Effects of temperature and salinity on oxygen consumption and ammonia excretion in different color strains of the Manila clam, *Ruditapes philippinarum*

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Introduction

❖ **Temperature has been long recognized as one of the fundamental factors affecting biological processes of poikilothermic organisms, such as feeding, respiration, growth, and reproduction.**

❖ **Salinity is another important environmental factors controlling marine species distribution and influencing physiological processes of marine and estuarine organisms, such as survival, hemolymph osmolarity, tissue water content.**

❖ **The Manila clam, *Ruditapes philippinarum*, is an economically important marine bivalve species of the China aquaculture industry, which has a wide geographic distribution along the coast in China and high tolerance to environmental factors, such as salinity and temperature.**

❖ **This species displays different shell color strains (White, Zebra, and Orange) in its natural habitat, which have been selected and cultivated for several generations through clam selective breeding programs.**



Zebra



White



Wild

In this study, we examined the effects of temperature and salinity on oxygen consumption and ammonia excretion of the White clams and Zebra clams, and compared with the wild clams to define optimum thermal and saline limits of this species.

Materials and methods

Two color strains of *R. philippinarum* (Zebra clam and White clam) were collected from the Zhangzidao aquaculture farm in Dalian, Liaoning Province, China. Wild manila clams were collected in the coast of Longwangtang, Dalian, Liaoning Province, China.

The clams with a similar mean shell length averaging at 19.03±0.93 mm, 20.90±1.34 mm and 23.81±1.11 mm, respectively, were used in the present study (Table 1).

Five temperatures were selected (15, 20, 25, 30 and 35 ℃) to evaluate the effect of acute temperature change on oxygen consumption. Five salinities (20, 25, 30, 35, 40 ppt) were selected to determine the effect of acute salinity change on the metabolic rates.

Closed-chamber respiration methods were employed to determine oxygen consumption rate (OCR) and ammonia-N excretion rate (AER).

Table 1 Biological characteristics of two shell color strains and wild population of *Ruditapes philippinarum*.

Shell color	Shell length/mm	Shell height/mm	Wet body weight/g	Soft tissue dry weight/g	Shell dry weight/g	Condition index /%[a]
White clam	19.03±0.93	13.53±0.62	1.06±0.16	0.24±0.03	4.35±0.29	5.93±0.62
Zebra clam	20.90±1.34	15.18±1.01	1.54±0.32	0.17±0.03	2.90±0.19	6.34±0.71
wild clam	23.81±1.11	17.47±0.87	2.13±0.35	0.48±0.05	5.41±0.31	8.85±0.80

[a] Condition index=（soft tissue dry weight/shell dry weight）× 100%.

Data analyses

$OCR = (DO_0 - DO_t)\ V / (DW\ T)$

$AER = (N_t - N_0)\ V / (DW\ T)$

$O:N = (OCR/16) / (AER/14)$

$Q_{10} = (R_2/R_1)^{10/(t2-t1)}$

SPSS 20.0

ANOVA

Duncan

Table 2 Q_{10} coefficients in different strains of *R. philippinarum* calculated from different temperature ranges.

Temperature range/℃	Zebra clam Q_{10} coefficients	White clam Q_{10} coefficients	Wild clam Q_{10} coefficients
15-20	1.463	1.137	1.472
20-25	1.385	2.523	1.944
25-30	2.741	1.476	0.693
30-35	1.423	4.326	0.177

Table 3 The effects of temperature on the O: N ratio of different strains of *R. philippinarum*.

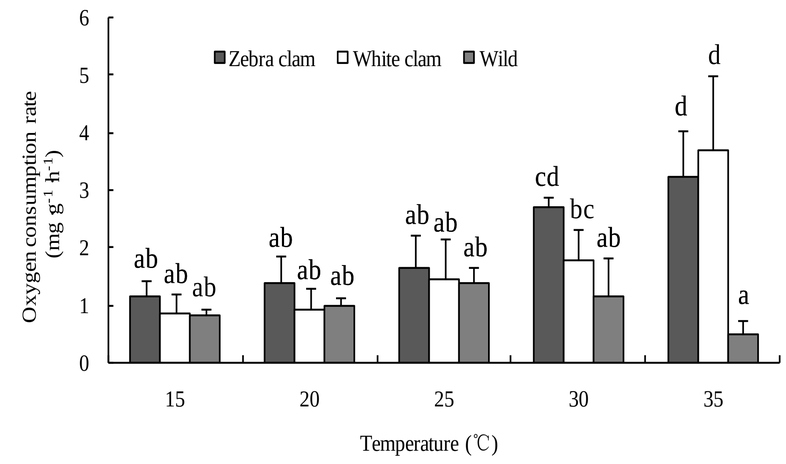
Temperature /℃	Zebra clam O:N ratio	White clam O: N ratio	Wild clam O: N ratio
15	25.37	11.75	20.26
20	56.68	16.67	21.34
25	57.30	24.61	19.48
30	31.04	23.17	48.20
35	24.40	34.44	15.38

