Geoarcheological Investigations on the Soviet Primorye Coast: Their Application to Interpretations of Paleoclimates and Former Sea Levels

A.O. Selivanov and V.P. Stepanov

Faculty of Geography
Moscow State University
Moscow 117234 USSR

ABSTRACT


Sixteen archeological sites along the coast of Soviet Primorye formed the basis for developing geoarcheological methodologies. Stages and methods of subsistence by ancient peoples are used to infer prior climatic conditions and former sea levels. Artifact-bearing sediments, geomorphological position, and results of granulometric, mineralogical-petrographical, and spore-pollen analyses as well as radiocarbon dates were studied for the sixteen archeological sites. Three broad levels of cultural development were identified—the Vestigial Neolithic, Bronze Age, and Early Iron Age. Based on three geoarcheological investigations, it was determined that sea level rose repeatedly to higher stands (compared to the present) during the Holocene. Transgressions are thought to have occurred 3000 years ago and again at about 2000 BP. These high stands are tentatively identified with the Atlantic period and also correspond with recognized relict shorelines along the Japanese coast. The correlation between changes in sea level and monsoon climate in coastal Primorye is attributed to the Petersen-Shnitnikov mechanism where a high monsoon index corresponds to a lowering of sea level and a low index to a rising sea level. A possible exception occurred 2000 years ago when a transgression coincided with a high monsoon index. It was probably a response to Holocene warming at this time.

ADDITIONAL INDEX WORDS: Atlantic period, Bronze Age, coastal midden, Early Iron Age, geoarcheology, monsoon, Subboreal period, Vestigial Neolithic

INTRODUCTION

Recent studies have emphasized the importance of coastal archeological finds and excavations for paleogeographical reconstructions. It has also been suggested that investigations involving studies of sedimentary rocks and the enclosed cultural relics should be identified by the specialized terms geoarcheology (SHACKLEY, 1979) or geological archaeology (RAPP, 1981). This geoarcheological approach can be particularly effective in studies of coastal zones, especially those which are characterized by dynamic sedimentary environments, as well as interpreting the ecological conditions of ancient maritime peoples. Until recently, investigations of this type were limited to the analysis of absolute heights of coastal archeological sites as indicators of former sea levels (e.g. BLAGOOLVIN and SCHEGLOV, 1968; SHILIK, 1980; SCHWARTZ and GRABERT, 1973; FAIRBRIDGE, 1976; REGRAIN, 1977; KRAFT et al., 1980). The surviving archeological sites are significant because they can be used to estimate the relative rise in mean sea level (MSL) for the Japan Sea (GANESHIN and OKLANIKOV, 1956).

Views to the contrary suggest that positions of ancient sea levels can not be deduced from the absolute height of archaeological sites (e.g. PIRAZZOLI,
1980). These objections were logically inferred from the alienation of the artifacts from the host rocks. Valuable methodical approaches that deal with the problem have been elucidated by DEVYATOVA (1976). It should be noted, however, that the elevation of an archeological site is, by itself, evidence of only the maximum possible height and minimal probable time of sea level rise at a given place. In our opinion, where archeological studies of ancient settlements are combined with geological-geomorphological investigations, they provide information valuable to the reconstruction of paleogeographical environments. The adaption of communities to their environments is directly reflected in their specific means of production (GABORI, 1979), and also in the migration of peoples. HENRY et al. (1981) have indicated some important concepts that deal with the adaption of ancient societies to coastal conditions and particularly with reconstructions of prior environments according to archeological evidence.

