WATER QUALITY AND AVICULTURE

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SUMMARY

The health of captive birds is profoundly affected by water quality. Municipal water sources are typically the safest and most hygienic. Residential wells may be a source of water contamination. Bacterial growth may be enhanced by poorly maintained filtration systems. Investigation of any outbreak of enteric bacterial disease problems should include evaluation of water supplies.

INTRODUCTION

As in the husbandry of any captive animal population, the quality of water utilized in aviculture is vital for health maintenance and avicultural success. Acclimated adults birds can withstand some level of water contamination. An open water container which becomes contaminated with feces or food will promote rapid bacterial growth. Water containing added vitamins can have a 100-fold increase in bacterial count in 24 hours. (1) Changing the water and rinsing will reduce the level of organic material and bacteria but unless a surface is washed and disinfected, an active biofilm remains. Sources of water may also be contaminated, leading to infection, especially if the numbers are amplified when passing through the water supply and filtration systems.(2,3)

Neonatal and juvenile birds, however, have immature immune systems and are much less tolerant of environmental, food-borne, and water borne-bacteria. In the psittacine nursery health problems are routinely associated with intestinal infection with common gram negative bacilli such as *Escherichia coli, Klebsiella pneumoniae* and *Pseudomonas aeruginosa.* (2,3,4,5)

WATER QUALITY IN MUNICIPAL WATER SYSTEMS

Modern hygienic standards demand safe, reliable sources of potable water. Municipal water sources are precisely controlled and continually monitored for safety. They are routinely required by local, state and federal regulatory agencies to sample water for both inorganic and organic chemicals as well as sampling for bacterial constituents. Both raw and finished water is tested for coliform bacteria. However

there are other species of bacteria that are of pathogenic concern, both to animals and humans. Many of these non-coliform bacteria species are present in raw groundwater supplies. In most cases, these bacteria were introduced during construction of wells by improper drilling practices and/or improper disinfection of drilling equipment. The presence of these types of bacteria is notorious for causing bio-corrosion to well casing and water treatment systems. The destruction of casing can introduce metals in concentrations that may adversely affect water quality. The most common of these metal producing species are iron-reducing and sulfur-reducing bacteria. Other bacteria that are of significant concern are opportunistic pathogens such as *Pseudomonas aeruginosa.* In most cases, plant disinfection processes eliminate this concern in the finished water supply. Municipal water supplies must also be routinely tested for metals, radioisotopes, calcium sodium chloride, hardness, total solids, and numerous priority pollutants including 129 chemicals (pesticides, herbicides, and fertilizers).

Bacterial sampling for all forms of bacteria, fungi, and algae should be performed on a routine basis. To assess the microbiological population in water, one must trap existing micro-organisms on a .45u filter in a specified volume of water.(6) The filter is then placed directly on nutrient agar. This will render a numerical value of colony forming units (CFU) per volume of water. Identification of isolated colonies on the membrane filter can then proceed by standard microbiological methods.

RESIDENTIAL WELLS

While regulation of municipal water supplies is extremely rigorous, this is not the case for small domestic users. Water supply wells for domestic use usually have a single sample obtained after construction of the well checked for coliforms, no further testing is required. Public health labs which test new well installations utilize standard aerobic methods and look only for fecal and non- fecal coliforms. Such gross contamination would be a sign of direct sewage line, or mammalian or avian fauna falling into the well, surface water entering the well, etc. The methods used would frequently miss *Pseudomonas aeruginosa, Aeromonas hydrophila* and other free living saprophytic opportunistic pathogens.

Residential wells are often contaminated (in South Florida). Over time bacteria may enter the system without the knowledge of the owner, affecting the quality of the water adversely. Well drilling companies can introduce contamination at the time of drilling if equipment is not sterilized or if they pass through contaminated strata when drilling the well. Subterranean water supplies can be contaminated. Many of the smaller domestic treatment systems, especially reverse osmosis systems, have a tendency to biofoul, reducing the efficiency of the unit. Eventually massive bacterial buildup occurs in the system, especially if the filters are not routinely changed.

BIOFILMS AND WELL CONTAMINATION

Biofilms, are a gelatinous matrix from the elaborated exoenzymes, proteinaceous exudates and mucous produced by bacteria. These biofilms look like mucous, often green and slimy. Biofilms in wells can include numerous bacterial species including *Aeromonas hydrophilla, Pseudomonas aeruginosa, Pseudomonas fluorescens, Acinetobacter sp., Enterobacter agglomerans* and a myriad of gram negative bacteria occasionally *Klebsiella pneumoniae.*

Biofilms can also contain iron-sulfur bacteria such as *Sameretilus natans, Gallionella ferruginea* and *Thiobacillus sp.* The end product of some sulfur reducing bacteria is sulfuric-acid causing dysfunction of the well casing, pumps and plumbing. Iron bacteria also corrodes steel well casing. Enzymes and chemicals produced by these bacteria can cause etching and degradation of well casings, pumps, and water equipment. Corrosion on the wall of the well casing can eliminate the sanitary seal provided by the casing.

