ECOLOGICAL STATE OF THE MARINE EDGE OF THE KILIA DANUBE DELTA IN 2011–2012

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The results of observations of the dynamics of the marine edge of the Danube Delta in 2011–2012 describe the main trends in the individual sections, taking into account the factors of their formation. Also, the results of observations of littering the sea edge of the Danube Delta with plastic waste, the registration of the dead dolphins, as well as botanical research are reported herein.

1. INTRODUCTION

The marine edge of the Danube Delta (MED) and the seaside of its mouth are areas of intensive transformation. Natural factors that form the MED include the following: the carry-over of sediments by the river, currents and associated with them the transportation of marine sediments, and deformations caused by sea roughness. Changes in the ratio of the river and of marine factors provoke growth, erosion or relative stability of avandelta areas [1]. Current dynamical processes at the marine delta edge depend on the reduction of the Danube sediment runoff, flow redistribution between Tulcea Arm and Kilia Arm, and the rise of the Black Sea level.

The MED is a unique biological object where newly-developed accumulative forms are covered with pioneer vegetation. Farther from the seashore to inland, you can trace the evolution of flora closely connected with the relief formation of the area. In addition to natural biological stuff, the surf and the wind bring to the seashore various wastes, mostly polymers (plastic bottles, plastic foam, cellophane, etc.). A substantial increase of plastic waste inflow into the MED happened in the mid-1990s.

2. ANALYSIS OF RECENT STUDIES AND PUBLICATIONS

Due to their uniqueness, the MED and some of its areas are the object of geodesic, ecological, hydrological, hydrobiological and other geographical surveys [1–8]. These surveys are essential for the management of nature conservation activity within the Danube Biosphere Reserve. Interesting is the description of vegetation species which appear under intensive changes of abiotic factors in the MED area. Studies on the contamination of the MED area with waste are unique of the kind. Dead dolphins found within the MED were also registered. Therefore, **the goal of the studies presented** herein is to determine and analyze current trends in changes of the Kilia Danube Delta marine edge, to make assessments of contamination with waste and to give a description of vegetation and of the registration of dead dolphins within the MED area.

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3. MATERIAL AND METHODS

To observe the dynamics of the Kilia Delta, the Danube Hydrometeorological Observatory (HMO) has set benchmarks and defined azimuths for permanent surveying profiles. Since the 1970s, the MED measurements are made in summer almost annually: geodesic surveys, measurement works, and the setting of new benchmarks if necessary.

In the framework of the international project ‘Building Capacity for a Black Sea Catchment Observation and Assessment System Supporting Sustainable Development’ (enviroGRIDS Black Sea Catchment), carried out in 2009–2013, two of the project partners, Danube HMO and Melitopol Pedagogical University, signed a co-operation agreement. The aim of it was to expand opportunities of local co-operation between these two partners, and to provide joint expeditions for integrated studies in the Danube Delta. In 2011–2012, the Danube HMO organized hydroecological expeditions which the authors of this paper took part in. These expeditions continued observations of the marine edge dynamics, defined ecological study plots (eco-polygons) and their spatial co-ordinates, made botanical description of eco-polygons and an inventory of waste on their borders.

Works on integrated ecological observations included the following:

1. Studies on the marine edge dynamics (Fig. 1), (geodesic observations on surveying profiles, measurement of coastal waters). Locations of surveying profiles were defined by benchmarks and an optical theodolite, in some cases – with geodesic GPS unit (Trimble R3). Levelling was made with an optical levelling instrument, depth mesurment near the coast was done by wading in water with a pole, and up to 5-m isobath – by an echo-sounder. Distance on land was measured with a measuring tape, and in the sea – with the GPS unit. When surveyed profiles of previous years were compared, all heights were cut to a unified system. Location of the ‘Ptashyna Kosa’ Spit was identified by marking particular points at the water’s edge – with GPS unit.

2. Inventory of agents of anthropogenic garbage in fixed study plots (Fig. 1) – registration, marking, description of plastic and other agents.

A plot to observe contamination (eco-polygion) was marked by a benchmark and the sea water edge. The left and right borders of the plot were as far as 20 m from the observation profile and are parallel to it. A theodolite and measuring tape was used to lay out the plots.

3. Botanical description of profiles and eco-polygons (species composition, vegetation projective cover and age of plants).

