectively. As is typical in this stage of development, the first adult instar, during which the females were primiparous, was distinctly longer than the longest pre-adult instar observed in all treatments. Mean lifespan did not differ among individuals reared in all treatments, although those reared in gradient 2 exhibited a longer mean lifespan than other groups (Tab. 1). The intrinsic rate of population ($r_m$) increase was not related to salinity and differed from 0.481-1.021. The value of $r_m$ was highest at 1 (Tab. 2). Mean generation time ($G$) was not related to salinity. $S. \text{mucronata}$ reared in 1 and 3 had a shorter mean generation time than those reared at control and salinity gradient 2. The net reproductive rate ($R_0$) increased with the salinity from 34.6 at control to 60.6 at 2, but $R_0$ did not increase with salinity $\geq 3$ (Tab. 2). The finite rate of increase ($\lambda$) decreased from 2.78 at 1 to 1.62 at 3, while 2.18 at control (Tab. 2).

**Embryonic development**

**Embryonic development process of $S. \text{mucronata}$**

The embryonic development of cladocera was divided into 8, 5, or 4 stages for different cladoceran species (Green, 1956; Murugan, 1975; Gulbrandsen et al, 1990). In the present study, the salient morphological features characteristic of the distinctive embryonic stages of $S. \text{mucronata}$ were divided into 15 stages (Tab. 3 and Appendix Figure).

The time of egg release from the ovaries to the brood chamber was very short. In freshwater at 25 °C, this time was about 20 seconds per egg release and typically all eggs were released within 2-4 minutes. The intervals between the release of the last juvenile from the brood chamber to the external environment and prior to the discharge of the first egg from the ovaries to the brood chamber is usually short and the eggless periods are only about 1-4 percent of the duration of
embryonic development (Huang, 1986, Bottrell, 1975). In the present study the eggless period was approximately 15.5 minutes, which is shorter than other species (Carmouze, 1983).

Stages of the embryonic development of S. mucronata are briefly described as followed:

I. Stages 1-2: Eggs changed from elongate columniform to oval and ovoplasm changed from even to translucent with a transparent peripheral zone. The central region of the egg had fat cells surrounded by cleaved peripheral granulated cells. At this stage, both the outer egg membrane as well as the inner naupliar membrane were seen (Appendix Fig.1-2).

II. Stages 3-6: Eggs divided from one cell to multiple cells. Vegetal and animal poles appeared and cell differentiation began (AdditiveFig.3-6).

III. Stages 7-8: The blastula and gastrula orderly formed (Appendix Fig.7-8).

IV. Stages 9-11: The antennae elongated and formed a “T” type embryo. The head rudiment was formed and a distinct head and limb rudiment were formed but eyes were not yet apparent (Appendix Fig.9-11).

V. Stages 12-13: Embryo had two very small pink eyes, which rapidly increased in size and became two large black eyes. A distinct single compound eye was formed and the embryonic heart began to beat. Juveniles in the brood chamber were able to turn around (Appendix Fig.12-13).

VI. Stages 14-15: The egg membrane was cast off and characters of adult morphology such as the straight ventral margin of the shell ending posteriorly in a spine, the quadrate shape, the fine short setae on the ventral margin of the shell, and the reddish color were developed. Then juveniles were released from the brood chamber and moved freely (Appendix Fig.14-16).

Parthenogenetic and ephippium females of S. mucronata are shown in additive (Appendix Fig.17-18).

Embryonic development at different salinities

The speed of embryonic development was significantly greater for females reared at 2 compared with those reared at other treatments (p<0.05), and the cumulative duration of each phase for individuals reared in salinity gradient3 was longer than those reared at other treatments (p<0.05). The cumulative duration of each phase corresponded to the mean of 25.4, 24.8, 23.2, and 28.0 hours per female for individuals reared in the freshwater control, and gradients 1, 2, and 3, respectively (Tab. 3).

Discussion

Many of studies looking at the effect of salinity on Cladocerans provide important physiological information and insight into their ecological differences. The present study identified Scapholeberis mucronata O. F. Müller as a freshwater zooplankton with a higher tolerance to low salinity concentrations. However, they vary from other geographically diverse populations such as Daphnia magna (Straus) (He et al, 1996). A study of some salt lakes in the JinNan and YinChuan regions, found S. mucronata in a small wetland with a salinity concentration 1.73. According to Alonso et al (1990), S. mucronata appeared and formed...
populations in a salty lake in Spain in which the salinity was 40. Zhao (1992) suggested that *S. mucronata* belongs to the halophile species, in which the appearance of amplitude is affected by salinity levels from 10 to 60 (Williams, 1983). However, Pennak (1989) pointed out that this species is broadly distributed throughout the USA but that they only inhabit freshwater sources. The differences in habitat are influenced by geographical isolation and by the genetic makeup of the organism.

