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Mass Stranding of Striped Dolphin, *Stenella coeruleoalba*, at Augusta, Western Australia: Notes on Clinical Pathology and General Observations

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ABSTRACT: Seventeen striped dolphins, *Stenella coeruleoalba,* were found stranded on a West Australian beach. Three animals died before a rescue attempt was made and a further three died during the rescue. The remaining dolphins were released 24 km offshore and were not seen again. One dolphin was noted to have a broken mandible. Evidence of physical trauma to the other dolphins was minimal; one adult female was observed with some peeling skin. Blood was collected for analysis. All dolphins were slightly dehydrated and had a leukogram typical of a stressed animal. Plasma biochemistry reflected primary muscle trauma. There were no clues to the cause of the stranding; observed pathology reflected damage that occurred as a direct consequence of stranding.

Key words: Striped dolphins, *Stenella coeruleoalba,* dolphin stranding, clinical pathology.

The striped dolphin, *Stenella coeruleoalba,* is distributed widely in tropical and temperate waters of the world. This off-shore, gregarious species is believed to be relatively numerous, commonly being found in aggregations of several hundred and sometimes in herds of several thousand (Leatherwood and Reeves, 1983).

Individual strandings of striped dolphins have been recorded occasionally (Gales et al., 1985) and only one record of a mass stranding, which occurred very close to the location of this event, has been recorded (Mell, 1988). In this report I describe the circumstances of a mass stranding of *S. coeruleoalba,* with information on their sex, size, hematologic values and blood biochemical values.

The stranding occurred on a gently sloping beach approximately 12 km east of the mouth of the Blackwood River and the township of Augusta (34°19′S, 115°10′E) in Western Australia (Fig. 1).

On 29 January 1989 at 09:00 a recreational fisherman observed a very large pod of dolphins, approximately 800 m long, moving east, parallel to the beach, behind some breaking waves 50 meters off-shore. The dolphins were moving rapidly, with some animals leaping clear of the water. The fisherman observed several animals leave the main pod, swim in through the surf and strand on a low reef platform. Travelling west the fisherman found several other dolphins on the beach. By 16:30 government officials, a veterinarian and volunteers were at the stranding site.

Seventeen *Stenella coeruleoalba* were found spread over approximately 3 km of beach (Fig. 1). Fourteen animals were still alive. Each live animal was placed in ventral recumbency, facing away from the sea and kept wet. A rapid clinical examination was carried out and size and sex data were collected. Ten of the fourteen animals were freeze-branded on their dorsal fins using metal numbers 5 cm high mounted on a metal frame. These numbers were immersed in liquid nitrogen for approximately 60 sec and then held on the right side of each dolphin's dorsal fin for 30 sec. The remaining four live dolphins were paint-marked.

The animals were not returned directly to the sea because of rough conditions. The dolphins were moved to the mouth of the Blackwood River (Fig. 1) by the techniques of Mell (1988). As the beach was impassable to vehicles, the animals were transported in four-wheel drive vehicles, some equipped with trailers, along rough tracks to the mouth of the river. The animals were then transferred to slings, tied alongside small boats and taken to a specially prepared netted-off area of shallows, approximately 1.5 m deep and with a surface area of about 250 m^2. After the death

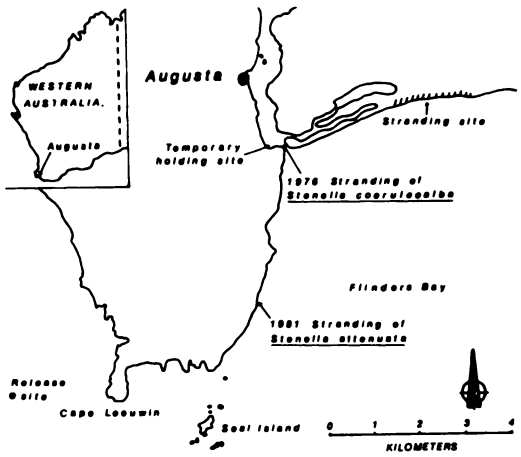

FIGURE 1. Stranding site, temporary holding area and release site of stranded striped dolphins.

of one dolphin that struggled violently during the boat stage of the transport, the remaining dolphins were transported 60 km by road to the holding site to avoid the problems associated with additional handling. One dolphin died on the beach prior to transport. The remaining twelve live dolphins had been transported to the holding site by 21:00 on 29 January.

