

Iron Storage Disease in Softbilled Birds (Hemochromatosis)

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What is Hemochromatosis?

Iron storage disease, technically known as hemochromatosis, occurs when too much iron accumulates in the liver and other major organs of the body. The body needs a certain amount of iron to produce hemoglobin, which is the means of transporting oxygen molecules from the lungs to all the other cells in the body. However, when too much iron builds up, the body begins to store it in the liver, then the heart, lungs, and other organs, where it can do significant damage eventually leading to death.

A second form of the disease, known as hemosiderosis, is a less malignant situation where the excess iron (called hemosiderin) accumulates in the tissues and circulates freely in the blood without actually damaging any of the major organs. However, hemosiderosis can be a precursor to hemochromatosis, at least in mammals. Diagnostic procedures discussed below may be useful in identifying hemosiderosis in a bird and therefore predicting which birds are at risk for developing hemochromatosis. Then, the owner can keep a closer eye on these individual members of the flock and take whatever prophylactic measures are deemed appropriate to avoid or limit the development of iron storage disease.

Owners of softbill species are frequently concerned about iron storage disease and obviously want to take whatever measures are necessary to prevent all members of their flock from developing this problem. Unfortunately, information as to the cause and cure of this disease is still evading researchers and softbill owners and breeders often receive conflicting information regarding diet, breeding, and treatment.

Which Birds Get This Disease?

The most common group of birds to suffer from hemochromatosis are the toucans, toucanettes, and aracari (family Ramphastidae). The disease is also often found in some mynahs and in birds of paradise (Sturnidae), and singular reports have surfaced identifying the disease in individual species of some orders including quetzals (Caprimulgiformes), tanagers and starlings (Passeriformes), curassows (Struthioniformes), and even some parrots (Psittaciformes). In general, birds that eat primarily fruit, insects, or are omnivorous tend to accumulate more iron in their livers and, thus, are more prone to the disease than birds that dine mostly on meat, fish, or grains and seeds.

While many owners and breeders of softbills believe that the disease is rampant among all softbill species, this does not seem to be the case. For example, "members of the family Musophagidae (touracos, plantain eaters, go-away birds) fit well within the category of frugivorous softbills, but no reported cases of

hemochromatosis in the literature or from an informal survey of breeders can be found. Therefore, the mere act of adding a softbill species to a collection does not necessarily mean that one must immediately be on the lookout for the symptoms of iron storage disease, nor do the birds need to necessarily be examined or tested for the problem unless they fall within one of the families with a strong reputation for developing this malady.

What Causes Hemochromatosis?

In humans, hemochromatosis is the most common genetically inherited disease known and, within the past few years, researchers have identified at least two different genes that cause or contribute to the problem. While research is still ongoing, it appears that the genes cause the digestive system to take up more iron than normal through the mucosal cells and deposit it in the liver and other organs. It is also interesting to note that, in humans at least; a diet high in iron has no effect one way or the other on the progress of the disease.

No one has yet fully investigated the various avian species thoroughly enough to positively identify a genetic cause or contributing factor and, therefore, whether or not there is a genetic "predisposition" to the disease in birds is still unknown. An ongoing debate among aviculturists, nutritionists, and geneticists continues on the question of whether or not dietary iron causes or contributes to the development of the disease. Until about five years ago, the common consensus was that a "low iron" diet (less than 100 ppm of iron, dry weight) was mandated to avoid the disease. However, a study undertaken on a flock of mynahs that were fed a diet containing less than 80 ppm of iron showed that the birds still developed the disease at the same statistical rate as birds on a 200+ ppm diet. This could point to the fact that mynahs, like humans, are genetically predisposed to the disease regardless of how much iron comes into their bodies; but this may not hold true for other species of birds with this problem. Current veterinary nutritionists believe that the use of a low iron diet cannot do any damage to a species prone to hemochromatosis and it could help. Therefore, diets containing less than 100 ppm are the standard recommendation.