4. Search and registration of dead dolphins within the MED area.

Methods of research: geodesic, hydrological and statistical graphical analysis, and botanical description. An analysis of surveying profiles, geographical maps, and satellite images was also made.

4. RESULTS AND ANALYSIS

Morphological changes. Summarized results of preceding studies on the dynamics of the marine edge of the Kilia Danube Delta are presented in the monograph “Hydrology of the Danube Delta” printed in 2004 [2]. Later, several other works were published [4–6]. The results of new studies for recent years presented are below.

Processes of growth and wave erosion of the marine edge of the Kilia Delta for short-time intervals (1–2 years) are often reversible and very changeable – strong storms change the position of young accumulative forms and cause their deformation. It is quite difficult to set correlations between relief changes and some hydrometeorological parameters [4]. The difficulty of finding these correlation links is related to rather rare studies of the MED morphological parameters, and the absence of surveys “before” and “after” the phenomena responsible for abrupt qualitative changes. The annual (once a year) survey at the MED gives us an integrated index of changes determined by several storms, hydrograph, wind rose of this particular year, occurrence of strong eastern winds, etc.

It is necessary to distinguish between short-time often reversible deformations of the marine edge caused mainly by some particular storm, strong wind or ice phenomena and long-term changes driven by perennial fluctuation of water drainage, changes in the runoff of river sediment, or runoff redistribution processes. In a separate group we should include changes induced by a direct anthropogenic impact on the marine edge: the construction of dykes and dredging works.

Based on the expedition studies of 2011–2012 we have identified major trends in the principal sections of the MED as follows (Fig. 1):

The coast of Zhebrianska Bay. From the southern part of the dyke of Sasyk Liman to the Badyk Bay the marine edge is represented by broad and mainly clean beaches, occasionally covered with *Elaeagnus sp.*, tamarisk and annual grasses. The marine edge is substantially changing there: spits are formed, then joined to the coast and after that eroded. Deepening and shallowing of the coastal zone can occur several times a year. In some areas the marine edge shifts by more than 50 m within one year. Last years Perebiina Spit (Fig. 1) was eroded and shifted toward the coast. At the mouth of the Polunochne Arm the coast is predominantly made up of shells of the sand gaper (*Mya arenaria*), lower layers consist of broken shells followed by black mud. Marine surf brings shell to shallows of the bay. The coast is eroded there, which is proved by lots of remnants of grass roots at the depth of 40–60 m up to 30 m from the coastline.

Spits in the area of the Polunochnyi Kut Bay (Durnyi Kut), at the mouth of the Shabash Arm, and at the western bank of the Shabash Island are eroded by waves and shifted southward. Taranova Spit is intensively transformed and has several breaches along its length. Satellite images from 2006 show that a drowned immobile cutter boat was situated inside the bay (near Prorvin Island and Taranova Spit), having been moved out in 2012 as far as 25 m toward the sea.

The area between the Potapovske and the Poludenne mouths. The coast at the mouth of the Potapovske Arm is washed out [2], and for the 2010–2011 period 55 m of the coast was eroded at the observation profile. The benchmark was destroyed and the distance was identified by GPS unit. A new benchmark was placed in 2011 south of the Potapovske Arm, 27 km offshore. In 2012, the distance from the sea water edge to this benchmark was reduced to 7 m.

Products of strong wave erosion of the mouth bar of the Potapovske Arm have formed a long and rapidly growing New Potapovska Spit (Fig. 1 shows the southern part of Potapovska Spit). For the period 1990–2011 an above-water part of the spit increased by 540 m. However, in the last years the spit growth rate decreased. In 2010–2012 the spit was washed out by 20 m at azimuth of observations. The southern end of the spit is currently stabilized and, under increasing deficit of sediments, it will be eroded from seaward.

The area between the mouths of the Poludenne and the Bystre Arms. Being protected by the New Potapovske Spit in the area of the right mouth spit of the Poludenne Arm, the MED started growing seaward. The wave erosion in 1975–1982 substituted by the growth of the coast. For the period 1992–2001 the spit growth amounted to 95 m. For the next 3 years the MED was stable, and then retreated a bit. In 2005–2008 the spit location was stable. In 2009–2012 the spit expanded by 25 m southward. According to a surveying profile, located to the north of the former mouth of the Seredne Arm (Fig. 1), during 1984–2009 the coast expanded by 160 m, growing by an additional 30 m in 2010–2012.

