

Genus *Krithe* (Ostracoda) as a Proxy to Decipher Paleoceanography: A Global Review of the Genus



Mohammed Noohu Nazeer, K Radhakrishnan*, S M Hussain, V Sivapriya and A Rajkumar

Department of Geology, University of Madras, Chennai

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Corresponding author: K Radhakrishnan, Department of Geology, University of Madras, Chennai

Abstract

Highlighting the implication on paleoceanography using different species of the Ostracoda genus, *Krithe* across the globe is reviewed. Distribution of the genus in ocean sediments make them stand apart from all other Ostracoda genera for paleo-oceanographic evaluation. Salinity, temperature, nature of sediments and depth of the water column impacts the occurrence of the species. Preferably, the genus *Krithe* adapt cooler environment species and is useful as glacial and interglacial markers. Evidential from the studies, the different species of the genus *Krithe* are found occurring in different marine settings which marks them a valid species for biomonitoring the ocean bottom.

Keywords: Ostracoda; *Krithe*; Paleoceanography; Biomonitoring; Ocean bottom sediments; Morphometry

Ostracoda (*Krithe*): A Prelude

Ostracoda shells provide valuable insight into the ecology, hydrology, and aquatic chemistry of the environment [1]. The sensitivity of Ostracoda on feeble environmental fluctuations, make them a good marker for the interpretation of geological past. Distribution of Ostracod species varies with environmental conditions and sedimentological parameters. They can tolerate a wide salinity ranges [2] and hence, can occur in different environmental settings- marine, brackish, fresh waters, mangrove ecosystems and wet paddy fields. Ostracoda genera, *Krithe* is benthic pandemic fauna and is globally distributed [3] which diversely occur in deep sea, escalated greatly by its paleo environmental and paleo-oceanographic applications. Being a temperature dependent, salinity tolerant, mud loving genus and moreover a widely distributed genus across the oceans, the genus and its capacity stands unique for correlation of diverse ocean settings. The occurrence of *Krithe* is attributed to zone of upwelling and cold-water regions [4]. Different studies pertaining to the deep sea, multi proxy analysis in genera *Krithe* is handy. The exploration on paleoceanography using the genera is not receiving any mileage, because of lack of a proper compilation.

Ostracoda genus *Krithe* as paleo-oceanographic biomarkers

Being benthonic and abundant in ocean sediments (not observed in shallow tropical zone), Ostracoda genus *Krithe*

marks its importance more than any other genera for paleo-oceanographic studies. Diversification of the genus *Krithe* is dominant beyond 1000m water depth, in bathyal and abyssal zone [5]. Glacial- interglacial cycles are marked using abundance and diversity of Ostracoda genus *Krithe* from Eastern Equatorial Pacific [3]. Higher counts of genus *Krithe* represents a cooler temperature and vice versa. *Krithe* is common along the Upper Cretaceous region in northern Gulf coastal plain of North America. The nature of the sediments as well as the oxygen concentrations are the reason for the occurrence of the genus to a limited area, which implies on the paleoenvironment [6]. Extensive studies on East China and Yellow seas, wherein about 520 grab samples were collected and examined for the distribution pattern of *Krithe* and *Parakrithe* genera focusing mainly on the oceanographic changes [7]. The genera were observed to occur in marginal marine conditions, and inner and middle shelf of the East China Sea and absence of the species addresses the lower salinity, higher temperature and coarser nature of the sediments and also the size of the shell varies with water temperature [8], which makes it useful for understanding bottom water chemistry and the temperature history of the ocean.

Deeper part of North Atlantic is dominated by diversified species of *Krithe* and the age determined aiding the microfossil assemblage is Eocene to Oligocene [9]. The significance of the temperature on shell growth and morphometry in taxa

Krithe praetexta praetexta from North Atlantic, lights into the paleothermometric calculations. The taxonomy and geographical distribution of different species of Ostracod genus *Krithe* is restricted and its occurrence in the influence of cold waters also implied on the paleoecology of Brazilian margin. Distribution of Ostracoda from marine, brackish and coastal waters on 7 species (*Krithe bartonensis*, *K. keyi*, *K. mersinensis*, *K. monosteracensis*, *K. praetexta*, *K. reniformis*, *K. similis*) from Turkey region were examined to decipher the ecological calculations [10]. Biostratigraphic studies using different species of genus *Krithe* in New Zealand addresses on the diverse environmental settings [11]. An appraisal on the Ostracoda *Krithe* from deeper regions of Southern Indian Ocean explained the diversification effects of the genus and the paleoecological traits [12].

