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Risso's dolphin (*Grampus griseus*) stranding on the coast of Israel (eastern Mediterranean). Autopsy results and trace metal concentrations

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Abstract

The stranding of Risso's dolphin (*Grampus griseus*) on the Mediterranean coast of Israel is reported in this study. High concentrations of trace metals (Hg, Cd, Zn, Fe and Se) were found in the various tissues analyzed, while Cu and Mn concentrations were naturally low. The specimen was found alive, but died a day later. The cause of death was attributed to bacterial bronchopneumonia in combination with endotoxemia, resulting in disseminated intravascular coagulation. Plastic bags found in its stomach contributed to the dolphin's poor physical condition. No connection was found between the high concentrations of trace metals in the internal organs and the cause of death. It is assumed that the high concentrations were a result of the high trophic level of this species, its diet and its advanced age. Anthropogenic influence could not be assessed due to the sparse database of trace metals for this species, in particular knowledge of the natural levels. © 2002 Elsevier Science B.V. All rights reserved.

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1. Introduction

Cetaceans (whales and dolphins), positioned at the top trophic level of the food web, are able to uptake, excrete, or detoxify heavy metals (Law, 1996). In some cases, the balance between ingestion and elimination processes leads to accumulation. Heavy metal accumulation in cetacea may be correlated with age (Viale, 1978; Martoja and Berry, 1980; Honda et al., 1983; Law, 1996) and coupled with metallothioneins, which play an important role in the transport and storage of metals (Law, 1996). The bioaccumulation may be natural or elevated as a result of marine pollution. Specific diet and food sources, the physiological state of the individual and the toxicological dynamics of the specific metal were found to be the major factors influencing bioaccumulation. Consequently, high variability in trace metal concentration exists among cetacea species and marine

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habitats (Viale, 1978; Law et al., 1992; Monaci et al., 1998).

The Mediterranean Sea is home to approximately 20 different cetacean species (UNEP/IUCN, 1994). The most abundant dolphin species are *Delphinus delphis* (common dolphin), *Tursiops truncatus* (bottlenose dolphin), *Grampus griseus* (Risso's dolphin) and *Stenella coeruleoalba* (striped dolphin). Stranding of dolphins in the Mediterranean Sea has been reported in the literature (Andre et al., 1991; Augier et al., 1993; Monaci et al., 1998, among others). Along the Mediterranean Israeli coast, 67 dolphins and whales were beached or stranded between 1993 and 1999 (Goffman et al., 2000; Roditi-Elasar, 1999). Out of the 67, only three were *G. griseus.*

Contrary to the extensive literature on trace metals in some of the abundant dolphin species, there are almost no data on trace metals in *G. griseus*, although this species is quite ubiquitous in all temperate and tropical oceans and adjoining seas (Nowak, 1999). *G. griseus* is an open sea species that preys almost exclusively on squid (Nishiwaki, 1972; Leatherwood and Reeves, 1982; Pauly et al., 1998; Kruse et al., 1999). There are several reports in the literature on beached *G. griseus* specimens, but not in the context of trace metals (Kim et al., 1996; Lawson and Eddington, 1998; Van Bressem et al., 1998). Trace metal concentrations were reported by Zonfrillo et al. (1988), Law (1994) and Law et al. (2001) in liver tissue of three *G. griseus* specimens from the UK, by Storelli et al. (1999) in various tissues of two specimens from the southern Adriatic Sea, and by Frodello et al. (2000) in one specimen from the western Mediterranean.

The objectives of this study were twofold:

i. To determine the concentrations of Hg, Cd, Cu, Zn, Mn, Fe and Se in various tissues of *G. griseus* specimens collected on the Mediterranean coast of Israel and to attempt to connect them to the autopsy results; and
ii. To increase the sparse database of contaminant data available for this species and to compare the concentrations found to those in other species from the study area.

2. Methods

Three specimens of beached *G. griseus* were found along the Israeli coast between 1993 and 1999. A young individual was found in May 1998 and a male of 320 cm in length in June 1998. Both were found decomposed with poor tissue integrity, and therefore no tissue samples were taken for heavy metal analysis.

