Biodiversity of Island Ecosystems of the Northern and Middle Caspian and a New Outlook at the Islands Age and the Caspian Sea Level Regime

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Abstract

Species diversity of some biota taxonomic groups of the larger islands (Chechen, Tyuleniy, Nordovyy, Kulaly) of the Middle and Northern has been established by the research expeditions of 2009-2013. Endemic taxa of species and subspecies rank have been found in the flora and fauna of this island group. The results of the GIS simulation (of the map), showing the water surface configuration under the sea level lowering have been presented and different approaches to explain the fluctuations in the Caspian Sea level and the mechanisms of islands and evolution and depositional bench lands of the Northern and Middle Caspian have been briefly described in the article. The supposition on the presence of island firm land throughout the holocoen (even during the highest sea level) has been made on the basis of analysis of the island biota composition and the causal explanation of the endemic taxa presence in the water area of the Middle and Northern Caspian.

Keywords The Caspian Sea; Biodiversity; Coastal and island ecosystems; Level fluctuation,Autochthonous speciation.

1 Introduction

Level regime of the Caspian Sea is an issue to be much discussed in the scientific printed matter in the theoretical and applied perspective. There were a variety of views on the causes of the fluctuation in this sea-lake [1–4] and forecast expectations of its level regime [5-17]. In these and other papers different hypotheses on the causes of the Caspian Sea level regime instability are grouped together in the geological, hydrogeological, climatic and technological conceptions. We do not set a goal to give a detailed analysis of the causes and forecasts of the Caspian Sea level fluctuations. It should be noted that the climate hypotheses, in our opinion, are of greater importance. Our interest to the Caspian Sea level fluctuations is connected with the necessity to give a causal explanation of the identified taxonomic characteristics of the Caspian Sea island biota.

2 Materials and Methods

During the 2009-2013 large-scale comprehensive studies of flora and fauna of the coastal and island ecosystems of the Northern and Middle Caspian were made jointly by Ecology and Geography Department of Dagestan State University and

Institute of Applied Ecology of the Republic of Dagestan. The research covered the western and eastern coasts, as well as the large islands of this part of the sea. The main focus of the expedition was to study the specific diversity of flora and fauna. Faunal material processing was performed in the Zoological Institute of the Russian Academy of Sciences (Saint Petersburg).

Table 1 Summary table of species diversity of the Island Middle and Northern Caspian

No.	Taxa	Number of Genera	Number of Species	New for the Science	New for Russia
1	**Darkling beetles (Coleoptera, Tenebrionidae)**	127	341	1 species	
2	**Owletmoths (Lepidoptera, Noctuidae)**	279	902	-	1subfamily 1genus
3	**Carabid beetles (Coleoptera, Carabidae)**	98	608	-	1 genus 1species
4	**Spiders (Aranei)**	131	290	2 species	-
5	**Click beetles (Coleoptera, Elateridae)**	6	12	-	-
6	**Oribatid mites (Acariformes, Oribatida)**	39	49	2 species	12 species
8	**Snout beetles (Coleoptera, Curculionidae)**	127	318	-	-
9	**Orthopterous insects (Orthoptera)**	24	30	-	-
10	**Dung beetles (Coleoptera, Scarabaeidae)**	133	363	1 species	1 subspecies
11	**Higher plants (Cormophyta)**	186	269	1 species	2 species
	TOTAL:	**1150**	**3182**	**7**	**20**

3 Results

As a result of this processing work of floristic (higher plants) and fauna (some groups of invertebrates) field data, the general picture of species diversity of large islands (Chechen, Tyuleniy, Nordovyy, Kulaly) of the North and Middle Caspian was determined. Firstly, it should be emphasized that the biota of the islands, in general, consists of taxa which are widely spread in the Eastern and, to a lesser extent, in the Western coast of the sea. There are also species which extend far beyond the Caspian Sea Region. However, the fauna and flora data given in Table 1 show that new species currently unknown for the science in

the continental part of the Caspian are proven to have appeared in the modern biota of the Caspian Sea islands. These are taxa of species or subspecies rank. Considering the above said, the modern floral or faunal status of the given species group is to be recognized as endemic. Formation and evolution stabilisation of these taxa requires time sufficient for the diagnostically important features to emerge.