The results and conclusions presented here are based on investigations of archeological sites along the Soviet Primorye coast. Of the sixteen sites studied, some were investigated for the first time. Six sites are reminiscent of the Vestigial Neolithic and transitional period to the Metal Age, namely: Rudnaya (upper layer) and Smychka-TIG in Rudnaya Bay; Zerkalnaya I and II in Rudnaya Bay and several sites in Southern Primorye (Karasevaya I, Early Archeological Culture, on the Yankovsky Peninsula, and at Suslova-Kalevala in the Kalevala Bay). One site (Rudnaya, lower cultural level) shows ages of the Developed Neolithic, another (Lidovka I in Rudnaya Bay, in Central Primorye) — of the Bronze Age, whereas the others — of the Early Iron Age (Melkovodnaya I, south of Kiyevka Bay; Zerkalnaya II and III; Karasevaya I and II, Min-onoska I and II, and Bezverkhovo on the Yankovsky Peninsula; Gerasimov Island in Southern Primorye). In order to determine the structural arrangement of subsistence for the ancient inhabitants of Primorye, implements, pottery shards, mollusc shells, and mammal and fish bones were studied at each site.

**METHODS**

The subsistence specialization of ethnic communities depends primarily on the socio-economic level of development. Only certain regional factors controlling the historical orderly development of the community depend upon the specific conditions of the natural environment. The segregation of changes in the means of subsistence engendered by natural (climatic) processes was accomplished, with a degree of probability, through studies of the facies of the host sediments enclosing the artifacts, the geomorphological situation of the ancient sites, and in some cases, through granulometric, mineralogical-petrographical and spore-pollen analyses. The Laboratory of Recent Deposits of the Geographical Faculty (Moscow State University) courteously provided ten radiocarbon dates from charcoal specimens of ancient wood-fires. Additional information for this compilation was gleaned from literary sources available on archeological relics and Holocene paleoclimates in coastal zones.

**Modern Climatic Fluctuations**

A characteristic feature of the area under study, resulting from its location at the eastern border of the Eurasian continent, is the monsoon air-mass transfer, which during the cold seasons is in conformity with the air-circulation, whereas during the warm seasons — of counterflow. Besides, during the autumn, due to the minimal contrast between the land and ocean temperatures and the increase in the meridional thermal gradient, the zonal index of circulation increases, whereas in the spring it decreases (VITVITSKY, 1980). As a consequence, the monsoons that cause changes in atmospheric temperature and humidity are more severe in this area during the autumn and winter than during the spring and summer. Other factors that additionally influence the climate include a decrease in the cooling effect of the Primorye sea currents and the approach of the primary hydrological front of the Japan Sea currents (HIDAKO, 1974). The climatic changes occurring over hundreds and thousands of years, according to the circulation manifestations, are similar to seasonal variations (SERGIN, 1978). Therefore, it may be inferred that the intensity of monsoon circulation increased during the Holocene cooling episodes, and decreased during the warming episodes. Consequently, the warming of the climate (for instance, during the 1930's — 1940's) was conducive to increases in biological productivity of the Japan Sea near the shores under study.

Owing to the high intensity of the monsoon circulation, the Primorye soils become flooded during the summer, freeze during the winter due to the thin snow cover, and dry up during the spring. Agriculture, even on the modern level of its development, is greatly limited in the coastal zone, due to the monsoon precipitation pattern (“The Southern Far East,” 1969). The increase in the intensity of the
monsoon circulation could have been crucial to the primitive communities, especially affecting their means of subsistence.

A characteristic feature of Primorye is the absence of relics of the Early Neolithic, whereas archaeological sites reminiscent of the Mesolithic and Developed Neolithic are known here. In our opinion this fact is directly related to the severe monsoon climate which prevailed in Primorye at this time, whereas the Early Neolithic cultures, dating back to 7000-9000 BP, developed in the Central Primorye (BOYARSKAYA et al., 1980). Evidence supporting our opinion is found in the spore-pollen data, which serve to indicate that at the beginning of the Boreal period birch-oak forests spread over Primorye (KOROTKII et al., 1980).