The third specimen was found alive on 8 June 1999 on the central part of the Israeli Mediterranean coast. The dolphin was held at sea by volunteers for 4 h, and then transferred to the rehabilitation pool of the Israeli Marine Mammals Research and Assistance Center (IMMRAC). It died 23 h after rescue efforts failed. The dolphin was measured and weighed, and then taken for autopsy, carried out following Dierauf (1990). Tissue samples from the muscle, liver, kidney, brain, blubber and skin, as well as blood and stomach contents, were collected for the determination of trace metals. Teeth for age determination were sampled and sent to Dr C. Lockyer in Denmark, who used the methods described by Hohn et al. (1989).

Tissue samples for trace metal determinations (Hg, Cd, Se, Cu, Zn, Fe and Mn) were kept frozen at -20 °C until analysis. Wet samples were digested with concentrated nitric acid in Teflon-lined, high-pressure decomposition vessels as described by Hornung et al. (1989). A separate digestion was performed for Hg determination. The solutions were specifically analyzed for Cd, Cu, Zn, Mn and Fe by flame atomic absorption spectrophotometry on a Perkin-Elmer 1100B spectrophotometer equipped with a deuterium-arc background corrector. Hg was analyzed by cold vapor atomic absorption spectrometry on a Coleman MAS-50B mercury analyzer. Se was analyzed at the Geological Survey of Israel by ICP-MS. Detection limits for Cd, Hg, Cu, Zn, Fe, Mn and Se were 0.03, 0.005, 0.03, 0.07, 0.04, 0.01 and 0.001 mg kg^{-1} wet weight, respectively. Chemical blanks that were run during the analysis presented no evidence of contamination. The samples were analyzed in duplicate and the results reported are the averages. Quality control and quality assurance of trace metal determinations were performed on

Table 1
Concentrations of trace metals in various tissues of the *Grampus griseus* specimen

Tissue	Concentrations (mg kg^{-1} wet wt.)						
	Hg	Cd	Se	Cu	Zn	Fe	Mn
Muscle	395	0.61	31.4	2.86	68.8	976	0.55
Liver	1326	14.3	378	6.11	36.2	1277	2.64
Kidney	65.4	7.63	25.3	2.93	32.0	233	0.61
Brain	193	0.08		4.15	31.3	42.7	0.40
Blubber	102	0.15	13.3	0.41	12.8	36.1	BDL
Skin	63.9	1.28		4.73	1087	217	BDL
Blood	10.8	0.33		0.85	5.08	753	BDL
Stomach contents	25.5	1.59		105	183	214	BDL

BDL, below detection limit, <0.01 mg kg^{-1} wet wt.

certified standard reference materials from the National Institute of Standards and Technology (NIST, bovine liver) and from the National Research Council of Canada (NRCC, DORM 2 and DOLT 1, dogfish muscle and liver). The standards were digested and analyzed in the same manner as the samples with each analytical run. All standard reference materials gave results within 5% of the certified values.

3. Results and discussion

3.1. Autopsy

The specimen was a 19-year-old female of 335 cm in length weighing 340 kg. The blubber thickness in the central body was 2.5 cm. The autopsy results showed that the dolphin was freshly dead, physically deteriorated and emaciated with a decayed tooth. The entire skin area showed many wounds with proliferated tissue. The skin lesions were characterized as suppurative granulomatous dermatitis. Areas of deep ulceration containing amorphic and necrotic substance were observed. The edge showed large amounts of neutrophils and bacteria. Large amounts of parasites were located at the blowhole. The internal examination began with DNA skin sampling, followed by removal of the blubber layer, and pectoral and dorsal fins. The ribs were removed and the entire organs were examined. Many internal parasites were found in the trachea. Patchy areas of hemorrhage with edema were observed in the lungs, which revealed severe bronchopneumonia. Histologically, there were inflammatory exudates that contained neutrophils and macrophages in the alveoli. The gastrointestinal tract was dissected, beginning with the tongue and proceeding caudally. The first stomach contained two 0.5-m plastic bags and the remnants of squid. The second and third stomachs were empty, excluding greenish fluid. The gastric mucosa was ulcerated. The intestine contained brown fluid and revealed many ulcers with numerous roundworms that were located on the intestinal mucosa. In the central nervous system, brain neurons and spinal cord, there was a large amount of lipomicin, which indicates old age. *Streptococcus alpha haemolytica* was isolated from all internal organs. No remarkable findings were observed in the other organs, including the brain and heart muscle.

The histological and microbiological results point to bacterial bronchopneumonia in combination with endotoxemia, which probably indicates disseminated intravascular coagulation (DIC) as the most likely primary contributing factor that led to the animal's demise. The plastic bags found in its stomach were a significant additional factor to the dolphin's poor physical condition.

