Rev. do Museu de Arqueologia e Etnologia, São Paulo, *3*: 55-65, 1993.

RELATIONSHIP BETWEEN SHELL-MIDDENS AND NEOLITHIC PALEOSHORELINES WITH EXAMPLES FROM BRAZIL AND JAPAN *

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SUGUIO, K. Relationship between shell-middens and neolithic paleoshorelines with examples from Brazil and Japan. *Rev. do Museu de Arqueologia e Etnologia*, São Paulo, *3*: 55-65, 1993.

RESUMO: Este trabalho trata de aspectos gerais dos sambaquis da costa sudeste brasileira, particularmente da planície Cananéia-Iguape (SP), enfatizando a sua utilidade na reconstrução de paleolinhas de costa a partir do Holoceno médio. Algumas peculiaridades dos sambaquis da planície de Kanto (Japão), aproximadamente contemporâneos aos brasileiros, são também apresentadas.

Em ambos os casos, para a identificação da posição de paleonível relativo do mar, as seguintes informações devem ser obtidas de cada sambaqui: (a) distância da atual borda marinha ou lagunar; (b) natureza e idade do substrato; (c) altitude do substrato acima do nível de maré alta; (d) épocas de ocupação e de abandono do sítio; (e) valores de $\delta^{13}C_{(PDB)}$ dos carbonatos das conchas; (f) espécies predominantes de moluscos e (g) tamanho do sambaqui.

UNITERMOS: Paleolinha de costa neolítica – Transgressão Santos – Transgressão Jomon – Holoceno, Brasil, Japão.

Generalities

Artificial accumulations made up of shells of brackish water and marine organisms are very commonly found in coastal regions around the world, as in Natal (South Africa), southern Madagascar, eastern Australia (particularly the "New England" coast of New South Wales), Senegal, middle Atlantic coast of the United States (Martin *et al.*, 1986).

In coastal Brazil, between the states of Rio de Janeiro and Rio Grande do Sul (Fig. 1), several hundreds of giant shell-middens (Fig. 2) are known. Their usefulness for sea-level height/shoreline reconstruction has been not very clearly expressed in many papers, but this problem was more precisely emphasized in Brazil only in the recent years (Martin & Suguio, 1976; Martin *et al.*, 1981/1982; 1986; Suguio, 1990 and Suguio *et al.*, 1992).

(*) Presented in Poster Session on August 31, 1992, during the 29th Internacional Geological Congress in Kyoto (Japan).

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Information about sea-level height/paleo-shorelines to be derived from the shell-middens

a) Geographic position – It may be assumed that the location of settlements is decided primarily by proximity to shellfish beds of sufficient richness to provide nourishment over a long period of time