**Site Elevation and Settlement Patterns**

From analytical studies of the relationship between the absolute heights of the archeological sites and their age, as expressed in archeological and physical terms, certain general inferences can be offered. Archeological sites of the Developed Neolithic (5000 to 7500 BP — BOYARSKAYA et al., 1979; BRODYANSKY, 1979) are commonly located on structural-denudation landforms that occur in the river mouth areas at heights of 20 to 40 m. Practically all the artifacts discovered at these sites consist of stone implements that were used in the production of material needs, which were based on hunting and fishing. The latter was an important factor that determined the change to a permanent way of life in local areas. The occurrence of archeological sites directly within the coastal zone suggests that the monsoon climate became somewhat milder during this time, which corresponds to the end of the glacio-eustatic transgression when sea level was near to its present datum.

According to the position of the surviving sites of the Vestigial Neolithic, Bronze, and Early Iron Ages, two ecological groups can be distinctly recognized. One group, consisting of long-term settlements with a large number of dwellings, populated the terrace-like landforms (over 15 m in height) that were of subaerial origin and now covered by proluvial-deluvial deposits (KRIVULIN et al., 1978; KOROTKII et al., 1980). The ancients of Primorye formed settlements along the western coast of Peter the Great Bay. They settled mainly on landforms that were morphologically similar to those of lacustrine-alluvial origin, probably because of the higher fertility of the soils.

Another group, represented by multiple seasonal and short-term stands, is found on low Holocene aggradational landforms, usually within ingressional inlets and bays. In this case archeological sites of different ages are situated at different elevations. Based on consideration of elevation and detailed facies-analysis of the environmental deposits, sea level stands during the Holocene may be estimated. Assuming the wave-action was of uniform intensity at a given place on the coast, we correlated the absolute height of the pinch-out of marine sediments in the coastal landform sequence (the breakpoint where the sea ceases to exert an influence on the cultural layer) with the absolute height of the respective zones within the modern beach. In some cases pebbles taken along the cross-section of the beach, were subjected to petrological analysis and their degree of roundness was evaluated (SELIVANOV and STEPANOV, 1981). These observations showed that the coastal barriers, which to-date are being formed in bays variously oriented in relation to the prevailing waves and currents, are of similar heights and do not exceed 2 m. On average, one to three storms per year occur where the waves reach to 3-5 m in height, as for example, in Rudnaya and Zerkalnaya Bays.

**VESTIGIAL NEOLITHIC SITES**

The archeological sites of the Vestigial Neolithic, occurring between the Middle Inlet in the Vladimir Gulf of Central Primorye, to the Karasevaya Inlet in Southern Primorye, are located on the highest Holocene coastal landforms at heights of 4.6 to 5.5 m. According to our estimates, sea level during the formation of these landforms was between +2.5 and +4 m. Observations conducted by the authors in the south of the Yankovskiy Peninsula and in the Astafyeva Inlet on the Gamov Peninsula, and by KRIVULIN et al., (1978) in Rudnaya and Zerkalnaya Bays discovered grottos at the same heights. These exposed surfaces showed typical abrasion polish and honeycomb cells infilled with rounded pebbles. The relics are similar to the Vestigial Neolithic because the radiocarbon dates of charcoal taken from wood-fires date back to 3900 to 4700 BP. These radiometric dates agree with archeological dates (BRODYANSKY, 1979). Algae peat specimens, taken from restricted lagoons that are cut off from the sea by aggradational landforms 4 to 6 m in height, show ages between 7300 to 7700 and 4300 to 4900 BP (KOROTKII et al., 1980). Another characteristic feature is the occurrence of two generations of coastal barriers, recognized in Rudnaya...
and other bays, that are dated at 3000±600 years (KRIVULIN et al., 1978). From consideration of these facts we infer that twice during the Atlantic period sea level rose, between 7500 to 8000 BP and at about 5500 BP. Evidence of a decline in mean sea level during the Middle Atlantic is found in the coastal barrier pebble-gravel deposits encountered at the head of the Nakhodka Bay where they accumulated 5790±110 years ago and lie at depths of 7 to 8 m below sea level (KAPLIN et al., 1978).