Surveys of captive birds (primarily in zoos or in quarantine stations in the United States) have produced arguments that there is direct correlation between immunological or nutritional stress and the disease. For example, birds reared or housed in crowded conditions or those deprived of a proper diet during transportation show a much higher mortality rate due to liver failure than similar populations of birds kept under more ideal situations. One explanation for this may come from comparing the birds to mammals. When infected with a bacteria, the immune system of many mammals sequester free iron in the liver temporarily, so that it will not be available to the bacteria for them to use in their cycle of reproduction. It has been speculated that the same thing happens in birds. Thus, when birds are in cramped, close quarters or are on insufficient diet, they become more susceptible to infection which leads to iron sequestration and, if not quickly reversed, iron storage disease. Yet, many other species of birds

kept under similar conditions do not develop the disease, casting doubt on stress as the only precipitating factor to consider.

Another theory regarding iron storage disease combines the concept of a genetic predisposition with a diet containing a high amount of bioavailable iron. Proponents of this theory say that birds prone to hemochromatosis, like toucans, come from tropical zones where the high amounts of rain leach the soil of minerals, such as iron. Thus, there is very little iron in the foods consumed by these birds in the wild and, over evolutionary time, their bodies have adjusted to hold on to whatever bioavailable iron comes their way. Then, when the birds are placed in a captive setting and fed a diet with significantly more iron content than they would ever get in the wild, the continued sequestration of the mineral eventually leads to the disease condition.

The problem with this theory, however, is that many of the species that suffer from the disease do not come from rain forest habitats. For example, many species of starlings and mynahs are naturally found in open grasslands or moderately dense forest areas where the soil, and thus the plants that grow upon it, are rich in minerals such as iron, creating no need for modification of the digestive system to store this metabolically necessary element.

How Is the Disease Diagnosed?

Unfortunately, most diagnoses of hemochromatosis are made at the time of the postmortem examination of the dead bird. The liver usually is pale in color and frequently contains yellow spots where the iron has accumulated enough to be visible to the naked eye. Additionally, diagnosis is confirmed by staining of tissue with Prussian blue to demonstrate iron-laden hepatocytes. The medical literature reports that the Ramphastids, more than any other family of birds, are prone to sudden death from the disease appearing fine one day and lethargic the next, followed by death within 24 hours or less. Other species, however, exhibit a gradual onset of symptoms that may indicate that a problem is developing, giving the owner enough time to institute medical measures to try to save the bird. Again, though, once significant symptoms begin to appear the chances of recovery or a life span more than a few weeks is highly unlikely.

If one owns a species known to be prone to hemochromatosis, certain antemortem procedures can reveal the presence of the condition even before, obvious external symptoms appear. These include radiographs that sometimes reveal an enlarged liver, ascites in the abdomen, and even an enlarged heart due to the excess iron deposited in the myocardium (heart muscle). Regrettably, blood tests are more often than not inconclusive, since tests for total serum iron, plasma iron or TIBC (total iron binding capacity) may not be elevated even though the bird has excessive iron deposits in the liver and other tissues.

A specific diagnosis can usually be made via a biopsy of the liver where a sample of liver cells is removed and stained with a dye specific for iron. The procedure itself is not without risk since it must be done under general

anesthesia and any bird not otherwise in optimal health might succumb to the process itself, even before hemochromatosis takes its final toll.

Treatment

Phlebotomy (blood letting) is still the treatment of choice for the disease. Depending upon the extent of damage to the liver seen on biopsy, practitioners usually start with removal of 1% of the bird's total body weight each week. The removal is accompanied by testing the hematocrit level (quantity of red blood cells), to make sure the bird does not become anemic during the process. The justification for this procedure is that removal of a portion of the bird's blood also involves removal of the iron used to carry oxygen to the cells. The bird's body will then recruit iron from the liver to replace the missing molecules, thus decreasing the damaging iron build-up in that and other organs.