Each dolphin was held in a stationary position in the water by volunteers throughout the night. One dolphin died soon after arrival at the holding site. At 01:00 on 30 January, blood was collected from the fluke vessels of eight dolphins and placed in glass tubes containing anticoagulant (EDTA) or plain silicone coated tubes. Blood samples were refrigerated and dispatched to Perth for analysis within 18 hr at VetPath Laboratory Services, Redcliffe, Perth, Western Australia 6104, Australia.

Hemoglobin (Hb) levels and total leukocyte counts (WBC) were determined using a Sequola-Turner Cell Dyn 300 Hematology Analyser with aperture adjustment (Sequola-Turner Corporation, California, USA). Plasma protein concentrations were measured using an optical refractometer (ATAGO Optical Works, Tokyo, Japan) while packed cell volume (PCV) was determined manually using a Clements microhematocrit centrifuge (Clements Pty Ltd, Sydney, Australia). Differential leukocyte counts were performed manually using blood films stained with a modified Leishman's stain (Schalm, 1965). Serum samples were assayed for urea, creatinine (creat), glucose (gluc), bilirubin, calcium (Ca), phosphorus (P), total protein and albumin (alb); and for aspartate aminotransferase (AST), alanine aminotransferase (ALT), alkaline phosphatase (ALP), gamma glutamyl transferase (GGT) and creatine kinase (CK) activity. All assays were carried out on a Hitachi 705 Automatic Blood Chemistry Analyser using commercial kits (Boehringer Mannheim, GmbH, Mannheim, West Germany). Serum sodium (Na) and potassium (K) concentrations were determined using a Corning 435 Flame Photometer (Corning Ltd, Essex, England). Serum cortisol was determined by radio-immuno assay (RIA), using a commercial I^{125} RIA kit (Amersham Cortisol, Amersham, Australia).

At 10:00 on 30 January eleven live dolphins were placed on mattresses on the rear deck of a large fishing boat and released 24 km west of Cape Leeuwin (Fig. 1). No released animals were resighted, despite extensive searches of the coast in the Augusta region in the ensuing weeks.

Postmortem examinations were carried out on four animals on the beach. Owing to weather conditions and lack of adequate equipment, no samples for histopathology were collected. The remaining two animals that were found dead at the original stranding site could not be found the following day.

Of the fifteen animals from which data were collected ten were females and five were males. Their mean length (±SE) was 237 ± 2 cm. The mean lengths of the males and females were 237 ± 4 cm and 237 ± 2 cm, respectively. Based on a t-test, there was no significant difference between the sexes ($P > 0.4$). The length of a single, female calf (133 cm) was excluded from this analysis.

Most dolphins had only minor physical

TABLE 1. Hematological and blood chemistry values for striped dolphins stranded at Augusta, Western Australia in January 1989.

