The current status of bottlenose dolphins (*Tursiops truncatus*) in the Black Sea

By Alexei Birkun, Jr.

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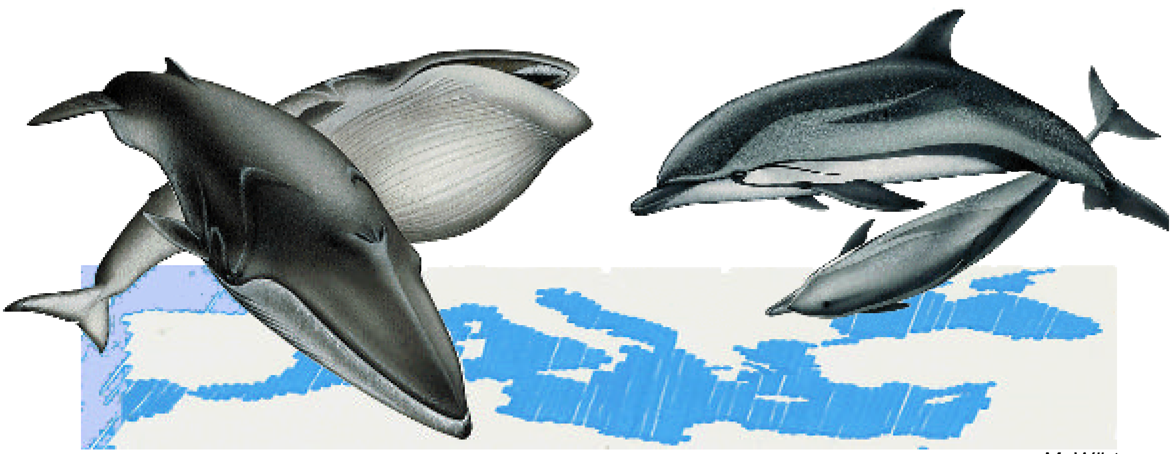

M. Würtz

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16, Bd. de Suisse
MC-98000 MONACO

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Alexei Birkun, Jr.

Laboratory of Ecology and Experimental Pathology, S.I. Georgievsky Crimean State Medical University, Lenin Boulevard 5/7, Simferopol 95006, Ukraine; AlexeiBirkun@home.cris.net

1 Introduction

The Black Sea biodiversity in general and the fauna of Black Sea marine mammals in particular are rather confined owing to inherent peculiarities of this basin including the high degree of geographical isolation of the sea, its low water salinity and quite severe environment, as well as because of a large amount of hypoxic and anoxic waters below 100-250 m. Three species of cetaceans – the harbour porpoise (*Phocoena phocoena*), the short-beaked common dolphin (*Delphinus delphis*) and the common bottlenose dolphin (*Tursiops truncatus*) – and one pinniped species – the Mediterranean monk seal (*Monachus monachus*) – crown the trophic pyramid of the Black Sea as top predators which have no natural enemies in this basin (Kleinenberg, 1956; Geptner *et al*., 1976; Jefferson *et al*., 1993).

In the last three decades, Black Sea biodiversity has been seriously damaged due to the human-associated degradation of the sea proper and its drainage basin (Zaitsev and Mamaev, 1997). The species composition of most marine communities was modified with the explosive expansion of some organisms and the depression of many others. The Mediterranean monk seal has disappeared almost completely from the subregion (Kiraç and Savas, 1996; Öztürk, 1999). Black Sea dolphins and porpoises, drastically affected by commercial direct killing continued till the early 1980s, are exposed to modern anthropogenic threats which cause the deterioration of habitats, the depletion of food resources and adversely impact cetacean population health.

The bottlenose dolphin population is known as the smallest Black Sea cetacean population which is negatively influenced by various anthropogenic impacts (Klinowska, 1991; Birkun *et al*., 1992; Birkun and Krivokhizhin, 1996 b). This population is protected by long list of international and national legislative acts, but practically its conservation status is far from perfection. The aim of this review is a critical evaluation of existent knowledge on Black Sea bottlenose dolphins with special respect to their taxonomic position, distribution, abundance, important threats and survival potentialities.

2 Taxonomy

The bottlenose dolphin is a single representative of the genus *Tursiops* and one of two Delphinidae species in the Black Sea (Table 1). For the first time it was recorded in this basin under the name *Delphinus tursio* by Rathke (1837). Fifty-five years later, Ostroumov (1892) has confirmed its presence and attributed it to the species *Tursiops tursio* Fabricius. Then, within taxonomic revision of Black Sea cetacean fauna conducted by Barabasch-Nikiforov (1940), local bottlenose dolphin was designated as the subspecies *Tursiops truncatus ponticus*. The author compared his own research data (1,450 individuals and 19 skulls were measured) with few publications on the Atlantic bottlenose dolphin and, as a result, has adduced four morphological peculiarities as diagnostic markers of the Black Sea subspecies:

(a) lesser body length (120-310 cm; 225 cm on average);
(b) some difference in typical coloration;
(c) short-cut beak with relatively more wide basis; and
(d) lesser number of teeth (from 74 to 90 in both jaws).

Table 1 – Taxonomic position of the Black Sea bottlenose dolphin

	Latin name	English name
Order:	**Cetacea** Linnaeus, 1758	Cetaceans
Suborder:	**Odontoceti** Flower, 1867	Toothed whales
Family:	**Delphinidae** Gray, 1821	Dolphins
Genus:	***Tursiops*** Gervais, 1855	Bottlenose dolphins
Species:	***Tursiops truncatus*** (Montagu, 1821)	Common bottlenose dolphin
Subspecies (?):	***Tursiops truncatus ponticus*** Barabasch, 1940	Black Sea bottlenose dolphin

The proposed new taxonomic position of the Black Sea bottlenose dolphin immediately excited strong objections from some cetologists (e.g., Zalkin, 1941). Later, Kleinenberg (1956) has examined 21 skulls and 50 carcasses which were 155-310 cm long with the mean length of 275 and 233 cm in mature males and females, respectively. He strictly criticized the preceding standpoint (Barabasch-Nikiforov, 1940) and recognized above features (especially, coloration, beak measurements and teeth number) as insufficient and unreliable criteria for the subspecies determination. However, he measured only two skulls of bottlenose dolphins from other (unspecified) sea(s). Of course, that was not enough for accurate comparative morphometric investigation.

No indisputable evidence, supporting either Barabasch-Nikiforov's or Kleinenberg's viewpoint, was reported during last 45 years. Nevertheless, in spite of persistent unsolved controversy, existing *de jure* and *de facto*, this animal is mentioned as the "rare endemic subspecies" in many publications belonging to subsequent authors originated mainly from the former USSR (Tomilin, 1957, 1983; Barabasch-Nikiforov, 1960; Geptner *et al.*, 1976; Anonymous, 1985; Birkun and Krivokhizhin, 1994; Sokolov and Romanenko, 1997).

Thus, precise genetic and biometric studies are needful to remove a vagueness of Black Sea bottlenose dolphin's taxonomic status. The use of subspecies name cannot be recommended unless and until it will be proved by certain data.

3 Range states and common names

Bottlenose dolphins inhabit territorial waters of all six Black Sea riparian countries (Petranu, 1997; Sokolov and Romanenko, 1997; Komakhidze and Mazmanidi, 1998; Konsulov, 1998; Zaitsev and Alexandrov, 1998; Öztürk, 1999) where they are known under following common names (Birkun *et al*., 1999 c):

- Bulgaria – Afala;
- Georgia – Afalina;
- Romania – Afalin, Delfinul cu bot de sticla, Delfinul cu bot gros;
- Russia – Afalina chernomorskaya, Butylkonosy del'fin, and (archaic) Nezarnak, Chornaya morskaya svinya [black porpoise], Ofalina, Afalin, Afelin;
- Turkey – Afalina;
- Ukraine – Afalina chornomors'ka.

4 Distribution and migrations

4.1 General layout

Bottlenose dolphins can be found somewhere in the Black Sea coastal waters (Kleinenberg, 1956; Tomilin, 1957; Sal'nikov, 1967; Arsenyev *et al.*, 1973; Geptner *et al.*, 1976; Arsenyev, 1980; *etc*.), and occasionally they occur far offshore in the more deep area (Morozova, 1981; Beaubrun, 1995; Mikhalev, 1996 b; Yaskin and Yukhov, 1997). For a long time they are known in the Turkish straits system (incl. the Bosphorus, Marmara Sea and Dardanelles) which connects the Black and Mediterranean Seas (Kleinenberg, 1956; Geptner *et al.*, 1976; Beaubrun, 1995; Öztürk and Öztürk, 1997). These cetaceans are common also in the Kerch Strait (Kleinenberg, 1956; Birkun and Krivokhizhin, 1998, 2000; Birkun *et al.*, 2002), and sometimes they visit the Sea of Azov (Zalkin, 1940; Birkun *et al.*, 1997). Seldom cases were reported when Black Sea bottlenose dolphins entered fresh waters, e.g. the Danube delta (Police, 1930; cited after Tomilin, 1957). In 2000, a group of four animals was sighted in the Dnieper river at a distance of about 40 km above its estuary (S.M. Chorny, pers. comm.) – that is nearly 100 km from the proper sea.

4.2 Main habitat

The circumlittoral waters over the shelf are the primary habitat of the Black Sea *T. truncatus*. During four boat surveys, carried out in 1985-1987 (Yaskin and Yukhov, 1997), most sightings (83.3-100%) were recorded in the places, which had a depth not more than 200 m (in the north part of the sea) or located within 5-mile-wide inshore stripe (in the east part of the sea) (Table 2). Unfortunately, the authors did not inform, were their observarion efforts equal in different zones (in particular, over the shelf, continental slope and deep-sea depression) or no?

Table 2 – Number of sightings (%) of bottlenose dolphins in different zones of the Black Sea (after Yaskin and Yukhov, 1997)

Term of boat survey	Number of sightings (%) in the zones with various depth (in brackets)		
	Waters over the shelf mainly (0-200 m)	Waters over the continental slope (0-2,000 m, with a bottom below 200 m)	Waters over the deep-sea depression (0-2,212 m, with a bottom below 2000 m)
July 1985	100.0	0.0	0.0
June 1986	98.8	1.2	0.0
October 1986	83.3	16.7	0.0
June 1987	86.3	4.1	9.6
On average	92.1	5.5	2.4

The Black Sea shelf is significantly wide (up to 200-250 km) in the northwestern part of the sea with a depth varying from zero to 160 m (Vylkanov *et al*., 1983; Zaitsev and Mamaev, 1997; Readman *et al*., 1999). In other coastal areas the shelf strip has a similar depth, but considerably less width, from 0.5 to 50 km. Thus, only about one quarter (24-27%) of the sea area has a depth of less than 200 m. The shelf is slightly inclined offshore; its relief is composed of underwater valleys, canyons and terraces. Pebbles, gravel, sand, silt and rocks cover the bottom. The intimate attachment of bottlenose dolphins to the shelf area is stipulated by appropriate distribution of their preferable prey – benthic and nearshore pelagic fishes. The Black Sea is stratified into the superficial layer of oxygenated waters and the deeper column of anoxic waters saturated by high concentrations (0.2-9.6 mg/l) of poisonous hydrogen sulphide (Zaitsev and Mamaev, 1997; Aubrey *et al*., 1999). A transitional interlayer between those strata lies at a depth between 100 and 250 m. Thus, only the upper 10-13% of the water mass is suitable for the habitation of aerobic marine organisms, including those which constitute the dolphin's diet. Bottlenose dolphins can dive deeper than 100-250 m (Leatherwood and Reeves, 1990), but that is, probably, not typical for the Black Sea because the deep-sea "dead" zone does not represent any gastronomic interest for them.

4.3 Settled habitation

There is no reliable information on the existence of resident dolphin schools, although groups and even large herds of foraging animals may stay in some places close to Crimean and Caucasian coasts for a few days to several months. In particular, annually from spring to autumn, bottlenose dolphins form compact accumulations near Tarkhankut peninsula of the Crimea (Zatevakhin and Bel'kovich, 1987, 1996; Bel'kovich and Zatevakhin, 1996) and also in the Kerch Strait and adjacent Black Sea area (Kleinenberg, 1956) with a peak of their presence in the Kerch Strait in June-July (Birkun and Krivokhizhin, 1998, 2000) (Fig. 1). Most sightings in the Bosphorus were recorded in May-June, while in the Marmara Sea – in October (Öztürk and Öztürk, 1997). Four separated accumulations of *T. truncatus* groups have been observed off the Crimea in June 1995, including the northwestern (around Tarkhankut peninsula), western (between capes Lukull and Khersones), southern (between capes Sarych and Ayudag) and southeastern (between capes Meganom and Ilyi) clusters (Birkun and Krivokhizhin, 2000). In summer 1997 and 1998, bottlenose dolphins were distributed mainly along the south and southeast Crimean coasts. Annual aggregation of dolphin schools during fall and early winter is typical for small delta-shaped area at the south extremity of the Crimea between Balaklava and Foros (Fig. 2).