3.2. Mercury and cadmium—non-essential elements

The concentrations of Hg found in the various tissues were very high (Table 1), even considering the wide Hg inter- and intra-species variation in marine mammals from different areas (Thompson, 1990; Law, 1996; Tables 2–4). Mercury absorption

Table 2
Concentrations of trace metals in various tissues of *Grampus griseus* from different areas

Location	Tissue	Length (cm)	Concentration (mg kg^{-1} wet wt.) Hg	Cd	Cu	Zn	Fe	Reference
South Adriatic Sea	Liver	299	1002	6				Storelli et al. (1999)
	Muscle		26.5	0.21				
	Kidney		61	7.3				
	Liver	311	478	8.4				
	Muscle		30.9	0.09				
	Kidney		48	15.9				
Western Mediterranean, Corsica	Liver[a]	310	989					Frodello et al. (2000)
	Kidney[a]		48.6					
	Muscle[a]		56.7					
	Skin		31					
UK	Liver	210	1.2					Zonfrillo et al. (1988)
	Kidney		0.6					
UK	Liver	161	1.3	<0.06	31	40		Law (1994)
UK	Liver	207	2.6	0.2	5.2	37	337	Law et al. (2001)

[a] Wet weight calculated based on 30% dry matter.

in dolphins can occur via pulmonary, cutaneous and digestive pathways. However, the latter is considered the most significant and the liver the most important accumulator of Hg in dolphins (Wagemann and Muir, 1984; Andre et al., 1990; Marcovecchio et al., 1990; Thompson, 1990; Augier et al., 1993; Law, 1996). Therefore, the expected order of Hg accumulation in the different tissues is: liver ≫ spleen ~ blubber ~ kidneys/pancreas > lungs > muscle ~ brain ~ skin > blood. We found a very similar order in the *G. griseus* specimen: liver > muscle > brain > blubber > kidney > skin > stomach contents > blood. The relative concentration in the muscle was higher than expected. The digestive pathway option of Hg accumulation is supported by the high concentration found in the stomach contents (25.5 mg kg^{-1} wet wt.). The limit of tolerance for Hg in mammalian hepatic tissue seems to be within the range 100–400 mg kg^{-1} wet wt. Above this range, hepatic damage can occur (Wagemann and Muir, 1984). The concentration found in the liver was well above the limit of tolerance; however, no remarkable findings were observed in the internal pathological examination of the liver. It is known that marine mammals have the ability to immobilize Hg as the selenide and accumulate it without apparent harm (Law, 1996); indeed, high Se concentration was found in the liver (Section 3.3).

Similar high Hg concentrations were found in *G. griseus* specimens from other areas in the Mediterranean Sea, while much lower Hg concentrations were found in the liver tissue of three *G. griseus* specimens found in the UK (Table 2; Zonfrillo et al., 1988; Law, 1994; Law et al., 2001). The specimens in the UK were younger than those found in the Mediterranean, and therefore may not have bioaccumulated Hg with age. An additional factor that may explain these differences is the Hg anomaly in the Mediterranean. It is known that Hg concentrations in biota from the Mediterranean are higher than the concentrations in the same species in the Atlantic due to natural introduction (Moore and Ramamoorthy, 1984; Bernhard, 1988). The Mediterranean region is part of the CircumPacific–Mediterranean–Himalayan mercuriferous belt causing natural Hg enrichment (UNEP/EEA, 1999). In Tuscany, Hg concentrations in red mullet were much higher near the geochemical Hg anomaly of Mount Amiata than in red mullet from other areas (UNEP/EEA, 1999). Anchovy, mackerel, sardine and tuna from

Table 3
Concentrations of trace metals in the various tissues of marine mammals from the Mediterranean Sea