Low-level well contamination can be exacerbated by poorly selected or maintained water filtration equipment. This is a very common problem with reverse osmosis systems, where biofilms form on the membranes of the system. The mixture of organisms produces elastases and collagenases which will erode and dissolve membranes. Prior to scheduled maintenance and changing filters, often times there is more bacteria in the water coming out of the filter than going in. Occasionally, algae is found in a well which is not completely anaerobic. This would indicate a connection to the aquifer to surface water supplies and a nutrient source being directly interconnected with the well. Because water entering the well bore moves quicker than flow further away from the well, the provision of nutrients is accelerated. If the biofilm grows it may clog the pore spaces in the aquifer causing the well to have excessive draw downs, adversely impacting the equipment.
Free living micro-organisms, by virtue of their ability to survive adverse environmental conditions can derive their nutrients from organic mater, plants, dissolved solids and even hydrocarbons.

Drilling contractors need to become more educated regarding proper disinfection practices for drilling water supply wells. This includes steam-cleaning the drilling rig and disinfecting all drilling equipment with a 2,000 milligram per liter chlorine concentration. In addition, water used for mixing drilling fluids must be from a potable water supply source. Well casings, well screens, and gravel packs must also be saturated in chlorine solutions prior to installation in the ground. After construction of the well and prior to the well being brought on line, the well should be shock chlorinated and tested for bacterial, fungal and alga concentrations.

CHLORINATION

Chlorination has historically been used in municipal water systems to maintain water hygiene. Recommended levels of chlorine in water systems is usually 0.5-1ppm. Some local municipalities run higher. Three (3.0) ppm safe for swimming. In reverse osmosis systems, excessive chlorine will disrupt membranes and may also be corrosive.

No bacteria are known to be resistant to chlorine at the proper concentration. Some parasites however, most notably *Cryptosporidium* cannot be controlled by chlorination. In order to detect *Cryptosporidium* large quantities of water, hundreds of gallons, must be filtered and the filter examined microscopically using an Acid Fast stain.

Should the well be found to contain bacteria, especially biofilms, it is virtually impossible to eliminate the bacteria from the system. Common practice has been to shock chlorinate the well similar to the shock chlorination of a swimming pool. It is important to determine the volume of the well casing and well bore and to displace that quantity of water with a chlorine solution of between 2,000 and 6,000 milligrams per liter. This chlorine solution should be allowed to remain in the well for a period of 24 hours and then flushed to waste. This procedure may be required to be performed on a routine basis to control the presence of bacteria in the well. Furthermore, it may also be appropriate to add a disinfection system at the well to mitigate bacteria in the water supply.

WATER CONTAMINATION PROBLEMS IN FIVE AVICULTURAL FACILITIES

Outbreaks of bacterial enteric infections and subsequent disease in both adults and juveniles were traced to contaminated water supplies at five avicultural facilities. In all five facilities, general health conditions of all stock and growth and survivability of hand fed chicks improved after measures were taken to improve water quality

Facility #1 Gross contamination of well - This facility, breeding both primates and numerous species of psittacine birds experienced morbidity and mortality of both breeder birds and chicks. The water supply was from an old, shallow well estimated to be 30 feet deep. Caging had been built in close proximity to the well and the potential for feces from both primates and birds to filter into the ground was high. The potential for surface water to enter the well was also present. Water was supplied to the birds by way of polyvinylclhoride (PVC) pipes with nipple drinkers. Blind ends were common in the system and no method for flushing or disinfecting of the system was available.

Nipple drinkers were cultured by swabbing and standard plating techniques, revealing widespread contamination with *E. Coli, Enterobacter sp.* and *Klebsiella sp.* Water lines were subsequently flushed with a strong solution (concentration unknown) of sodium hypochlorite (Chlorine bleach). Chlorinated water was introduced into the lines and then water pressure was turned off to prevent drinking. After 2-3 hours the lines were flushed with clean water. All water lines were altered so that no blind ends existed which could be a site for stagnation. Faucets and sprinkler timers were installed and would periodically open resulting in flushing of water lines. Water cleanliness and incidence of disease was reduced but not satisfactorily.

Access to the well was obtained for direct culture (often not allowed by municipalities). One gallon of water was collected in a plastic container from which distilled water was removed. After determination that the well was grossly contaminated, the owner decided to drill a new, deeper well upon assurance of the well driller that the resultant water would be excellent quality. After installation of the new well, reported to be some 150 feet deep installation of ancillary equipment including a new pump, holding tank, particulate filter, and evaporator to remove sulfur, the problem again subsided temporarily. Approximately 4 months after installation of the new well, morbidity and mortality again began to rise. The well was again tested and found to be contaminated with *Pseudomonas aeruginosa*. At that time an injection chlorinator was installed in the lines prior to the holding tank. Routine monitoring of the injection chlorinator was emphatically recommended by the supplier. Subsequent to chlorination the bacterial enteritis problem was reduced to a very low level. Continuous monitoring of chlorine levels and weekly maintenance of the system is vital to prevent problems Long term effects of chlorination are not known in birds and appropriate levels of chlorination are assumed to be similar to those appropriate for human consumption. Subsequently the chlorine levels were checked and found to be in excess of 3 ppm. The chlorine levels are now routinely monitored on a weekly basis with a pool chlorine testing kit to detect problems of over/under chlorinating.