4.4 Migrations

Herds of several hundred animals follow each autumn from the east towards the south-west along the south coast of the Crimea (Birkun and Krivokhizhin, 1996 a, 2000) with their obvious intermediate stop in just mentioned triangle (Fig. 2). According to indirect data, other schools migrate at the same time to the same place from the west and northwest coasts of the peninsula. Such annual assembly of different groups can be utterly important for the sustenance of breeding harmony within Black Sea population. The reality of autumn migrations from the east to south-west has been confirmed by means of tagging experiment (Veit *et al*., 1997). Two individuals of the Black Sea bottlenose dolphin, the male and female, were released in the late August 1996 in Taman' Bay of the Kerch Strait, and dorsal fins of those animals were marked by the removing of dermal tissue in characteristic patterns. Two weeks later, both dolphins were sighted triply near Yalta, south Crimea, at a distance of more than 200 km from the release site. The marked animals were observed foraging within a larger group of relatives.

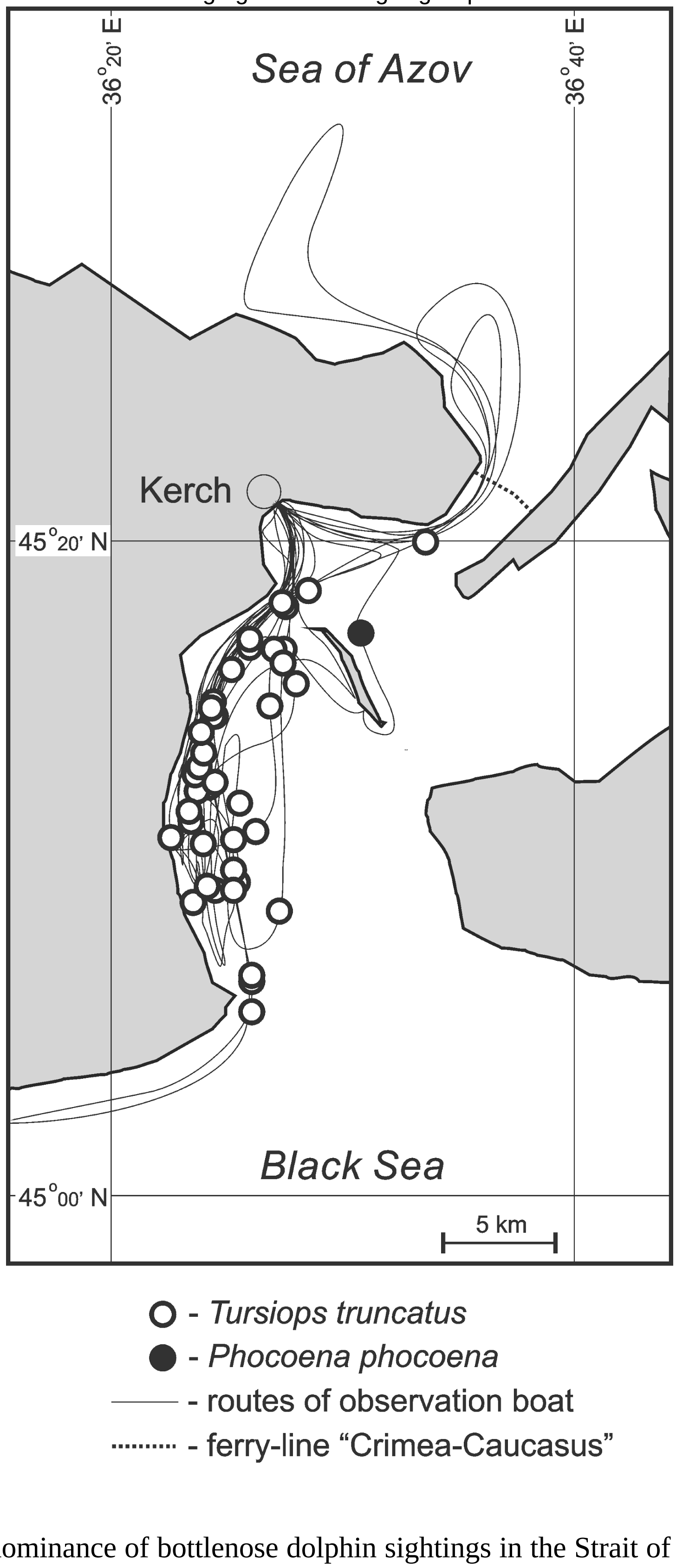

Fig. 1 – The predominance of bottlenose dolphin sightings in the Strait of Kerch in summer according to results of boat survey conducted in June 1997 in the western part (Ukrainian

waters) of the strait (after Birkun and Krivokhizhin, 1998).

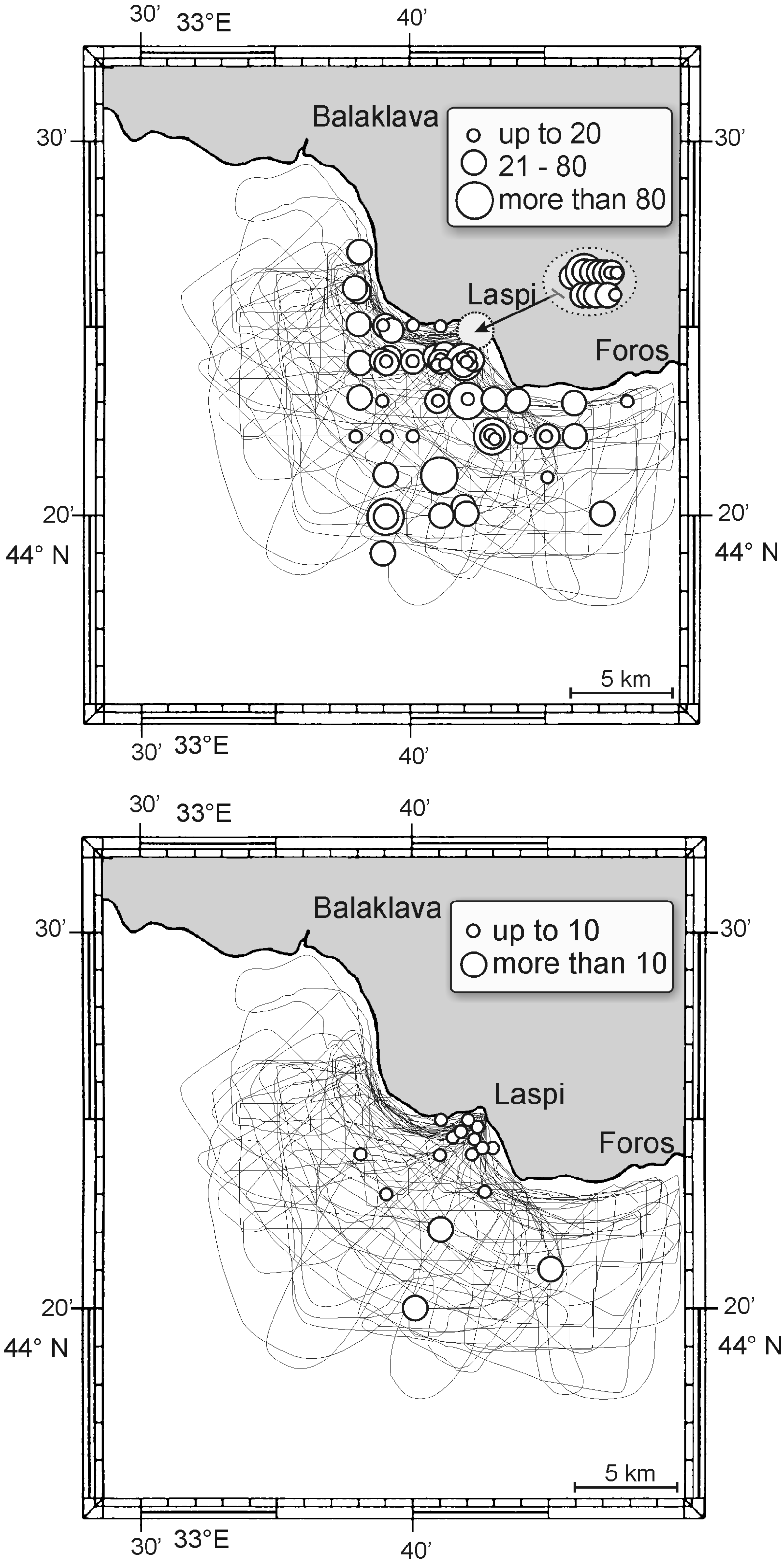

Fig. 2 – The predominance of bottlenose dolphins (above) in comparison with harbour porpoises (below) in coastal waters off the south Crimea in August-December 1998. Tracklines of observation boat are shown; rough scale of cetacean group sizes is presented in the legend (after Birkun and Krivokhizhin, 2000).

Certainly, the distribution features and migratory routes should be studied more thoroughly, including, in particular, the Turkish straits system – the single path for probable genetic exchange between Black Sea and Mediterranean cetaceans. It looks like a paradox that until now there are no strict scientific proofs of any link (or its absence?) between these two neighbouring populations. Systematical sightings surveys, covering coastal waters during various seasons, are necessary as well as the collecting of photo-identification data and radio tagging/tracking of free rangering animals. The mapping of distribution patterns and migratory ways of basic prey species can also be helpful, taking into consideration a broadly circulating empiric thesis that general motion of Black Sea cetaceans is tightly bound with movements of their food sources (Kleinenberg, 1956).

5 Population estimates

5.1 Absolute abundance

The bottlenose dolphin population usually is considered as the smallest in comparison with other cetacean populations in the Black Sea (Silantyev, 1903; Zalkin, 1940; Kleinenberg, 1956; Geptner *et al.*, 1976). In the 20th century the population has been reduced by mass direct killing managed for the dolphin-processing industry, however total number of taken animals remains unknown. Until now, there are no reliable scientific data on this population abundance. The estimates carried out in the former USSR in 1967-1974 (Zemsky and Yablokov, 1974) and in Turkey in 1987 (Çelikkale *et al.*, 1989) were discredited by the IWC Scientific Committee due to methodological blunders committed in observation schemes and statistic interpretation (Smith, 1982; Klinowska, 1991; Buckland *et al.*, 1992; IWC, 1992). The later Soviet estimates, which were produced in 1975-1993 (Mikhalev *et al.*, 1978; Yukhov *et al.*, 1986; Sokolov *et al.*, 1990; Mikhalev, 1996 a; Yaskin and Yukhov, 1997) and not yet reviewed by the IWC Scientific Committee, demonstrate similar mistakes, namely the incorrect survey design and erroneous data treatment. Therefore, existent figures on absolute abundance of Black Sea bottlenose dolphin population (Table 3) have mainly historical significance (as published notes of how it was done), but cannot be recommended as the basic data for further comparisons and conclusions.

Table 3 – Estimated absolute abundance of Black Sea bottlenose dolphin population

Period	Abundance (no. of animals)	Reference
Early 20th century	30,000-50,000	Bushuyev (2000)
1967-1974	85,000	IWC (1992) after Zemsky and Yablokov (1974)
1973	31,000	Zemsky (1975)
1976	56,000	Mikhalev *et al.* (1978)
July 1983	< 5,000-10,000	after Yukhov *et al.* (1986)*
April and July 1987	67,257	after Çelikkale *et al.* (1989)**
1985-1987	7,000±3,000	Sokolov *et al.* (1990); Yaskin and Yukhov (1997)

* Between 55,000 and 60,000 cetaceans, including nearly 50,000 common dolphins (*Delphinus delphis*), were estimated for the entire Black Sea area. Consequently, the overall number of bottlenose dolphins and harbour porpoises did not exceed 5,000-10,000 animals.

** A total of 454,440 individuals was estimated for all three Black Sea cetacean populations (*D. delphis*, *T. truncatus* and *P. phocoena*) taken together, and a share of bottlenose dolphins constituted 14.8%.

