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The Changes in the Breeding Behaviour of the *Microcarbo Pygmaeus, Nycticorax Nycticorax, Ardeola Ralloides Bubulcus Ibis, Egretta Garzetta* Species on the South-Western Coast of the Caspian Sea

Abulfaz N. Taghiyev [1, 2], Natavan A. Karimova [1] and Samira V. Badalova [1]

[1] *Ministry of Science and Education of the Republic of Azerbaijan, Baku State University (Department of Zoology and Physiology) Academician Zahid Khalilov Street-33, Baku, Az 1148, Azerbaijan.*

[2] *Ministry of Science and Education of the Republic of Azerbaijan, Institute of Zoology, A.Abbaszade 1128, block 504, Baku, AZ1004, Azerbaijan.*

Abstract

IN 2008-2023, the changes in breeding behavior of the migratory-nesting bird populations of *Microcarbo pygmaeus, Nycticorax nycticorax, Ardeola ralloides, Bubulcus ibis, Egretta garzetta* on biotopes were studied on the South-Western coast of the Caspian Sea. Hundreds of thousands of bird populations from Africa and South-East Asian countries migrate to the Azerbaijani sector of the South-Western part of the Caspian Sea every year. Among the above-mentioned bird species only *Bubulcus ibis* has a migratory-nesting population in the Gizilaghaj Bay of the Caspian Sea. The rest of the species have migratory-nesting and sedentary populations. The number of migratory-nesting populations in the study area is a hundred times more than that of sedentary populations. During this period, intra-species and inter-species competition intensifies in the struggle for nesting, feeding, roosting, resting, shelter and other living conditions between migratory-nesting and sedentary bird populations. The water level reduction and the related destruction of reeds and tamarisks, intra-species and inter-species competition lead to changes in the breeding behaviour of migratory-breeding bird populations. As a result, the continuous, sustainable reproduction of these species becomes difficult, and the adoption of new nesting places by the species makes conservation problems more urgent.

Keywords: Population, Nesting, Sedentary, Migratory, Gizilaghaj Bay.

Introduction

The hydroregime of water bodies determines the productivity of many waterfowl and shorebird populations. By changing the existing conditions of water plants, water level fluctuation directly and indirectly affects the nesting place, food base, trophic and biotopic relationships of waterfowl and shorebirds and raises the issue of bird conservation [12].

The wide range of different biotopes, the diversity of the area and its location on the migration routes of birds in Gizilaghaj bay are of particular importance for the reproduction of waterfowl and migratory-nesting bird populations [9, 10]. The breeding behavior of migratory-nesting populations of 5 species (*Microcarbo pygmaeus, Nycticorax nycticorax, Ardeola ralloides, Bubulcus ibis, Egretta garzetta*) belonging to 2 orders, 2 families and 5 genera in Gizilaghaj Bay that formed many years ago (until 2008-2010 years), has changed due to the decrease of water level and the destruction of reeds and tamarisks. Studying the effect of natural and anthropogenic changes on the breeding behavior of these bird populations, which occur depending on the water level fluctuation, is important for solving the problem of preserving the genetic fund and natural biological diversity.

Law of the Republic of Azerbaijan "On Animal World" dated June 4, 1999, Collection of environmental laws of the Republic of Azerbaijan [3, 4], Decree of the President of the Republic of Azerbaijan dated December 21, 2002, on the protection of biological diversity and its genetic

*Corresponding authors: Abulfaz N. Taghiyev, E-mail: abulfaztagiyev@yahoo.com, Tel.: +99450 328 47 74
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fund, in 2006 the National Strategy and Action Plan for the protection and sustainable use of biodiversity in the Republic of Azerbaijan was developed, in 2010 the "Gabala Agreement" on the protection of biological diversity were signed. By the implementation of the adopted convention, order and legislative acts, it is required to conduct research related to the protection of natural habitats of animals.