The strongest expansion of the coast occurred directly to the north of the mouth of the Bystre Arm. There, on the left mouth spit, formed of sediments of the Bystre Arm and products of wave erosion, the MED grew by more than 500 m over 1975–1985, with an abrupt jump in 1983–1984. Prior to 2002, the marine edge in this area periodically retreated or expanded, and since 2002 the coast has been intensively growing [1, 2, 4]. In 2008–2009, a stone dyke was constructed on the left spit of the Bystre Arm. It connected the left bank of the arm and a 'German' dyke built in 2004. The dyke protects a shipping route from muddying by sediments which are carried from north and south. According to our observations, since the very moment of its existence the dyke, encouraged more intensive development of new accumulative forms from its northward side. Observations at an old azimuth were stopped in 2011, followed by the setting of a new benchmark and defining a new azimuth.

In 2011–2012, the marine edge retreated there as far as 18 m. The sand, accumulated near the left side of the dyke is loose and forms sand dunes. When the north wind blows the dunes move, partially run over the dyke and fall into the canal. To all appearances, this process will soon stop, due to fixation of the sand spit and dyke by delta vegetation. Generally, this area, under increasing deficit of sediments, will stabilize or even be eroded.

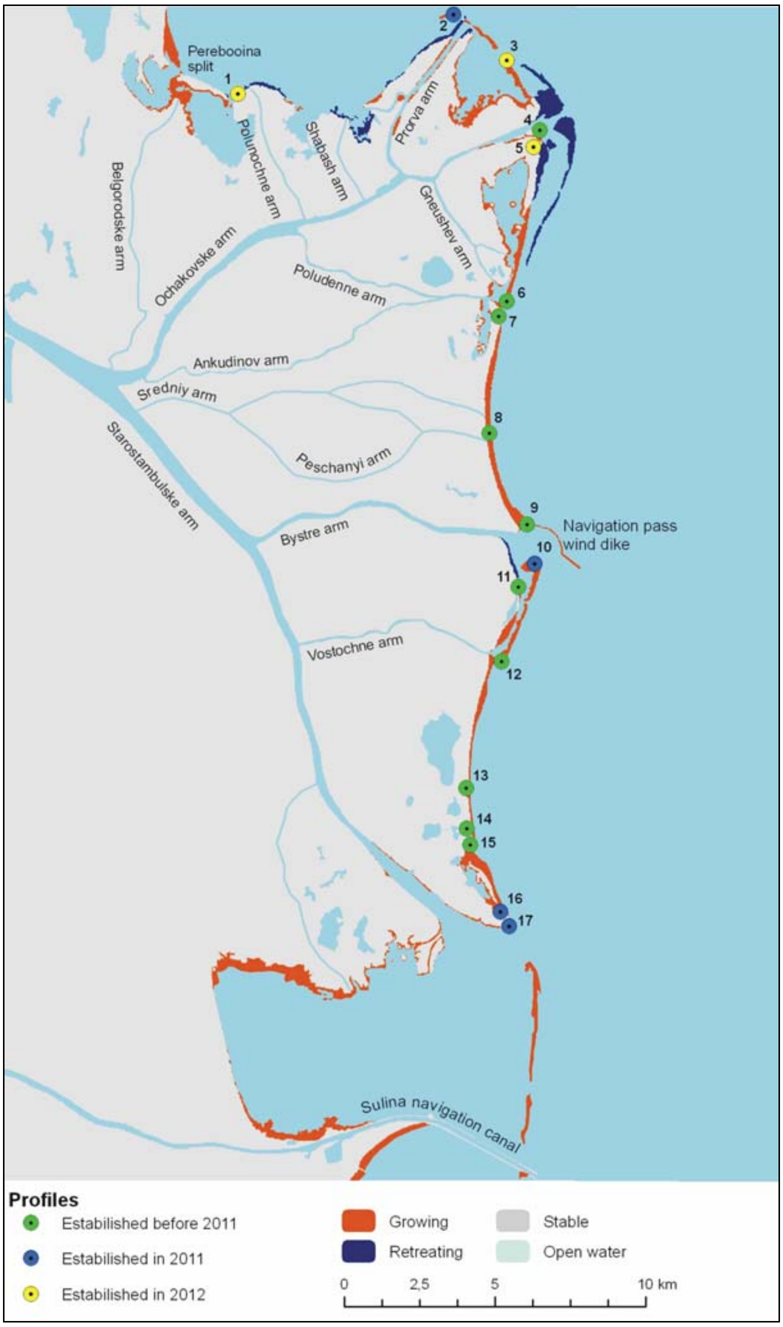

Fig. 1 – Skeleton map of location of profiles and eco testing grounds at the marine edge of the Kilia Danube Delta.