5.2 Local stocks

It is testified that Black Sea bottlenose dolphin population is divided into several quite distinctly separated herds, and each herd consists of 60-150 animals (Bel'kovich, 1996).

The most investigated herd ("local population") occupies during warm season an area of 800 km^2 close to the Tarkhankut peninsula (northwest Crimea), between Bakal Spit and Lake Donuzlav (Zatevakhin and Bel'kovich, 1987, 1996; Bel'kovich and Zatevakhin, 1996). According to results of two aerial surveys, carried out with a three-year interval in the 1980s, this socially independent herd included from 104 to 112 individuals. Meantime, according to land-based observations during five field seasons, the size of this community averaged 69 dolphins with a maximum of 98 animals. From spring to autumn the Tarkhankut herd composed of several smaller dolphin groups with a mean group size of about six individuals (from 4.0 to 8.2 animals on average in different years) and a maximum group size of 42 individuals (Zatevakhin and Bel'kovich, 1987).

Line transect aerial survey, conducted in July 2001 (Birkun *et al*., 2002), has revealed a herd of bottlenose dolphins (13 sightings; 33 individuals) in the Strait of Kerch (890 km^2), and no cetaceans of this species were found in the Sea of Azov. Dolphins were distributed in the north and mid thirds of the strait including shallow Taman' Bay. The minimum uncorrected abundance estimate of the Kerch herd came to 91 individuals. At the same time, harbour porpoises were recorded in the north half of the strait (7 sightings; 12 individuals) and in the Azov Sea proper (78 sightings; 110 individuals); their minimum uncorrected abundance estimates were evaluated as follows: 46 and 2,417 animals in the strait and sea, respectively. Earlier, in 1997, bottlenose dolphins were recorded in the Kerch Strait almost every month (except January and December) from local ferry line between the Crimea and Caucasus and by voluntary observers: the single animals constituted 17%, small groups (2-10 individuals) – 74%, and medium-sized schools (11-20 individuals) – 9% of all sightings registered; besides, groups from three to approximately 100 animals were recorded in the strait by boat survey conducted that year in June (Birkun and Krivokhizhin, 1998).

In coastal waters close to the south extremity of the Crimea (between Balaklava and Foros; Fig. 2) the mean size of bottlenose dolphins groups came to 48-54 individuals in August and to 36-44 animals in September 1998, while the largest groups consisted of 150-200 dolphins (Birkun and Krivokhizhin, 2000).

5.3 Relative abundance

During past century the abundance ratio between two inshore species of Black Sea cetaceans has been considered as an axiom: the harbour porpoise is a predominant form while the bottlenose dolphin represents a minority (e.g. Kleinenberg, 1956; Geptner *et al*., 1976). Some sightings surveys, which confirmed this maxim, were carried out 14-16 years ago in the USSR and Turkey. A total of 261 bottlenose dolphins and 787 harbour porpoises (1:3) were recorded in 1985-1987 within five boat surveys in the north and east parts of the Black Sea from Odessa to Batumi (Yaskin and Yukhov, 1997). Similar ratio – 14.8% of bottlenose dolphins and 52.7% of harbour porpoises (1:3.6) – was estimated in 1987 for a 58-km-wide strip along the entire south coast of the sea (Çelikkale *et al*., 1989).

In 1990-1999 period, 397 primary records of cetacean sightings were collected in coastal (20-60 km wide) Black Sea area surrounding Crimean peninsula from Karkinitsky Bay to the Kerch Strait (Birkun and Krivokhizhin, 2000; Birkun *et al*., 2001). Special observations were carried out in June 1995, June 1997, June-July and September 1998 by means of sailing and motor yachts which covered distances from 255 to 934 km (10,371 km in total). It was shown that in 1997 and 1998 there was prominent growth (more than in five times) of bottlenose dolphin's abundance index in comparison with 1995. Meantime, the level of harbour porposes presence demonstrated an expressive decline in 1998 after temporal elevation in 1997. So, the ratio between bottlenose dolphin's and harbour porpoise's abundance indices performed a trend toward clear prevalence of bottlenose dolphins: 1995 – 0.8:1; 1997 – 0.9:1; June-July 1998 – 6.8:1; September 1998 – 12.9:1. The difference between last two figures can be explained by annual autumn accumulation of bottlenose dolphins in the waters closed to the south extremity of the Crimea, between Balaklava and Foros (Fig. 2). Regular patrolling of that area in September-October 1997 and August-December 1998 confirmed the undoubted predominance of bottlenose dolphin abundance in comparison with harbour porpoise one (Fig. 3). As it was mentioned above, the *Tursiops* herds of hundreds animals migrate every fall to this relatively small area from the eastern and, probably, other parts of the Black Sea. On the other hand, mass incidental mortality in bottom-set gill nets is the most obvious cause of marked decrease of harbour porpoises number (Birkun *et al*., 2000) .

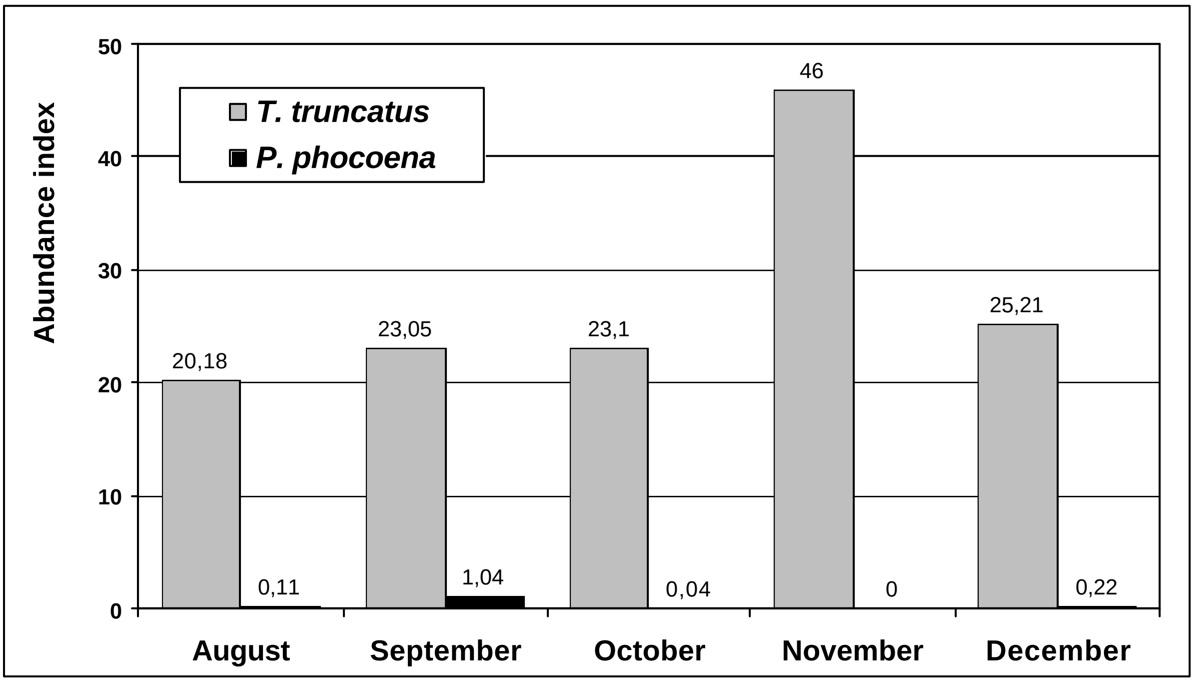

Fig. 3 – Bottlenose dolphin and harbour porpoise relative abundance estimated for coastal area between Balaklava and Foros, south Crimea, in August-December 1998 (after Birkun and Krivokhizhin, 2000; Birkun *et al*., 2001).

No recent data are available on relative abundance of cetaceans in other parts of the subregion as well as in Black Sea waters off the Crimea from January to May inclusive. Thus, for the moment the predominance of bottlenose dolphins in comparison with harbour porpoises should be considered as an appearance which is typical for Black Sea shelf area along the Crimean coast from June to December only.

6 Selected aspects of biology

6.1 Reproduction

Black Sea bottlenose dolphins are cetaceans with a relatively long life span (perhaps, 25-30 years or more) and low fertility (Tomilin, 1957; Geptner *et al*., 1976). Females become mature earlier (after 5-6, maximum 12 years) than males (8-12 years). Sexual behaviour can be observed during the whole year with a peak in spring-early summer. The ovulatory season (maximum five spontaneous ovulations) is extended from March to October with a peak in June; the highest concentrations of testosterone in males were recorded in July and the lowest – in January (Ozharovskaya, 1997). The 12-month-long gestation periods take turns with barren intervals continuing from 2-3 to six years (Tomilin, 1957), but in captive females the reproductive cycle did not exceed two years (Ozharovskaya, 1997). The parturition results usually in one calf. Lactation period varies from four months to over 1.5 year. Mentioned peculiarities of reproduction (low fertility rate with prolonged barren intervals) seem to be basic natural limitation of bottlenose dolphin population growth. It is supposed that one female during her life can produce not more than eight calves (Tomilin, 1984; cited after Ozharovskaya, 1997).

6.2 Nutrition

Bottlenose dolphins are piscivorous predators. Benthic and pelagic fishes, both small and big, represent suitable prey. 14 fish species have been recorded as a prey of Black Sea bottlenose dolphins off the Crimean and Caucasian coasts (Table 4). Black Sea scad and shad are also mentioned in some publications (Birkun *et al*., 1999 c).

Table 4 – Target fish species of Black Sea bottlenose dolphins and their importance for the cetaceans and commercial fisheries: P – primary, S – secondary and U – undefined

Fish species	Bottlenose dolphins	Fisheries [e]
Whiting, *Merlangius merlangus euxinus*	P [b], S [a]	S
Black Sea turbot, *Psetta maeotica*	P [a, b]	P
Thornback ray, *Raja clavata*	P [a], S [b]	S
Mullets, *Lisa aurata et L. saliens*	P [c], S [a, b]	P
Grey mullet, *Mugil cephalus*	P [c], S [a, b]	P
Far-east mullet, *Mugil so-iuy*	P [d]	P
Anchovy, *Engraulis encrasicolus ponticus*	S [a, b, c]	P
Red mullet, *Mullus barbatus ponticus*	S [a, b]	P
Bonito, *Sarda sarda*	S [a, b]	P
Zander, *Lucioperca lucioperca*	S [a]	U
Bream, *Abramis brama*	S [a]	U
Sea scorpion, *Scorpaena porcus*	S [a, b]	U
Corb, *Umbrina cirrhosa*	S [b]	U

[a] – Zalkin (1940); [b] – Kleinenberg (1956); [c] – Tomilin (1957);
[d] – Krivokhizhin *et al*. (2000); [e] – according to Prodanov *et al*. (1997), with additions.

In recent years the acclimatized Far East mullet (*Mugil so-iuy*) has became probably the preferred prey causing bottlenose dolphin stock migrations off the Crimea (Birkun and Krivokhizhin, 2000).

7 Important threats

In the past, commercial killing was the main human activity affected the population, although a share of bottlenose dolphins in catches was usually less than common dolphins and harbour porpoises. Nowadays, the most important man-made threats are presented by habitat degradation, disturbance and incidental capture in fishing gear. Since the mid 1960s hundreds of animals were taken alive in the USSR and Romania for military, commercial and scientific needs. The Russian Federation and Ukraine are continuing that practice in their waters. Natural diseases also play certain role in the limitation of Black Sea bottlenose dolphins abundance.

7.1 Direct killing

The dolphin processing industry, based on the mass direct killing of small cetaceans (common dolphins, harbour porpoises and bottlenose dolphins), took place in all Black Sea riparian countries (Silantyev, 1903; Kleinenberg, 1956; Nikolov, 1963; Danilevsky and Tyutyunnikov, 1968; Berkes, 1977; Dima and Vasiliu, 1992; Yel *et al*., 1996; *etc*.). It was banned in the former USSR (present Georgia, Russia and Ukraine), Bulgaria and Romania in 1966, and since 1983 – in Turkey. Purse-seining and shooting were the two principal methods used in Black Sea cetacean fisheries.