	Mean ± SE	Range	Sample size	Normal values for *Tursiops truncatus*[a]
Hemoglobin (g/dL)	20.9 ± 0.3	19.7 to 22.1	7	14 to 16
Packed cell volume (%)	57 ± 1	53 to 60	7	41 to 49
White blood cells (/μL)	5,514 ± 507	2,700 to 6,900	7	6,000 to 12,000
Neutrophils (/μL)	4,406 ± 491	2,052 to 6,141	7	3,300 to 7,800
Neutrophils (%/μL)	79 ± 3	64 to 89	7	55 to 65
Banded neutrophils (%/μL)	5 ± 2	3 to 7	2	1 to 5
Lymphocytes (/μL)	751 ± 120	486 to 1,400	7	900 to 3,000
Lymphocytes (%/μL)	14 ± 2	8 to 25	7	15 to 25
Monocytes (/μL)	184 ± 39	54 to 336	7	<300
Monocytes (%/μL)	3.3 ± 0.6	2 to 6	7	<1 to 5
Eosinophils (/μL)	142 ± 44	27 to 280	5	360 to 3,240
Eosinophils (%/μL)	1.8 ± 0.7	0 to 5	7	6 to 27
Total serum protein (g/L)	75 ± 1.3	72 to 80	7	70 to 80
Albumin (g/L)	39 ± 0.7	35 to 41	7	30 to 50
Globulin (g/L)	23 ± 0.8	21 to 26	7	16 to 22
Albumin/globulin ratio	1.59 ± 0.09	1.23 to 1.85	7	2 to 3
Alkaline phosphatase (U/L)	693 ± 136	157 to 1,053	7	33 to 403
Aspartate aminotransferase (U/L)	626 ± 93	369 to 1,084	7	
Alanine aminotransferase (U/L)	134 ± 18	92 to 237	7	
Gamma glutamyl transferase (U/L)	32 ± 2.6	23 to 45	7	
Urea (mmol/L)	14.2 ± 0.7	11.3 to 15.9	7	
Blood urea nitrogen (mg/dL)	39.7 ± 1.8	31.6 to 44.5	7	41 to 66
Glucose (mmol/L)	6.3 ± 0.3	5.4 to 7.4	7	
Creatine kinase (U/L)	6,255 ± 2,296	440 to 14,610	7	
Creatinine (μmol/L)	171 ± 8	136 to 193	7	
Amylase (U/L)	5 ± 0.7	4 to 8	7	
Bilirubin (μmol/L)	20 ± 3	11 to 32	7	
Sodium (mmol/L)	166 ± 0.6	164 to 168	7	150 to 161
Potassium (mmol/L)	4.1 ± 0.1	3.9 to 4.4	7	4 to 5
Phosphorous (mmol/L)	2.82 ± 0.22	2.34 to 3.94	7	
Magnesium (mmol/L)	1.04 ± 0.03	0.97 to 1.21	7	
Calcium (mmol/L)	2.13 ± 0.11	1.84 to 2.62	7	
Calcium : phosphorous ratio	1.32 ± 0.05	1.11 to 1.5	7	
Plasma cortisol (nmol/L)	307 ± 37	210 to 490	7	

[a] Wallach and Boever (1983).

trauma; however, dolphin 16 had a broken mandible approximately 80 mm from the tip of the rostrum; the anterior portion of the mandible was reflected slightly to the right and was in a fixed position. Dolphin 12, which was lactating and assumed to be the mother of the calf (dolphin 13), was the only animal with significant skin peeling. The peeling was restricted to the axilla, head and small areas on the dorsum of the animal. All other animals showed behavior indicative of stress, in particular tachycardia, rapid and shallow respiration, and frequent vocalizations.

Blood samples were collected approximately 18 hr after the dolphins were first found on the beach. Data from dolphin 16 were excluded because this animal had undergone severe trauma. There are not published accounts of biochemical reference values for the genus *Stenella*. For comparison, values reported for the bottle-nosed dolphin (*Tursiops truncatus*) (Wallach and Boever, 1983) are included in Table 1.

The striped dolphins had slightly elevated Hb and PCV values compared to the bottle-nosed dolphin (Table 1). The

WBC counts were marginally low, with a marked leukopenia in dolphin 5. All dolphins had a mild, relative neutrophilia, but in absolute values most neutrophil counts were within normal ranges; dolphin 5 actually having a neutropenia. With the exception of dolphin 10, all animals showed an absolute and relative lymphopenia, with all dolphins having an absolute eosinopenia. Cell types were normal in appearance in dolphins 1, 2, 3, 7 and 10. Dolphins 5, 8 and 16 had neutrophils with a mild left shift (i.e., the appearance of immature, band neutrophils in the blood after the storage reserve of mature, segmented neutrophils is diminished), and some vacuolation and granulation. Total serum protein concentrations were within normal ranges for bottle-nosed dolphins, with the exception of dolphin 16 which had a slight hypoproteinaemia.