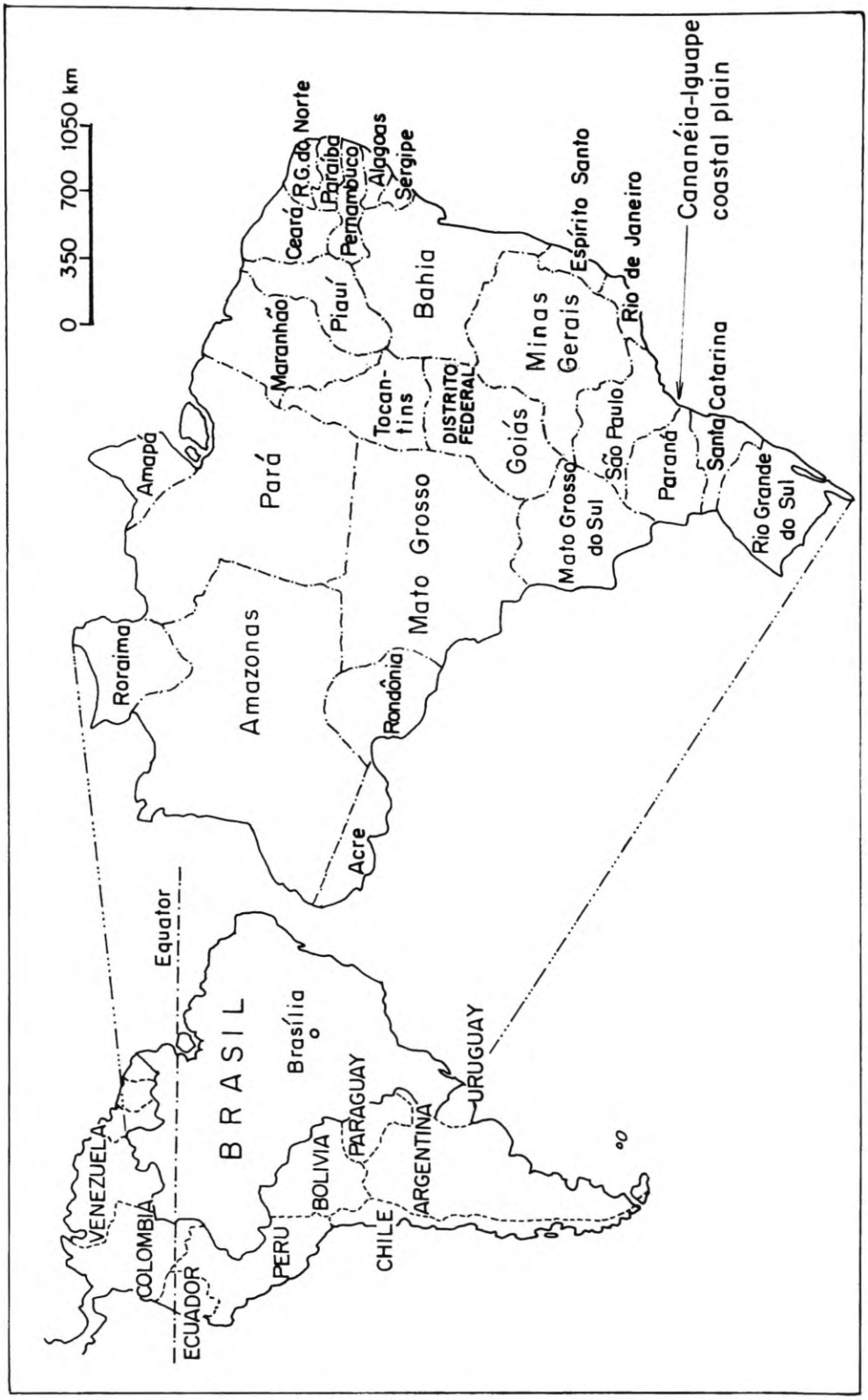
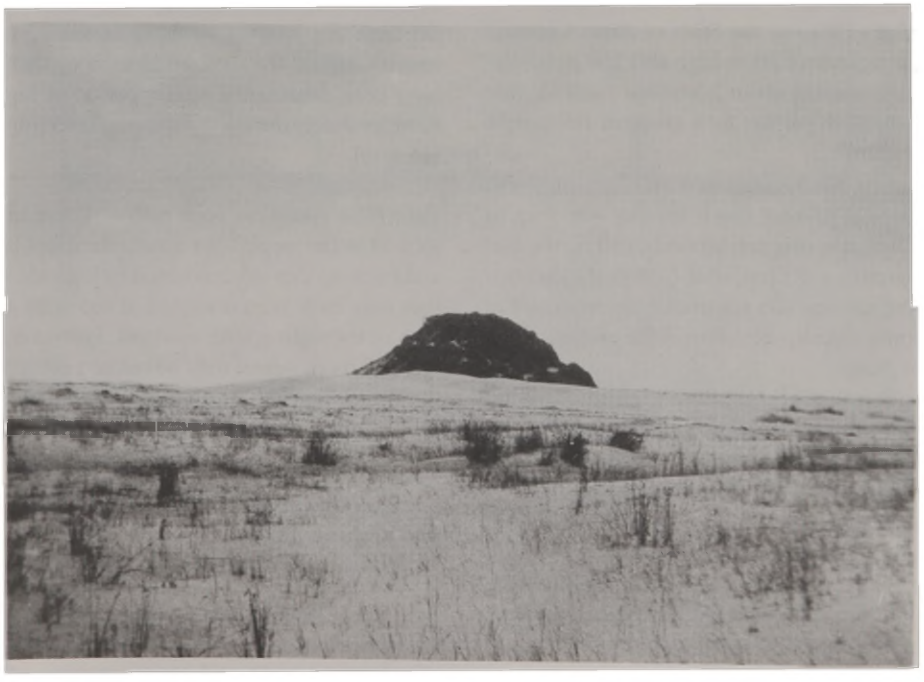


Fig. 1 - Location map of the studied area.