In the 19th century cetaceans were killed almost exceptionally for the oil obtained by the melting of their fat and sold as the lamp-oil for home lighting (Silantyev, 1903). In the 20th century, in the Soviet Union the dolphin oil found new application in the pharmaceutics as the raw material for vitamin-D-containing medicines and in the tanning industry as the currier's oil; it was used also for the manufacturing of paint, varnish, soap, engine and lubricating oil; the muscles were used for tinned meat and sausages, the skin for leather goods, and the residues of cetacean carcasses were utilized for the production of "fish" meal, bone fertilizer and glue (Kleinenberg, 1956; Tomilin, 1957). The lubricating oils, "Delfinol" vitaminous remedy, shoe polish, leather and dried meat were produced in Bulgaria (Tsvetkov and Boyev, 1983). The main products of Turkish dolphin fisheries were the oil and meal for poultry feed (Berkes, 1977; Yel *et al*., 1996; Öztürk, 1999).

The precise number of Black Sea cetaceans killed and processed in the 19th and 20th centuries is unknown. In the 20th century in the former Russian Empire and then in the USSR it undoubtedly exceeded 1.5 million animals of all three species, while other Black Sea states together probably killed about four to five million (Birkun *et al*., 1992; Birkun and Krivokhizhin, 1996 b). It is commonly acknowledged that the Black Sea cetacean populations were strongly reduced by the fishery (Zemsky and Yablokov, 1974; Smith, 1982; Klinowska, 1991), and that perhaps they did not recover until now (Birkun and Krivokhizhin, 2001). A lack of reliable population estimates (Smith, 1982; Buckland *et al*., 1992; IWC, 1992) does not allow to confirm or reject this assumption.

The statistics of Black Sea cetacean fisheries were usually expressed as total weight or total numbers in the catch without species differentiation. However, since the 19th century the bottlenose dolphin was known as the most rare prey in the Tsarist Russia and USSR, while the common dolphin represented a main target species, and the harbour porpoise had an intermediate commercial importance (Silantyev, 1903; Kleinenberg, 1956). According to Bodrov *et al*. (1958), a total of 1,201,803 individuals of all three Black Sea cetacean species were killed and processed in the Soviet Union from 1931 to 1957. It was calculated also that within the same period (between the early 1930s and mid 1950s) the average proportion of the three species in the Soviet harvest was: one bottlenose dolphin (0.5%) per 10 harbour porpoises (4.7%) per 200 common dolphins (94.8%) (Zalkin, 1940; Kleinenberg, 1956). Thus, the number of bottlenose dolphins, processed in the USSR during above 27 years (1931-1957), can be roughly estimated as a little more than 6,000 individuals. This figure seems to be very dubious (vastly undervalued) because of only one, but significant fact: in spring 1946, over 3,000 bottlenose dolphins (i.e. more than 50% of just mentioned total) were caught during one day (!) in one place close to the south Crimea (Kleinenberg, 1956; page 74).

In the late 1950s -early 1960s the common dolphin fraction began to decrease (80-90%) in the Soviet catches, and harbour porpoises became the numerically dominant in 1964-1966 (Danilevsky and Tyutyunnikov, 1968). According to these authors, a similar inversion of species composition occurred at the same time in Bulgaria. Nevertheless, a number of killed bottlenose dolphins sometimes was very high and even predominant in comparison with other species. For example, in 1961, the Bulgarian cetacean fishery was concentrated almost exceptionally on *T. truncatus* and caught about 13,000 individuals (Nikolov, 1963). The sex ratio of 53 bottlenose dolphins, examined in April 1966 at the Novorossiysk dolphin processing factory, was almost 1:1 (27 males and 26 females); pregnant and lactating females constituted 63% and 7.4%, respectively, of all females examined (Danilevsky and Tyutyunnikov, 1968).

From 1976 to the early 1980s the Turkish harvest consisted mainly of harbour porpoises (80%) with a relatively small quantitiy of bottlenose dolphins (2-3%) (IWC, 1983; Klinowska, 1991).

No dependable information on intentional killing of wild Black Sea bottlenose dolphins is available since the ban of cetacean fisheries in 1983. Unlawful direct take of dolphins seems to be limited by the lack of adequate market in the riparian countries, but *a priori* it is still possible in some cases of conflict interaction between marine mammals and coastal fisheries (see 7.4). In some Black Sea countries the intentional killing was replaced by the premeditated live capture of bottlenose dolphins for dolphinaria (see 7.5).

7.2 Habitat degradation

The habitat of Black Sea *T. truncatus* is used by humans for shipping, fishing, mineral exploitation, tourism, recreation, military exercises and waste disposal (Vylkanov *et al*., 1983; Bilyavsky *et al*., 1998; Kerestecioglu *et al*., 1998; Tuncer *et al*., 1998). Besides, coastal area and drainage basin are under a pressure from urban development, industry, hydro- and nuclear energetics, agriculture and land-improvement. Numerous anthropogenic threats responsible for bottlenose dolphins' habitat degradation can be assembled into three principal groups:

- various kinds of pollution;
- physical modification of the seabed; and
- irretrievable take of natural wealth including the (over)exploitation of marine living resources.

7.2.1 Pollution

Irrespective of sources, anthropogenic pollution of the Black Sea is subdivided into (Black Sea Transboundary Diagnostic Analysis, 1997; Mee and Topping, 1999):

(a) contamination related to various chemical substances (nutrients, crude oil and petroleum products, persistent synthetic pollutants and trace elements);
(b) radioactive contamination;
(c) pollution by solid wastes;
(d) biological pollution including microbial contamination and introduction of alien species of marine organisms; and
(f) acoustic pollution.

The effects of pollution on Black Sea bottlenose dolphins are studied poorly yet, and speculations around this problem usually look like an idle talk.

7.2.1.1 Nutrient pollution The Black Sea is utterly polluted by organic matter and inorganic nutrients originating from agriculture, animal husbandry, domestic and industrial sewage, *etc*. The excessive loading of sea water with nitrogen- and phosphorus-containing substances is considered as a primary cause of the decline of the shelf ecosystems (Zaitsev, 1993; Mee and Topping, 1999) which are crowned by inshore top predators including bottlenose dolphins. A large share of nutrients is contributed to the sea by rivers. The peak of nutrient inputs has been observed in the 1970s and 1980s (Zaitsev and Mamaev, 1997). Huge inputs of nutrients are causing the eutrophication of shallow waters mainly in the northwestern Black Sea shelf area. This phenomenon includes the production of algal and zooplanktonic blooms; decline of water transparency; oxygen deficiency in the near-bottom water layer; disappearance of benthic phytocenoses at a depth below 10 m; mass mortalities of benthic fishes and invertebrates with associated widespread decay of their remains and seaweed residues (Zaitsev and Mamaev, 1997). Fish mass mortality events occur in the Black Sea since the late 1960s; blooms of dinoflagellates became annual since the early 1970s. The areas of eutrophication in the northwestern Black Sea expanded from 3,500 km^2 in 1973 to 40,000 km^2 in 1990 (Zaitsev, 1993). Finally, the "hyperfertilization" of sea water has resulted in widespread decline of biodiversity (Zaitsev, 1999). The assumed cetaceans-applied effects of the nutrient pollution include the diminution of forage areas and the depletion of benthic food resources. Both these effects could be stressful for bottlenose dolphins which consume benthic fishes. Besides, the fertilized water represents a growth medium for potentially pathogenic bacteria (see 7.2.1.7 and 7.6.2) and for toxin-producing planktonic species whose toxins may be accumulated in cetacean prey.

7.2.1.2 Oil pollution in the Black Sea is concentrated predominantly in the coastal area around river mouths, sewerage outfalls, harbour and industrial installations. Accidental and operational spillage of oil and petroleum products from vessels contributes to the pollution in both inshore and offshore areas. According to incomplete data presented in the Black Sea Transboundary Diagnostic Analysis (1997), about 111,000 tn of oil are discharged into the Black Sea every year. The Danube's outflow values (53,300 tn/year) come to a half of the estimated total annual load. Significant concentrations of total petroleum hydrocarbons and products of oil degradation were detected in sea water and sediments near the Danube delta, close to the ports of Sevastopol, Ilyichevsk, Odessa, Kerch, Sochi, Varna and in the Prebosphoric area (Bayona *et al*., 1999; Mikhailov, 1999; Readman *et al*., 1999). Oil pollution induces deterioration of coastal marine ecosystems and affects the neuston superficial layer (Zaitsev and Mamaev, 1997) causing the elimination of eggs and larvae of fishes (incl. different mullet species and anchovy) which constitute a considerable part of bottlenose dolphin's diet.

7.2.1.3 Persistent organic pollutants Important synthetic pollutants are represented in the Black Sea by organohalogens: DDT and its derivatives (DDD, DDE), polychlorinated biphenils (PCBs), hexachlorohexanes (HCHs), hexachlorobenzene (HCB), chlordanes, butyltin compounds, heptachlor, heptachlor epoxide, aldrin, dieldrin, endrin, methoxychlor, and mirex which enter the sea mainly from agriculture, industry and municipal sewage. Although there is no evidence of widespread contamination of the sea by these substances, their levels in sea water and sediments sampled in some coastal areas (near Danube delta, Odessa, Sevastopol, Sochi, close to the Bosphorus and in the Kerch Strait) appear to be quite high (Mikhailov, 1999; Readman *et al*., 1999). The latter publication presents the ranking of organohalogen concentrations in Black Sea surficial sediments as follows: DDTs > HCHs > PCBs > HCB > cyclodienes. A similar ranking has been earlier reported for Black Sea fishes and harbour porpoises (Tanabe *et al*., 1997). The low DDE/DDT values combined with relatively high concentrations indicate current, certainly illegal DDT usage around the Black Sea (Readman *et al*., 1999). Persistent organic pollutants are lipophilic and liable to bioaccumulation in food webs attaining maximal concentrations in the fat of top predators including marine mammals. To date the contamination of Black Sea bottlenose dolphins is known worse (samples from six animals were studied; Table 5) than that of harbour porpoises. Bottlenose dolphins probably appear to accumulate higher concentrations of DDTs, HCHs and HCB in their blubber than common dolphins, but lower ones in comparison with harbour porpoises (Birkun *et al*., 1992, 1993). Bottlenose dolphins also accumulate in their tissues (blubber, muscle, liver and kidney were sampled) PCBs, heptachlor, heptachlor epoxide, aldrin, dieldrin, endrin, methoxychlor and mirex (BLASDOL, 1999).

7.2.1.4 Trace elements Contamination by trace elements, including heavy metals, is not a basin-wide problem in the Black Sea but in some coastal areas the surface sediments reveal increased inputs of chromium, lead, copper, zinc, vanadium, cadmium, cobalt, nickel, arsenic, mercury, iron, and manganese (Readman *et al*., 1999; Windom *et al*., 1999). The known hot spots of contamination are the outlets of Danube and Dniester rivers, the areas near Odessa, Sevastopol, Yalta and Sochi cities, the Strait of Kerch and the area near the Bosphorus. Elevated concentrations of nickel were also found in the eastern part of the Turkish Black Sea. The concentrations of total mercury and methylmercury have been determined in tissues of four bottlenose dolphins sampled in the Crimea (BLASDOL, 1999) and 17 individuals from the north Caucasus (Glazov and Zhulidov, 2001), while the content of cadmium, chromium, copper, lead, manganese, selenium and zinc was studied in latter individuals only (Table 5). Mercury levels found in Black Sea bottlenose dolphins were one order of magnitude lower than in their Mediterranean relatives (BLASDOL, 1999). It was concluded also that kidney tissue in Caucasian bottlenose dolphins is more contaminated by all mentioned elements in comparison with harbour porpoises from the same area (Glazov and Zhulidov, 2001).

7.2.1.5 Radioactive contamination The principal sources of radioactive pollution of the Black Sea are: (a) past nuclear weapon tests, carried out in the air in different points of the world in the 1950s-1960s, and (b) the Chernobyl catastrophe, occurred in the USSR in 1986 (Vakulovsky *et al*., 1994; Osvath and Egorov, 1999). As a consequence of those events, the anthropogenic radionuclides (^{137}cæsium, ^{90}strontium, $^{239\text{-}240}$plutonium, *etc*.) were introduced to the sea mainly by atmospheric precipitations and rivers, particularly, by the Dnieper and Danube. In the 1990s the Black Sea showed relatively high concentrations of radionuclides in comparison with other marine basins except the Baltic and Irish Seas which were also strongly polluted. Mean concentrations of ^{137}cæsium in the water, sediments and fish were one order of magnitude higher in the Black Sea than in the Mediterranean (Osvath and Egorov, 1999). Nevertheless, it is considered that the existing levels of radioactive contamination do not represent radiological problem for Black Sea biota and human population (Zaitsev and Mamaev, 1997; Osvath and Egorov, 1999). In contrast to harbour porpoises, whose tissues were examined for concentrations of ^{137}cæsium (Güngör and Portakal, 1996), Black Sea bottlenose dolphins were not tested radiologically up to now.