The duration and frequency of the phlebotomy procedure will vary from one bird to another, depending primarily on the condition of the liver when the initial diagnosis is made. It is not at all unusual for a bird to undergo blood letting twice a month for two to three years before complete remission of the disease is declared. Moreover, follow-up liver biopsies will be necessary throughout this period to measure the effectiveness of the process and to determine whether or not treatment may be halted.

In humans, iron-chelating agents have also been used to deal with the disease but these drugs have generally not proved to be effective in avian species. One report of a clinical trial of deferioxamine on a Channel-billed Toucan (administered subcutaneously on a daily basis) resulted in a 60% decreased liver iron concentration over four months. Yet, other veterinary practitioners and medical researchers have reported consistently disappointing results with the various iron-chelating drugs available, leaving phlebotomy as the medical treatment of choice at the present time.

Can Diet Prevent or Cure the Disease?

The answer is yes and no, depending upon the cause. In birds with a confirmed predisposition to hemochromatosis (called idiopathic hemochromatosis or IH) due to genetic makeup, diet will have little or no effect on the development or course of the disease. This has been verified by the study done on Rothschild's Mynah Birds *Leucopsar rothschildi* and by extensive work on IH in humans. For species that have the disease that are not genetically predisposed (or where the genetics are still unknown) a low iron diet or some alternative means of reducing the bioavailability of the iron consumed may have an effect on their development of the disease.

Regardless of the reason a species develops hemochromatosis, it seems to be well settled by multiple medical studies in both birds and mammals that the consumption of ascorbic acid (Vitamin C) increases the body's ability to take up iron. Therefore, citrus fruits and other food high in Vitamin C are not recommended for birds prone to iron storage disease.

More recently, the aviculturists at the Riverbanks Zoo in South Carolina have begun an experiment with the ramphastids in their collection by adding tea to the birds' drinking water on a regular schedule. The theory behind the procedure is that in the wild, the birds drink primarily rainwater caught in tree cavities, where the water is subject to the leaching of tannins from the plants themselves. Studies on humans have shown that the consumption of tannins reduces absorption of bioavailable iron in the diet. Therefore, it is theorized that tea in the toucans' water will bind the iron, making the mineral unavailable for digestion and absorption. The study is still in its early stages and it will be interesting to see if, in the long run, the life expectancy of the various members of the ramphastid collection avoid development of hemochromatosis and/or live a longer life because of this tea brew.

So, What's The Bottom Line?

Based on research to date, both by veterinarians, nutritionists, geneticists, and aviculturists in the field, there seems to be no question that birds belonging to the Ramphastid family and many (if not all) of the mynah species are prone to idiopathic hemochromatosis. Thus, a low iron diet is likely to have little or no effect on these birds. To keep the birds healthy and alive, liver biopsies need to be done early on and appropriate medical intervention, such as phlebotomy taken, if the owner wishes the bird to live a long life span. As to species that do not suffer from IH, or for whom the genetic component in the development of the disease is unknown, a low iron diet certainly cannot do any harm and may have the potential of keeping an individual bird from developing hemochromatosis during its lifetime. Thus, a low iron diet might be indicated, particularly when combined with the elimination of foods rich in ascorbic acid from the items regularly fed.

Finally, all of this raises the issue of whether birds with confirmed cases of hemochromatosis or hemosiderosis should be placed in a breeding program, where they have the opportunity to pass their defective genes on to their offspring. Some balance between the medical and ethical issues needs to be reached and this seems best left to individual aviculturists raising toucans, toucanettes, aracari, and mynahs. Without captive breeding, these species may go extinct and the problem of possibly developing iron storage disease becomes moot. Nevertheless, it is incumbent upon breeders to inform those who buy or otherwise acquire these birds what their medical history is with respect to this eventually fatal problem.

Further Reading

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