Although there is some information about *Microcarbo pygmaeus, Nycticorax nycticorax, Ardeola ralloides, Bubulcus ibis, Egretta garzetta* species inhabiting the coastal strip from the southwestern coast of the Caspian Sea (401204N-502214E) to the border with the Islamic Republic of Iran [1], the effect of the decrease in the water level and the destruction of reeds and tamarisks on their reproductive behavior has not been studied. In general, the adaptation of waterfowl, shorebird and other ecological groups of birds to changes in water level has been poorly studied [7, 12]. In ornithological local literature, the latest information about the nature of settlement, reproduction, trophic and biotopic relationships of waterfowl and shorebird migratory-nesting bird populations in the Azerbaijani sector of the South-Western coast of the Caspian Sea were provided by different scientists [8, 13, 14, 15]. Although studies on the nesting and breeding behaviour of these species (*M.pygmaeus, N. nycticorax, A.ralloides, B.ibis, E.garzetta*) have been conducted in several European countries [1, 2, 5, 6, 11], as well as in Asia, such researches are new in Azerbaijan.

Since 1975, Gizilaghaj Bay has been of international importance as one of the 12 wetlands in the world. Since many small lakes in the dry areas near the South-Western coast of the Caspian Sea have been completely dried up due to human agricultural activities, the importance of Gizilaghaj Bay for waterfowl and shorebirds migratory-nesting populations has become even more relevant.

Methods

Field studies were conducted in 2008-2023. The number of individuals in the migratory-nesting (*Microcarbo pygmaeus, Nycticorax nycticorax, Ardeola ralloides, Bubulcus ibis, Egretta garzetta*) and sedentary bird populations in the Lesser Gizilaghaj bay during the wintering period were taken into account ($39^0 10' 16''$ N, $49^0 13' 52''$ - $38^0 50' 55''$N, $48^0 51' 44''$ E).

A sanctuary attached to Gizilaghaj bay has been established in 1926, an ornithological reserve in 1929, and a National Park in 2018. Only 1/5 of the area of Gizilaghaj bay that existed in the 20s of the last century is left [19]. In 1931, the total area of Greater Gizilaghaj Bay was 850 km^2, the water volume was 3.5 km^3, the average depth was 4.1 m, and the maximum depth was 4.5 m. In 1946, most of the area became dry as a result of water reflux, the area of the bay was reduced to 712 km^2, the water volume was 1.5 km^3, the average depth was 2.1 m, the maximum depth was 2.8 m, the length of the coastline - 116.0 km, the width - 24.0 km. In 1965, the length of the coastline was 92.0 km, its width was 24.0 km. In 1967-1970, the depth of the bay varied from 0.6 to 2.5 m. The maximum length of Lesser Gizilaghaj bay was 16.7 km, the width - 6.5 km, the length of the coastline - 38.9 km, the water volume - 0.15 km^3, and the depth was 0.5-2.5 meters. The Caspian Sea does not have a direct connection with the world ocean, and the water level gradually rises and falls. The first instrumental observations in the Caspian Sea began in Baku in 1837. Based on observation data of the “Neft dashlari” Hydrometeorological Station of the Caspian Sea, the sea level is determined due to the height calculated from the conventionally accepted horizon in the absence of surface waves and currents on the sea (Figure 1).

Over the past 186 years, the sea level has changed dramatically three times. In 1929-1977, it fell 3.0 meters, in 1978-1995 it rose 2.5 meters, and from 1996 to 2023, the sea level is falling. Currently, the sea level is 28.05 meters above the world ocean level. The biggest change in the water level was in 1862 (-24.0 m) and in 1977 (-29.0 m). In 1996-2023, the water level in the sea decreased by more than 1.0 meters (Table 1). According to international prediction, it is likely that the water level will drop by 9.0-18.0 meters by the end of the century. If this happens, the sea will lose 1/3 of its total area.

Despite the water level reduction in the Caspian Sea, there is a difference in the water level in the Northern ($39^0 03' 32''$N,480 $56' 48''$ E - $39^0 04' 21''$ N, $48^0 53' 27''$ E) and Southern ($38^0 52' 32''$ N,$48049' 43''$ E) parts of Lesser Gizilaghaj bay. Gizilaghaj bay consists of Greater and Lesser Gizilaghaj bays and they are connected by three canals (The Fish passing canal, Crash canal, and Spawning canal). Until the 1980s, the water level in both bays was regulated by means of sluices built on these channels. Regulation of the water level between both bays was carried out until the mid-1980s through the sluices. Later, the destruction of the sluices caused changes in the water level and salinity between the Lesser and Greater bays, as well as the flora and fauna. The Lesser bay, which is connected with Greater bay by canals and pipes, has become a closed water basin in a sense. In the northern part of the bay, the water level is high depending on the volume of water entering from the Kura River through the Vilash ($39^0 03' 31''$N, $48^0 49' 01''$E) and Akkusha ($39^0 16' 16''$ N; $48^0 57' 33''$ E) rivers. In the Southern part of the bay, the water level decreases as the water flows into the Caspian Sea through the Fish passing canal (because it is located higher than the sea level).