Mg/Ca partitioning in *Krithe* shells from Norwegian Sea, Cape Hatteras, Gulf of Mexico revealed that bottom water temperatures are less than 30C in global oceans where the genus *Krithe* occurs. Stable isotopic studies by many researchers have

inferred that *Krithe* is a cooler water genus. Branson & Elderfield [13], used trace elements (Mg and Sr) and Electron Probe Micro Analysis to decipher paleothermometry along with the paleosalinity. The evolution of bottom ocean and the paleowater conditions can be decoded by the shell chemical studies using the genera. Morphometric calculations on *Krithe iniqua* and *Krithe compressa* from Monte San Nicola section deciphered the shape variations and potential differences between the two species [14]. The occurrence of *Krithe bartonensis* from Gebal Mokattam, Egypt along with several other species of Ostracoda and Foraminifera explained the paleo-oxygenation, turbidity and paleoenvironment (Ashraf, 2004). The genus *Candona*, which occurs in fresh water and sediment sequence [15] can be considered as a fresh water and marginal marine equivalent of the genus *Krithe*. Biostratigraphy and ecological studies on different species of Ostracoda from Bay of Biscay including different genera of *Krithe* review to deduce the evolution of the Bay [16] (Table 1).

Table 1: A brief review of the studies on Ostracoda genus *Krithe* from across the world and their corresponding implications.

Species	Location	Implication	Reference
<i>Krithe cushmani</i>	US Gulf Coastal Plain	Paleoenvironment	Puckett, 1997 [6]
<i>Krithe and Parakrithe</i>	East China & Yellow sea	Paleoenvironment	Zhao & Whatley, 1997 [7]
<i>Krithe comma</i> , <i>K. dialata</i> , <i>K. pseudocomma</i> , <i>K. prolata</i> , <i>K. triangularis</i>	Southern Australia	Paleoceanography	Ayress, et al, 1999 [5]
<i>Krithe reversa</i> , <i>K. trinidadensis</i> , <i>K. morkhoveni</i> , <i>K. gnoma</i> , <i>K. coimbraisp.nov</i>	Brazilian margin	Paleoecology	Carmo and Sanguinetti, 1999.[17]
<i>Krithe bartonensis</i>	Gebel Mokattam, Egypt	Paleoenvironment	Ashraf, 2004 [16]
<i>Krithe compressa</i> , <i>Krithe comma</i>	New Zealand	Biostratigraphy	Ayress, 2006 [11]
<i>Krithe iniqua</i> , <i>Krithe compressa</i>	Monte San Nichola	Morphometry	Aiello et al, 2007 [14]
Multiple species of <i>Krithe</i>	Eastern Equatorial Pacific	Glacial-Interglacial	Stepanova and Lyle, 2014 [3]
<i>Krithe sp.</i>	South Indian Ocean	Paleoecology	Cristianini & Abiraman, 2012 [12]
Multiple species of <i>Krithe</i>	Off Turkey coast	Ecology	Ferda et al , 2015 [10]
<i>Krithe sp.</i>	Basin of Iceland	Paleosalinity& Paleotemperature	Benson and Elderfield, 2018 [13]
Multiple species of <i>Krithe</i>	Bay of Biscay, Spain	Ecology and Biostratigraphy	Rodriguez-Lazaro et al, 1999 [4]
<i>Krithe praetexta praetexta</i>	North Atlantic	Paleoemperature	Yamaguchi, 2018 [9]

Conclusion

The genus is distributed across all the oceans, except for shallow tropical bottom sediments. The wide geographical occurrence of these genera makes them useful in paleo-oceanographic reconstruction and correlation. Compiling the works on the genus *Krithe* reveals that the genera thrives on lower temperature (3°C), moderate salinity and fine grade substrate (clay and silt) favourable for their distribution. *Krithe* is a better Ostracoda genus in deciphering deep sea temperature evolution and ocean hydrology (except for shallow tropical zones).

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