

man SRP19 protein), are also conserved in AmphiSRP19. The lysine-rich C-terminus existing in AmphiSRP19 and other known SRP19 proteins is a strongly hydrophilic region and is probably involved in other functions such as interaction with rRNA or nuclear transport.

Expression of *AmphiSRP19* in different adult tissues was analysed by Northern blotting. As shown in Figure 3, a single 0.86 kb *AmphiSRP19* transcript is detected in all the tissues examined though the transcripts in the ovaries and testes appear more abundant than those in other tissues. In addition, spatio-temporal expression of AmphiSRP19 during embryogenesis was examined by whole mount *in situ* hybridization using embryos or larvae of amphioxus. *AmphiSRP19* transcripts are found ubiquitously in the early embryos from zygote to neurula (Figure 4 a–e). Interestingly, AmphiSRP19 is expressed conspicuously at both anterior and posterior ends of the newly hatched and 1-day larvae (Figure 4 f, g), and in the 2-day larvae, AmphiSRP19 is expressed more intensely in the posterior half than in the anterior half (Figure 4 h). However, histological examination indicates that *AmphiSRP19* transcripts are present in all the embryonic tissues, including ectoderm, neural tube, mesoderm, notochord and endoderm of the newly hatched and 2-day larvae (Figure 4 i, j). These findings are obviously consistent with the expectation that *SRP19* is an essential housekeeping gene. The prominent feature of the growing larva is that it elongates markedly. The higher rate of *AmphiSRP19* transcription in both anterior and posterior ends of the newly hatched and 1-day larvae and in the posterior half of the 2-day larvae might be due to the continuous cell division in these regions, which involves active protein-secretion processes.

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Effect of salinity on larval growth of horseshoe crab, *Tachypleus gigas* (Müller)

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Growth of the trilobite larvae of *T. gigas* was studied at salinity ranging from 10 to 40‰. In terms of body weight, the growth was higher (232 ± 7.5 mg/week) ($P < 0.05$) at 40‰ salinity, and the first moulting was also recorded on the 35th day. Though the maximum weight attained by the larvae was at salinity 10‰ (260 ± 5.9 mg/week) ($P < 0.05$), its moulting was not recorded until the 45th day. At 20 and 30‰, the weights attained by the larvae were 177 and 165 mg respectively, and moulting occurred on the 42nd day at both salinities.

THE Indian horseshoe crab, *Tachypleus gigas* (Müller) is distributed along the northeast coast of India¹ and migrates to the sandy shore adjacent to the mouth of the estuary for breeding throughout the year². The female lays about 200 eggs per spawning on the sandy beaches and the male fertilizes them. The trilobite larvae hatch out 40–45 days after fertilization and return to the sea. During different developmental stages and migration, the trilobite is subjected to salinity changes from estuarine to marine conditions. Here we report on the effect of salinity on the growth of trilobite larvae of *T. gigas*.

Mature animals were collected from the sandy beach at Balramgari, Orissa (lat 19°16'N; long 84°53'E). The gametes were collected and fertilized *in vitro* following the method described by Chatterji¹. Fertilized eggs were incubated at $27 \pm 1^\circ\text{C}$ with adequate aeration. Hatching of the larvae occurred 42–45 days after fertilization. The average

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prosomal width of the larvae immediately after hatching was 3 mm, average total length was 4 mm and weighed between 137 and 142 mg. The larvae were reared at different salinities but were not fed, as they were left with substantial amount of yolk to sustain³.

The randomly collected larvae were acclimatized gradually at salinities of 10, 20, 30 and 40‰. Salinities 10, 20 and 30‰ were prepared by diluting filtered (0.5 µm) sea water of 40‰. Ten larvae were then transferred to each glass aquarium tank (40 l) containing sea water with salinity 10, 20, 30 and 40‰. Three replicates were used for each set of salinity. In each tank, a 5 cm thick sand bed was made for burying the larvae. The tanks were also provided with continuous aeration. Temperature of all the tanks was maintained at $27 \pm 1^\circ\text{C}$ with thermostatically controlled titanium heaters.

Growth of the larvae was monitored in terms of weight. Weights of larvae were recorded on an Electronic Single Pan Anamed Balance (M × 7000 series; accuracy 0.01 g) after blotting the excess water and increment in weight was noted at weekly intervals. The observation was continued up to the 45th day until the moulting of all trilobite larvae into juveniles.

The growth of larvae was calculated at weekly intervals from the average observed weight attained in different salinities. The data were subjected to ANOVA to test whether the growth rates under different salinities were significantly different from each other. The accepted level of significance was $P < 0.05$. Initially, at all the salinities, the increment in weight was rapid but it slowed down and became irregular at later stages (Figure 1). The growth increment was always higher at 40‰ up to the 35th day when the first moulting was observed (Figure 1).

Maximum weight attained by the larvae was recorded at 10‰ on the 42nd day (260 mg; mean increment = 20 ± 5.9 mg/week) and at 40‰ on the 35th day (232 mg; mean increment = 18.5 ± 7.5 mg/week). At salinities 20 and

30‰, maximum weights attained on the 42nd day were 220 mg (mean increment = 13.8 ± 5.1 mg/week) and 215 mg (mean increment = 12.5 ± 7.9 mg/week) respectively.

The present study showed that at salinity 40‰, the growth rate was faster and moulting occurred on the 35th day of the experimental period, whereas moulting in other salinities (10, 20, 30‰) was recorded on the 42nd day.

A preliminary study has been conducted by Jegla³ to demonstrate the effect of salinity on the growth of trilobite larvae of the horseshoe crab. In the present study, a detailed investigation was made, where a significant relationship ($P < 0.05$) was observed between salinity and growth of the larvae. The present study showed that the larvae were adapted to different salinities (10 to 40‰) due to their high degree of tolerance and adaptation in their osmo-regulatory mechanism.