Fig. 2 - Some of the shell-middens found in SE Brazil.

2A - An enormous shell-midden near Saí river mouth (State of Paraná), composed dominantly of Anomalocardia brasiliana.



2B - A huge shell-midden within a coastal eolian dune field near the Jaguaruna town (State of Santa Catarina) composed dominantly of Anomalocardia brasiliana.

(Fairbridge, 1976). If this is true, one may assume a close relationship between the positions of the shell-middens and the paleoshorelines, and the positions of some shell-middens well inland can be explained only by a lagoon extension significantly greater, and hence a sea-level higher than at present. At the culmination stage of the postglacial trans-gression (Santos transgression in Brazil and Jomon transgression in Japan) some shell-middens occur as far as 30 to 35 km in Brazil and more than 50 km in Japan (Kantò plain).

While it is relatively easy to establish the geographic relationship between the position of a shell-midden and a nearby ancient lagoon, estuary, or bay, it is much more difficult to establish the vertical relationship between the altitude of its substrate and the sea-level during its construction. We can only assume that initially it was above the local high-water spring tide (HWST) level, a very important assumption for interpreting shell-middens whose substrates are now located beneath the present HWST.

b) Size of the shell-middens – In coastal Brazil they exhibit a variety of shapes and sizes, ranging from huge elongated (300 x 60 x 6 m) or ellipsoidal (86 x 40 x 25 m) to small circular (10 x1 ~ 1.5 m) accumulations. One shell-midden examined by Fairbridge (1976) in the State of Santa Catarina was approximately 20 m high and 100 m in diameter, representing about 2.5 billion shellfish, that is, 100 shellfish per day for a group of 100 people for 500 years.

It seems that the shell-middens from the Kanto plain (Japan) present much smaller size than in Brazil. Perhaps, this can be explained by the fact that, according to Kosugi *et al.* (1989), the shellfish collecting activity was not usually so important in total food-gathering activities of the earlier Jomon stage of Japan.

In general, the more inland shell-middens are smaller than those situated near the present strandline. This is to be expected as maximum lagoonal extent periods were very short.

c) Faunal composition – About 50 different species of mollusks have been identified within the shell-midden of the Brazilian coast (Bigarella, 1949), but there are only five dominant species:

Anomalocardia brasiliana Gmelin
Ostrea brasiliana sp.
Ostrea arborea Chemnitz
Lucina jamaicensis Chemnitz
Modiolus brasiliensis Chemnitz

In Kanto plain (Japan) shell-middens, according to Kosugi *et al.* (1989), some of the dominant species are: *Corbicula atrata, Tapes philippinarum* and *Meretrix lusoria*. Most of these mollusks lived within sandy or clayey-sandy sediments deposited in brackish to marine and shallow-water lagoons and bays (Figs. 3 and 4).

In general, the more inland shell-middens have their dominant species composed of brackish to almost fresh water mollusks.

d) Types of substrates – The coastal Brazil shell-middens are located on four distinctive types of substrates (Fig. 5):

Type I: Pleistocene marine terraces – These terraces are found inland from the maximum extent of Holocene lagoons, corresponding to periods of highest Holocene sea-level (5,100 years B.P.).

Type II: Holocene marine tarraces – These terraces were deposited as beach-ridges following the highest Holocene sea-level and, therefore, the shell-middens on these terraces have necessarily been built after 5.100 years B.P.

Type III: Ancient lagoonal deposits – These deposits are located in front of sandy marine terraces. Hence, the shell-middens upon them must have been constructed after a period of high sea-level, probably during the ensuing lowering of the sea-level.

Type IV: Crystalline rock hills – These hills are located at the margins or centers of ancient lagoons and bays. As they never covered by high sea stands, they may have been occupied at any time and are thus not sensitive time markers. However, those situated more inland may have been settled when the lagoon reached its greatest extent.