Species	*N*	Location	Tissue	Concentration (mg kg^{-1})				
				Hg	Cd	Cu	Zn	Fe
T.t, D.d, S.c, Z.c	12	Western Mediterranean (wet wt.)[a]	–	1.6–604	0.01–29			13.6–669
S.c	13	Western Mediterranean, France (dry wt.)[b]	Liver	68–2272				
			Muscle	7.4–155				
			Kidney	14.3–341				
			Blubber	0.4–3.1				
			Brain	3.5–81				
			Skin	4.9–19.9				
S.c	125	Western Mediterranean, Italy and Spain (dry wt. averages)[c]	Liver	593, 1043	4.43, 3.95	22–39	111, 161	
			Muscle	53, 28	0.10, 0.05	6.2, 6.8	37.5, 20	
			Kidney	44, 63	27.51, 8.38	14.2, 12.3	100, 82	
			Brain	3, 9	0.07, 0.06	15.4, 9.7	45.8, 40.4	
			Skin	9, 10	0.10, 0.03	2.5, 4.2	475, 482	
S.c	35	Western Mediterranean, France (wet wt.)[d]	Liver	1.2–1544				
			Muscle	1.0–81.2				
			Kidney	1.4–179				
T.t, D.d, S.c, G.m	5	Western Mediterranean, Corsica (dry wt.)[e]	Liver	134–4,250				
			Kidney	41–256				
			Lung	12–301				
			Muscle	16–334				
			Skin	15–31				
			Bone	2.1–150				
S.c	4	Eastern Mediterranean, Israel (wet wt.)[f]	Liver	1.4–143	0.07–4.55	1.09–12.4	23–53	129–594
			Muscle	0.45–11.4	0.02–0.14	1.12–1.83	7.9–32	104–245
			Kidney	1.9–9.9	0.18–15.2	2.58–4.01	17–32	63.4–232
T.t	16		Liver	1–490	0.12–1.12	3.2–24	15.4–105	163–699
			Muscle	0.4–14	0.04–0.2	0.7–1.7	10–47	76–340
			Kidney	0.3–32	0.06–7	1.9–5.3	12.5–30	66–246
			Brain	0.28–10.5	0.01–0.14	2.03–4.75	10–22	18–74
			Skin	0.27–10.3	0.04–0.3	0.5–2.16	157–368	9.5–137
S.c	19	North-West Mediterranean (dry wt.)[g]	Liver	12.6–4400	0.2–12.8		150–387.5	
	22		Muscle	6.5–168.4	0.07–1.8		41.7–108.3	
	18		Kidney	5.8–204.4	10.8–98.8		96.9–193.9	
	13		Brain	2.8–121.4	0.06–0.40		45.1–84.3	
T.t	4		Liver	12.2–13,155	0.3–1.06		125–262	
	6		Muscle	4.9–292.1	0.04–0.57		46.5–86.3	
	5		Kidney	7.1–882.3	0.2–11.2		78.3–175.5	
	6		Brain	1.6–5.0	0.07–0.11		79.9–108.2	

N, number of specimens; S.c, *Stenella coeruleoalba*; D.d, *Delphinus delphis*; T.t, *Tursiops truncatus*; M.w, Minke whale; G.m, *Globicephala melas* (pilot whale); Z.c, *Ziphius cavirostris*.

[a] Viale (1978).
[b] Augier et al. (1993).
[c] Monaci et al. (1998).
[d] Andre et al. (1991).
[e] Frodello et al. (2000).
[f] Roditi-Elasar (1999).
[g] Leonzio et al. (1992).

Table 4
Concentrations of Hg in various tissues of marine mammals from areas other than the Mediterranean Sea

Species	Location	Tissue	Hg (mg kg^{-1})		*N*	Reference
Lagenorhynchus albirostris	North Sea	Muscle	2.3–10.6	DW	3	Siebert et al. (1999)
		Liver	5.7–220.7			
		Kidney	2.0–17.0			
Phocoena phocoena	North & Baltic Seas	Muscle	0.6–398	DW	57	
			0.2–108	WW		
		Liver	0.6–449	DW		
			0.2–130	WW		
		Kidney	0.5–160	DW		
			0.1–33.5	WW		
Delphinapterus leucas	Canadian Arctic & St. Lawrence estuary	Muscle	0.36–33.4	DW	107	Wagemann et al. (1990)
		Liver	0.04–756			
		Kidney	0.8–228			
Stenella attenuata	Eastern Pacific Ocean	Muscle	0.1–9.17	WW	44	Andre et al. (1990)
		Liver	0.18–217.5			
		Kidney	0.03–14.16			
Globicephala melas	North Atlantic Ocean	Liver	52–84	WW[a]		Caurant et al. (1994)
		Kidney	4.9–5.7		97	
Phocoenoide dalli	Northwestern Pacific	Liver	6.38	WW	1	Fujise et al. (1988)
		Kidney	1.8			
Tursiops truncatus	South Carolina Coast	Liver	<0.5–146.5	WW	34	Beck et al. (1997)
Tursiops gephyreus	Southwestern Atlantic Ocean	Muscle	5.5±0.8	WW	1	Marcovecchio et al. (1990)
		Liver	86.0±7.3			
		Kidney	13.4±2.5			
Pontoporia blainvillei		Muscle	3.0±1.2			
		Liver	3.8±1.6		1	
		Kidney	1.9±0.7			
Kogia breviceps		Muscle	1.6		1	
		Liver	11.7			
		Kidney	10.5			
Stenella coeruleoalba	French Atlantic coast	Muscle	1.5–12	WW	8	Andre et al. (1991)
		Liver	1.2–87			
		Kidney	3.3–15			
Six species of marine mammals	Irish Sea	Liver	0.5–280	WW	42	Law et al. (1992)