In order to study the effect of the water level reduction on the breeding behavior of migratory-nesting (*Microcarbo pygmaeus, Nycticorax nycticorax, Ardeola ralloides, Bubulcus ibis, Egretta garzetta*) bird populations, investigations were carried out during the reproduction period, in the water area of Gizilaghaj bay, in wetlands and dry areas, by route method, on foot, with motorized and non-motorized boats, and by car ($38^0 57' 09''$ - $49^0 02' 16''$, Figure 2). Binoculars and a Carl Zeiss telescope were used. Breeding behavior of these migratory-nesting bird populations was studied in May, June, July, August. 5,000 km by car, 850 km by motorboat, 144 km by non-motorized boat, and 451 km on foot have been travelled.

Results and discussion

During the study, the number of pairs and nests formed by migratory-breeding bird populations in the reproduction period were recorded. In some of these migratory-nesting species, it is difficult to get close to the nest, and sometimes, in order not to destroy the nest, and not disturbing the species and the chicks in the nest, bioethical rules have been followed by observing the nest from a distance using binoculars and a telescope.

The water level reduction in the Southern part of the bay creates favourable conditions for poachers hunting medicinal leech (*Hiruda medicinalis orientalis*). As a result, disturbing factors (noise, etc.) have a small effect on the breeding behavior of birds (they do not build nests in those areas).

Migratory-nesting species *Microcarbo pygmaeus, Nycticorax nycticorax, Ardeola ralloides, Bubulcus ibis, Egretta garzetta* nested in tall reeds and tamarisks in suitable areas of the bay until 2008-2010. Since 2008, due to mass decay of reeds in the bay and low water levels, reproduction of these bird populations have been greatly reduced, as nesting in tamarisks has become dangerous. The main nesting places were only in remained tall reeds and tamarisks in the area of 30.0 hectares called Dannik ($39^0 00' 12''$ N, $48^0 53' 16''$) in the South of the bay (an area consisting of lakes), and in 2010-2021 in the area called Pirman (3950 ha, $39^0 05' 37''$ N, $48^0 48' 49''$) in the Northern part of the bay. The large number of migratory-nesting individuals of *Microcarbo pygmaeus, Nycticorax nycticorax, Ardeola ralloides, Bubulcus ibis, Egretta garzetta* species, but the reduction of nesting places in new ecological conditions, suppression by species such as *Ardea alba, Ardea purpurea, Ardea cinerea,* and other factors affected their breeding behavior (Table 2). In 2022-2023, these migratory-nesting bird populations were forced to change their breeding places to the artificial forest strip on the left side of the Baku-Astara railway ($38^0 56' 37''$N, $48^0 48' 39''$E - $38^0 57' 15''$N, $48^0 46' 29''$E) in the area of 11.02 ha, and from 2023 to the artificial forest massive near Vilash and Huseynhajili village ($39^0 02' 25''$N, $48^0 45' 12''$E) of Masalli district.