Comparison of geological and archeological data on sea-level in the Cananéia-Iguape and Kanto plains

The Cananéia-Iguape coastal plain, situated in southernmost State of São Paulo, has the shape of a large crescent and covers an area of about 2,500 km^2 (Fig. 6). A large part of the plain is occupied by remnants of more-or-less dissected

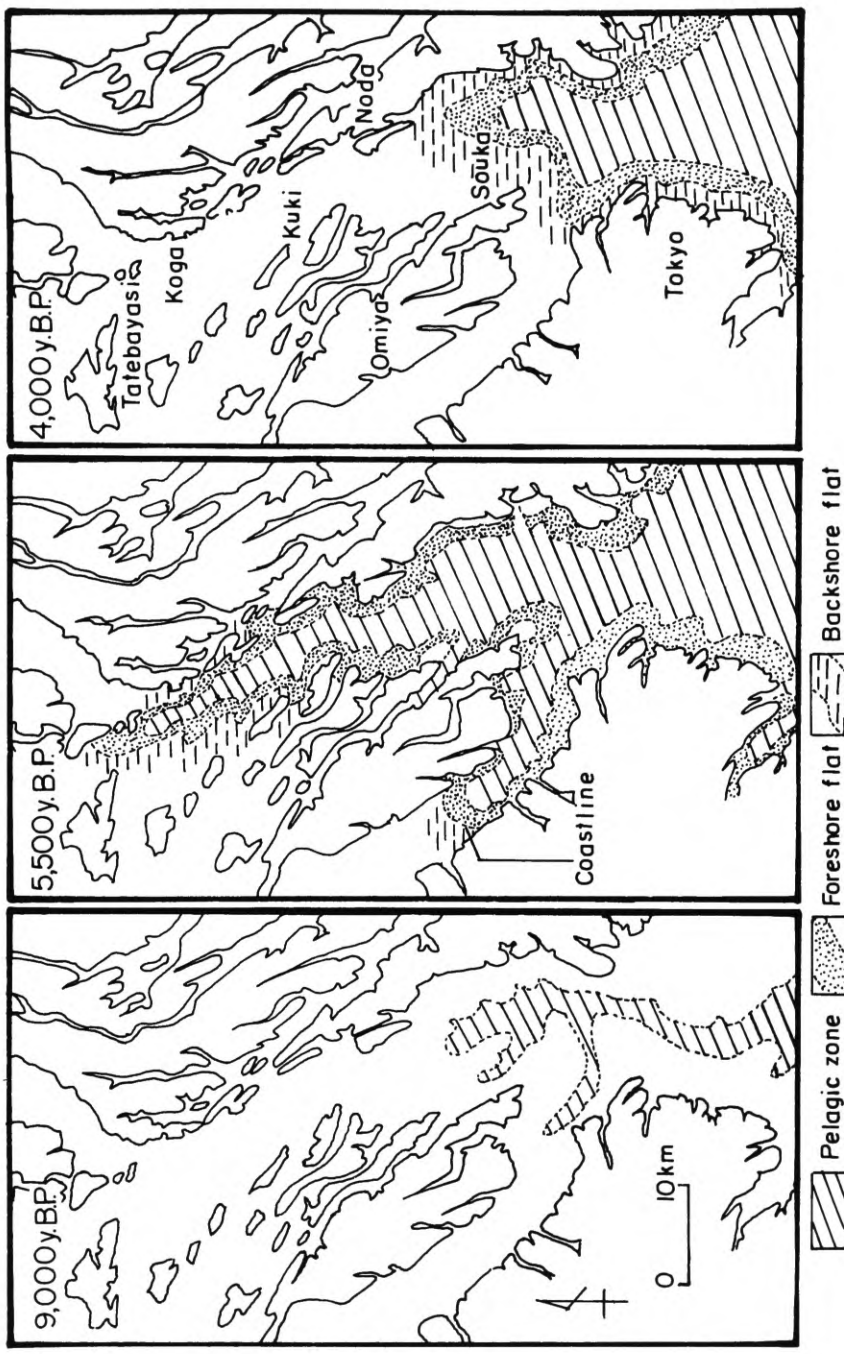


Fig. 3 - Coastlines and their surrounding environments in the Paleo-Okutokyo bay at 9,000 y. B.P., 5,500 y. B.P. and 4,000 y. B.P. (Kosugi et al., *1989).*