Table 5 – Studies on contaminants and microelements in Black Sea bottlenose dolphins

No. of animals	Stranded, by-caught or captive	Year of sampling	Location of sampling	Substances considered	Tissues considered	References
2	stranded	1990	Crimea (Ukraine)	S DDTs, S HCHs	blubber	Birkun *et al*. (1992)
2	stranded	1990	Crimea (Ukraine)	2,4'-DDE, 4,4'-DDE, 2,4'-DDD, 4,4'-DDD, 2,4'-DDT, 4,4'-DDT, S DDTs, HCB, a-HCH, ß-HCH, ?-HCH, d-HCH, S HCHs	blubber	Birkun *et al*. (1993)
2 2	stranded captive	1997	Crimea (Ukraine)	mercury (total and organic), PCB isomers and congeners, S PCBs, p,p'-DDE, o,p'-DDE, p,p'-DDD, o,p'-DDD, p,p'-DDT, o,p'-DDT, S DDTs, HCB, S HCHs, aldrin, dieldrin, endrin, heptachlor, heptachlor epoxide, methoxychlor, mirex	blubber, muscle, liver, kidney, brain	BLASDOL (1999)
17	by-caught and stranded	1996-1999	Caucasus (Russia)	mercury (total and organic), cadmium, chromium, copper, lead, manganese, selenium, zinc	muscle, liver, kidney, skin	Glazov and Zhulidov (2001)

7.2.1.6 Marine debris The Black Sea and its coasts seem to be subject to very high levels of solid wastes, although no formal studies of its extensiveness, sources, patterns and effects have yet been made. Marine dumping of municipal garbage is known in Turkey and Georgia (Mee and Topping, 1999). The sites of explosive objects disposal are mapped off the Crimea; five such areas are located at a depth from 80 to 1,300 m. Navigation charts reflect also the distribution of sunken vessels and other scrap metal over the shelf area; in particular, a plenty of destroyed and lost weapons are disposed since World War II in the north part of the sea. Floating litter including plastics and lost fishing nets represent particular threats to cetaceans (Zaitsev, 1998) which sometimes ingest inedible things and may get themselves entangled. A number of foreign bodies have been collected from stomachs of Black Sea common dolphins: coal slag, pieces of wood and paper, bird feathers, cherry stones, and even a bunch of roses, whereas only pebbles and sand were found in wild bottlenose dolphins (Kleinenberg, 1956).

7.2.1.7 Microbe (faecal) pollution Pathogens associated with land-based discharges, coastal diffuse sources and liquid wastes incoming from ships represent a potential health risk to cetaceans (Birkun, 1994). Actually, almost all Black Sea cities and settlements discharge their effluents (treated, partially treated or untreated) into the marine environment directly or via rivers. The estimated (probably underestimated) total volume of sewage entering the sea comes to over 571,000,000 m^3 per year (Bartram *et al*., 1999). Up to 44% of seawater samples taken during warm season (May-September) near beaches in different Black Sea countries were significantly contaminated by intestinal bacteria. In particular, the number of faecal coliforms and faecal streptococci exceeded, respectively, 20,000-100,000 and 4,000 per litre (Bartram *et al*., 1999). The concentration of *Escherichia coli* in sea water near Odessa sometimes rose up to 2,400,000 microbe cells per litre (Zaitsev, 1998). Wide diversity of enterobacteria (*Escherichia*, *Proteus*, *Edwardsiella*, *Klebsiella*, *Citrobacter*, *Enterobacter* and *Salmonella spp.*) and pyogenic cocci (*Staphylococcus spp.*) have been recorded in Georgian coastal waters (Zhgenti, 1998). The elevated concentrations of coprostanol have been detected in surficial sediments sampled near Sochi, Danube delta and Bosphorus (Readman *et al*., 1999). The cetacean-related effects of microbial pollution are considered usually as natural pathological processes (see 7.6), although faecal contamination of sea water is mainly anthropogenic. The list of bacteria indicated in various samples taken from wild Black Sea bottlenose dolphins is shown in Table 6.

Table 6 – Bacteria and antibacterial antibodies detected in wild Black Sea bottlenose dolphins

Species	Isolated cultures	Detected antibodies
Leptospira interrogans		+ [b, c]
Pseudomonas putida	+ [f]	
Pseudomonas alcaligenes	+ [e, f]	
Flavobacterium lutescens	+ [e, f]	
Alcaligenes faecalis	+ [e, f]	
Escherichia coli	+ [e, f]	
Klebsiella pneumoniae	+ [e, f]	
Proteus mirabilis	+ [f]	+ [d]
Vibrio proteolyticus	+ [e, f]	
Aeromonas hydrophila	+ [e, f]	
Aeromonas caviae	+ [e, f]	+ [d]
Micrococcus luteus	+ [e, f]	
Staphylococcus aureus	+ [e, f]	+ [d]
Staphylococcus epidermidis	+ [e, f]	
Staphylococcus saprophyticus	+ [e, f]	
Sarcina spp.	+ [g]	
Bacillus licheniformis	+ [e, f]	
Bacillus spp.	+ [e]	
Erysipelothrix rhusiopathiae		+ [a]
Corynebacterium spp.	+ [g]	

[a] - GABION (1983); [b] - Gulov (1984); [c] - Reichuk *et al*. (1986);
[d] - YEVLAKH-2 (1986); [e] - Birkun *et al*. (1988); [f] - Birkun and Miloserdova (1989);
[g] - Birkun (unpubl. data).

7.2.1.8 Introduction of alien species Marine organisms, causing this kind of biological pollution, usually arrive in the Black Sea from oceanic vessels either as their external "foulings" or in their ballast waters, which often appear to be discharged without preventive treatment (Zaitsev and Mamaev, 1997). The ctenophore (comb jellyfish) *Mnemiopsis leidyi*, accidentally introduced in the early 1980s, has reportedly exerted negative impact on the stocks of Black Sea pelagic fishes (mainly anchovy and scad) and, as a consequence, on cetaceans which feed on those fishes (Vinogradov, 1996). Over only a few years, this raptorial invader has become a dominant species; by the end of the 1980s, its total biomass in the basin was estimated at about 1,000,000,000 tn (Vinogradov *et al*., 1989) with a gradual decrease in this value during the 1990s (Mutlu *et al*., 1994; Mutlu, 2001). The outbreak of *M. leidyi* in 1988-1990 has led to the depletion of zooplankton forage sources for pelagic fishes and to the large scale consumption of their eggs and larvae; both effects, combined with overfishing have resulted in a collapse of pelagic fish resources (Zaitsev and Mamaev, 1997). There is therefore considerable reason to regard the introduction of *M. leidyi* as a form of biological pollution which is potentially able to affect Black Sea bottlenose dolphin population by the depletion of its feedings stuff.

Another kind of biological intervention in the Black Sea relates to coastal dolphinaria and oceanaria which keep exotic species of marine mammals in the nearshore open-air pens, although sometimes those constructions do not prevent escapes of captive animals into the sea. Such cases have been known since the early 1980s in the former USSR and during the last decade in the Russian Federation and Ukraine (Birkun and Krivokhizhin, 1996 a, 2001). The list of spontaneously released cetaceans and pinnipeds include the white whale (*Delphinapterus leucas*), the northern fur seal (*Callorhinus ursinus*), the Steller sea lion (*Eumetopias jubatus*), the harbour seal (*Phoca vitulina*), the Caspian seal (*Phoca caspica*) and, perhaps, one or two other pinniped species. The exact number of irrevocably escaped alien marine mammals is unknown, but it probably comes to ? few tens including two belugas which were observed many times in the wild near the Turkish, Romanian, Bulgarian and Ukrainian coasts in the early 1990s. During the last 12-14 years, solitary individuals of otariids have been recorded in the Black and Azov Seas including Karkinitsky, Kazantipsky, Feodosia and Sevastopol bays, the coast of Kerch peninsula, Arabat Spit and beaches of Sochi and Batumi. In April 1988 and April 1989 two different fur seals were recorded near Eregli, Turkey (Kiraç and Savas, 1996). According to the observations of local inhabitants and fishermen, in 1995-1998 two or three individuals of true seals (one of them allegedly had a collar) were seen annually in winter and spring in the Kerch Strait at the coast of Tuzla island (Birkun and Krivokhizhin, 2001). The fate of most accidentally released marine mammals and their possible influence on indigenous Black Sea cetaceans including bottlenose dolphins remain uncertain. Presumably, they can be a source of infections circulating in dolphinaria.

7.2.1.9 Acoustic pollution No scientific data are available on cetaceans-applied effects of sounds and noises caused by technogenic intervention into the Black Sea environment. At the same time potential sources of acoustic pollution seem to be clear and their possible role in the disturbance of bottlenose dolphins is considered in the following sections (see 7.2.2, 7.3.1, 7.3.2, 7.3.3).

7.2.2 Physical modification of the seabed

The main habitat of Black Sea bottlenose dolphins – shelf area – is under relentless pressure of various man-made physical "improvements" of the seabed, coasts and rivers inflowing into the sea. Some of these activities represent important threats for cetaceans being because they are responsible not only for widespread habitat degragation, but also for permanent or periodical disturbance of dolphin herds:
(a) channel dredging and marine dumping of removed sediments;
(b) sand extraction from the sea bottom;
(c) offshore gas and oil exploitation; and
(d) bottom trawling.

7.2.2.1 Channel dredging and marine dumping of removed sediments Habitat deterioration and disturbance of Black Sea bottlenose dolphins can be induced by the dumping of bottom sediments removed due to the deepening of navigation canals and reconstruction of ports. The dredging and dumping works cause a noise pollution and lead to the decline in water transparency, destruction and silting of benthic coenoses, and, thereby, to the reduction of cetaceans foraging capabilities. These human activities are the most peculiar to shallow waters of the northwestern shelf area, estuaries of big rivers (Danube, Dnieper, Dniester and South Boug) and the Kerch Strait. According to Bilyavsky *et al*. (1998), there are more than 30 dumping sites in the Black Sea coastal waters, and ten of them are in the northwestern area, where 5,000,000 m^3 of soil have been dumped annually since 1963 by the USSR and Ukraine. In the Kerch Strait 21,000,000 m^3 of soil were dredged and dumped during 1991-1997. In Romania from the mid 1980s to mid 1990s up to 7,000,000 m^3 of sediments have been removed each year in order to enlarge the port of Constantza, and about 1,000,000 m^3 were dredged annually from the entry of the Sulina channel connected with the Danube (Petranu, 1997). The rate of sediment accumulation at Black Sea dumping sites exceeds the natural sedimentation rate by more than 1,000 times (Bilyavsky et al., 1998).

7.2.2.2 Sand extraction from the sea bottom for building industry is widespread in the northwestern Black Sea shelf area. As a deteriorative and disturbing factor this activity is similar to the dredging, but it does not result in marine dumping. Millions tonnes of sand are extracted in Ukraine in Dzharylgachsky, Karkinitsky and Tendrovsky bays, from Odessa, Dniester and Shagany sandy banks (Zaitsev, 1998) and Lake Donuzlav.

7.2.2.3 Offshore gas and oil exploitation This kind of human activity can disturb bottlenose dolphins and do harm to their habitat in different stages of its technological chain – from geological and geophysical reconnaissance of deposits by means of trial boring and undersea bursts to industrial transportation of extracted gaz and oil by bottom pipelines. The appraisal drilling and seismic exploration are widely spread on the Black

Sea shelf. Bulgaria, Romania and Ukraine have started commercial gas and oil extraction from the sea bottom approximately 40 years ago. Basic centres of this industry, which could be designated as the hot spots with multipotential risk for marine environment, are situated in the northwestern part of the sea. In 1980-1990s seven gas and gas condense deposits have been exploited here by Ukraine; besides, it was announced that another 150 sites on the Ukrainian shelf with a total area of 70,500 km^2 are on offer for further exploitation (Bilyavsky *et al*., 1998).