N, number of specimens; DW, dry weight; WW, wet weight.
[a] Averages.

the Mediterranean show significantly higher levels of Hg than the same species in the Atlantic (Bernhard, 1988). Tables 3 and 4 show the results of reviews of the concentrations of Hg in various tissues of marine mammals species from the Mediterranean and other seas, respectively. Inspection of the concentrations in the liver, as the major Hg-accumulating organ, indicates the concentrations in the marine mammals from the Mediterranean to be higher than in marine mammals from other seas, with maximal values of 4400 and 756 mg kg^{-1}, respectively. The comparison is qualitative because of the lack of biometric records, as well as the relatively few specimens from each species. Future biometric data and Hg concentrations in specific cetacean species and their prey may be able to support the hypothesis that the known Hg anomaly in the Mediterranean significantly affects the concentrations of Hg in cetacea as well.

The concentration of Cd found in the liver and kidney was high, but similar to the concentrations found in specimens from the southern Adriatic (Storelli et al. 1999; Table 2). As for Hg, the Cd concentrations were much higher than those found in the UK specimens (Zonfrillo et al., 1988; Law, 1994; Law et al., 2001). Although the concentrations were high, no remarkable findings in the liver and kidney were observed in the post mortem examination. The concentrations of Cd decreased in the following order: liver > kidney ≫ stomach content > skin > muscle > blood > brain, in agreement with accumulation through dietary pathway (Law, 1996). Indeed, Cd in the stomach content was high (1.59 mg kg^{-1} wet wt.). It should be noted that the relative position of liver and kidney were inverted, for kidney is considered to be the main organ for accumulating Cd (Thompson, 1990).

Hg and Cd are usually accumulated in marine mammals via the diet; the higher the trophic level of the animal, the more accumulation expected. Pauly et al. (1998) assigned *G. griseus* a high trophic level of 4.3, with 85% of its diet comprised of squid. Remnants of squid were found in the first stomach during the autopsy. Squid are well-known Cd accumulators and a source of this metal to their predators (Martin and Flegal, 1975; Honda and Tatsukawa, 1983; Caurant and Amiard-Triquet, 1995; Law, 1996; Koyama et al., 2000). High Hg and Cd concentrations, 0.3 and 12.1 mg kg^{-1} wet wt., respectively, were found in the liver of one specimen of *Sepia officinalis* from the study area (unpublished results).

The Hg and Cd concentrations in *G. griseus* were higher than those found in *T. truncatus* and *S. coeruleoalba* from the study area (Roditi-Elasar, 1999; Table 3). Although these species have the trophic level of 4.2, similar to the value of 4.3 for *G. griseus* (Pauly et al., 1998), there are main differences in the relative diet compositions that could explain the differences in trace metal bioaccumulation. The diet of *G. griseus* is mainly composed of squid (85%) and *T. truncatus* mainly feeds on fish (70%), while the diet of *S. coeruleoalba* is more varied and is comprised of 35% squid and 55% fish.

3.3. Se, Zn, Cu, Mn and Fe—essential elements

The order of decreasing Se concentrations found in the different tissues was similar to that found for Hg: liver > muscle > kidney > skin > blubber. In the liver of seals, porpoises and dolphins the concentration of Hg is clearly correlated with the concentration of Se (Martoja and Berry, 1980); it has been suggested that Se could have a protective effect against the toxic action of Hg compounds, by storing it as mercuric selenide (Koeman et al., 1973). Histological studies of livers from specimens of Cuvier's beaked whale (*Ziphius cavirostris*) and bottlenosed dolphin showed that the selenide is present as black particles (1–5 μm) located in the connective tissue of the portal vessels. These particles are not attacked by proteolytic enzymes, and are therefore inert (Law, 1996). Law et al. (2001) found an increasing trend for Hg/Se ratios from close to zero to around unity with increasing Hg concentration in livers of different marine mammals, reflecting the detoxification of Hg. In this study, we found a ratio of 1.38, similar to the Hg/Se ratios of 1.48 and 1.65 reported in the liver of two specimens of *G. griseus* from the Adriatic sea (Storelli et al., 1999), indicating the presence of the selenide compound.