The cooling and deterioration of the monsoon climate at the end of the Atlantic is reflected in the spore-pollen spectra, which show an increase in birch-shrub types and decrease in broad-leaved plant types (KOROTKII et al., 1980), also the deposition of cold-resistant diatoms (PUSHKAR, 1979) in the peats overlying the Atlantic lagoon sediments.

In the archeological sites of the Vestigial Neolithic, in Moryak-Rybolov and Zerkalnaya Bays, at Siniye Skali in Olga Bay, discoveries were made of plummets for fishing nets, needles and bodkins made of bone, fish-scaling cleavers (POROTOV and STEPANOV, 1978), and bones of sea fishes (GARKOVICH, 1967). These finds suggest that the ancients here engaged primarily in fishing, fruit-gathering, and hunting. The tools that were unearthed in the sites on high landforms at Rudnaya I (upper cultural level) and Kirovskii are characteristically of another type. Highly abundant among them are stone grain-crushers, chime-hoops, mattocks, adzes, and arrowheads. Of importance is the discovery of reaping blades at Rudnaya Bay (made out of javelin spearheads). This find, together with the discovery of charred millet grains, confirms OKLADNIKOV and DER EVYANKO’s (1973) supposition that hoeing of the land played a considerable role in the subsistence of the ancient inhabitants of the high landforms.

The exploitation of marine resources and origin of land cultivation in the coastal zone seems to indicate that the monsoon climate was milder at this time than at the end of the Atlantic and beginning of the Subboreal period. During the Middle Subboreal period, cedar-nut-oak forests spread out northward along the coast (KOROTKII et al., 1980). Judging by the diatom flora, the climate during this period was milder than at the present time (PUSHKAR, 1979). The wide spread of oak forests and absence of horned cattle in the adjacent areas, suggest that the conditions were favorable for hog-breeding.

**BRONZE AGE SITES**

At the end of the second millennium B.C. the Synegaiskaya culture of the Bronze Age existed in the continental part of Southern Primorye, where the livelihood of the people depended upon land-cultivation (DYAKOV, 1979) and hog-breeding (BRODYANSKY, 1974). From detailed studies of the archeological sites at Lidovka, which are similar to the Kidovskaya culture of the Bronze Age (end of second beginning of first millennia B.C., according to DYAKOV, 1979), the authors arrived at the conclusion that the ridges, which rise 20 to 40 cm above the granite weathering crust, were hand-hewn. The discovery of millet grains, stone hoes, reaping blades, and grain mills with chime-hoops, confirm the trend toward farming (DYAKOV, 1979). The nature of the stone implements suggests, however, that hunting was still important.

Our evidence suggests, in contrast to the ancient peoples of the Vestigial Neolithic culture who lived in hollows of the dug-out type (OKLADNIKOV and DER E VYANKO, 1973), that the people of the Lidovskaya culture lived in light above-ground bark tents (of the chuma-type). These bark tents imply warming and weakening of the monsoon climate. The authors have not found any direct evidence indicating the stand of sea level at this period; however, attention is called to the fact that most of the surviving sites of the Lidovskaya and Synegaiskaya cultures lie on high structural-denudation landforms. On the low landforms occurring at heights about 4 m above sea level, at Smychka in Rudnaya Bay, discoveries were made of pottery shards which, according to TATARINOV (1979), are similar to the Lidovskaya culture. Here, the present authors discovered arrowheads, bows, and chips that directly overly gravel deposits of the coastal barrier, which date back to 3000±600 years ago (MGU-608). In Tabunnaya Bay south of Yankovsky Peninsula the authors unearthed pottery shards of the same kind and a coal seam that occurred in a similar geomorphologic position at the same height as the former finds. It is thus conceivable that sea level underwent a rise during the Lidovskian, i.e. about 3000 years ago.