Dolphin 16 had a marked elevation of AST, ALT, GGT and CK (Table 1), all of which were probably the result of muscle and other tissue damage associated with the trauma that broke the dolphin's mandible. All other dolphins had marked elevation in CK, and some elevation in ALP, AST and ALT. Serum Na concentrations were also elevated in all animals.

No gross abnormalities were noted during the postmortem examination of the four dead dolphins.

The reasons why odontocetes mass strand is subject to much conjecture (Geraci, 1978; Best, 1982; Klinowska, 1985). There are, however, few descriptions of the animals during the stranding, particularly with a view to providing a prognosis for survival if the animals are returned to the sea. Clearly, clinical pathology is a useful tool to address this question, particularly with the advent of quick-test kits that can be used at a whale stranding site. Ideally, serial blood samples should be collected to investigate the degree and rate of organ damage. However, single samples, such as those reported here provide hitherto unavailable data on hematologic and biochemical analysis of stranded marine mammals.

Hematologic values of the striped dolphins in this study reflect animals that probably were hemoconcentrated, as shown by the elevated Hb and PCV, and stressed, as shown by the leukopenia, lymphopenia and eosinopenia. It is possible the hemoconcentration was due to adrenaline release and the resultant release of high PCV blood from the spleen, rather than dehydration which would normally be associated with hyperproteinemia, a finding not seen in this study. The left shift and toxic changes to neutrophils in dolphins 5, 8 and 16 probably reflected a physiological stress phenomenon as supported by the occurrence of leukopenia with relative neutrophilia and absolute lymphopenia and eosinopenia. It is possible that a bacteremia or septicemia occurred, but these distinctions are not readily made, based on the available data. Furthermore, the vacuolation and granulation of some neutrophils may have been a result of the delay in blood film preparation. The marked leukopenia in dolphin 5 was of unknown etiology. There was no clear evidence of any pre-existing infections.

Creatinine phosphokinase, an indication of muscle damage (Duncan and Prasse, 1986), was the most elevated of the serum enzymes. Elevations of this enzyme are noted post-exercise in most species; however, the degree of increase in dolphins 1, 2, 3, 5, 7 and 16 was indicative of more severe myopathy. It is not surprising that a marine mammal would suffer marked muscle damage during the traumatic initial stranding, which would be exacerbated by the period of weight borne by the ventral and lateral musculature before the animals were returned to the sea. The concentration at which CK indicates a life-threatening myopathy is unknown. Creatinine concentrations were not markedly increased. Creatinine is affected by protein diet, protein catabolism and urinary excretion efficiency, and elevations are

thought to indicate early renal dysfunction due to organ failure or vascular shock as well as reduced renal flow associated with dehydration (Duncan and Prasse, 1986). It would be valuable to monitor the concentrations of this protein over a period of several days post-release.

The AST concentrations also were elevated in most dolphins. This enzyme is found in most body cells; however, its concentrations are particularly high in skeletal muscle in domestic animals (Duncan and Prasse, 1986). Although it is not used as a specific test for muscle damage, its elevation, in conjunction with high CK concentrations does indicate muscle damage.

Alanine aminotransferase concentrations of above 19 U/L in dolphins are considered elevated (Medway and Geraci, 1965). This enzyme is relatively non-specific and is found in the liver, but does occur in other organs including muscle (Duncan and Prasse, 1986). Its moderate elevation in the dolphins in this study may further reflect severe muscle damage or may possibly indicate some degree of liver, or other organ, damage.

Based on the clinical and pathological findings, there are no clues to the etiology of the stranding. The data reflect damage that occurred as a direct consequence of the stranding. The fact that no dolphins were resighted on the beaches after the release does not necessarily indicate the animals survived. There clearly is a need for more work of this type to be conducted. Perhaps some animals should be maintained and monitored in captivity for extended periods after a stranding. The collection of serial blood samples over the course of a rescue procedure would greatly assist veterinarians attending a stranding; currently they lack reliable prognostic indicators.

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