7.2.2.4 Bottom trawling in the proper sense has been prohibited in the Black Sea at the beginning of the 20th century (Zaitsev *et al*., 1992). In the 1970s the riparian countries virtually recommenced this kind of fisheries under the new name of near-bottom trawling, allegedly specialized in the catching of sprat. However, both near-bottom and pelagic trawls could be easily transformed into bottom trawls (Konsulov, 1998), and their modified use in the shelf area seems to be practically uncontrolled today. The detrimental effect of seafloor trawling consists in direct mechanical damage inflicted on benthic communities and in the stirring up of sedimented pelitic matter, which causes a decrease of water transparency and buries bottom biocoenoses in neighbouring areas. The magnitude of bottom-trawling impact on cetaceans (including the decrease of forage grounds and prey accessibility) has not been estimated, although bottlenose dolphins, undoubtedly, can be influenced by this kind of fisheries.

7.3 Disturbance

Some man-made threats, supposedly provoking the disturbance of bottlenose dolphin herds (the dredging and dumping of bottom sediments and the mineral extraction from the seafloor), were just mentioned in section 7.2.2. Other anthropogenic sources of cetacean disturbance could be concerned with shipping, military, scientific and conservation activities.

7.3.1 Marine traffic

The shipping lanes crossing the Black Sea by various directions coincide with main habitat and migration ways of bottlenose dolphins because marine traffic is concentrated mostly in coastal waters over the shelf, especially, in the areas near harbors. Among numerous ports, locating in the Black Sea and contiguous waters, there are three harbor agglomerations which play obviously the most important role in the disturbance of bottlenose dolphins and could be denoted as potential hot spots affecting their distribution and migrations:

- the Bosphorus shipping junction with adjacent areas in the Black and Marmara Seas (Turkey);
- the Kerch Strait shipping junction with adjacent areas in the Black and Azov Seas (Russia and Ukraine);
- the northwestern harbor agglomeration including ports in Odessa Bay and estuaries of Dnieper, Dniester and South Boug rivers (Ukraine).

The shipping in the Black Sea has an annual tendency to increase from spring to autumn with a summer maximum due to sharp enhancement of small scale cabotage traffic and marine tourism. Most domestic and international passenger lines operate within warm season only. The highest level of Black Sea marine traffic intensity has been achieved in 1985-1992. However, further development of shipping facilities is expected (Strategic Action Plan, 1996). It was supposed that a number of cetaceans passing through the Bosphorus has a trend to decrease from year to year due to heavy traffic forming a barrier to their move between the Black and Marmara Seas (Öztürk, 1999). Sometimes cetaceans visit internal space of harbors with a risk for animals safety (B.G. Alexandrov, pers. comm.). Thus, the collisions between bottlenose dolphins and vessels seem to be possible, but probably they are not so frequent.

7.3.2 Military activities

Since the Second World War there was no any armed conflict in the Black Sea, however long-term aftereffects of past battles represent a latent threat to marine wildlife until now (see 7.2.1.6). During the post-war time a peak of military escalation has happened in the mid 1960s to mid 1980s. That was a reinforcement period for the USSR navy, when special marine areas (the firing practice sites, target ranges, proving and training grounds) have been set up in the Black and Azov Seas. Some «entry prohibited areas» continue to be explotable in the shelf zone for war games and other exercises. High frequency irradiation and noise pollution from naval ships, submarines and navy-co-operating aviation are also included in the list of major environmental problems related to military activities in the Black Sea (Bilyavsky *et al*., 1998). In 1977 the underwater explosion (124 tn in TNT equivalent) has been set off in order to destroy sunk cruiser wrecked not far from Sevastopol at a depth of 130 m (Leibovich, 1996).

7.3.3 Scientific researches and dolphin-watching activity

Eco-tourism is still in its infancy in the subregion, so there is no commercial whale-watching in the Black Sea. In 1995-1998 a series of cetacean sightings surveys was carried out in coastal Black Sea waters off Crimean peninsula and in the Kerch Strait by means of sailing and motor yachts (Birkun and Krivokhizhin, 2000). The boats sometimes exerted an attractive influence on bottlenose dolphins (animals joined the moving yachts and escorted them). The disturbance may also be caused by small flying vehicles such as motor hydro-deltaplanes which became popular in many touristic places. According to the first experience acquired in 1997 (Birkun, unpubl. data), bottlenose dolphins do not react on these objects flying above them at a height over 50 m with a speed of 90 km/hr.

7.3.4 Cetaceans rescue and release events

One sick bottlenose dolphin was rescued in Laspi Bay, Ukraine, in 1997; that animal after veterinary examination and first aid was released without further monitoring. In 1996 two captive Black Sea bottlenose dolphins were released in Taman' Bay, Russia (Veit *et al*., 1997); one of them (male) spent six years in the "Dolphin Reef Eilat" in the Red Sea (Israel), another (female) – has been caught three months before the liberation; both animals were sighted in two weeks after release among wild dolphins (see 4.4). A fair amount of bottlenose dolphins escaped from the military oceanarium in Sevastopol (Zhbanov, 1996) and from some other Ukrainian and Russian dolphinaria. Reiterated escapes of exotic marine mammals from captivity were mentioned in section 7.2.1.8 as peculiar examples of biological pollution. It is necessary to underline that release operations, in spite of their obvious benevolence, usually are stressful and may cause a disturbance/damage to both the discharged and wild marine mammals.

7.4 Interaction with fisheries

Conflict interaction between fisheries and bottlenose dolphins was substantially alleviated, but not stopped completely after the ban of cetacean mass killing in 1983 (see 7.1). Cetaceans and fishermen continue to be in the state of chronic confrontation because they have similar (but rival) vital interests in fish consumption and often catch their prey in the same areas during the same time. That is a main reason of mutual negative influence of coastal fisheries and Black Sea *T. truncatus*, and that constitutes, probably, a common problem for many fishing sites in riparian countries.

7.4.1 Impact of bottlenose dolphins on fisheries

There is no absolute crossing between fish species preferred by dolphins and fish-markets. Among fourteen species, attributed as a prey of Black Sea *T. truncatus* (Table 4), seven species were recognized as likely the most important objects of their nutrition. They are: three species of indigenous mullets (*M. cephalus*, *L. aurata* and *L. saliens*), far-east mullet (*M. so-iuy*), turbot (*P. maeotica*), whiting (*M. merlangus euxinus*) and thornback ray (*R. clavata*). However, the two latter species are considerably less important for commercial fisheries in comparison with the former five. Another three fish species – anchovy (*E. encrasicolus ponticus*), red mullet (*M. barbatus ponticus*) and bonito (*S. sarda*) – are valuable for fisheries, but obviously play the secondary role in bottlenose dolphin's diet. Residuary four species – corb (*U. cirrhosa*), sea scorpion (*S. porcus*), zander (*L. lucioperca*) and bream (*A. brama*) – were occasionally recorded in the stomach of dolphins, and they also represent very little importance for Black Sea fisheries. Finally, some fishes, e.g. sturgeons (*Acipenser spp*. and *Huso huso*), are enormously attractive for humans consumption, but they mean next to nothing for cetaceans feeding. Thus, fish resources that can provoke bottlenose dolphins and fisheries into direct competition are most probably various mullet species and turbot.

At present, no true quantitative data are available on the adverse effects of such competitive interactions on fisheries. Some Ukrainian and Russian fishermen mention episodes in which bottlenose dolphins raise trouble by damaging their nets or catch, or stealing caught fish from the nets. The same problem is known to be occurring in Romania and Turkey (Police, 1930, cited after Tomilin, 1957; Öztürk, 1999). No statistics are available on such conflicts and ensuing financial losses, and no appropriate compensation is stipulated for fishermen from their governments. There is no evidence that Black Sea fishermen use acoustic deterrent devices or any other special means to reduce undesirable interactions with bottlenose dolphins.

7.4.2 Impact of fisheries on bottlenose dolphins

Fisheries could provoke a number of effects on Black Sea *T. truncatus* :

- alteration of foraging possibilities;
- modification of behaviour;
- deterioration of habitats;
- mortality and non-mortal injuries in fishing gear; and
- alteration of distribution and migrations.

7.4.2.1 Fisheries-related changes of forage resources Mainly coastal but also pelagic fisheries can affect Black Sea bottlenose dolphin population through excessive exploitation of fish species representing the dolphin's basic prey. Negative trends in abundance are observed in indigenous mullets and turbot, especially in the northern part of the Black Sea (Zaitsev and Mamaev, 1997), where pressure from legal and illegal fisheries is clearly pronounced. Overfishing, combined with eutrophication and the outburst of a raptorial invader, *Mnemiopsis leidyi* (see section 7.2.1.8), has led to the rapid decline of anchovy abundance. As a result, the total catch of anchovy experienced a 12-fold drop: from an absolute maximum of 468,800 tn in the 1987-1988 fishing season to 39,100 tn in 1990-1991 (Prodanov *et al*., 1997). Deliberately introduced far-east mullet, *M. so-iuy*, is an example of the influence of aquaculture on Black Sea cetacean forage resources. The introduction of this species, originated from the Sea of Japan, was carried out during 1972-1984 in the lagoons and coastal waters of the northwestern Black Sea and the Sea of Azov (Zaitsev and Mamaev, 1997). Since the late 1980s this fish became widespread throughout the region and at present it is caught in all Black Sea countries. Bottlenose dolphins include this new species in their ration (Krivokhizhin *et al*., 2000; Birkun and Krivokhizhin, 2001).

7.4.2.2 Modification of feeding strategy and behaviour It is known from Ukrainian fishermen that fishing activities could be attractive for bottlenose dolphins. They may use fisheries as additional food source and include their visits to fishing boats and stationary nets into their foraging strategy. Bottlenose dolphins, are interested in both active and passive fishing types operating inshore. Solitary individuals of this species were seen more than once foraging within trap nets in the Kerch Strait, and sometimes attempts to chase them away from traps were made by means of noise and oars (V.S. Dikiy, pers. comm.). In spring 1999 one dolphin came every day during several days to a trammel net set near Cape Meganom, southeast Crimea; during each visit, the animal fed on red mullet caught in the net, leaving behind in the mesh only the fish heads (Yu. N. Ivannikov, pers. comm.). Bottlenose dolphins tend to gather around trawling boats, probably attracted by occasional discards (*e.g.*, whiting); thus, cetaceans have an opportunity to take advantage of this non-used resource (S.V. Krivokhizhin, pers. comm.).

7.4.2.3 Deterioration of bottlenose dolphins habitat The impact of fisheries on bottlenose dolphin habitat comprises all negative influences which are peculiar to small- and medium-scale shipping (*e.g.*, sewage, oil and noise pollution), but it also includes some specific extra threats. Actually, the widespread distribution of various types of fishing gear can be considered a peculiar kind of marine pollution by solid objects (see 7.2.1.6). That is true indeed regarding countless illegal nets and nets which were discarded or abandoned. High concentrations of fixed and floating fishing gear in some coastal areas result in the reduction of habitat space and represents a potential risk of entrapment. One more problem relates to seafloor trawling (see 7.2.2.4).

7.4.2.4 Accidental mortality in fishing gear Bottlenose dolphin by-catches occur in shallow waters of the continental shelf in all six riparian countries. This species never predominated in national by-catch scores. According to the results of regular studies (Vasiliu and Dima, 1990; Pavlov *et al*., 1996; BLASDOL, 1999; Öztürk *et al*., 1999), during the past decade (1990-1999) a total of 448 accidentally entrapped cetaceans were recorded in the Black Sea, including 425 harbour porpoises (95%), 10 common dolphins (2%) and 13 bottlenose dolphins (3%). The absolute numbers of population losses due to by-catch were not estimated in most Black Sea countries. Supposedly, every year at least 200-300 bottlenose dolphins are accidentally caught in Turkey (Öztürk, 1999), but it is impossible to understand the origin of these figures taking into account published statistics (only one by-caught bottlenose dolphin has been recorded during five years, 1993-1997, along the entire European coast of Turkey) (Öztürk *et al*., 1999).

