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LUNG PATHOLOGY IN STRANDED CETACEANS ON THE MEDITERRANEAN COASTS.

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Introduction

Since 1962, many autopsies of stranded cetaceans gave me the possibility to describe what appeared like abnormalities, in various organs; we relate here our findings concerning abnormal aspects of the lungs.

Material

Lungs came from carcasses of cetaceans beached on the french coasts of the northern Mediterranean, particularly of Corsica. Only the entirely autopsied carcasses are mentionned here: *Tursiops truncatus*: 5; *Ziphius cavirostris*: 4; *Physeter macrocephalus*: 2; *Balaenoptera physalus*: 1; *Delphinus delphis*: 1; *Stenella coeruleoalba*: 4.
Furthermore two *Delphinus delphis* were harpooned off the West African coast (Zaire) and autopsied to provide histological samples and chemical levels of reference, bearing in mind that the gulf of Guinea is an area less polluted than the Mediterranean or the European Atlantic coasts.

Methods

We started with an autopsy for direct observation of pulmonary tissue, bronchioles and circulatory system. Dissection led to the detection of macroscopic properties important for diagnosis, like elastic or fibrotic texture, homogenous or heterogenous colour and texture which indicate congested or calcified or fibrosed areas of the tissue, and even calculi. Histology and electronmicroscopy allowed to detect calculi invisible to the naked eye. Much information came from histological studies (method in VIALE et al, 1973); histological slides were submitted to X-Ray detection with a microprobe Cameca (slides of 7 um) fixed in alcohol 100% or Carnoy (MARTOJA et VIALE 1977).

Methods of quantitative analysis:

Hg: atomic absorption without flame;

Fe: mineralisation by way of calcination; atomic absorption with flame;

Ti, Cr, Cd, Pb: atomic absorption in graphite oven.

MET and MEB were used to detect mineral microgranules: calculi were microanalysed with Camebax (VIALE, 1977; MARTOJA et VIALE, 1977; VIALE, 1979 b.)

Findings

1. Lung pathology in Whalebone Whales

Five *Balaenoptera physalus* stranded or accidentally killed during the last twelve years gave us little information. Two did not have autopsies and two others were only sampled for chemical analyses. The fifth was a new born calf when seen slowly swimming offshore allongside its mother, but the next day found dead uninjured on the beach. The death was caused by oedema of the lungs. Trachaea and bronchioli were filled with a frothing substance obstructing them. First I thought this small whale had drowned; but the diagnosis of oedema was supported by the evidence, with autopsy, of cardiopathy. The kidneys appeared morphologically normal in volume and colour, but a nephropathy was probable in correlation with the amount of PCB and DDT in this animal (Table 1).

Equally, metal pollutants were well represented in this newborn *Balaenoptera*, in particular iron (Table 2).

The lungs show a large amount of iron; the titanium content in this newborn's lung means that this metal is not always due to atmospheric pollution, but comes from the mother's pollution by way of placenta. The relative titanium content of the mother's lung can be lower than the newborn's one (Table 3; VIALE, 1977).

The heart disease in this Baleen whale was evident when seeing the big volume, the hypertonicity, the clear red colour different from the dark one of other whales stranded with normal heart (probably it was richer in actin than in myosin, in relation to hypertonicity). The internal volume of the ventricule was low compared with the total size of the heart. It explains an insufficient pump function on the heart, which has caused the over-crowding of plasma in

Table 1 : PCB and total DDT with its different residues, in p.p.m. of fresh weight.

Tissues	PCB	DDT + residues
Blubber	0,3	0,8
Brain	0,12	0,13
Medulla	1,7	1,4
Liver	0,8	0,5

Table 2 : Metallic pollutants, in p.p.m. of fresh weight.