The order of decreasing Zn concentrations found in the different tissues was: skin ≫ stomach contents > muscle > liver ~ kidney ~ brain > blubber > blood. The concentration of Zn found in the liver was on the lower side of the range, 20–100 mg kg^{-1} wet wt., postulated by Law (1996) for marine mammals. Similar concentrations were found in the liver of *G. griseus* from the UK and other species in the Mediterranean (Tables 2 and 3). Exceptionally high concentrations were found in the skin, the highest concentration recorded among all the species collected in the study area (Roditi-Elasar, 1999). Highest Zn concentrations in the skin were also found in *S. coeruleoalba* off Japan and the western Mediterranean (Honda and Tatsukawa, 1983; Monaci et al., 1998) and in *T. truncatus* from the study area (Roditi-Elasar, 1999; Table 3). It is known that Zn accumulates in hard tissues, such as bone, hair, skin, and feathers, of some marine and terrestrial animals, and therefore may be introduced through the skin (Thompson, 1990).

Cu concentrations were low in all the tissues. Cu in the liver was found to be on the lower side of the concentration range in liver for adult marine mammals (3–30 mg kg^{-1} wet wt.; Law 1996). The order of decreasing Cu concentrations found in the different tissues was: stomach contents $\gg$ liver $>$ skin $\sim$ brain $>$ kidney $\sim$ muscle $>$ blood $\sim$ blubber. The highest concentration in the stomach contents, followed by the liver, again points to diet as the main source of Cu for *G. griseus.* Indeed, the concentration of Cu in the liver of *S. officinalis* from the study area was very high (1450 mg kg^{-1} wet wt., unpublished results), but comparable to Cu concentrations found elsewhere (Martin and Flegal, 1975). Comparison to two *G. griseus* specimens from the UK shows that one had similar concentration, while one was high, on the higher side of the normal range (Table 2). Similar concentrations were found in other species in the Mediterranean (Table 3).

There are almost no data on Mn concentrations in marine mammals, but they are thought to be lower than 7 mg kg^{-1} wet wt. in any tissue (Thompson, 1990). In this study, the Mn concentrations were low and natural in all the tissues. Cardellicchio et al. (2000) found similar Mn concentrations in six specimens of striped dolphins (*Stenella coeruleoalba*) stranded in Southern Italy, of 0.27, 3.19, 0.63, 0.47 and 0.52 mg kg^{-1} wet wt. in the muscle, liver, kidney, brain and blubber, respectively.

The order of decreasing Fe concentrations was: liver $>$ muscle $>$ blood $>$ kidney $\sim$ skin $\sim$ stomach contents $>$ brain $\sim$ blubber. In this case, Fe concentrations were similar to those found in other species stranded along the Israeli coast (Table 3), except for the concentration in the liver, which was higher. Fe was also high in the liver of one *G. griseus* specimen from the UK (Law et al., 2001). Increase in Fe concentration with age has been demonstrated in the tissues of marine mammals. Fe concentration in the muscle is known to be associated with the diving ability, which controls myoglobin content with high oxygen-combining capacity (Watanabe et al., 1998). These facts can be linked to the high Fe concentrations found in the liver, muscle and blood.

In conclusion, high concentrations of trace metals were found in one *G. griseus* specimen, but no connection could be found between them and the autopsy results, which showed no remarkable findings in the internal organs. This and the similar high concentrations found in three other specimens from the Mediterranean led to the assumption that the high concentrations are a result of the high trophic level of this species, its diet and its old age. However, anthropogenic influence and Hg anomaly in the Mediterranean Sea cannot be ruled out, but these are difficult to assess in view of the sparse data on trace metals for this species, in particular if the concentrations are naturally high and small changes from those levels need to be detected. More data on trace metals coupled with pathological examination will be able to shed light on these questions. The monitoring of stranded cetacea species reaching the Israeli coast continues; however, due to the stochastic nature of stranding and sample acquirement, establishment of a database is a slow process.

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