According to last authors, in Turkey all registered cases of cetacean by-catch (62 harbour porpoises and one bottlenose dolphin) have occurred in turbot bottom gill nets from April to June. However, there is a cursory mention that harbour porpoises and bottlenose dolphins die in Turkish waters also due to the sturgeon and sole (*Solea spp.*) bottom fisheries (Öztürk, 1999). According to BLASDOL (1999), cetacean by-catches are most frequent during the year's second quarter (108 cases, or 68% of the reported total) off the Ukrainian, Bulgarian and Georgian coasts too. By-catches, recorded within risky months (April-June), occurred in bottom gill nets for turbot (99 harbour porpoises and five bottlenose dolphins) and trap nets (two bottlenose dolphins); during the other months one bottlenose dolphin was found in turbot net. In addition, local fishermen reported that bottlenose dolphins were sometimes incidentally caught in purse seines used to catch far-east mullet (*M. so-iuy*) in the Kerch Strait and for the winter fishery for anchovy off the coast of Crimea (A. Chashchin, pers. comm. to S. Krivokhizhin). Thus, bottom-set gill nets and turbot fishing period between April and June appear the principal fishing gear and season which are hazardous for Black Sea bottlenose dolphins and, especially, for harbour porpoises. Other fishing techniques, including purse seines, trammel and trap nets, seem to be of secondary importance.

Almost all recorded by-catches are lethal. There is no published evidence of any dolphin or porpoise survived in fishing nets in Bulgaria, Georgia, Romania and Turkey. Out of more than 2,000 entrapped cetaceans on record, 99.9% of have died in the nets in Russia and Ukraine in 1968-1993 (Pavlov *et al*., 1996). Only two bottlenose dolphins, entangled with their teeth and tail flukes in trap nets, were released alive in Ukraine in 1997-1999 (BLASDOL, 1999). No direct data are available concerning Black Sea cetaceans which after the entrapment manage to break loose from fishing nets without human assistance. Certainly, this kind of unrecorded by-catch should take place, and sudden appearance of ragged holes in nets suggests this idea to fishermen. On the other hand, some free ranging bottlenose dolphins show evident signs of past by-catching. For instance, individuals bearing net marks were sighted repeatedly between Foros and Balaklava, south Crimea, in 1997 and 1998 (Birkun and Krivokhizhin, 2000). One dolphin had a loop of rope tightened around the tail stock, while another individual missed the left pectoral fin (S.A. Popov, pers. comm.), probably as a result of traumatic amputation.

7.4.2.5 Alteration of distribution and migrations As shown above, fisheries degrade and confine living space and feeding resources of Black Sea bottlenose dolphins; some fishing operations attract them providing with an additional source of food; however, some (maybe many) individuals perish in fishing nets. All these factors are likely to influence bottlenose dolphins distribution and migrations, which mainly depend on the distribution, migrations and abundance of prey stocks (Zalkin, 1940; Kleinenberg, 1956; Tomilin, 1957). Certainly, solid data are needed to provide a better understanding of the mechanisms involved.

7.5 Capture for dolphinaria

Since the early 1960s, the USSR Navy showed particular interest in Black Sea bottlenose dolphins. The military oceanarium has been established in June 1965 and began its activities in Kazachya Bay of Sevastopol in April 1966 (Zhbanov, 1996). Now this governmental institution (Scientific Research Center “The State Oceanarium”) operates as a body depending on the Ministry of Defence and National Academy of Science of the Ukraine (Lukina *et al*., 2001). During the 1980s the Romanian Navy captured cetaceans on repeated occasions for the civil dolphinarium in Constantza (Vasiliu and Dima, 1990). The statistics of Black Sea live capture cetacean fisheries are not published. Since the 1960s many hundreds (probably, up to one thousand) of bottlenose dolphins were taken alive in the former USSR (mainly) and Romania for military, commercial and scientific needs. The Russian Federation and Ukraine are continuing that practice periodically in Taman’ Bay (Kerch Strait) and off the south Crimea. During last 15-18 years the captures were concentrated on *T. truncatus*; representatives of two other Black Sea cetacean species are not so interesting for dolphinaria because of difficulties in their maintenance. The capture operations, carried out by means of the purse-seining, sometimes accompanied by solitary and serial deaths of bottlenose dolphins as a result of strong stress and asphyxia. Most such cases, but one (Abramov, 1989), were not published in the Soviet Union. At least four bottlenose dolphins (September 1986) have died due to the “live” capturing in Romania (Vasiliu and Dima, 1990).

There are eight dolphinaria in Russia, where Black Sea bottlenose dolphins are kept together with other marine mammal species originated mainly from the Far East and Arctic. Four Russian dolphinaria, locating on the Caucasian coast (Bolshoy Utrish [Anapa], Maly Utrish [Novorossiysk], Gelendzhik and Sochi), are supplied by natural sea water. Other four facilities (Moscow, St.-Petersburg, Rostov-na-Donu and Yessentuki) use artificial or semi-artificial salted water. Eight dolphinaria are functioning in Ukraine (Yalta, Partenit [Alushta], Karadag [Feodosia], Dnepropetrovsk, two in Evpatoria and two in Sevastopol). Half of these share common defects (lack of water preparing and sterilizing systems, water circulation too slow, obsolete equipment, and deteriorated constructions). Romania and Bulgaria each possess one dolphinarium, correspondingly, in Constantza (hosting bottlenose dolphins imported from Russia) and Varna (holding the descendants of Caribbean bottlenose dolphins imported from Cuba). A total of 80-120 marine mammals (primarily Black Sea bottlenose dolphins) are currently maintained in the pools and open air cages of all mentioned facilities, including 40-50 bottlenose dolphins in Ukraine (Birkun and Krivokhizhin, 2001) and three bottlenose dolphins in Romania. In addition, there is yet another dolphinarium in Georgia (Batumi), but it does not work since the early 1990s, when its bottlenose dolphins were exported to Yugoslavia with further re-export to Malta (Entrup and Cartlidge, 1998).

Black Sea countries have no strict legal requirements for the use of captive cetaceans for science, commerce or other purposes. From two to four dozen bottlenose dolphins of reproductive age are captured every year in Russia and sporadically in Ukraine to replace dead animals. A total of about 40 individuals have been caught in Ukraine in 1995-2000 (Birkun and Krivokhizhin, 2001). The destiny of most captive cetaceans is clear: a short working life for humans, followed by disease and death caused usually by multi-bacterial pneumonia and septicaemia (Birkun *et al*., 1992). No successful breeding programmes and technologies exist for Black Sea cetaceans, although some publications portray the opposite (Bogdanova *et al*., 1996; Lukina *et al*., 2001).

During the 1980s and 1990s the exploitation of captive cetaceans intensified, and the number of seasonal dolphinaria for public display and for "swimming with dolphins" programmes has increased. At Soviet times there were translocations of Black Sea military bottlenose dolphins to the facilities in the Japanese and Barents Seas. During the last decade the export of bottlenose dolphins from Russia and Ukraine has expanded, for example, to Argentina, Byelorussia, Chile, Cyprus, Egypt, Hungary, Iran, Israel, Lithuania, Romania, Turkey, United Arab Emirates, Vietnam, and former Yugoslavia countries. It is known that during the touring of cetacean exhibitions, deceased dolphins were sometimes replaced with freshly caught animals (Birkun *et al*., 1992). Further details on the export of Black Sea bottlenose dolphins and their fate are available from the WDCS report (Entrup and Cartlidge, 1998).

7.6 Natural mortality and pathology

Normal mortality rate is not evaluated for Black Sea population of bottlenose dolphins. Meantime, some natural pathogens are known to induce lethal diseases in these animals (Birkun *et al*., 1992). According to yearly dynamics of cetacean strandings recorded in the Crimea (Krivokhizhin and Birkun, 1999), since 1989 there was one elevation of bottlenose dolphin natural mortality. That was a prominent peak of *T. truncatus* strandings recorded in 1990 (20 dead animals or 44% from all bottlenose dolphin landings reported during 1989-1996 period) (Krivokhizhin and Birkun, 1999). An origin of that event remains unclear; probably it was caused by undetermined virus infection affected at the same time also Black Sea common dolphins and harbour porpoises.

7.6.1 Virus infections

The outbreak of morbilliviral disease has happened among Black Sea common dolphins in July–September 1994 (Birkun *et al*., 1999 b). It was supposed that morbilliviral infection has spread to the Black Sea from the Mediterranean, where it affected striped dolphins (*Stenella coeruleoalba*) in 1990-1992 (Aguilar and Raga, 1993). In other view, the Black Sea possibly was a persistent focus of cetacean morbilliviral infection during indefinably long time before the epizootic in common dolphins. The two facts, related to bottlenose dolphins, may be indirect proofs of this assumption:

(a) serum antibodies against *parainfluenza II* and *III viruses* were detected, respectively, in 10% and 2% of bottlenose dolphins kept in the Sevastopol's oceanarium in the early 1980s (Gulov, 1984). Both the parainfluenza viruses and morbilliviruses belong to the same family Paramyxoviridae, therefore the antigenic crossing between them is possible, and an infectious interaction between bottlenose dolphins and morbilliviruses can not be excluded in those cases;

(b) morbillivirus-specific antibody titers were indicated in Black Sea bottlenose dolphins maintained in the Tel Aviv's Luna Park in 1994 (M. Garcia-Hartmann, pers. comm.). The animals could not be infected in Israel; obviously, they contacted with the pathogen in the wild or at previous place of captivity in the Black Sea. Anyway, infectious interaction with a morbillivirus occured before the epizootic in Black Sea common dolphins.

Serum antibodies to *influenza A2 virus* (strain "Khabarovsk") and to *Flavivirus* (acarine encephalitis virus, strain "Sofiin") were detected in captive bottlenose dolphins maintained in Sevastopol (Gulov *et al*., 1982; Gulov, 1984). Besides, 17% of wild bottlenose dolphins were seropositive to *Flavivirus* too. Both viruses were not isolated, and any symptoms of a sickness were not recorded in those cases.

7.6.2 Bacterial diseases

Current knowledge on bacteria, infecting wild Black Sea bottlenose dolphins, is rather limited (Table 6). In the 1980s the screening of various antibacterial serum antibodies has been carried out in several tens of animals which were sampled just after their live capture for dolphinaria (GABION, 1983; Gulov, 1984; Reichuk *et al*., 1986). As a result, diagnostic titers of antibodies to *Leptospira* and *Erysipelothrix spp*. were determined in some cases, although bacterial cultures were not isolated and no specific lesions were found by means of routine veterinary examination. Nevertheless, it was supposed that Black Sea bottlenose dolphins may be the victims, carriers and reservoirs of the leptospirosis and erysipelas. The role of these bacterial infections in cetacean natural morbidity and mortality is not specified until now. Fatal epizootics of the erysipelas (Nifontov, 1969; Rodin *et al*., 1970; GABION, 1983) and listeriosis (Oleinik and Gulov, 1981; Gulov, 1984) have been recorded amongst captive bottlenose dolphins which died usually due to the septicaemia.

Inshore species of cetaceans are considered as the targets for polymicrobial anthropogenous pollution of the Black Sea (Birkun, 1994). A number of opportunistic bacteria, originated most probably from the untreated sewages, were isolated from the skin, respiratory tract and internal organs of wild bottlenose dolphins investigated *post mortem* and alive (Table 6) (Birkun *et al*., 1988; Birkun and Miloserdova, 1989; BLASDOL, 1999). Those organisms, belonging to intestinal microflora (*Alcaligenes*, *Escherichia*, *Klebsiella* and *Proteus spp.*), halophilic aquatic bacteria (*Vibrio* and *Aeromonas spp*.) and pyogenic cocci (*Staphylococcus spp.*), may cause local and generalized secondary infections in the weakened individuals primarily compromised by helminth infestation, non-infectious pathology or traumata (Birkun and Miloserdova, 1989). In this respect the mass mortality event recorded in 1990 could be the convincing example (Birkun *et al*., 1992; Krivokhizhin and Birkun, 1999). Multi-microbial pollution of coastal waters causes a permanent risk of mixed-infectious injuries (mainly pneumonias and septicaemias), when two and more species of opportunistic bacteria and fungi are involved in pathological process. It was shown that *Staphylococcus aureus* in combination with various enterobacteria (most often – with *Proteus mirabilis*) constitutes a continual threat for wild and captive Black Sea bottlenose dolphins (YEVLAKH-2, 1986; Birkun *et al*., 1990; Birkun, 1994). In such cases the development of local suppurative inflammation and generalization of septic lesions are accompanied by immune response and immunopathological reactions to the antigens pertaining to different members of morbific bacterial associations.