Undoubtedly, the present-day configuration of island biota taxa natural habitat of the Middle Caspian depends on the scale and time duration of transgressive and regressive sea cycles and on the causes predetermining those events. In line with the nature of these cycles changes in the species composition and structural organisation of the island biocenoses were taking place.

The need for a causal interpretation of the present-day configuration of the natural habitat of the biota species composition of the islands investigated and the endemic taxa presence made us develop a hydrodynamic GIS model of the Caspian. To solve this problem, a three-dimensional model of the Caspian Sea has been made in Map 2011 GIS. Matrices keeping the hydrodynamic GIS models functioning are based on approximately forty thousand depth soundings. The base level of the Caspian Sea in this simulation is -28 m point.

Below (Fig.1-10) is the configuration of the sea water surface at different points of sea level lowering. The analysis of these materials allows us to make some important points:

1. The catastrophic reduction of the sea water plane square takes place with a gradual lowering of its level up to -38 m (Fig.6).
2. At the level of -30 m by the islands of Chechen, Nordovyy, Kulaly overland connection with coastal land appears (Fig.2). Island Tyuleniy has the same connection between -31 and -32 m (Fig.3).
3. Between -32 and -33 m within the Ural furrow an independent pool is differentiated (Fig.4).
4. From the level of -34 m the baring of underwater bench land chain from the area of Chechen island in the direction of Kulaly island begin to show (Fig.4,5).
5. At the level of -38 m a separate pool of Ural furrow disappears (Fig.6).
6. At the level of -40 m the Northern Caspian is completely drained (Fig.7).
7. A further drop in the level up to -45 and -50 m does not result in a large reduction of the water plane (Fig.8).
8. A further drop in the level up to -100 m or to -150 m, does not result in a critical reduction of the water plane (Fig.9,10).

4 Discussion

As it was previously shown [18], a causal interpretation of autochthonous profiles of the water biota of the Caspian Sea and, as a consequence, high levels of endemism of its taxa does not present a problem.

A different situation arises with understanding and explaining the endemism pattern of the coastal and especially island taxa. The modern faunal or floral status of the new species for science is to be considered as endemic. The species and subspecies rank taxa were identified in this group of species. For those taxa to be formed and evolutionally stabilized sufficient time is required for diagnostically important features to appear.

It is obvious that the modern natural habitat configuration of the island biota taxa of the Middle Caspian depends on the scale and the duration of transgressive-regressive sea cycles and the causes that predetermine the course of the events. According to the nature of these cycles the change in the species composition and structural organisation of the coastal island cenoses was taking place.

The shelf area of the North Caspian has a variety of numerous accumulative bench lands, shoals and islands. Yet our attention is drawn to another feature in their distribution: they are found and grouped exclusively in the field of sea zone extensions of Prikumskaya uplift zone and Tersko-Caspian trough. The same is observed in the eastern part of the Northern Caspian. According to O.K. Leontyev [19], the concentration of alluvia is associated with the local uplifts. N.A. Kasyanova [20] believes that concentration of alluvia is confined to the tectonically active currently local uplifts, proving this by the fact that along the sea extension of anticlinal zones of Karpinski Range there also was found a series of local uplifts and that accumulative bench lands here are not present (or their forms are few). This can be explained taking into account the features of modern geodynamics of those areas: Prikumskaya uplift zone has a higher current geodynamic activity compared with that of Karpinski Range [20].

However, the high latest tectonic activity of the local uplifts, located within the sea extension of Karpinski Range proven by the power reduction of the upper levels in almost all uplifts should be noted [21].