On the left side of the Baku-Astara railway, between the village of Gumbashi of the Lankaran district and the village of Tazakand ($38^0 56' 36''$N, $48^0 46' 37''$E) of the Masalli district, a field-protecting forest strip where birds form a colony was built in 1941. In this forest strip, the area where birds form a colony is 1300 meters long and 60-70 meters wide. The forest strip starts 70-80 meters from the Northern part of the river Gumbashi. In the Southern part of the river the village of Gumbashi is located. The main tree species that the forest strip consists is the *Caspian locust* (*Gleditsia caspica* Desf., 1809). Oak trees (*Quercus macrantera* Honen, 1838) are also rarely found (about 15 trees in total). The height of both trees is 15-18 meters. In the second tier cherry trees (*Prunus cerasifera* Ehrn., 1789) with a height of 4-5 meters have grown. The forest strip consists of trees planted in 8 lines. Each line consists of two rows of trees with a distance of 1.0 meter between them. In some places, trees have grown in one row, and in some places, the row has been destroyed and many young trees have formed as a result of self-regeneration. The longitudinal distance between trees is 2.4 -3.10 meters (average 2.75 meters), transverse distance is 6-7 meters. Birds' nests are not found in the first 100 meters of the forest strip from the direction of the Gumbashi river and in the first 4 rows of the forest strip from the railway direction. Only at a distance of 500-800 meters from the colony, in the 3rd and 4th lines in the direction of the railway, in some trees of the longitudinal rows (every 6-9 meters), few nests of birds are found (4-7 nests in each tree). In the first 4 lines of the forest strip in the direction of Gizilaghaj bay, a minimum of 4, an average of 12-16 (average of 14), a maximum of 32-40 (average of 36) nests were recorded per tree in all lines (4+14+36=18.0) (average 18.0). If we exclude the first 100 meters of the forest strip where nests are not recorded, the number of tree lines (1200 /2.75) is 436.36. If we multiply 436.36 rows of trees by 4 lines (436.36×4), we get 1,745.44 trees. Considering that there are 2 trees in each row, it is equal to 1,745.44×2=3,490.88 trees. If we multiply the average number of nests in trees (3,490.88×18.0=62,835.84) to the number of trees, we get 62,835.84 nests. If we consider two parent individuals in each nest, this equals (62,835.84×2=125,671.68) 125,671.68 parent individuals. Colony-forming species *Microcarbo pygmaeus, Nycticorax nycticorax, Ardeola ralloides, Bubulcus ibis, Egretta garzetta* are monogamous birds. Considering minimum 2 and maximum 5 eggs in each nest (average 3.5 eggs (individual)), it equals 125,671.68×3.5 = 439,850.88 eggs (individual).

Cherry-plum trees in the 2nd layer of the forest strip are grown in the first 2 lines from the bay side at a distance of 2.4-3.10 meters (average 2.75). Some rows have 2-3 trees, some have 1 tree (on average 2 trees). Cherry-plum trees are 4-6 meters tall, and the lowest nests are 2.50 meters above the ground. Cherry-plum trees are bordered by blackberry bushes (*Rubus saxatilis* L., 1753) from the direction of the bay. Between the blackberry bushes and the first line of the forest strip, there is a canal with a width of 3.0 meters, and the water level in this canal is 0.30-0.60 meters. Canal was directed from the Vilash river to carry out agricultural works. The distance from the forest strip where the birds form a colony to the coast of Gizilaghaj bay is about 3326 meters. The minimum number of nests in a cherry-plum tree is 4, the average is 7-11 (average 9), the maximum is 15-18 (average 16.5) nests. The average number of nests (4+9+16.5=29.5/3=9.8) is 9.8. The nests were not recorded in the cherry-plum trees in the first 100 meters of the forest strip in the direction of the Gumbashi river. If we divide the distance of 1200 meters of the forest strip (1200/2.75 m=436.36) by the number of rows of trees, 436.36 rows of trees are obtained. If we take an average of 2 trees in each row, 436.36 ×2=872.72 trees are obtained. If we multiply the obtained number (the number of trees) by 2 rows, we get 872.72×2=1,745.44 trees. If we multiply the number of trees (1,745,44) by the average number of nests, we get (1,745,44×9,8)=17,105,312 nests. Considering 2 parents and an average of 3.5 eggs (chicks) in each nest, 1,745.44×2×3.5=12,218.08 individuals are obtained. The arrangement of the birds forming a colony in the forest strip in the Caspian locust tree is as follows: in the 1st tier, the pygmy cormorant, in the 2nd tier, the little egret and the black-crowned night-heron, in the 3rd tier, the cattle egret and squacco heron.

As a result of the change in breeding behavior in 2022-2023 in the forest strip near the village of Gumbashi on the Baku-Astara railway, the number of birds in the Caspian locust tree in 2023 was 439,850.88 for the first time. 12,218.08 bird colonies have settled in the cherry-plum tree in the second tier.