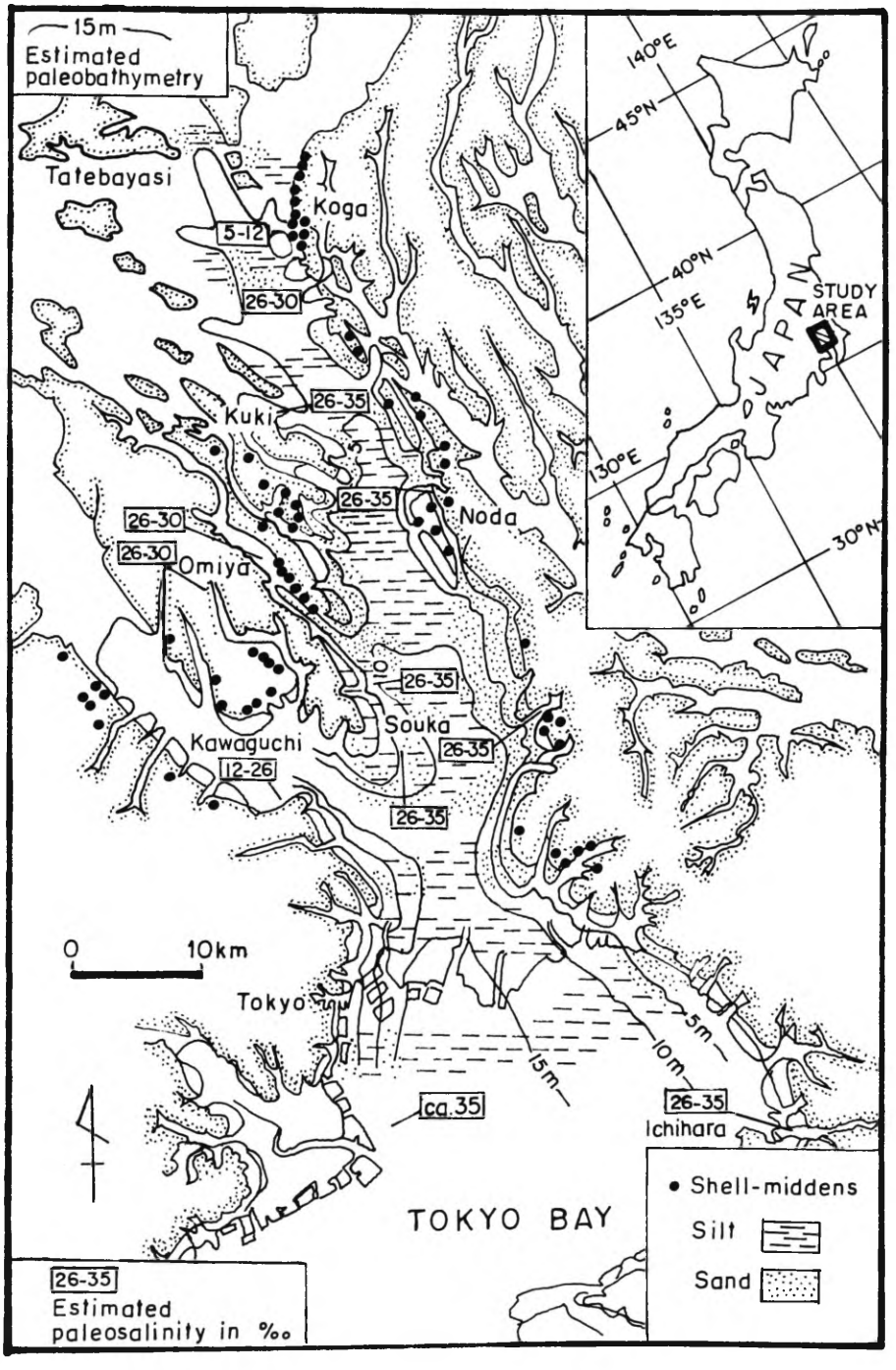


Fig. 4 - Paleogeography of the Paleo-Okutokyo bay and its surrounding at the Kurohama Earlier Jomon age (5,500 y.B.P.) (Kosugi et al., 1989).