A higher growth rate at salinity 40‰ was observed compared to 20 and 30‰. An abnormally high growth in body weight was recorded at 10‰, which could be attributed to absorption of water by the soft integument of the body of the larvae as an adaptation to maintain this osmotic balance of the body fluid in low-salinity waters. This could probably have resulted in an abnormal increase in body weight of the larvae before the first moulting^{4,5}.

The present study also shows that moulting frequency is probably also controlled by salinity. At 10‰ salinity, moulting was recorded on the 42nd day, whereas the same was observed on the 35th day at 40‰ salinity. This suggests that trilobites are best suited to an environment where the salinity is ~40‰. The delayed growth of the trilobite larvae in other salinities could be due to diversion of most of the energy towards maintaining the osmotic balance of the body fluid of the trilobite larvae, as reported by several workers⁶⁻⁸. At lower salinity of 10‰, the larvae seem to undergo an important osmotic equilibrium state, especially during the monsoon season. The trilobites therefore, migrate from low-salinity regime to achieve better growth. In some marine crustaceans, salinity has been reported to affect significantly the larval growth⁹⁻¹³.

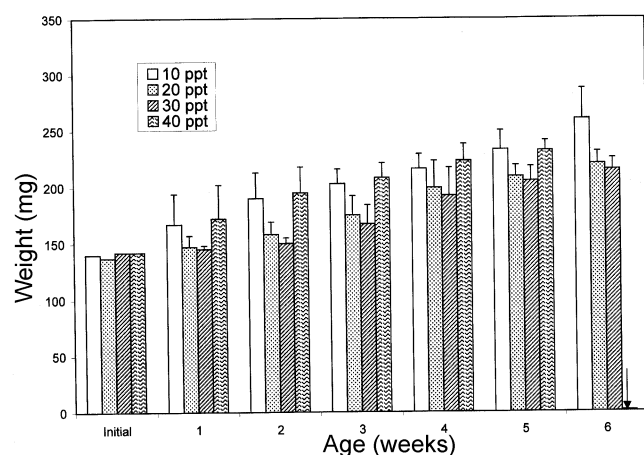


Figure 1. Growth rate of trilobite larvae of *T. gigas* at different salinities (arrow shows hatching of trilobite into juveniles at salinity 40‰ on the 6th week).

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Estimation of geothermal gradients and heat flow from Bottom Simulating Reflector along the Kerala–Konkan basin of Western Continental Margin of India

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Temperature at the Bottom Simulating Reflector (BSR) can be estimated from the pressure–temperature relation of the gas-hydrate stability phase curve. The geothermal gradient and hence the heat flow could be deduced if the seafloor temperature and thermal conductivity of sediments are known. In the present study we have studied a seismic line of the Kerala–Konkan

basin of the Western Continental Margin of India, where BSR is identified on a seismic section. The seafloor temperature was used from the oceanographic data available from the region. Geothermal gradients and heat flow were estimated from the position of BSR using the phase relation system of gas hydrate and thermal conductivity of the sediments. The estimated geothermal gradient and heat flow in the area around this line are 34.88°C/km and 69.76 mW/m² respectively.

NATURAL gas hydrates or clathrates are ice-like crystalline solids, composed of cages of water molecules that host low-molecular-weight gases (mainly methane), which are thermodynamically stable within a limited range of pressure and temperature. They are known to occur in the polar regions in association with permafrost and in the sediments within the upper few hundred metres of ocean floor on many continental margins^{1–4}. Pressure and temperature conditions control gas hydrate formation in the submarine sediments. Figure 1 displays the phase diagram of gas hydrates. The solid line represents the pure methane-hydrate phase curve with the pressure converted to depth assuming hydrostatic conditions in both water and sediments. The dashed line represents the hydrothermal curve as a function of depth. Figure 1 shows the zone from the seafloor down to a depth of up to a few hundred metres, where gas hydrates are stable. At the point where the curve of the conditions in the sediments (dashed line) crosses the phase boundary, we reach the bottom of the zone where methane hydrate is stable. The base of the hydrate stability field represents the phase boundary between the gas hydrate-bearing sediments above and the free gas or gas charged or water-bearing sediments below. The characteristic reflector, which in principle coincides

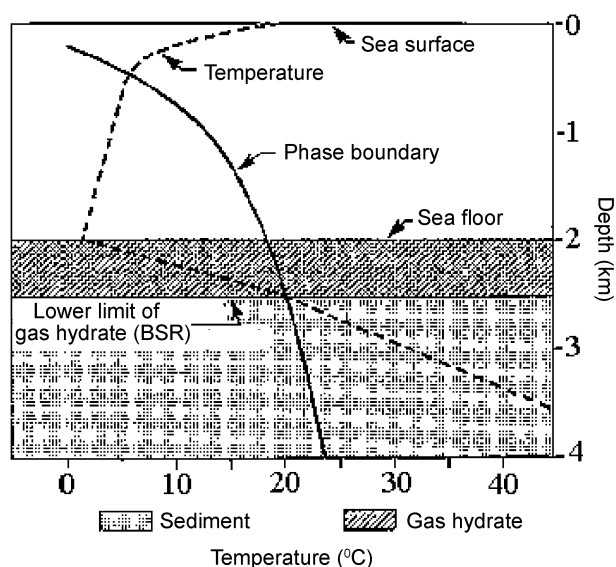


Figure 1. Stability region of methane hydrate in sea water as defined by temperature (T) and pressure (P , indicated as water depth).

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