**EARLY IRON AGE SITES**

Among the surviving archeological sites in Primorye, the most wide spread are relics of the Likovskaya culture of the Early Iron Age. More than ten radiocarbon dates are available on objects discovered in coastal areas (the dates show ages between 1700 to 3000 years). From these dates, as well as the sophisticated evolution of the culture, which is reflected in certain sites, e.g. on the
The people of the Yankovskaya culture, who characteristically settled at a distance from the coast, engaged in land-cultivation and cattle-breeding (ANDREYEVA, 1978). Sea-food gathering was a common activity of the ancients that populated the high structural-denudation landforms. This notion is supported by discoveries of kitchen-middens consisting of mollusc shells, mammal and fish bones, and pottery shards (Peschanoy, Bezverkhovo, Cape Briener, Siniye Skali). Traces of land-cultivation are restricted to rare finds of several stone hoes, tubular bones, and mammal horns. As indicated by the tools, cattle-breeding played even a smaller role. In contrast to the archæological sites of the Vestigial Neolithic, where bones of wild beasts are of predominant occurrence (GARKOVICK, 1967), the sites of the Yankovskaya culture at Peschany (OKLADNIKOV, 1963) and Bezverkhovo (identified by I.V. Kirillova, Laboratory of Recent Deposits) consist mostly of bone remains of domestic pigs and dogs.

At sites on the low aggradational landforms, no traces of ancient dwellings have been found. Kitchen-scrap discovered here, although similar to those described above, do not form heaps (e.g. Karasevaya II). Among the tools found here, the most common are spearheads, arrowheads, fishing plummets, axes, and adzes. The pottery remains at these sites are much less diversified, compared to those of the higher permanent settlements. The most prevalent occurrences are earthen pots of various sizes, bowls and large flat plates, whereas jugs, goblets, and vases, that are highly abundant in the permanent settlements, are absent. In our opinion, these sites can be regarded as seasonal short-term fishing camps. The paucity of iron tools, which first appeared at this time, and the absence of long-horned cattle and horses (ANDREYEVA, 1977), suggest that the Yankovskians, due to the increase in the population within the coastal zone, experienced a shortage in land and meat products at the end of the spring and beginning of summer. Some of the people must have migrated to the lower aggradational landforms where they engaged in fishing, mollusc-shell gathering, and hunting. Mollusc shells were apparently also gathered during other seasons.

Studies of the species-composition and ecology of the molluscs that comprise the shell-mounds (23 species), provide valuable information on the local hydrological conditions that existed in some coastal areas at this time. For instance, in the area of the archeological site at Bezverkhovo the coastal landforms were already created at this time. Reaching to 3.5 to 4.5 m in height, they cut off the Lebyazhya lagoon from the sea. This fact confirms our inference concerning the ages of the coastal landforms of different heights.

The radiocarbon dates and other archeological data suggest that the archeological sites of the Yankovskaya culture along the western coast of Peter the Great Bay are older than the sites occurring farther east. This implies decadence of the Yankovskaya cultural traditions. According to ANDREYEVA (1977), some vessels discovered in the eastern part of the area show tar-smeared traces or repair. The burial mounds of the Yankovskians are generally poor in artifacts. The critical situation is apparent from the fact that the stone implements were made exclusively from local rock-types.

In the early settlements of the Yankovskaya culture, bones of southern fish species play a prominent role. Today such fishes (tunny, Pacific ocean herrings, etc.) enter the waters of Primorye only during the warm season. Besides, the fishes were larger than modern examples (OKLADNIKOV, 1963). This seems to suggest that the cold Primorye currents were less influential on climate during the beginning of the Yankovskian period, than today.
and during the Vestigial Neolithic. Supporting evidence is found in the absence of salmon bones, which occur abundantly in the archeological sites surviving from the Vestigial Neolithic (Garkovik, 1967). Today the distribution of these species is limited to the south by the Japan Sea. The sites of the Late Yankovskaya culture reveal fewer fish bones of southern species, whereas salmon bones appear here. Archeological sites of the Yankovskaya culture at Bezverkhovo, Peschanoy and others, show that the dwellings of the ancients were also of the warm semi-dugout type. The sequence of the lagoon terrace dated first millennium B.C., shows a decrease of broad-leaved pollen and the appearance of birch-alder types and cedar-elfin wood, which first appears in the Holocene here (Korotkii et al., 1980). This leads to the conclusion that climatic deterioration and monsoon strengthening occurred during the development of the Yankovskaya culture. Considering the rather high density of the coastal population, this could have had a crucial impact on the livelihood of the people.