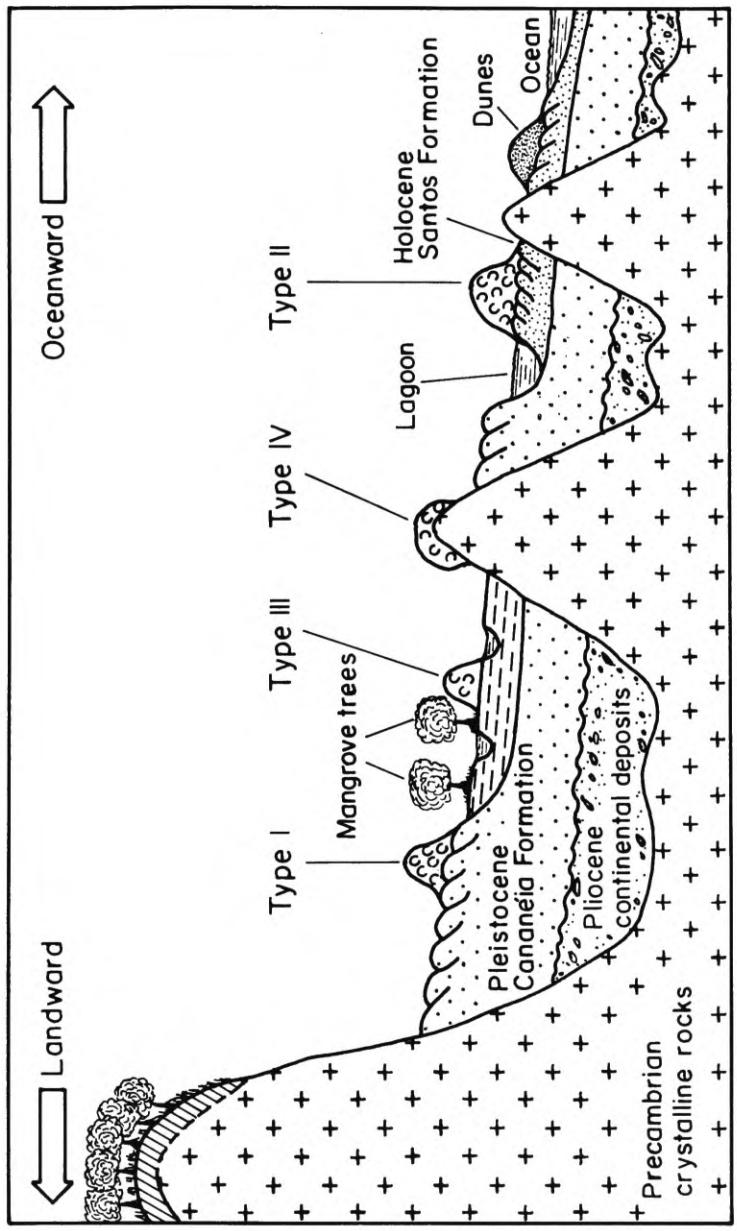


Fig. 5 - Distinctive types of substrates of the shell-middens along the Brazilian coast (Modified from Fairbridge, 1976).