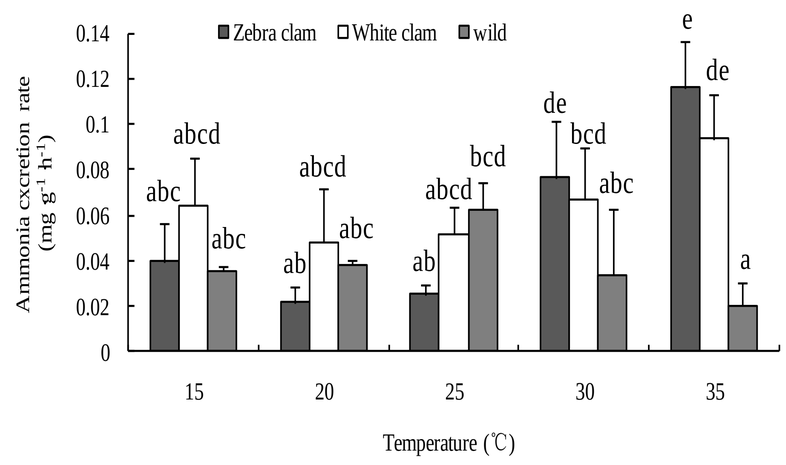
Results

❖ **At a constant salinity of 30 ppt, the oxygen consumption rate (OCR) of White clam and Zebra clam varied from 0.862 and 1.152 mg•g^{-1}•h^{-1} (15 ℃) to 3.690 and 3.238 mg•g^{-1}•h^{-1} (35 ℃).**

❖ **The highest OCR of wild clam was observed at 25 ℃ (1.388 mg•g^{-1}•h^{-1}), whereas lowest OCR was at 35 ℃ (0.486 mg•g^{-1}•h^{-1}).**

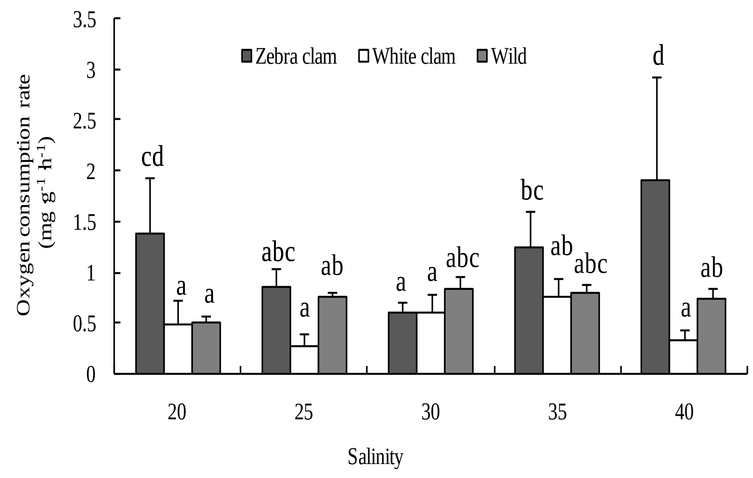
❖ **The highest Q_{10} coefficients were 2.741 for Zebra clam, 4.326 for White clam, and 1.944 for wild clam at temperatures of 25–30, 30–35 and 20–25 ℃, respectively.**

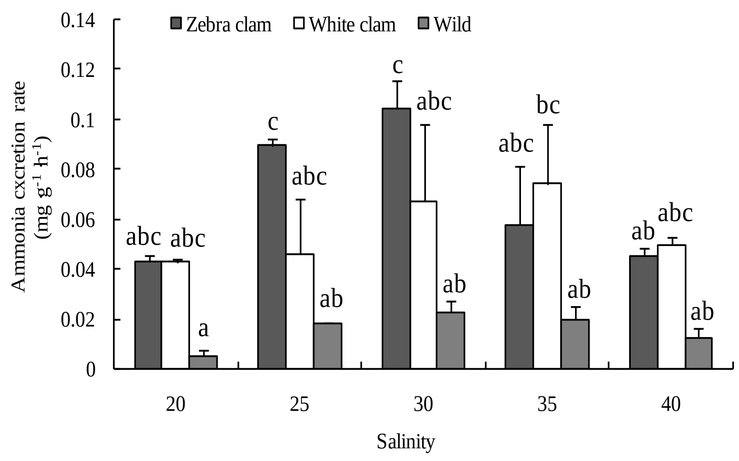




❖ **At a constant temperature of 15 ℃, the OCRs of the clam ranged from 0.275 to 0.767 mg•g^{-1}•h^{-1}, from 0.603 to 1.906 mg•g^{-1}•h^{-1}, and from 0.438 to 1.086 mg•g^{-1}•h^{-1} for the White clam, Zebra clam, and wild clam, respectively.**

❖ **When the salinity is beyond 35 ppt, the OCR decreased and the turning point was found in the White clam and wild clam, but the Zebra clam OCR still increased to a highest level (1.906 mg•g-1•h-1) at 40 ppt ($P < 0.05$).**





❖ **These results show that the cultivated color strains of *R. philippinarum* were different from wild clams in terms of metabolic activities.**

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