BERINGIDA: LAND, SEA, AND THE EVOLUTION OF CRYOXERIC ENVIRONMENTS AND FAUNAS

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The concept of Beringida was formulated to emphasise the former faunal entity of the exposed shelf and coastal lowlands of north-east Siberia and Alaska (Sher, 1976). The basic idea behind it was to abandon the earlier notion of Beringia as a land bridge, periodically connecting two different continents and allowing occasional migration of species. Similarity between the Pleistocene mammals of the Yana-Kolyma Lowland and Alaska turned out to be so close (and much closer than between each of these regions and the lower latitudes of their own continents), that it seemed more appropriate to consider those areas as belonging to a single paleofaunistic unit, that had a long and rather peculiar history of its own. From the perspective of Beringida as a whole, the area of the modern Bering Strait with its dynamic history of sea level change, was viewed rather as a periodically emerging water and climatic barrier, separating that unitary land into western and eastern parts. The unique character of the history of this relatively narrow zone has been emphasised (Yurtsev, 1970; Sher, 1976), and it has been proposed to reserve the name "Beringia" for it; in this paper we describe it as Central Beringida (CB).

West Beringida (WB), i.e. the Siberian part of the ancient land beyond the limits of CB, seems to have had the most stable history in the Late Cenozoic. The currently inundated part of WB is considered to correspond to the shelves of the East Siberian and Laptev Seas, thus extending from about Wrangel Island to the Taimyr Peninsula. That area was not subjected to glaciations (except the highest ranges); instead, sediments of a peculiar syncryogenic formation (Yedoma) were widely deposited there (Sher, this volume). Evidence of marine transgressions in WB is very limited and restricted mostly to its northernmost part.

The fossil environmental record in the coastal lowlands of WB, though far from being complete and continuous, provided some important landmarks for the late Cenozoic. It documents that permafrost and tundra-type plant and insect communities had already developed by 2.5 Ma at the latest (the Kutuyakh Beds, Sher et al., 1979). Repenning and Brouwers (1992) believe that the Kutuyakh rodent fauna is quite close to Fish Creek fauna on the arctic coast of Alaska, but the Siberian counterpart may indicate "greater aridity and a steppe-forest mosaic in the more continental environment of Yakutia". In fact, the first steppe insects have been recorded in WB a little later, possibly around 2.0 Ma (Sher et al, 1979). Later increase in continentality resulted in the development of xeric grassland, further permafrost aggradation, and the evolution of a diverse fauna of arctic grazers by approximately 1.5 Ma (the Olyorian Mammal Age). Some phases during the Olyorian supported vegetation almost inseparable from the typical tundra-steppe of the later Pleistocene, while the well-established "Chenopod" horizon, straddling the Matuyama-Brunhes boundary, is possibly one of the most arid episodes in the history of arctic environment.

Thus, the fossil record indicates that tundra-steppe plant and insect communities, and a fauna of arctic grazing mammals, coevolved in WB throughout the Pleistocene. It seems quite likely that these very peculiar types of communities originated in WB, from where many Beringidan mammals dispersed to the temperate latitudes of Eurasia and North America in the course of subsequent climate cooling and the spread of periglacial conditions during glacial ages (Sher, 1986, 1992; Repenning, Brouwers (1992). It has also been suggested that the cold and arid plains of WB could have served as a shelter (or refugium) for those tundra-steppe mammals intolerant of the interglacial environments in lower latitudes (Sher, 1997).

All of these considerations imply that WB must have retained a quite continental climate during most of the Pleistocene. In the context of this assumption it is interesting to consider, in a broader chronological scale, two hypotheses, recently forwarded in connection with the Pleistocene-Holocene transition in the Arctic (Sher, 1997).

The first suggests that modern "zonal" lowland tundra is not so much a zonal, as a coastal phenomenon. It follows from the fact that most peculiarities of the present climate of tundra (cool summer, reduced insolation because of frequent dense clouds, strongly decreased evaporation, overhumification in spite of very low precipitation, etc.) are directly related to the influence of the cold water mass of the arctic shelf seas. (It should be noted that these features are almost all antagonistic to the climate inferred for tundra steppe, cf. Sher: this volume). So, it is quite possible that the position of the tundra "zone" is directly tied to the position of the shoreline, and shifted with changes in the latter.