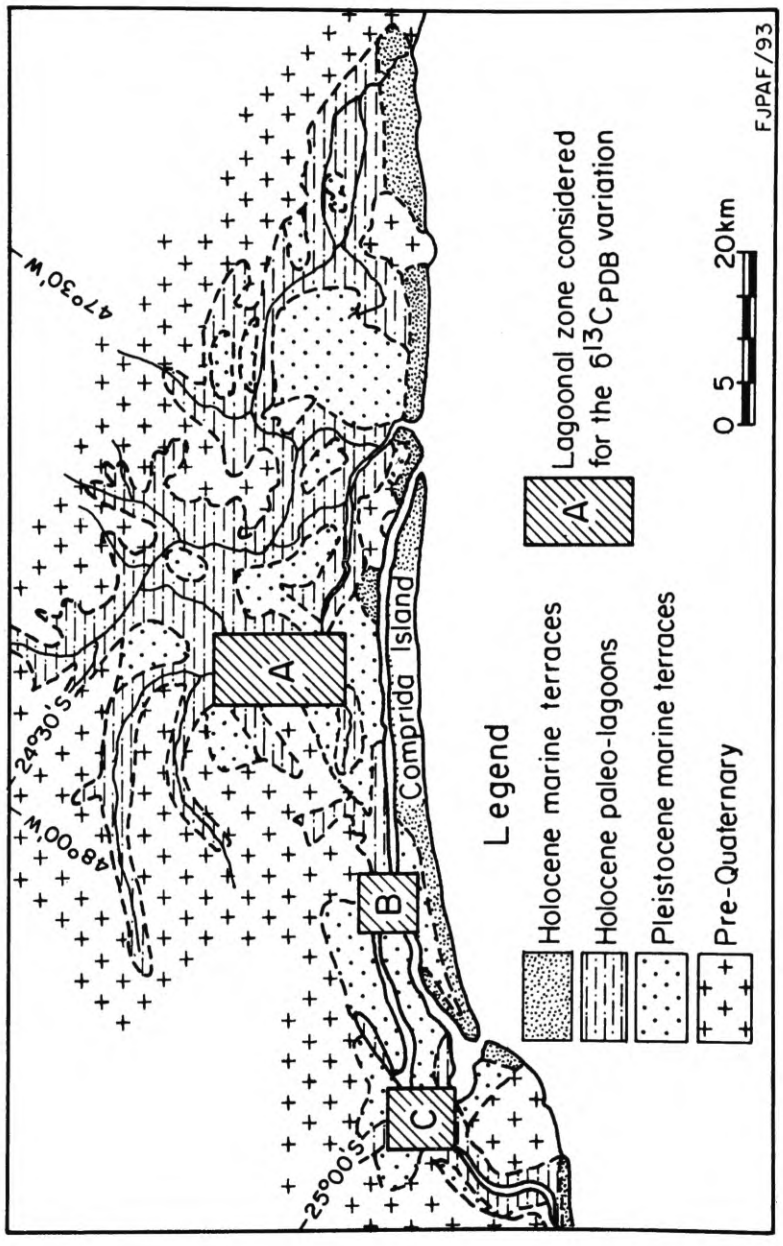


Fig. 6 - Schematic geologic map of the Cananéia-Iguape coastal plain (State of São Paulo) (Suguio et al., *1992).*

Pleistocene marine terraces and by presently dried-out ancient lagoonal area, at the far inland margins of which several shell-middens have been found. Since the end of the last century, about 100 shell-middens were known, some of them occurring as far as 30 km inland from the present coastline.

Shell debris and wood fragments from littoral marine or lagoonal deposits have been dated, and this information, when associated with the nature of the sediments, allowed us to reconstruct, at

