

TOXIC EFFECTS OF SILICOFLUORIDATED WATER IN CHINCHILLAS, CAIMANS, ALLIGATORS, AND RATS HELD IN CAPTIVITY

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SUMMARY: Two independent experiences with animals in captivity revealed a dramatic onset of severe debilitating symptoms when the nonfluoridated water supplies were changed to municipal water fluoridated with fluorosilicic acid, H₂SiF₆. The first group of animals, chinchillas in a small fur farm operation, quickly more than doubled their water consumption with the change to silicofluoridated water and gradually began to have inferior fur quality, stillbirths, and premature mortality. In the second group of animals, when a similar change in the water occurred, caimans and alligators in a noncommercial private animal collection exhibited swelling and ulceration of eye membranes and later bloated bellies, liver silicosis, spinal deformity, tumors, and shortened life spans. The health of the rat colony in this collection rapidly deteriorated and numerous tumors developed. When hatchling caimans were raised in distilled water, they remained healthy until, because of their size, they were transferred to the silicofluoridated water, after which the above symptoms began to appear. Similarly, when the rats were changed to distilled water, tumor formation ceased, and they became healthy with greatly extended life spans.

Keywords: Alligators; Caimans; Chinchillas; Eye membrane injury; Fluorosilicic acid; Fluoridated water; Liver silicosis; Rat tumors; Spinal deformity; Stillbirths.

INTRODUCTION

Although the rapid onset of adverse health effects in humans following fluoridation of drinking water has been on record for over 50 years,^{1,2} there appear to be few reports of such hypersensitivity in animals. In two recent accounts, a change from nonfluoridated water to water fluoridated with fluorosilicic acid, H₂SiF₆, was found to cause not only typical dental and even skeletal fluorosis but also allergic hypersensitivity in horses.^{3,4} Here we describe what occurred with the introduction of such silicofluoridated water to a small chinchilla fur farm in Auburn, Kansas, and to a noncommercial private collection of caimans and rats and a few alligators in Kansas City, Missouri.

MATERIALS AND RESULTS

1. Experience with chinchillas: For about six months during the early 1970s, co-author RFF successfully operated a 50-animal chinchilla fur farm in Auburn, Kansas, a small community 15 miles southwest of the state capital city of Topeka. Within a few days after the low-fluoride Auburn well water was changed to the H₂SiF₆-fluoridated Topeka municipal water system, the animals began to drink more than twice as much water as before and started to exhibit a dramatic deterioration in the normal velvety softness of their fur. In addition, they suffered a

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catastrophic decline in reproductivity with a large number of stillbirths and other abnormalities.

At this point, with everything else left unchanged, half the chinchillas were placed on distilled water, and their water consumption soon decreased and became normal. No further stillbirths occurred among them, and the marketable quality of their fur was restored. Among the chinchillas continuing to drink the silicofluoridated water, however, high water intake and stillborn litters persisted. Even the adults in this group began to die prematurely. Because of these events, and in view of a declining chinchilla pelt market, RFF decided to disband the colony and move to another community. Interestingly, a similar experience was reported from an excessively high fluoride content in a commercial pellet food at a chinchilla farm during the late 1940s in northwestern USA.⁵

2. Experience at Parrot Hill Croc Farm: From 1961 until 1981, caimans, alligators, and rats were successfully bred and raised at Parrot Hill Croc Farm in Kansas City, Missouri. Throughout these years and afterward, the same curator-technical illustrator and full-time caretaker (PNJ) lived and worked closely with these animals, affectionately identifying and caring for each caiman and alligator by name (Figure 1). Her registered caiman collection was one of the largest noncommercial private enterprises in the world. During this period, the relatively rare reproduction of caimans in captivity occurred in June 1978, and, among an average of 20 caimans and alligators, only one died (from a ruptured ovarian tract). The rat colonies, begun many years earlier, were healthy and prolific with many of the rats living for well over three years. Only four tumors were found among the hundreds of rats that were raised.



Figure 1. Twenty-year-old male caiman “Hojo” with curator Pat Nichols Jacobs in June 1998.

Beginning of toxic effects: On April 9, 1981, fluoridation of the Kansas City, Missouri water supply was initiated with fluorosilicic acid, H_2SiF_6 . Within three days the eye membranes of the caimans and alligators began to swell and

gradually became ulcerated as illustrated in Figure 2A–D. The animals also began to avoid being in the water, preferring to remain on deck more than normal and going from tank to tank, evidently in search of water less irritating to their eyes. These eye conditions were diagnosed by a qualified veterinarian (Frank Serra, DVM, Overland Park, Kansas) to have no other cause. With only distilled water in their environment, very young caimans did not exhibit these eye membrane injuries nor any of the other symptoms described below. During clement weather, the avian population in the area drank from and emptied the outdoor water baths filled with distilled water before drinking from water baths filled with the silicofluoridated water.