7.6.3 Microalgae vegetation

Microphytic algae, predominantly diatoms (Bacillariophyta), are known to produce a fouling film over the skin of captive bottlenose dolphins maintaining in Russian and Ukrainian dolphinaria. The pathogenic significance of this cosmetic defect continues to be a point of discussion (Birkun and Goldin, 1997; Goldin and Birkun, 1999). Meantime, pronounced microalgal vegetation on skin surface is a reliable indicator of feeble health in captive cetaceans and/or unfavourable zootechnic and veterinary conditions (e.g. limited room hindering animals mobility, stagnant and polluted water, *etc*.) in the places of their captivity. Visible algal film has never been recorded in wild Black Sea cetaceans, but sparse cells of the diatoms (*Licmophora sp*. and *Nitzschia hybrida* f. *hyalina*) were detected in skin scrapes collected from few newly captured bottlenose dolphins (Goldin, 1996, 1997).

Numerous cells of non-parasitic dinoflagellates (Dinophyta) and unidentified unicellular seaweeds were found in blowhole swabs of bottlenose dolphins and belukhas (*D. leucas*) kept together in the open-air sea pen in Laspi Bay, south Crimea (Krivokhizhin and Birkun, unpubl. data). Unfortunately, no data are available on cetaceans-applied effects of Black Sea dinoflagellates and their toxins, although “red tides” caused by blooms of these microalgae became common in the subregion since the 1970s (see 7.2.1.1).

7.6.4 Mycoses

Black Sea bottlenose dolphins can be contaminated by microscopic fungi which may cause secondary infections of integumentary tissues (superficial mycoses or dermatomycoses) and internal organs (deep or systemic mycoses). According to the research conducted in the former Soviet Union, opportunistic fungi, invading bottlenose dolphin skin and allegedly inducing superficial mycoses, are represented by the genera *Alternaria*, *Rhodotorula*, *Cladosporium*, *Mortierella*, *Trichophyton*, *Rhombophytum* and *Hyphomyces* (Zakharova and Zagoruyko, 1978; Zakharova *et al*., 1978 a; Tomilin and Bliznyuk, 1981; Zakharova *et al*., 1982; Zakharova and Dralkin, 1985). Maculated, papulous and ulcerative dermatites, caused by fungi and bacterial-mycotic associations, are widely spread in bottlenose dolphins off the Crimea coast. There is no direct evidence that dermatomycoses themselves lead to lethal end, but they usually open a gateway for further microbe intrusion and promote systemic dissemination of pathogens.

Deep mycoses were reported in captive bottlenose dolphins: one case of pyonecrotic broncho-pneumonia caused by *Aspergillus fumigatus* (pulmonary aspergillosis) (Oleinik *et al*., 1982) and two cases of chronic sepsis caused by *Candida sp.* (systemic candidiasis) (Gulov, 1984) have resulted in animals death.

7.6.5 Parasitic diseases

Protozoan infections and external macroparasitism are unknown in Black Sea bottlenose dolphins. The internal macroparasites of Black Sea *T. truncatus* are represented by six species of helminths belonging to the flukes (Trematoda; three species), tapeworms (Cestoda; one species) and roundworms (Nematoda; two species) (Table 7). The life circles are not investigated for all of them.

Table 7 – Helminths of Black Sea bottlenose dolphins

Parasites	References (first publications)
Trematodes	
Braunina cordiformis	Delamure *et al.* (1963)
Synthesium tursionis	Delamure and Serdyukov (1966)
Pholeter gastrophilus	Birkun *et al.* (1992); Krivokhizhin (1992)
Cestodes	
Diphyllobothrium stemmacephalum	Delamure (1945, 1971)
Nematodes	
Stenurus ovatus	Delamure (1945)
Crassicauda sp. (*C. grampicola*?)	Birkun *et al.* (1992); Krivokhizhin (1992)

Flukes *Braunina cordiformis* and *Synthesium tursionis* were recorded in gastrointestinal tract; all infrequent findings of these parasites belong to the 1950s-1960s (Delamure *et al*., 1963; Delamure and Serdyukov, 1966). Their role in dolphin mortality remains unclear. Stomach fluke *Pholeter gastrophilus*, a causative agent of chronic deforming gastritis (pholeterosis), have been first reported in Black Sea *T. truncatus* in the early 1990s (Birkun *et al*., 1992; Krivokhizhin, 1992). The extensiveness of this invasion came to 63% in stranded bottlenose dolphins (Krivokhizhin, 2000). In cases with pronounced sclerotic, necrotic and granulomatous lesions in gastric wall, the pholeterosis can be complicated by pyloric stenosis and, presumably, by gastric bleeding and perforation which may lead to animals death.

The intestinal invasion, caused by tapeworm *Diphyllobothrium stemmacephalum* (diphyllobothriosis), is characterized by relatively low extensiveness (13% of stranded bottlenose dolphins are infected) (Krivokhizhin, 2000) and low to moderate intensity (1-14 worms per host) (S.V. Krivokhizhin, pers. comm.). A death, admittedly, may be caused by obstructive intestinal impassability (ileus, volvulus) due to the bundling of twisted helminths in gut's lumen.

The nematode *Stenurus ovatus* is known for a long time as a lung parasite of Black Sea bottlenose dolphins (Delamure, 1945), but any indices of the extent of this invasion and any opinion on its role in cetacean morbidity were not published before the 1990s (Krivokhizhin, 1997). Delamure (1955) recorded *S. ovatus* in a blowhole, bronchi and blood vessels. Among eight stranded animals, examined in 1989-1999, there was one animal with the parasites in bronchi and with calcified residues, probably originated from nematodes, in the lung tissue; two more individuals had calcifications only (Krivokhizhin, 1997, 2000). In all those cases, chronic broncho-pneumonia combined with focal purulent bronchitis and alveolitis suggested associative participation of helminths and pyogenic microflora in the development of tissue injury.

The first finding of spirurids *Crassicauda sp.* in Black Sea cetaceans has been recorded in 1989 in a harbour porpoise stranded on the Crimean coast (Krivokhizhin, 1989). During the 1990s these worms were repeatedly found in porpoises and also in common and bottlenose dolphins (Birkun *et al*., 1992; Krivokhizhin, 1992; Birkun and Krivokhizhin, 1993; Krivokhizhin and Birkun, 1994; Birkun *et al*., 1999 a). After consultations (J.A. Raga, pers. comm.; A.S. Skryabin, pers. comm.) the nematodes have been preliminary attributed to *Crassicauda grampicola* (Krivokhizhin, 2000). The parasites always located in cranial sinuses (predominantly in pterygoid sinus) and inner ear and usually caused osteolytic lesions in the surrounding skull bones with their perforation, in particular, to cranial cavity. The reactive focal meningitis has been observed in some cases. According to the data collected during eleven years (1989-1999), the crassicaudosis affected 25% of stranded bottlenose dolphins (Krivokhizhin, 2000). The intensity of the invasion did not exceed four nematodes per host (S.V. Krivokhizhin, pers. comm.). It is thought that this infection may lead to cetacean live strandings and lethal end due to cerebral disorders.

Unidentified helminths have been extracted from tumour-like formation located in bottlenose dolphin's skin (Zakharova *et al*., 1978 b). Microscopic calcifications, presumably originated from necrotized helminths (nematode larvae?), were indicated in kidneys of another individual (BLASDOL, 1999).

7.6.6 Environmental hazards

Stormy weather was supposed as a probably important mortality factor for newborn bottlenose dolphins (Zalkin, 1940; Kleinenberg, 1956). Nevertheless, calves less than 1.5 m long were never recorded stranded in the Crimea (Birkun and Krivokhizhin, unpubl. data).

7.6.7 Miscellaneous injuries

Multifarious disease conditions and injuries found occasionally in Black Sea bottlenose dolphins (Table 8) were not attributed to the above-mentioned types of pathologies, although most inflammatory lesions in integument tissues and internal organs could be possibly caused by known (but not isolated) viruses, bacteria, fungi and helminths. The current knowledge on non-infectious diseases and congenital anomalies (e.g. arteriosclerosis and partial albinism) is very limited. Parallel skin scars caused by intraspecific interaction are the most frequent traumatic lesions recorded in bottlenose dolphins.

Table 8 – Miscellaneous pathological findings related to disease processes and anomalies in wild Black Sea bottlenose dolphins (infections with known etiology are not included)

Pathological findings	References
Respiratory and cardiovascular systems	
Purulent and necrotic broncho-pneumonia and bronchitis	BLASDOL (1999)
Chronic pulmonary abscesses	unpubl. data
Arteriosclerosis of aorta	BLASDOL (1999)
Digestive system	
Worn teeth	Silantyev (1903); Belkovich *et al*. (1978); BLASDOL (1999)
Broken-off teeth	BLASDOL (1999)
Loss of teeth	BLASDOL (1999)
Necrotic (ulcerative) stomatitis, glossitis and pharyngitis	BLASDOL (1999)
Foreign bodies in the stomach	Kleinenberg (1956)
Acute gastritis (incl. erosions and ulcers)	unpubl. data
Chronic gastric ulcers	unpubl. data
Necrotic gastroenteritis and chronic enteritis	BLASDOL (1999)
Hepatitis (incl. cholangitis and pericholangitis)	BLASDOL (1999)
Focal pancreatitis	BLASDOL (1999)
Immune, endocrine and urogenital systems	
Suppurative and necrotic splenitis	BLASDOL (1999)
Fibrous atrophy and lymphoid depletion of the spleen and lymph nodes	BLASDOL (1999)
Suppurative lymphadenitis	BLASDOL (1999)
Foci of suppurative inflammation in adrenals	BLASDOL (1999)
Interstitial nephritis	BLASDOL (1999)
Integument and bones	
Skin scars	Belkovich *et al*. (1978); BLASDOL (1999)
Hypo- and hyperpigmented epidermal spots	Belkovich *et al*. (1978)
Albinism (partial)	BLASDOL (1999)
Unspecified dermatites	BLASDOL (1999)
Lordoscoliosis and kyphoscoliosis	unpubl. data

8 Conservation measures

The future of Black Sea marine mammals in general and *T. truncatus* population in particular is a problem of concern on different levels of international co-operation. Local bottlenose dolphins and their habitat are protected by a series of worldwide, European, regional and subregional legislative acts including the Bonn Convention, CITES, Berne Convention, ACCOBAMS and Bucharest Convention. Black Sea population of bottlenose dolphins is listed in the Classification of endangered marine mammals of UNEP Global Action Plan for Conservation, Management and Utilization of Marine Mammals (1985). This population is noted as vulnerable (VU) in IUCN Red Data List and therefore it is presented in IUCN/SSC Conservation Action Plan for

Cetaceans (since 1988 incl. last update in 2001). The bottlenose dolphin is also presented in IUCN Red Data Book on cetaceans and Black Sea Red Data Book.

The list of international documents and institutions which recognize the necessity of conservation and research of Black Sea cetaceans is quite long. There are many talks around these animals, but few activities only for their real protection and monitoring of their status. The IWC Scientific Committee is concerned because of a lack of reliable data on Black Sea cetacean abundance and on the numbers of their kills (1977, 1983, 1990, 1992). In 1994 the European Cetacean Society (ECS) has sent the appropriate Letter of Concern on the "Future of Black Sea Dolphins" to the governments of Black Sea countries and to the European Union. The 1st International Symposium on Marine Mammals of the Black Sea (Istanbul, 1994) has adopted a similar Declaration. Both documents distributed among various governmental, nongovernmental and intergovernmental organizations were as a summary of urgent needs for Black Sea cetacean research and conservation. In 1996 the Ministers of Environment of Black Sea countries have adopted a number of cetacean conservation measures listed in the Strategic Action Plan for the Rehabilitation and Protection of the Black Sea (paragraph 62). All three cetacean species inhabiting the Black Sea are mentioned in the EC Directive No.92/43/EEC on the conservation of natural habitats of wild fauna and flora: common dolphin – in Annex IV "Animal and plant species of Community interest in need of strict protection"; harbour porpoise and bottlenose dolphin – in Annex II should mean that special protected areas have to be created for them.

At the national level Black Sea cetaceans are protected by the Animal World Laws, governmental decrees and various ministerial regulations. The bottlenose dolphin is included in the National Red Data Books of Bulgaria, Georgia, Russia, and Ukraine. Under the national legislation of most Black Sea countries, the endangered spesies as well as other species listed in national Red Data Books should be monitored and managed by appropriate governmental programmes. In March 2001 the Parliament of Ukraine has approved by law the National Programme for the Conservation and Rehabilitation of the Environment of the Azov and Black Seas. Some specific measures concerning the monitoring and conservation of marine mammals are specified in paragraph 3.1 of this document.

A list of references is available on request from the CITES Secretariat.