Location:

1. Profile of the left bank of the Polunochne Arm	10. Profile in the north of the Ptashyna Spit
2. Profile of the left spit of the Prorva Arm	11. Profile between the mouths of the Vostochne Arm and the Bystre Arm
3. Profile on the Taranova Spit	12. Profile of the left bank of the Vostochne Arm (in the south of the Ptashyna Spit)
4. Profile of the right bank of the Potapovkse Arm	13. Profile of the left bank of the former Zavodnynske Arm
5. Profile in the north of the Potapovska Spit	14. Profile of the left bank of the Tsyhanske Arm
6. Profile of the Potapovska Spit	15. Profile of the right spit of the Tsyhanske Arm
7. Profile of the right spit of the Poludenne Arm	16. Profile between the Tsyhanske Arm and the Starostambulske Arm
8. Profile of the left bank of the Seredne Arm	17. Profile of the left spit of the Starostambulske Arm
9. Profile of the left bank of the mouth of the Bystre Arm	

The area between the mouths of the Bystre and the Starostambulske arms. In this MED area the most essential changes are recorded south of the mouth of the Bystre Arm (Fig. 1). The right mouth spit of the Bystre Arm, deprived of sand sediments from the arm, was strongly eroded by the sea roughness during 1977–2002 (north-eastern and eastern waves passed over Ptashyna Spit and reached the coast). Observations over the last years show a relative stabilization of the coast on the left spit of the Bystre Arm.

Farther to the south, between the mouths of the Bystre and the Vostochne arms, the MED was growing. In 1975–1995 it expanded almost by 200 m. The following years the coast was slightly eroded by waves. In 1997–1998, according to the observation profile, the above-water spit appeared (it was called ‘Ptashyna’ [English: Bird’s Spit]), and the MED made an abrupt jump growth into the sea. Between old and new marine edges a lagoon developed (local: *kut*) 1.1–1.2 m deep and 600–800 m wide. As for 2011–2012, the spit approached the ‘bedrock’ coast as far as 50 m in some places. Now the lagoon is 100–300 m wide and about 0.5–0.6 m deep.

In 2002–2003 the southern end of the Ptashyna Spit approached the mouth of the Vostochne Arm. After that, the spit stopped growing, being prevented by water drainage of the Vostochne Arm. In the last years, a general trend of spit shifting closer to the coast was recorded. The northern part of the spit is the most resistant one. In the near future the spit will join the coast, obviously it will be a southern part of the spit where the minimal width of the lagoon was 50 m in 2012.

North and south of the Vostochne Arm the MED was generally more or less stable and showed some trend of expanding. In this area the bank is intensively overgrown with woody plants.

Farther south the MED is recorded to grow. The left mouth spit of the Tsyhansky Arm has a growing trend, the same as the seaside. In this section the MED grew by 90 m during 1990–2012.

At the profile between the mouths of the Tsyhanske and the Starostambulske Branch arms the MED growth amounted to 30 m over the 2005–2012 period.

The MED also expanded in the area adjacent to the left mouth spit of the Starostambulske Arm. Last year it grew by 5–10 m. Also, the marine edge of Tsyhanka Island and the northern part of Nova Zemlia Island is observed to rebuild.

Inventory of agents of anthropogenic garbage. Within the defined eco-polygons (Fig. 1) investigations were carried out of the morphological structure of anthropogenic inclusions, i.e. visual identification of different wastes the so-called anthropogenic agents. The amount of the same agents was calculated, and they were marked and weighed. It should be noted that there is no recreation activity in the study area and the agents are brought by water or wind.