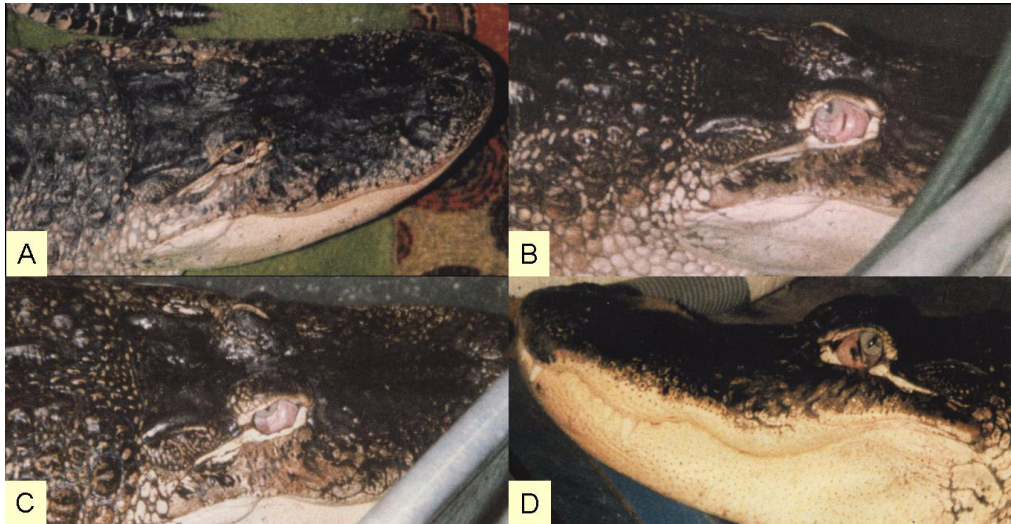


Figure 2. Eye membrane changes in female alligator “Nicholas” (d. Dec. 3, 1987, aged 20 years): A - Normal appearance of right eye Sep. 10, 1980, seven months before start of fluoridation on April 9, 1981. B - Swollen right eye membrane with downward displacement of lower eyelid Nov. 19, 1981, eight months after fluoridation began. C - Further swelling and beginning of ulceration of right eye membrane Sep. 10, 1983. D - Increased inflammation and ulceration of left eye membrane Nov 19, 1984.

Serious illness and deaths: By late 1981, without any change in diet or housing conditions, and no evidence of any vector-borne disease, the animals also began to exhibit bloated bellies, gastric distress, and spinal deformities (see Figures 3 and 4).

During the next 20 years, 32 caimans and 3 alligators died, many in apparent agony. Over half (18) were less than 10 years old, compared to a normal lifespan of 25 years or more. Autopsy revealed severe disintegration of the intestinal tract in the form of Crohn’s disease, liver silicosis, and other gross abnormalities. In addition, none of the eggs laid since 1981 hatched, and all were found to be infertile, even though matings had occurred.

Additional observations: Since the water requirement for the collection was ca. 700 gallons/day, the cost of effectively defluoridating the tap water or obtaining suitable nonfluoridated water was prohibitive. However, hatchling caimans raised on distilled water remained in excellent health until, because of their size, they had

to be switched to the silicofluoridated tap water. In every case the above-mentioned symptoms soon developed.



Figure 3. Six-year-old female caiman “Hiss-a-fer” with severely bloated belly in late 1981 following fluoridation of the water earlier that year.



Figure 4. Male caiman “Shep,” (hatched from hand-held egg June 8, 1978; died Sept 15, 1998) showing spinal deformity and bloated belly that developed in the late 1980s several years after fluoridation of the water began.

Cancer in rats: During the first six months after fluoridation began, the appearance and health of the rats declined dramatically. Tumors started to appear, with over 200 being counted and as many as 6 per rat. Beginning October 1, 1981, the rats were given only distilled water to drink. Their condition quickly improved, and no further tumors were detected. Their reproductivity and their lifespans increased significantly, with some of the rats reaching more than 7 years of age.