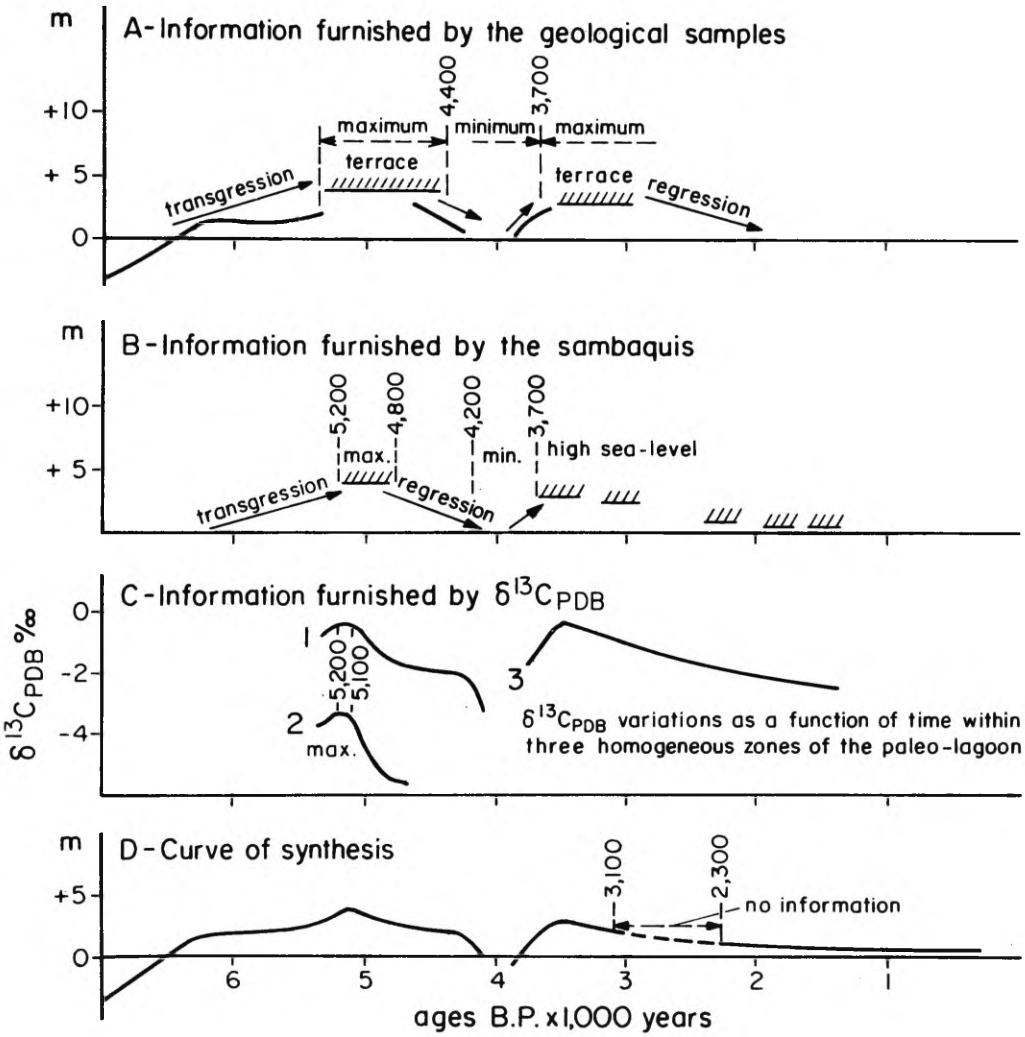


Fig. 7 - Reconstruction of relative sea-level fluctuation curve for the past 7,000 years in the Cananéia-Iguape region (State of São Paulo) (Suguio et al., *1992).*

least partially, the past 7,000 years of the last postglacial sea-level height/shoreline evolutionary history (Fig. 7A).

Dating of the shell-middens in this area confirms the conclusions on relative sea-level reached on the basis of the geological evidence. The geographic positions of these shell-middens only makes sense if the sea-level is higher than at present (Fig. 7B), mostly during the culmination stage between 5,200 and 4,800 years B.P.

On the other hand, the $\delta^{13}C_{(PDB)}$ values can be used as an index to marine vs. continental influences and as an indirect evidence of relative sea-level change (Fig. 7C), according to Flexor *et al.* (1979). The results of $\delta^{13}C_{(PDB)}$ analyses provide additional confirmation of both the geological and archaeological conclusions adumbrate above, allowing us to establish a relative sea-level fluctuation curve during the past 7,000 years for the Cananéia-Iguape lagoonal region (Fig. 7D). The accuracy of this curve is supported by the agreement between the three independent line of information used to create it.

In the Kanto plain, informations derived from the shell-middens, concerning to their geographic positions, faunal composition and types of substrates have been certainly used in postglacial relative sea-level reconstruction. On the other hand, many papers from archeological viewpoint have been published.

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ABSTRACT: This paper deals with general aspects of the southeastern Brazilian coast shell-middens, particularly from the Cananéia-Iguape (State of São Paulo) plain, emphasizing their usefulness for the paleoshorelines reconstruction after the mid-Holocene. Some peculiarities of the Kanto (Japan) plain shell-middens, almost contemporaneous to the Brazilians, are also presented.

In both cases, for the relative paleosea-level identification, the following information must be obtained from each shell-midden: (a) the distance from the present sea or lagoonal margin; (b) the nature and age of the substrate; (c) the altitude of the substrate above high-tide level; (d) the overall dates of site occupation and abandonment; (e) the $\delta^{13}C_{(PDB)}$ values of the carbonates in its mollusk shell; (f) the dominante mollusk species, and (g) the size of the shell-midden.

UNITERMS: Neolithic Paleoshoreline – Santos transgression – Jomon transgression – Holocene, Brazil, Japan.

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Recebido para publicação em 15 de junho de 1993.