The inflow of these agents into the MED has an interesting mechanism. Eastern winds and accompanying currents bring plastic to the coast. Then, depending on wind force and an agent’s properties (weight and size) it can be carried deep into the territory of the coast and stay there. The west wind usually does not provoke a reverse outflow of the agents because a surface west wind at the seaside is almost completely cancelled by delta vegetation and it cannot move the agents. In the northern part of the Kilia Delta these winds come from the north (bringing the agents) and south. It means that both the growth and retreat of the marine edge will accumulate mainly plastic on fore delta.

The analysis of *in situ* observation results allows to conclude that a main type of waste in the eco-polygons are plastic bottles of different size – 89% in number and 82% in weight of all waste (Fig. 2). In addition, remains of plastic containers and packages, disposable tableware, plastic foam, etc. were also found. So, the main type of waste in the MED area is rubbish consisting of polymeric material: polyethylene terephthalate, polyethylene, polypropylene, polystyrole ethylene vinyl, and cellophane. It is because of the properties of polymeric materials: they can be easily carried by water or wind and have a low level of biodegradation. It should be noted that in some cases it is impossible to make a precise visual identification of polymeric material. Further, for more accurate identification, studying the burning reaction of these agents would be advisable.

In addition to polymeric materials, metal and glass waste was also found (also resistant to biodegradation) but they did not exceed 2.5% of all waste items found in the eco-polygons. However, further detail observations of the morphological structure of waste are required because different components are not equally dangerous for the environment.

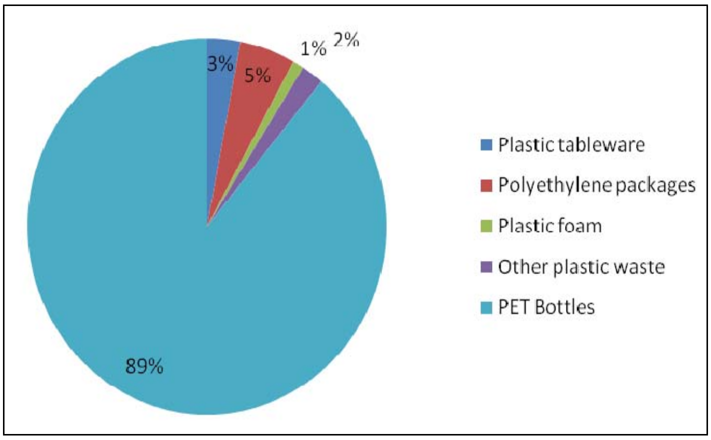

Fig. 2 – Distribution of different types of polymeric waste (by number).

The main danger of polymeric waste is that being chemically and microbiologically inert they litter the coastal zone, can provoke death to animals, put obstacles to the normal functioning of ecosystems, and produce unaesthetic visual contamination. An additional factor, intensifying the impact of this waste, is the contents of boxes, bottles or packages – various building materials, chemical solutions, detergents, etc.

Observations of the number of plastic bottles in 9 eco-polygons enables the assessment of a summarized amount of this type of waste for the whole MED area. To make this assessment all the MED area was divided in sites, each of them relating to a particular eco-polygon (Fig. 1), i.e. the conditions for accumulation of this type of plastic waste in a particular site are identical to those observed in the representative eco-polygons.

As the plastic waste is inert, the accumulation level existing in the study territory has been formed during a long period of time, parallel to changes in the MED area. Taking into account that a sharp increase in the production and consumption of plastic bottles goes on since 1995, we took the estimated period from 1995 to 2011 to calculate a summarized inflow of plastic bottles into the MED. Then we made an assumption that for that period the MED evenly expanded seaward proportionally to the growth of the total Kilia Delta area. Thus, according to our estimation, the current mean rate of the delta growth is of 0.22 km a year and, therefore from 1995 to 2011 (16 years) the delta area expanded by 3.52 km. The length of the active edge is 32.24 km which means that the mean expansion of the MED equalled 109 m. Table 1 shows the average amount of plastic bottles in 8 MED sites. As one can see from the table, the amount of plastic waste varies quite significantly in different eco-polygons. The highest amount occurs in the eco-polygons of the Potapovske and the Tsyhanske arms, the lowest amount of plastic is seen in the northern islets and spits of the Kilia Delta. Based on our assessment, we conclude that for the years 2011–2012 the Ukrainian part of the MED holds about 2.5 tons of plastic bottles and about 0.5 tons of other synthetic waste.