Facility #2 Low level contamination of water was causing repeated outbreaks of bacterial problems in a psittacine nursery. Upon manufacturers recommendation that "medically pure" water could be obtained by installation of a reverse osmosis water purification system, the system was installed under the sink with a separate faucet supplied for the unit. A few months later the problem returned with cultures in chicks being primarily *Escherichia coli, Enterobacter* spp. *Klebsiella* spp. *Acinetobacter*, and occasionally *Pseudomonas aeruginosa*. Faucets were cultured by swabbing and plating and were found to be heavily contaminated with predominately *Pseudomonas* sp. and *Klebsiella* sp.. Lines were chlorinated and filters changed. A few months later the problem re-occurred. At this time the well was sampled and found to be contaminated with *Pseudomonas*. An in line UV light sterilizer was then installed between the well and the reverse osmosis (RO) unit. RO filters are religiously changed every few months (More frequently than recommended). The problem has been minimized since that time.

Facility #3 Facility 3 also had a well contamination problem discovered subsequent to a chick mortality problem. This facility had an old well and had installed a reverse osmosis system for the nursery. The manager could not remember when the reverse osmosis system was last serviced. A strong concentration of a disinfectant solution (Virkon-Antec International, UK) was used to wash syringes which were then rinsed and allowed to air dry prior to use. Formula was prepared using bottled water. Heavy contamination was found in water faucets, syringes, reverse osmosis filters and in the well. A commercial company was hired to clean the well by a vacuuming process which removed a large amount of organic debris. An injection chlorination system was installed and the reverse osmosis system was put on a routine maintenance schedule.

Facility #4 A specialty pet shop selling primarily hand fed psittacines had concerns about the cleanliness of the municipal water supply and changed to a bottled water provided in 5 gallon bottle and utilizing dispenser which was capable of supplying both hot and cold water. This water was used for mixing hand-rearing formula. Subsequently the chicks began to develop problems and cultures revealed frequent bacterial infections, primarily again *E coli, Klebsiella* and occasionally *Pseudomonas*. Culture of water from the dispenser revealed contamination. The owner changed to a tilting holder which supported the bottle but allowed water to be poured from the bottle without passing through a dispenser. Subsequent problems were dramatically reduced.

Facility #5 This facility was experiencing excessive dead in shell and cultures revealed *Pseudomonas aeruginosa* predominately. Attempts at treatment of birds were palliative. Injection of antibiotics into the eggs was frequently practiced. Upon visiting the farm it was discovered that the breeder was using water bottles for the breeding birds. All water bottles were reportedly cleaned and bleached weekly but were contaminated with *Pseudomonas*. Bottles were exposed to sunlight. Pseudomonas infections were common in the breeding stock . The breeder removed all bottles and installed a fall through watering system. All adult birds were treated with Enrofloxacin (according to antibiogram) but some subsequent failures of therapy were found. These birds were subsequently treated by use of an inactivated, autogenous bacterin. Subsequent egg infections and mortality was within normal limits

REFERENCES

1. BRUE, R.N.(1994), Nutrition, In *Avian Medicine: Principles and Application*, BW Ritchie, GJ. Harrison and LR. Harrison (eds), Wingers Publishing, Lake Worth, FL, 1994. pp 63-95.

2. CLUBB, S.L. (1996), Aviculture Medicine and Flock Health Management, In *Avian Medicine and Surgery*, RA Altman, SL Clubb, G Dorrestein and K Quesenberry (eds), W.B. Saunders Co., Philadelphia, PA, 1996 pp 101-116.

3. FUDGE, A.M., REAVILL, D.R., ROSSKOPF, W.J.(1992), Clinical aspects of avian Pseudomonas infections: A retrospective study, Proceedings of Association of Avian Veterinarians., New Orleans, LA, pp 141-155.

4. DREWES, LA and FLAMMER, K.(1986) Clinical Microbiology, In *Clinical Avian Medicine and Surgery*, GJ Harrison and LR Harrison (eds) W B Saunders Co, Philadelphia, PA pp. 157-171.

5. DORRESTEIN, G. (1996) Bacteriology, In *Avian Medicine and Surgery*, RB Altman, SL Clubb, G Dorrestein and K Quesenberry, W.B. Saunders Co., Philadelphia, PA, pp 255-280.

6. ANONYMOUS, (1997) Water microbiology, Lab and field procedures. (Technical Manual) Millipore Systems, Bedford, MA 01730