Reproduction is a major physiological activity for any living organism and is influenced by the prevailing environmental conditions (Vernberg and Vernberg, 1972). The review of the reproductive capacity of Cladocera in relation to the environment by Zheng (1990) provided information on various environmental factors affecting parthenogenetic reproductive behavior for many species of Cladocera. However, he did not mention the studies on the effect of salinity on growth or parthenogenetic reproduction. In this study, salinity was the only variable factor in the experiment and obviously had a direct impact on growth and neonate production. Females reared at lower salinity (1-2) had a longer lifespan; higher $r_m$, $R_0$ values, and neonate production, and a faster rate of growth. These observations were in close agreement with the earlier studies of Segawa and Yang (1987) and Achuthankutty, et al (2000). Age at first reproduction and the size of the first clutch were two determining factors affecting the $r_m$ value (Cole, 1954; Meats, 1971; Snell, 1978; Lynch, 1980; He, 1983).

The individuals of *S. mucronata* reared in all treatments began with the same number of pre-adults, but a different number of eggs were produced in the first clutch. *S. mucronata* reared at salinity gradients 1 and 2 reproduced with 12.57±0.74 and 12.43±0.27 eggs in the first clutch, which was more than other treatments. Population at gradients 1 and 2 had a higher $r_m$ value. The rate of egg production (a value) is an index of many synthetic factors, which strongly relates with adult instar numbers and number of eggs per clutch (Huang, 1983). Because of the greater number of eggs per clutch, individuals reared at salinity gradients 1 and 2 had higher overall rates of egg production. The results of the present study reveal that salinity gradients 1 and 2 could be considered the optimum salinity amplitude for the population of *S. mucronata*.

Few studies regarding the effect of salinity on the embryonic development of Cladocera have been published (Wang et al, 2000). The present study indicates that there were variations in the duration of the embryonic period with different treatments. The rate of development was relatively faster for individuals reared at 1 and 2 than those reared at other salinity gradients, which prove that this species is suitable to live in low salinity water.

It is known that a small increase of salinity in freshwater can stimulate metabolism, growth, and reproduction of freshwater animals. *Daphnia magna* reared at 2-3 had the highest feeding rate and rate of food assimilation, while the rate of oxygen consumption was lowest for individuals reared in salinity gradient 2 (Wang, 1991; Yang, 1997). These results indicated that the physiological activity of *D. magna* was stimulated by the environment conditions of 2-3. In addition, in a study on the effect of salinity on standard metabolism and the energy budget of carp, it was found that the feeding rate, rate of growth, and rate of energy metabolism for individuals reared at salinity between 3 to 7 were all higher than those reared in freshwater,
while standard metabolism, rates of oxygen consumption were lowest at 3. In the present study, the rate of growth and embryonic development were faster for *S. mucronata* reared at 1-2 than those reared in other salinities. These findings were in keeping with the results mentioned above.

Such a stimulative effect can be explained by two aspects of bioenergetics: first, a small increase of salinity in freshwater can accelerate the capacity for assimilation and absorption in freshwater animals, which enhances the efficiency of energy assimilation. Secondly, many of freshwater animals must maintain the stability of ion concentration within the cells through the active uptake of ions and this osmotic regulation requires the consumption of energy. Increasing salinity in freshwater reduces ion gradients inside and outside of cells which causes freshwater animals to decrease their energy consumption in order to osmoregulate and increase energy consumption for growth reproduction.

Females with resting eggs were not observed in the present study. Production of resting eggs was probably a genetically acquired trait to overcome the extreme temperature changes experienced during glacial periods (Madhupratap et al, 1996). No study has yet yielded any evidence to show that salinity extremes induce resting egg formation in invertebrates.

From present study, we know that population of *S. mucronata* have higher *r* and tolerance to low salinity and that the adult body length is less than 1mm. Therefore, this species can be considered as a potential resource for using as a live aquaculture feed.

**Conclusions**

The acute effects of salinity on *S. mucronata* indicate that 4 and 4.5 its upper limit for reproduction and survival. The survival and growth rate of individuals reared at gradients 1 and 2 were higher than those reared in other salinity gradients. The mean size of adult females decreased from 820 to 743 μm when the salinity was increased from 1 to 4. To individuals reared in gradients 1 and 2, the *r* of population was 1.021 and 0.903; the rate of egg production was 1.281 and 1.390; the cumulative egg production was 83.2 and 106.0 and mean life span was 16.05 and 17.30, respectively. These values of life-history parameters were higher than those of individuals reared at 3. No eggs were produced by females reared at 4 during the entirety of the experiment. Furthermore, specimens reared at gradients 1 and 2 had a more rapid rate of embryonic development. The above results show that *S. mucronata* prefer an environment with lower salinity (1-2). Resting egg formation and sexual reproduction did not occur in any of the tested salinity gradients.

**Acknowledgements**

The study complies with the current Chinese laws. We thank the graphic processing software of OriginPro 9.0 (OriginLab Corporation©, Northampton, MA 01060 USA).