As a whole, a colony of 439,850.88+12,218.08= 452,068.08 individuals of *Microcarbo pygmaeus, Nycticorax nycticorax, Ardeola ralloides, Bubulcus ibis, Egretta garzetta* was formed in the area. At a distance of 1300 meters of the forest strip, the main tree is Caspian locust (*Gleditsia caspica* Desf., 1809). After the Caspian feather is replaced by Eastern oak (*Quercus macranthera* Honen, 1838) in the forest strip (1300 meters), not even a single nest of birds forming a colony is found. Although the forest strip is located in a safe place away from settlements.

Another area where *Nycticorax nycticorax, Ardeola ralloides, Bubulcus ibis, Egretta garzetta* bird populations have changed their breeding behavior in Gizilaghaj bay is the forest strip near Vilash and Huseynhajili villages of Masalli region. No colony of *Microcarbo pygmaeus* species was recorded in this forest strip. There are 2 (two) field protective forest strips located close to each other in the area near the village of Vilash and Huseynhajili. The forest strip where the birds form a colony is located 150-160 meters away from the road on the right side of the Vilash-Goytepe highway. In the 2nd forest strip near the area (highway located 400-500 meters from the road) no colony of birds was recorded. The trees in this forest strip are composed of Eastern oak (*Quercus macranthera* Honen, 1838). Caspian locust (*Gleditsia caspica* Desf., 1809) and cherry-plum trees (*Prunus cerasifera* Ehrn., 1789) are not found. The height of the eastern oak tree is 15-18 meters. The length of the forest strip is 140 m, the width is 60 m, the longitudinal and transverse distance between the trees is 2.4-3.10 m (on average 2.75 m). The length of the forest strip near Vilash-Huseynhajili village is 140/2.75=50.90 rows of trees, the width of the forest strip is 60/2.75=21.81 rows of trees. The total number of trees in the forest is 50.90×21.81=1,110.29. The minimum number of nests in each tree is 1.0, on average -4-6 (on average 5.0). The maximum number of recorded nests is 9-12 (on average 10.5) (on average (1.0+5.0+10.5)/3=5.5). Considering that *Nycticorax nycticorax, Ardeola ralloides, Bubulcus ibis, Egretta garzetta* are monogamous birds, if we multiply the number of parent individuals (male and female) by the total average number of nests and the number of eggs (individuals) in the nest, this is 110.29×5.5×3.5 = equal to 21,373.08 individuals. It is assumed that these species that form a colony in this forest strip are mainly individuals from the Northern part of the bay.

Thus, the migratory-nesting species *Microcarbo pygmaeus, Nycticorax nycticorax, Ardeola ralloides, Bubulcus ibis, Egretta garzetta*, reproducing in the Gizilaghaj bay for many years, were deprived of nesting places due to the new ecological conditions. Nesting places in new ecological conditions created the problem of conservation of these species.

Conclusion

1. Awareness campaign should be carried out in all villages about the colonies formed by migratory-nesting *Microcarbo pygmaeus, Nycticorax nycticorax, Ardeola ralloides, Bubulcus ibis, Egretta garzetta* bird populations in the forest strip of Baku-Astara railway between Gumbashi village of Lankaran district and Tazakand village of Masalli district, and also in the forest strip near Huseynhajili village and Vilash. The territory should be controlled by the employees of the Gizilaghaj National Park and the village

municipalities. A comprehensive action plan should be prepared by the Ministry of Ecology and Natural Resources.

2. An action plan should be developed by Ministry of Ecology and Natural Resources to prevent damage to the forest strip (destruction of self-regeneration, drying of trees, etc.) due to excreta of colony-forming bird populations.

3. Research on the breeding behavior of migratory-nesting *Microcarbo pygmaeus, Nycticorax nycticorax, Ardeola ralloides, Bubulcus ibis, Egretta garzetta* bird populations in Gizilaghaj bay and surrounding forest strips should be continued, the public and related organizations should be informed.

Conflicts of interest

There are no conflicts to declare.