While not rejecting the genetic connection between the accumulative bench lands and islands Ye.N. Badyukova et al. propose a different interpretation of the previous data and, accordingly, a new version of those accumulative forms origin. [22] She believes that the zonal arrangement of bench lands and islands is conditioned by the location of the ancient coastlines of the various stages of the New Caspian transgression.

Some scholars proposed to reconstruct the Pleistocene Caspian basin based on summarizing the results of the malacofaunal analysis and the data of the comprehensive study of the Caspian region sediments.T.A. Yanina proposes another

sequence of the Pleistocene events on the basis of the factual data collected over the years of field, and laboratory investigations of the key sections of the Pleistocene sediments and the Caspian malacofauna localities. [23]The main attention is paid to the leading for the Caspian Sea and endemic for the Ponto-Caspian brackish-water shell-fish of Didacna Eichw genus, which features rapid evolutionary development at the species and subspecies level played the essential role of the genus for stratification of the sea Pleistocene of the Caspian Sea and paleogeographic reconstructions of its basins. To monitor the results of the malacofauna analysis they used a conjugated method of the latest sediments investigation and events reconstruction.

The possibility of islands surface absolute altitude increase following the banked up water level [19] suggests that even during the periods of high water levels in the North Caspian Sea there were island lands where the process of new species formation took place. During the Holocene (the last 10 thousand years), the level of the Caspian Sea did not rise above -20 m [23]. If it was so Tyuleniy, Chechen and possibly Kulaly islands and the adjacent islands existed all this time since the highest points of the island rise above the present sea level by 5-8 metres and the emergence of the continental links of the western and eastern shores secured a rich representation of Turanian species (up to 30-60%) in northern Dagestan and the variety of reliquiae of Sarykum sand dune with its typical Central Asian flora and fauna (to the level of subendemics).

Fig. 1 Sea surface configuration at the level of - 28,6 M.

Fig. 2 Sea surface configuration at the level of - 30 M.

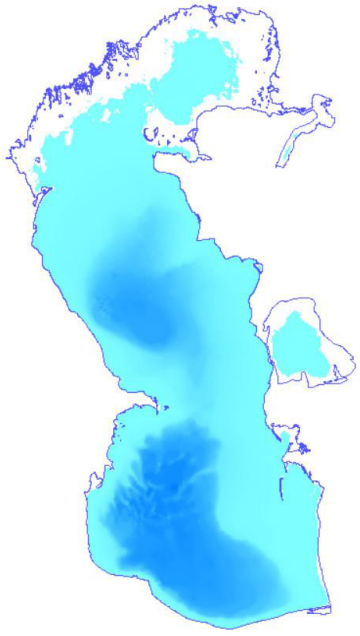

Fig. 3 Sea surface configuration at the level of - 32 M.

Fig. 4 Sea surface configuration at the level of - 34 M.

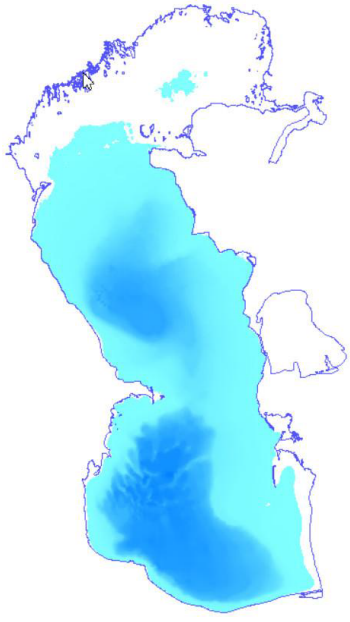

Fig. 5 Sea surface configuration at the level of - 36 M.