Tissues	Fe	Ti	Cr	Cd	V	Pb	Hg
Kidney	130	2,5	0,9	0,001	0,16	0,02	0,05
Lung	165	1,5	0,6	0,002	0,09	0,04	0,05

Table 3 : Metal contents in the lungs of various cetaceans beached in the french mediterranean coasts. Comparison with a specimen captured along the coast of Zaire (West Africa). In p.p.m. of fresh weight.

Species	Hg	Fe	Ti	Cd	Cr	Pb
Tursiops truncatus (male, 30 years old, octobre 1975)	8,95	130	0,06	0,003	0,51	0,003
Tursiops truncatus (male, ½ year old, July 1974)	2,40	82	0,17	O,18	0,18	0,25
Tursiops truncatus (male, 2 years old, march 1973)	0,67	257	7,3	0,12	0,07	-
Physeter macrocephalus (9 years old if male, 10 if female, december 1974)	1,90	73	0,30	0,25	1,05	0,50
Ziphius cavirostris (female, pregnant, 6 to 12 years old, december 1974)	23,00	280	2,30	0,30	0,60	0,09
Ziphius cavirostris (foetus in the uterus of the last)	3,15	119	3,45	0,07	1,40	0,24
Balaenoptera physalus (new born, januari 1975)	0,05	165	1,52	0,09	0,002	0,04
Delphinus delphis (male, more than 12 years old, november 1973)	51,00	236	0,60	0,12	0,15	-
Delphinus delphis (male more than 9 years old, harpooned in the Gulf of Guinea, march 1975)	4,20	65	0,10	0,14	0,17	0,12
Stenella coeruleoalba (less than 1,5 years old, june 1973)	2,83	-	-	-	0,05	-

lungs, and an insufficient ventilation. Histologically, the lung of this Rorqual showed "Hyalin membranes" that means a "drowned lung" (BASSET, pers. comm.).

2. Lung pathology in Toothed Whales

2-1. Parasitism. Frequent diseases in *Stenella coeruleoalba*: a young female (1,40 m) less than half a year old was only suckling when found stranded in november. Its lungs were invaded by numerous Nematodes: *Halocercus delphini.* These very long worms attached by two or three individuals plaited together, obstructed the bronchioles and caused congested or ulcerated areas where they were fixed to the pulmonary tissue.

2-2. Tuberculosis. One *Tursiops truncatus* out of 5 cases presented tuberculous aspects in lung: it was a thirty year old male accidentally caught in a trawl. Its lungs showed white scars visible to the naked eye which appeared to be calcified zonulas of 7 to 10 mm diameter, related to an anterior supposed tuberculosis (BASSET, pers. comm.).

2-3. Bronchitis. Presented by one *Tursiops truncatus* out of 5 cases, young male half a year old which was in suckling and feeding stage. Its bronchioli showed degenerative zones of the inner epithelium. Congestive areas were visible in the pulmonary tissue while the alveoli were modified by hypertrophy; disease diagnosed as bronchitis (BASSET, pers. comm.).

2-4. Alveolitis. In the same animal the alveolar space was filled with an homogenous substance, coagulated by fixing treatments, which overstreched the alveolar tissue, so that they were visible to the naked eye magnified and hypertrophied. In the APS-positive substance, there were many macrophagic cells.

Besides, the epithelium of the bronchia was altered, its cells were disjointed and laid in the lumen of the bronchioli, so that the chorion was denuded in these pathological areas (BASSET, pers. comm.).

Furthermore, these two *Tursiops* were also rich in many pollutants, particularly in their lungs. The iron content of the young *Tursiops*'s lungs was 82 p.p.m. of fresh weight, while Cd, Ti, Cr, V, Hg were also present in these organs (VIALE, 1977) (Table 3).

2-5. Mineral calculi. Present within the lungs of *Physeter macrocephalus*, one case of spherical stones. Each stone shattered when bombarded by electrons from scanning observations or X-ray spectrographic studies. Scanning shows that each calculus is made of tiny spheric concretions coming from a continuous precipitation of magnesium phosphate. Besides, these concretions included some other components like Ca, K, Fe, Ti etc. (VIALE, 1977).