Botanical research. In the course of our work we studied all the territory of the forming seashore from the northernmost part (the Polunochne Arm Mouth) to the end of the Tsyhanka Island in the south of the Danube Biosphere Reserve. In the study area, 110 species of plants were found which make up 11.4% of all the higher plants of the Danube Biosphere Reserve (966). The plants in the coastal part of the Kilia Danube Delta include 12 species (10.9%) of trees and shrubs, and 98 species (89.1%) of grass. The latter consists of 36 species (32.7 %) of perennial grasses, 2 (1.8 %) of biennial and 60 species (54.6 %) of annual grasses. The high percentage of perennial plants including tree-shrub species (48%) is not typical of the primary syngenesis of isolated natural formations like the Danube Delta [7, 8]. In the Kilia Danube Delta, a powerful water flow, especially during floods, brings a huge amount of vegetative propagating plants (reed, willow, poplar, etc.) which are able to fix on the substrate and then participate in the pioneer vegetation on new coastal formations.

Table 1

Assessment of the amount of plastic bottles in the MED area

Site	Length of site	Amount of plastic bottles, g/m^2	Overall weight of bottles, kg
Prorva-Potapovske	5	0.108	58.86
Potapovske – south of Potapovska Spit	5.52	1.611	969.31
south of Potapovska Spit– Seredne	4.33	0.696	328.49
Seredne – north of Ptashyna	4.78	0.592	308.44
north of Ptashyna Spit – south of Ptashyna Spit	3.4	0.586	217.17
south of Ptashyna Spit – Zavodnynske	4.43	0.753	363.60
Zavodnynske – Tsyhanske	1.73	0.708	133.51
Tsyhanske – Starostambulske	3.05	0.662	220.08
Total			2599.46

The analysis of species occurrence has revealed that only one species, *Xanthium strumarium L.*, was present in each of the 12 profiles; it is an adventive annual plant with wide ecological amplitude. Six species of plants occurred in 11 profiles: *Chenopodium rubrum L., Juncellus pannonicus L., Salsola soda L., Leymus sabulosus Tzvel., Phragmites australis (Cav.) Trin. ex Steud., and Tamarix ramosissima Ledeb*. More than half the profiles had only 20 species of plants, or 18.2% of the total analyzed flora. These 20 species are typical coenosis-forming plants of coastal new formations of the Kilia Danube Delta. Among the rest of the plants, 44 species (40%) occur only in one of the profiles; these are species which are recorded mostly on the edge of ecotopes and found only as solitary specimens.

In the process of the research it was established that the most intensive growth of the delta and formation of the vegetation cover occur in the southern part – the end of the Tsyhanka Island, to the left from the starting point of the Starostambulske Arm. In this area, the soil is represented by sand alluvial (marine) and muddy alluvial (river) deposits. There, the whole site, inwashed by the last year or the past two years, has 90 species out of the 110 mentioned above. However, the profile itself (a section from the benchmark to the water) holds only 38 species of plants. Therefore, the analysing the flora only within the profiles cannot reflect a complete picture of the syngenesis process on the marine edge of the Kilia Danube Delta.

Registration of dead dolphins was carried out throughout the outer part of the MED during the expeditions of 2011 and 2012. The majority of dead dolphins were registered in 2012. It was established that 9 out of the 11 remains belonged to the harbour porpoise (*Phocoena phocoena*) (Nos 1–9, Fig. 3), one was the Black Sea bottlenose dolphin (*Tursiops truncatus ponticus*) (No. 10, Fig. 3), and one was the short-beaked common dolphin (*Delphinus delphis*) (No. 11, Fig. 3).

The first dead harbour porpoises were found on the 26 July, 2012 to the right of the Prorva Arm Mouth on the Taranova Spit (Nos 1, 2, Fig. 3).