**References**


Figure 1 (on next page)

LC$_{50}$s (a) between salinity and time and survivorship (b) of *S. mucronata* reared at different salinity gradients.

Value of LC$_{50}$s represent mean (±SE) value. S0, S1, S2 and S3 expressed control, 1, 2 and 3, respectively.
Fig. 1

(a) The relationship between salinity (psu) and age (h) can be described by the equation:

\[ y = 4.132 + 9.334 \exp\left[-\frac{(x-3.847)}{5.012}\right] \]

with a coefficient of determination \( R^2 = 0.976 \).

(b) Survival percentage (%)

- S0
- S1
- S2
- S3

The survival percentage decreases over time (d) as follows:

- Time (d) ranges from 0 to 30.

Survival percentage (%) decreases sharply in the initial period and then levels off.
Figure 2 (on next page)

Body length (a), cumulative egg production (b), number of egg per clutch (c) and reproductive value (d) of *S. mucronata* reared at different salinity gradients.

Body length and number of eggs per clutch curves represent mean (±SE) value. S0, S1, S2, S3 and S4 expressed control, 1, 2, 3 and 4, respectively.
Fig. 2

(a) Body length (mm) vs. Time (d)

(b) Cumulative eggs (ind./female) vs. Adult instar number

- S0: $y=1.3238x+0.5611$
- S1: $y=1.2809x+0.7186$
- S2: $y=1.3902x+0.5824$
- S3: $y=0.9209x+0.5128$
Table 1 (on next page)

The effect of salinity on the population increase parameters in *S. mucronata*.

The effect of salinity on the population increase parameters in *S. mucronata*. 
<table>
<thead>
<tr>
<th>Salinity</th>
<th>$A_R$ (days)</th>
<th>No. clutch per female</th>
<th>No. neonates per female</th>
<th>No. neonates per clutch</th>
<th>Mean lifespan (days)</th>
<th>Mean intervals between clutch (days)</th>
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<td>control</td>
<td>4.28 (0.76)</td>
<td>7.14 (2.16)</td>
<td>52.00 (22.46)</td>
<td>8.37 (1.77)</td>
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<td>1 psu</td>
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<td>6.20 (1.69)</td>
<td>54.90 (16.23)</td>
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<td>2 psu</td>
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<td>67.33 (17.78)</td>
<td>8.79 (0.90)</td>
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<td>3 psu</td>
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<td>9.38 (4.17)</td>
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<td>14.20 (6.01)</td>
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<td>-</td>
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The effect of salinity on intrinsic rate of increase, generation time, net reproductive rate, and finite rate of increase in *S. mucronata*
Tab.2  The effect of salinity on intrinsic rate of increase, generation time, net reproductive rate, and finite rate of increase in *S. mucronata*

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Table 3 (on next page)

The effect of salinity on duration of each phase of *S. mucronata*

The effect of salinity on duration of each phase of *S. mucronata*
<table>
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<th>Development phase</th>
<th>Duration of each phase</th>
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<tr>
<td>Membrane lift</td>
<td>0.5~1min</td>
<td>0.5~1min</td>
</tr>
<tr>
<td>2-cell stage</td>
<td>2.1±0.4h</td>
<td>2.1±0.6h</td>
</tr>
<tr>
<td>4-cell stage</td>
<td>1.8±0.4h</td>
<td>1.9±0.4h</td>
</tr>
<tr>
<td>8-cell stage</td>
<td>2.4±0.5h</td>
<td>2.3±0.5h</td>
</tr>
<tr>
<td>Mang-cell stage</td>
<td>1.6±0.8h</td>
<td>1.5±0.6h</td>
</tr>
<tr>
<td>Blastula stage</td>
<td>2.5±1.0h</td>
<td>2.4±0.9h</td>
</tr>
<tr>
<td>Gastrula stage</td>
<td>2.0±0.6h</td>
<td>1.9±0.5h</td>
</tr>
<tr>
<td>Formation of &quot;T&quot; type embryo</td>
<td>1.7±0.5h</td>
<td>1.6±0.3h</td>
</tr>
<tr>
<td>Formation of antenna rudiment</td>
<td>1.8±1.1h</td>
<td>1.7±1.0h</td>
</tr>
<tr>
<td>Formation of pereiopod rudiment</td>
<td>2.0±0.8h</td>
<td>2.0±0.8h</td>
</tr>
<tr>
<td>Formation of 2-compound eye</td>
<td>1.7±0.3h</td>
<td>1.8±0.4h</td>
</tr>
<tr>
<td>Single compound eye stage</td>
<td>3.6±1.1h</td>
<td>3.4±1.3h</td>
</tr>
<tr>
<td>Membrane rive</td>
<td>0.8±0.4h</td>
<td>0.8±0.3h</td>
</tr>
<tr>
<td>Expel from matrix</td>
<td>2~4min</td>
<td>2~4min</td>
</tr>
<tr>
<td>Cumulative duration of each phase</td>
<td>25.4h</td>
<td>24.8h</td>
</tr>
</tbody>
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