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TABLE 1. Water level change at the "Neft Dashlari" Marine Meteorological Station in the Caspian Sea (1995-2022) (Musayev 2022)

Years	Months												Annual average, cm	Baltic system
	1	2	3	4	5	6	7	8	9	10	11	12		
1995	149	153	158	163	165	175	179	169	155	151	150	149	160	- 26.40
1996	148	147	149	152	150	154	147	133	124	119	118	115	138	- 26.62
1997	116	118	115	120	123	135	142	132	119	117	120	123	123	- 26.77
1998	110	110	102	102	124	139	141	132	124	118	115	118	120	- 26.80
1999	112	110	114	114	119	124	127	128	123	124	109	105	117	- 26.83
2000	109	108	109	105	112	122	124	120	111	105	105	101	111	- 26.89
2001	90	89	92	98	107	116	121	114	108	94	84	93	101	- 26.99
2002	92	90	95	99	105	118	124	120	107	99	97	98	104	- 26.96
2003	95	91	94	103	109	121	125	123	115	105	108	105	108	- 26.92
2004	99	105	108	109	116	122	131	130	124	115	109	110	115	- 26.85
2005	103	113	115	117	124	139	145	143	129	125	122	120	125	- 26.75
2006	117	115	115	117	126	131	134	123	113	102	103	101	116	- 26.84
2007	98	103	102	107	117	129	129	124	114	101	104	101	111	- 26.89
2008	107	105	108	113	119	130	128	123	114	106	100	104	113	- 26.87
2009	101	98	103	111	114	122	124	120	107	107	107	102	110	- 26.90
2010	100	99	99	105	113	122	122	112	98	90	85	80	102	- 26.98
2011	80	80	77	79	87	95	96	91	76	70	72	67	81	- 27,19
2012	66	71	71	73	81	89	93	73	67	72	74	64	75	- 27.25
2013	58	62	62	68	75	89	92	90	76	69	58	60	72	-27.28
2014	57	57	56	62	68	75	75	62	53	71	75	33	62	-27.38
2015	31	33	33	42	44	50	52	42	31	16	9	12	33	- 27.67
2016	14	9	21	31	37	49	57	51	43	32	29	25	33	- 27.67
2017	23	23	23	27	37	46	47	47	39	37	25	21	33	- 27.67
2018	25	21	22	28	32	43	50	41	28	16	15	6	27	- 27.73
2019	9	7	7	13	18	26	29	19	6	- 4	- 8	- 6	10	- 27.90
2020	- 6	- 1	1	5	13	28	28	21	12	- 5	- 9	- 11	6	- 27.94
2021	- 15	- 9	- 13	- 10	- 3	5	6	- 3	- 12	- 30	- 38	- 45	- 14	- 28.14
2022	- 41	- 42	- 39	- 39	- 32	- 23	- 24	- 34	- 47	- 57	- 63	- 67	- 42	- 28.42

Fig. 1. Tamasa is used to measure the water level at the Sea Hydrometeorological Station of the "Neft dashlari" in the Caspian Sea.

Fig. 2. The geographic location of the study area: 1 - Tazakand village, 2 - Gumbashi village, 3 - Fish passing channel, 4 - Crash channel, 5 - Water flowing channel.

TABLE 2. Changes in breeding behavior of the bird populations of *Microcarbo pygmaeus, Nycticorax nycticorax, Ardeola ralloides, Bubulcus ibis, Egretta garzetta* on the South-Western coast of the Caspian Sea

	Species	Changes in the breeding behavior of migratory-nesting bird populations									
		Northern (Pirman) area of Gizilaghaj bay				Southern (Dannik) area of Gizilaghaj bay				Forest strip	
		Relevant biotopes on the border of the bay with Gizilaghaj village		Relevant biotopes near Akkusha post		The border of Tazakand, Gumbashi villages and other areas of the bay		Dannik area		The area between Gumbashi and	The area between Huseynhajili and Vilash
		Until 2008-2010	2010-2022 years	Until 2008-2010	2010-2022 years	Until 2008-2010	2010-2021 years	Until 2008-2010	2010-2022 years	2022-2023 years	2023
1.	*Nycticorax nycticorax*	+	-	+	+	+	-	+	+	+	+
2.	*Ardeola ralloides*	+	-	+	+	+	-	+	+	+	+
3.	*Bubulcus ibis*	+	-	+	+	+	-	+	+	+	+
4.	*Microcarbo pygmaeus*	+	-	+	+	+	-	+	+	+	-
5.	*Egretta garzetta*	+	-	+	+	+	-	+	+	+	+

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