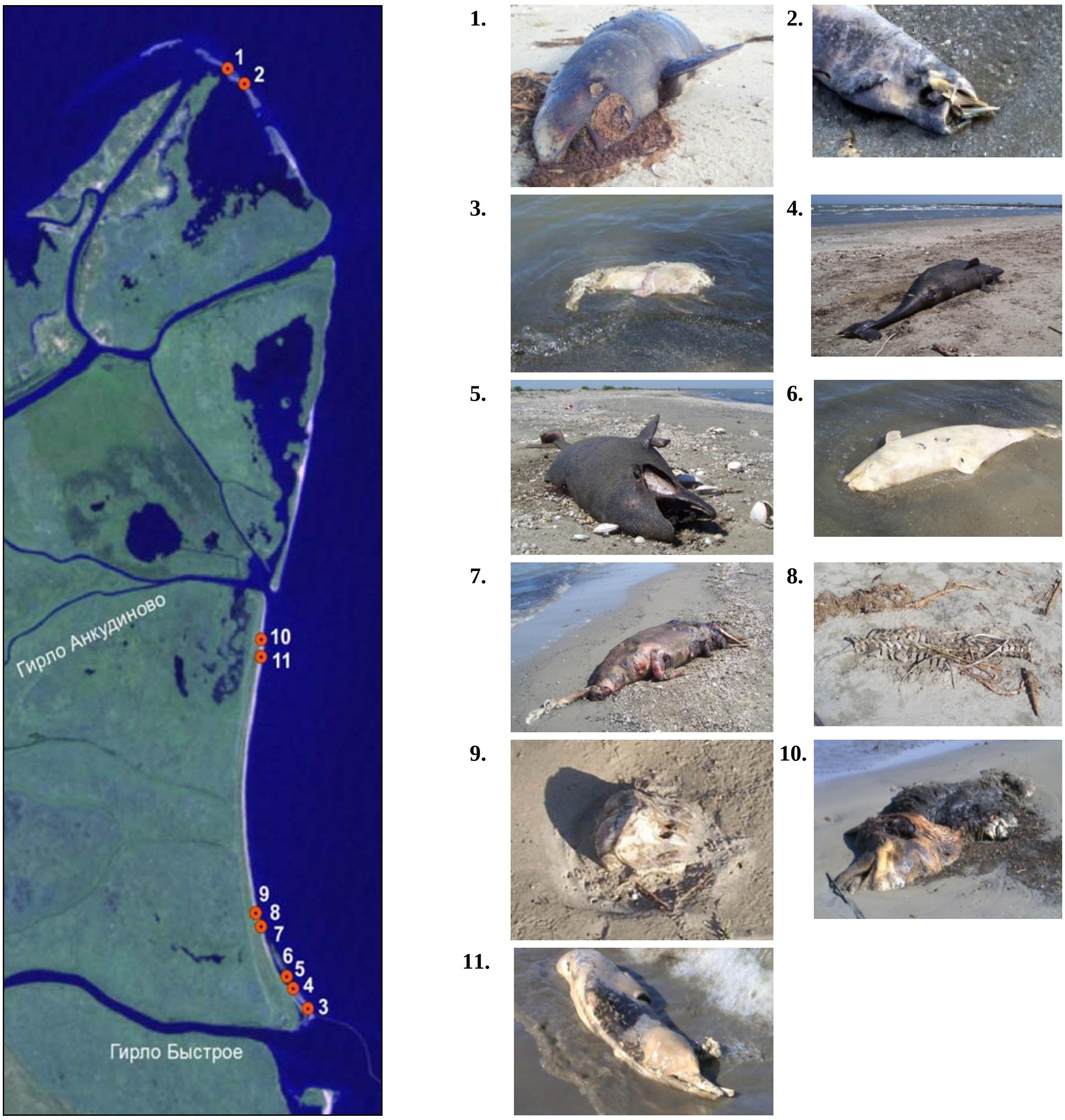

Fig. 3 – Dolphins and porpoises found on the 26th and the 28th of July, 2012 during an expedition the MED.

Other dead bodies of harbour porpoises in various stages of decomposition were found on the 28th of July, 2012 in the section 7.5 km long between the Poludenne and the Bystre Arms. That very

day in this section we also found a large bottlenose dolphin (No. 10) and a short-beaked common dolphin (No. 11). A White-tailed Eagle was feeding on the corpse of a large bottlenose dolphin.