The pottery shards discovered in the upper part of the Yankovskaya cultural layer on the marine aggradational landforms (Mekvodnaya I, Karasevaya II, Minoneska I, II) are, in some cases, conspicuously rounded, the degree of roundness increasing to 70 to 80%. The pottery shards that were unearthed at Mekvodnaya I and Minoneska II sites are considerably smaller (significant in statistical terms) than those that were discovered at Bezverkhovo and Reynke, which are located on landforms of subaerial origin. In the first case the fragments reveal a higher degree of roundness (Kuzmin and Stepanov, 1981). Apparently, during the post-Yankovskian period the sea exerted a definite influence on the cultural layer of the lower accumulative landforms, i.e. about 2000 years ago sea level probably rose to +0.5 to +1.0 m in height, show ages of 900 to 1300 years (Korotkii et al., 1980), which corresponds to the time when sea level again experienced a decline.

Archeological sites reminiscent of the Krounovskaya and Olginskaya cultures of the Iron Age are located nearly exclusively on high landforms and do not provide evidence amenable to the reconstruction of sea level during the past 2000 years. However, the local vegetation in the area of Mekvodnaya I reveals a change at this time to drought-resistant plant types (Selivanov and Stepanov, 1981), which confirms a lowering of sea level. The situation of these sites on high bald bedrock mountains can, evidently, be associated with the welfare of the ancient people. Armed conflicts between factions of the same tribes arose subsequent to the formation of classes and in response to population pressures in the coastal zone of Primorye. During this period the role of sea-food resources in the sustenance of the people decreased markedly.

A cold humid climate may have prevailed at this time, as deduced from the intricate heating systems that existed in the ground dwellings of the people of the Krounovskaya culture (Andreyeva, 1977). During the period of the Olginskaya culture at the middle of the last millennium B.C., the amount of broad-leaved and Korean cedar types increased in the pollen spectra, whereas birch shrub-types decreased (Korotkii et al., 1980). According to the Chinese chronicles, during this period the population of Primorye was engaged in highly productive wheat cultivation (Shavkunov, 1968). From this, we infer that the monsoon climate was milder in the coastal zone during the second half of the first millennium B.C.

The conquest of the Churchen Agricultural State during the 13th Century, that marked the beginning of the onslaught of the Turkish invaders over the entire Eurasian continent, corresponds in time to the increase in the humidity of the climate in the inland areas of Asia (Gumilev, 1979). In Primorye, the living conditions became less favorable due to the deterioration of the monsoon climate. This explains the decrease in the population of the coastal zone and the reason for their return to hunter-gatherer lifestyles. The Chinese chronicles of the 14th to 17th Centuries indicate that the soils in Southern Primorye, which are highly fertile today, were barren.

**CONCLUSIONS**

Our estimates of the age and height of Japan Sea level transgressive phases during the Middle to Late Holocene (Figure 1.1), based on geoarcheological data, suggest that sea level rose repeatedly to higher stands during the Holocene than the present sea level (Korotkii, et al., 1980). The ages suggested by us for the definite transgressive phases are closely similar to those estimated by Korotkii et al. (1980; Figure 1.2) and Badyukov and Kaplin (1979; Figure 1.3) on the basis of geological-geomorphological data. Some discrepancies are, however, observed. For instance, according to our geoarcheological evidence, sea level rose slightly during the Subboreal period (about 3000 years ago). This rise is in agreement with Badyukov's
and Kaplin's opinion. There was another high stand about 2000 years ago, but this phase is missing from the BADYUKOV and KAPLIN (1979) curve. It is stressed that these two transgressive phases have been tentatively identified in the Atlantic period.