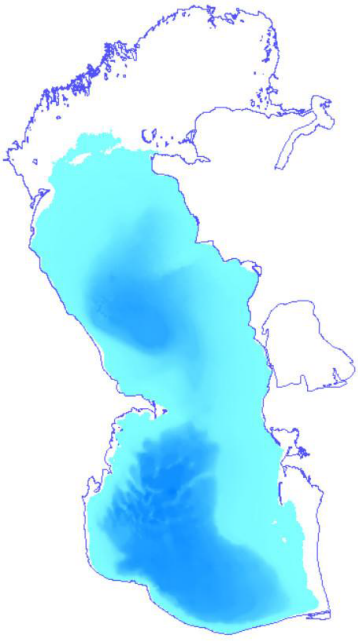

Fig. 6 Sea surface configuration at the level of - 38 M.

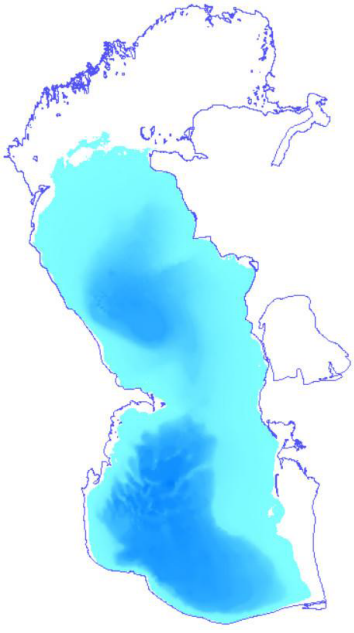

Fig. 7 Sea surface configuration at the level of - 40 M.

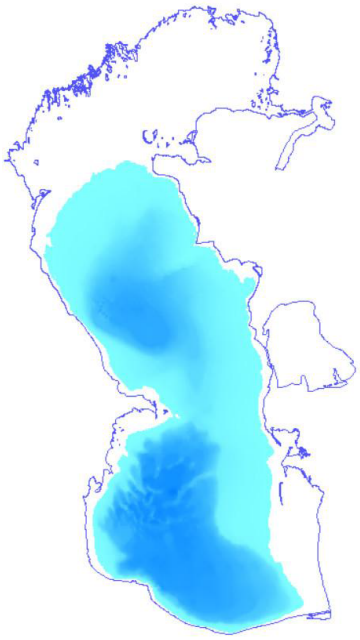

Fig. 8 Sea surface configuration at the level of - 50 M.

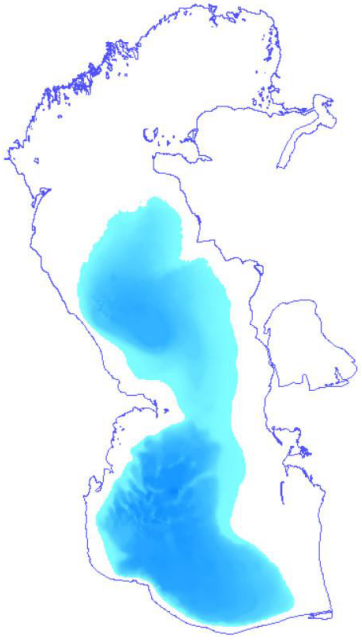

Fig. 9 Sea surface configuration at the level of - 100 M.

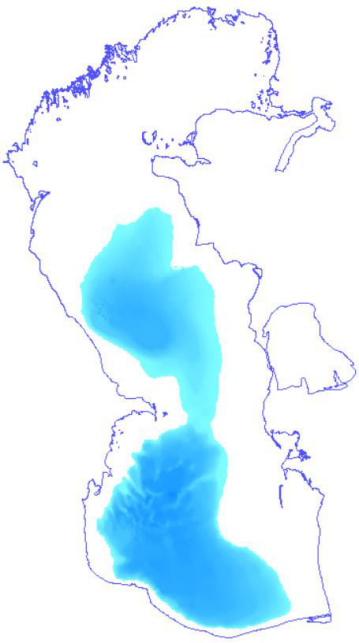

Fig. 10 Sea surface configuration at the level of - 150 M.

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