Such a great number of dead dolphins and porpoises in a similar stage of decomposition was obviously connected with a prolonged storm which had prevented fishermen from coming to the sea and check their nets. When the storm was over, all dolphins and harbour porpoises were thrown from the nets into the sea. The majority of harbour porpoises is also an indirect evidence that death was caused by fishing nets (the harbour porpoise has the highest mortality percentage in fishing nets, chiefly those for turbots, spiny dogfish or sturgeons).On the other part, if dolphins die in fishing nets their caudal fins are typically absent. In our case, only one specimen of the harbour porpoise (No. 7) had not a caudal fin (not taking into account a skeleton and a skull of the porpoise (Nos 8 and 9). According to Internet data, registered the mass death of dolphins in 2012 in the Black Sea at the seaside of Sochi City (Russia) and in the Crimea (Ukraine) was not related to their being caught in fishing nets. Therefore, we can assume that in our case a part of the dolphins died from natural causes, such as diseases.

The expedition of 2011 found the remains of two harbour porpoises and one large Black Sea bottlenose dolphin in the same area, between the Poludenne and the Bystre Arms. A case of devourment of the dead bottlenose dolphin by a wild boar was recorded.

According to fishermen, a large shoal of porpoises was observed in Zhebrianska Bay in mid July, a week prior to the start of the 2012 expedition.

According to visual observations the abundance of dolphins close to the coast in June–July 2012 along the north-western Black Sea seashore from the Danube Delta to Odessa City was much higher than in the same period of 2011. It was due to sea currents which caused the fish shoals to come closer to the coast. If such conditions will recur (because of climate change) the number of dolphins and porpoises in the catches of local fishermen can substantially increase.

The results of observations, including the skeleton map and photo materials, were given to the Danube Biosphere Reserve, which is a focal point of the Ukrainian National Net for the Cetaceans Monitoring and Conservation (NNCC), and also to Brehm Laboratory (Simferopol, Ukraine) which is a co-ordination centre of the NNCC (http://www.dolphin.com.ua/).

The Danube Delta, including the territory of the Danube Biosphere Reserve, is very important for the NNCC activity, and the DHMO staff also provides registration of dead dolphins during annual expeditions. We would therefore recommend to extend an ecological component of the MED survey and include in it dolphin observations and cases of their death at the seashore or in fishing nets. The results of these observations will be submitted to the NNCC focal point in Vilkovo City, i.e. to the Office of the Danube Biosphere Reserve. Then they will be entered in a common database, also available on-line to supplement it with new data. These data are required to monitor the animal mortality rate and mortality causes.

A special attention should be paid to a section of the Kilia Danube Delta from the Poludenne Arm to the Bystre Arm. There, a dam, recently constructed for navigation in the Bystre Arm, buldges 2.5 m in the direction of the sea that a situation apparently creates the conditions to catch dead bodies of dolphins and porpoises that the waves had tossed up.

5. CONCLUSIONS AND PERSPECTIVES FOR FURTHER RESEARCH

1. The greatest impact on current MED-forming processes is due to the following factors: reduction of the Danube sediment runoff of, redistribution of the water flow between the Tulcea Arm and the Kilia Arm, and the rise of the Black Sea level. In the last years, the drainage of the Ochakovske Arm reduced the flow of sediments to the utmost. It was caused by a decrease of the water content in the Kilia Arm and the termination of dredging work in the Prorva Arm and its Soedinitelnyi Canal (2007). It obviously leads to a deficit of sediments in the northern part of the Kilia Delta, especially in dry years. In 2011–2012, erosion processes accelerated in the area of the northern spits of the Kilia Delta, at the mouth of the Potapovske Arm. The northern and southern parts of the Kilia Delta are not so much affected by sediment deficit owing to the relative stability of the Starostabmulske Arm.

2. The accumulation of polymeric waste, coming to the marine edge of the delta from the outside, is an ongoing process both in the growing and retreating parts of the MED.

3. As for 2011–2012, the Ukrainian MED holds about 2.5 tons of plastic bottles and about 0.5 tons of other synthetical waste.

4. The formation of pioneer vegetation in the Kilia Danube Delta depends on the composition of soil-forming structures, soil salinity and the development rate of the area. In the Danube Biosphere Reserve, 110 higher plant species participate in covering new coastal formations, which is a great number of plants for primary syngenesis.

5. Measures for dolphin protection in the Black Sea countries should be intensified. The Danube Hydrological Observatory (Izmail, Ukriane) is recommended to extend an ecological component of the MED survey programme and include in it dolphin observations and cases of their death at the seashore or in fishing nets.

6. Integrated monitoring of the marine edge of the Danube Delta should be continued and expanded, by involving Romanian experts as well.

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