Also noteworthy is the fact that the transgressive phases that we identify here correspond with those recognized on the Japanese Islands (TAIRA, 1980; Figure 1.4). This curve, as well as other curves depicting the changes in the Japan Sea shoreline during the Holocene, show two transgressive phases during the Atlantic period.

Our method does not give any direct evidence of sea level changes in between these transgressive phases. Only indirect indications can be found for the first millennium B.C. The application of the geoarcheological method provides a means for plotting a hypothetical curve of monsoon climatic changes in the coastal zone of Primorye (Figure 1.5). The high potentialities of the geoarcheological method for reconstructions of the monsoon climate and changes in sea level are best reflected for time-periods when changes occur in the archeological cultures, ethnic groups, and socio-economic formations, when certain critical circumstances obliged the ancients to return to more rewarding means of sustenance. In this particular case we refer to the active exploitation of sea-food resources. Besides, such reconstructions are restricted to those time-intervals (in this case, the Middle and beginning of Late Holocene), when the subsistence of the ancients became high enough that changes in the

Figure 1. Fluctuations of far east seas during the Middle-Late Holocene. Curves are plotted for the coast of Soviet Primorye. A: Sea-level curves (1) based on geoarcheological data obtained by the authors, (2) based on geological-geomorphological data (after KOROTKIi et al., 1980), (3) based on geological-geomorphological data (after BADYUKOV and KAPLIN, 1979), (4) age of maximum sea level transgressive and regressive phases on the Japan oceanic coast (after TAIRA, 1980)[arrow-distance from abscissa axes is directly proportional to the transgressive (regressive) phase-amplitude], and B: Climate changes during the Middle-Late Holocene (5) postulated changes in the monsoon climate on the Soviet Primorye coast according to the authors' geoarcheological data, and (6) changes in the relative humidity of the continent (according to SHNITNIKOV, 1957) [the vertical dashed lines show phases of minimum relative humidity on the continent].
natural environment occurring over the range of several millennium did not directly affect the livelihood of the people. the low level in the means of production was the decisive factor in determining the dependency of the primitive communities on the changes in the natural environment.

Holocene sea level changes and phases similar in age occurring over a period of about 2000 years have been noted in other areas of the World Ocean (TERS, 1973; FAIRBRIDGE, 1976; MÖRNER, 1976; SHILIK, 1980, etc.). The controlling factors governing changes in sea level can only be the global eustatic processes and (or) geoidal eustasy, in MÖRNER's (1976) understanding of the term.

At the same time, changes in sea level and monsoon climate in the coastal zone of Primorye, as indicated by the authors, can be explained by the Peterssen-Shnitnikov mechanism - redistribution of the moisture between the continents and oceans (SHNITNIKOV, 1957: Figure 1.6). The high sea monsoon (and humidity) index of the climate corresponds to a lowering of sea level whereas a low index corresponds to its elevation. The only known exception in our case is the transgressive phase that occurred about 2000 years ago; it coincided with an increase in the monsoon index. This probably resulted as a response to the general Holocene (Interglacial) warming in Antarctica, where, according to NAYA (1963), the glacier-relaxation glacial retreat occurred approximately 5000 years ago.

From cautious extrapolations of climatic rhythms over future periods, reliable forecasts might be made concerning natural changes in climate and sea level, on the one hand, and the specific conditions of land-cultivation within the monsoon coastal areas of the continent, on the other hand. Thus, unfavorable climatic phases of the monsoon climate (particularly for land-cultivation) in coastal areas correspond to favorable climatic conditions for inland areas of the continent, and vice-versa.

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Editorial Note:

Traditional Soviet bibliographic style includes only the journal volume and issue number. We have made no effort to complete citations as most of them refer to work in the Russian language.