DISCUSSION AND COMMENT

Although silicofluorides are widely used for water fluoridation, their biological effects have had only limited study.⁶ As observed here, a change from nonfluoridated water to water fluoridated with fluorosilicic acid produced lethal toxicity in chinchillas, reptiles, and rats reared in captivity. In the literature, the LD₅₀ of sodium fluoride for chinchillas has been reported to be 100 mg NaF/kg bw without exhibiting clinical evidence of toxicity at half this dosage.⁷ However, as already mentioned, chronic intoxication of chinchillas from fluoride in their diet has been reported.⁵ Here the source of the rapid onset of symptoms (evident in the more than two-fold increase in water consumption) was clearly the Topeka tap water fluoridated with fluorosilicic acid at a concentration of 1 mg of fluoride ion per liter.

In the caimans and alligators at the Parrot Hill Croc Farm in Kansas City, eye membrane injury along with adverse gastrointestinal and skeletal effects began to occur after the existing municipal water supply was fluoridated with fluorosilicic acid. However, as might be expected, not every animal was affected in the same way. Although toxic effects of silicofluoridated tap water, including excessive water consumption, have been observed in monkeys,⁸ a search of the scientific literature did not disclose any reports of fluoride effects in caimans. By contrast, there are many reports of toxicity studies of fluoride in rats, including some relating to cancer,⁹ but apparently there are none directly for silicofluoridated tap water like that seen in a chronic toxicity study on monkeys made some years ago at the Yerkes Primate Research Center in Atlanta, Georgia.⁸

Here the rapid onset of tumorigenicity, poor appearance, and shortened lifespan of the rats after the tap water underwent fluoridation with fluorosilicic acid was especially striking, along with the reversal of these effects simply by changing to distilled water. In the young caimans adverse effects of the tap water were likewise prevented in the same way. Finally, it should be mentioned that many pet stores do not use or recommend fluoridated tap water for baby reptiles, and zoos that use fluoridated water have also encountered problems similar to those reported here.

Presentations of this work were made at the XXIInd and XXVth conferences of the International Society for Fluoride Research.^{10,11}

REFERENCES

- 1 For details and references, see Waldbott GL. A struggle with titans. Chapter 11. New York: Carlton Press; 1965. Also, Waldbott GL, Burgstahler AW, McKinney HL. Fluoridation: the great dilemma; Lawrence, KS: Coronado Press; 1978; Chapter 9.
- 2 Spittle B. Allergy and hypersensitivity to fluoride. Fluoride 1993;26(4):267-73.

- 3 Krook LP, Justus C. Fluoride poisoning of horses from artificially fluoridated drinking water. *Fluoride* 2006;39(1):3-10. Cf. Burgstahler AW. Failure to diagnose fluoride poisoning in horses caused by water fluoridation [editorial]. *Fluoride* 2006;39(1):1-2.
- 4 Justus C, Krook LP. Allergy in horses from artificially fluoridated water. *Fluoride* 2006;39(2): 89-94.
- 5 Cox WR. Hello test animals ... chinchillas? or you and your grandchildren. Milwaukee, WI: Lee Foundation for Nutritional Research; 1953.
- 6 Coplan MJ, Masters RD. Silicofluorides and fluoridation [guest editorial]. *Fluoride* 2001;34(3):161-4.
- 7 Astrakhantsev VI. Toxicity of sodium fluoride for chinchillas. USSR. *Nauchnye Trudy, Nauchno-Issledovatel'skii Institut Pushnogo Zverovodstva I Krolikovodstva* 1970;9:311-2.
- 8 Manocha SL, Warner H, Olkowski ZL. Cytochemical response of kidney, liver and nervous system to fluoride ions in drinking water. *Histochem J* 1975;7:343-55.
- 9 Doull J, Boekelheide K, Farishian BG, Isaacson RL, Klotz JB, Kumar JV, Limeback H, Poole C, Puzas JE, Reed N-MR, Thiessen KM, Webster TF, Committee on Fluoride in Drinking Water, Board on Environmental Studies and Toxicology, Division on Earth and Life Studies, National Research Council of the National Academies. *Fluoride in drinking water: a scientific review of EPA's standards*. Washington, DC: The National Academies Press; 2006. [Contract No.: 68-C-03-013. Sponsored by the U.S. Environmental Protection Agency]. p. 316-20.
- 10 Jacobs PN, Burgstahler AW. Toxic effects of water fluoridation on crocodilians and rodents in captivity [abstract]. *Fluoride* 1998;31(3):S8.
- 11 Burgstahler AW, Freeman RF, Jacobs PN. Early and prolonged toxic effects of silicofluoridated water on chinchillas, caimans, alligators, and rats in captivity [abstract]. *Fluoride* 2002;35(4):259-60.