The second hypothesis concerns the position of the shoreline during regression phases. Because of the shallowness of the WB shelf, the sea coast ran much farther north than the southern limit of the pack ice under present conditions which are considered as "interglacial". It is hard to envisage that this limit was essentially farther north during glacial phases. Hence, it seems quite likely that when the shoreline retreated to much higher latitudes, the land could immediately contact pack ice through most of the year, including summer. Certainly, the formation of perennial ice cover in the Arctic Ocean is and was a very complicated process, which depends not only on global temperature, but on the sea and land distribution, river run-off, etc. For example, at present the main volume of new ice contributing to the Transpolar Drift is formed just within the shallow shelves of the WB seas; in the absence of these seas the whole situation of the ice regime in the Arctic Ocean could be very different from that of the present day. The possibility of a very sharp reduction in summer open water areas during regression phases in the WB sector should be examined by paleoceanographers (some of whom have themselves suggested this - Dunaev, Pavlidis, 1990). We only wish to draw attention to the possible consequences of this hypothetical situation for the land biota. The huge land mass (approx. 2.500x500 km) protruding far into high latitudes was a significant factor in increased continentality by itself. If it was not bordered by large areas of cold open waters in summer, but by ice instead, that should have resulted in even higher desiccation of the environment in WB. It should be stressed that, unlike the Panarctic Ice Sheet model, this hypothetical model does not imply the "sealing up" of the whole Arctic Basin and the isolation of its central part from water exchange. However, the supposed existence of the vast WB land mass should have had an immense effect on air, water, and ice circulation in the Arctic, and we believe that it should be taken into account, at least, as a possible option, by climate modelling and other kinds of reconstruction of past environments in Beringida.

If this situation was possible during the late Pleistocene regression, it seems just as likely to have happened during earlier low sea level phases. This could explain the early evolution of cryoxeric conditions in WB. At present, there is not much direct evidence to verify this hypotheses, but some data are rather suggestive. An extremely xeric environment on the Kolyma Lowland during the Matuyama/Brunhes transition clearly implies that the shoreline ran much further north at that time. About 700 km to the north, on Faddeevskiy Island (76°N), the Kanarchak Suite, referred to the Late Pliocene - Early Pleistocene (probable equivalent of the Olyorian, but possibly older) was deposited on a very flat coastal plain (tidal flat) under permafrost conditions and includes ice layers and ice-wedge casts (Chamov, 1990). Pollen spectra portray tundra vegetation with "distinctive coenoses of tundra-steppe type" (Zyryanov, 1989). Syncryogenic Yedoma-type sediments referred to the late Matuyama Chron have been reported (Arkhangelov et al., 1996) from Lyakhov Island (cf. Sher, this volume). The age correlations need to be verified, but these data generally agree with the assumption of a vast land with cryoxeric environment in WB in the Early Pleistocene. The same assumption could be equally reasonable for the earlier appearances of xeric assemblages in the lowlands (see above for Repenning and Brouwers' opinion).

Very rare and poorly documented evidence of marine deposits within the present mainland in WB has already been mentioned. In some coastal sections referred to the Late Pliocene - Early Pleistocene a few species of brackish-water and marine diatoms have been found in admixture to the complex of freshwater forms, but the sediment environment is still debatable. The same is true for Middle Pleistocene sediments of apparently marine or lagoon origin. Findings of marine shells in Pleistocene sediments are known from the shelf islands only, mostly in the northern group. Age assignment of these sediments is often far from being clear. For instance, dating of a marine section on Kotelniy Island (with marine shells and forams) to the Kazantsevo (Eemian) transgression is rather doubtful. ESR dating of marine shells from this island revealed a much older age of all samples (385-550 Ka, Bol'shiyanov et al., 1996).

Although our knowledge of the Pleistocene history of the WB shelf is still quite poor, and further research is urgently required, at least some evidence indicates that the idea of stability of continental development, allowing early origin and long evolution of cryoxeric environments in this area is quite plausible. In the framework of the whole Beringida, the WB area could have served as a source of species peculiar to the tundra-steppe biome. It is suggested that the dispersal of particular cryoxeric species and communities was regulated not only by the presence or absence of the Bering Strait as a physical barrier, but also by the distribution of sea and land at the time, which controlled climatic and environmental situation in the generally more mesic area of CB. The idea of mesic control by CB over the dispersal of cryoxeric elements was discussed by Yurtsev (1982), Guthrie (1990), and others; recently, it has been splendidly developed by the research of Berman (this volume) and by bottom cores studies in the Bering Strait (Elias et al., 1996). We may only hope that similar multidisciplinary work will be done some day on the Laptev or East-Siberian shelf, to examine tundra-steppe assemblages hidden below the present cold sea. Recent international research activities in this area, such as The Laptev Sea -2000 Project, and others, allow some hope.