2-6. Crystalline concretions. These formations are observed in many organs of several species of Odontoceta stranded on the mediterranean French coasts: *Tursiops truncatus* (1 case out of 5 autopsies), *Delphinus delphis* (1 out of 1), *Stenella coeruleoalba* (3 out of 4), *Grampus griseus* (2 out of 3), *Ziphius cavirostris* (2 out of 4). Only the mineral concretions of interest with respect to the lungs will be mentioned here. However it should be born in mind that the most important point is that these mineral concretions or crystals were found to be present equally in other organs, so that it is not particular lung pathology. Such a mineral oversupply necessarily involves a disfunction which becomes pathogenic. During autopsy, these lungs show a granular texture, apparent to the touch, and lack the characteristic elasticity. The endothelium of large arteries shows prominent crystals visible to the naked eye, which have their bottom embedded in the wall of the vessel. Under stereomicroscope these crystallisations appear bright and transparent; scanning examination reveals the presence of flat regular concretions. We have analyzed them with X-ray spectrographic methods and microanalysis. These stones are magnesium phosphate including little quantities of various compounds: K, Ca, Cl, S.

In all species where they are found, these stones have the main components which are always associated, when they are big enough, with different metallic pollutants: Fe, Ti, Ni, Zn etc. (photo in VIALE 1979 a).

3. Storage possibilities of lungs.

3-1. Iron storage. Quantitative analysis of iron in the lungs were systematically made in seven carcasses of stranded Cetaceans. The relative iron content is always high, as well as that of the liver; often the kidneys show an equally large iron content. Histology and microanalysis show that iron is found in tiny granules, opaque for light and electrons, scattered in the interalveolar connective tissue. These granules may be gathered. Iron can appear in the calculi when they are big enough to be visible with the naked eye.X-ray photographs of the iron atoms show clearly a concentration inside the calculi and a distinct scarcity in the areas between them.

The presence of such mineral calculi in the arteries of lungs signifies a trophic origin of their components and not an atmospheric pollution origin.

3-2. Titanium storage. Like the iron, titanium is stored in the lungs of the new-born whale, and equally in a foetus taken from the uterus of a *Ziphius cavirostris*. This foetus had more titanium in its lungs than its mother. Lungs seem to be a specific storage organ for titanium (Table 3).

The titanium, common in the atmospheric dust, can be found in the pulmonary spaces of many terrestrial species. But here the significant amount of titanium in a foetus points to the fact that titanium can also pass through the placenta from the maternal blood and can be specifically stored in the lungs. This property relates probably to the abundance of the macrophagous cells in the lungs; it is the same in the case of siderosis, with iron.

3-3. Other metal storages. We report in Table 3 the results of analysis of mercury (organic and inorganic alltogether), chromium, cadmium, lead, iron and titanium. For comparison, one can see the contents of the metals in a *Delphinus delphis* captured in the Gulf of Guinea (Afrika) giving "referencial" contents. Mercury is always well presented in the mediterranean specimens. MARTOJA and VIALE (1977) showed that the methylmercury is transformed in a mineral form: the selenid mercury, stored in the liver. The lung is probably the way to excrete the methyl radical, so it is possible that the lung can store inorganic mercury like the liver, but in much less quantity.

Conclusions

The stones found in the lungs of cetaceans probably serve the purpose of storing potentially harmful substances like titanium, nickel, iron, aluminium, besides magnesium and calcium. This also means that this magnesium and calcium, immobilized as phosphates, are therefore unprofitable to metabolism. They give evidence that magnesium and calcium metabolism is unbalanced. In fact, these pathologic aspects are often to be found in cetaceans before weaning; the lactation period supplies a number of pollutants from maternal milk and abundance of calcium and magnesium.

Therefore, these pollutants and their supposed resulting diseases are probably an important cause of the high infant death rate in NW mediterranean cetaceans.

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