

LEAD POISONING IN SWANS AND OTHER WATERFOWL

There are **NO** forms of lead or its' compounds which are not toxic. Ingestion of any lead, no matter how little, has been demonstrated to have a measurable biological effect.

Lead in a water soluble form would be extremely toxic to all forms of aquatic life but fortunately for the environment, lead compounds are not very soluble and there are few ways in which significant quantities of water soluble lead can actually be lost or escape into the environment. If a 'lead spill' did occur then there would certainly be heavy mortality across the complete range of water life from all the invertebrate genera through to the fish and waterfowl.

Lead manifests its 'toxic action' through its capability of binding to and inactivating the sulphha-hydril groups which are the keys to the action of all the biochemical enzyme reactions which occur in life.

Ingested lead acts as a whole body poison affecting all the biological systems including respiration, growth, fertility, the nervous system, digestion, excretion etc. This all embracing toxic action is so different to the single blockage of respiration which occurs in cyanide toxicity or to the two or three affected systems during arsenic exposure. The number of significant chemical and biological processes which are damaged by lead produce a wide range of symptoms of varying severity which are influenced by many other factors. These include the age and sex of the bird, the type of lead compound ingested, the amount and rate of lead ingestion, the percentage solubilised by the action of the digestive system etc.

Birds can be grouped into two sorts from their digestive apparatus. Birds with a soft walled stomach generally eat meat whether fish or small animals. The bones may be partially or completely solubilised by the action of secreted hydrochloric acid in the same way many animal's digestive systems function. Non digestible items include fur, feather, bone and foreign objects are regurgitated and expectorated as pellets. This group includes fish eaters like HERONS, GREBES, KINGFISHERS, GUILLEMOTS and some fish eating duck as well as the birds of prey such as the OWLS, HAWKS, EAGLES and VULTURES.

Many seed eating birds and all the waterfowl have an alternative system which involves modified stomach structures known as the '**Proventriculus and Gizzard**'. These birds use the soft walled proventriculus to lubricate and add digestive enzymes to the recently swallowed food before it passes through to the gizzard for mastication.

The gizzard has a particularly thick wall with tough internal grinding pads. Sandy grit, ranging up to eighths gravel, is ingested whilst the bird is feeding. When food arrives in the gizzard, stretch receptors fire and send signals to the brain which in turn causes movement of the two halves of the gizzard and the food is literally broken down by the action of the moving grit similar to rubbing a 'ham sandwich between two sheets of sandpaper'! It is this abrasive action of the working gizzard which so effectively solubilises ingested foreign objects.

Ring-pulls, nuts and bolts, fish hooks, swivels and nylon line can all be disposed of given sufficient time, however it is the softer metal, lead, which is so much easier to grind up and absorb. **Any form of ingested lead whether spent gun shot, ingested ledger weights or split shot is thus abraded almost atom by atom.** Indigestible foreign matter cannot escape from the gizzard due to the action of the duodenal sphincter and is retained permanently or until it has been worn away. It is this fairly rapid attack and solubilisation of lead which overwhelms the defence mechanism by which small amounts of toxins can be eliminated.

One of the first actions during the onset of lead poisoning is, the nerve endings in the wall of the gizzard become inactivated or blocked by lead atoms. The grinding action of the gizzard ceases.

This has two effects. Firstly, no further digestion occurs and thus the energy and nutritive compounds in the food remain unavailable. In effect, **once the gizzard has become impacted due to the lack of mastication, then the bird is in a period of incipient starvation.** Secondly, as no food is getting past the gizzard, compounds like blood sugar start to fall which prompts the affected bird to continue feeding.

This may go on for up to two weeks, however the food stuffs are merely accumulating throughout the upper digestive tract. The oesophagus of swans in particular can often contain up to 2kgs of food and this can cause a visual distortion or bulging outwards of the neck which is visible from some distance. In an effort to maintain the bird's body temperature, which in fact is slightly higher than a mammal's, body fat is catabolised to produce heat and energy and at the same time shrinkage of all internal organs and muscle blocks begins to occur as proteins and carbohydrates are also released. **The liver and other organs may lose up to 50% of their normal size during this process. The net result is a rapid drop in body weight.**

A healthy adult cob might be expected to weigh around 15kg but this would fall to about 7kg and the pen would similarly drop from a healthy weight of 10 to 12kg down to as little as 5kg. The severe loss of body musculature rapidly results in the loss of flight and terminally, **it becomes difficult for the bird to stand.** The marked loss of muscle from the neck results in the often seen 'dropped' neck appearance where the bird cannot maintain correct head carriage. Accumulation of large amounts of food in the oesophagus often produces dribbling when affected birds attempt to drink as the water in the mouth cannot be swallowed as quickly as normally.

Absorbed lead is specifically moved around the body attached to surface receptors on the red cells and it can thus get to all the tissues. **The lead content of the whole blood is a sensitive indicator for absorbed lead.** Lead accumulating within the bone marrow specifically interferes with the chemical synthesis of haemoglobin, the red oxygen-carrying protein which is essential for respiration. **Affected birds will have significant anaemia and the red cell count itself will fall as the cells have a reduced biological half-life.**

Other significant effects of absorbed lead include terminal liver and kidney failure. Severely affected birds often have a very smelly greenish diarrhoea.

Swan rescuers have frequently described birds as having behavioural changes. Many of these may be of a relatively minor nature and may be seen only by experienced handlers or after a spell of observation. Certainly birds with early symptoms of lead toxicity seem to be withdrawn and likely to be on their own and not with the flock. They are often unresponsive when offered food and thus difficult to catch. There are suggestions response times are lengthened thus in early cases making **the flying bird more prone to aerial accidents.**

The ingestion of lead from whatever source is very variable. The size and weight of each item may be very different. Each separate piece of lead may be ingested over widely varying time intervals from several days apart to all at the same time if a string of shot is swallowed on a line at one go. The rate the lead is ground up and absorbed can vary with the type of food being consumed. **The rate of absorption itself is higher in the female than the male and is particularly enhanced in the young quickly growing birds which have greater demands for calcium – lead acts as a calcium mimic.**

The resulting lead toxicities in a number of different cases may thus vary from instances of acute poisoning to the more frequent chronic form with all stages in-between.

Symptoms	Causes
Dropped neck	Weakness of neck muscles
Swollen neck	Accummulation of food material in the oesophagus
Dribbling when drinking	Accummulated food in the oesophagus making swallowing of water difficult
Inability to fly	Weakness and atrophy
Inability to stand/paddle	Weakness and atrophy of leg muscles, bird may be blown across lake or drift over weir
Light birds	Severe drop in body weight due to gizzard impaction and resulting starvation
Foul-smelling greenish diarrhoea	Gastro-intestinal disruption, lack of solids, "renal" failure
Paleness of skin	Severe anaemia due to poisoning of bone marrow
Behavioural changes	Impairment of central nervous system
Interrupted moult	Due to toxic effect of lead and also to poor body condition