

Alligator Behavior: The Accuracy of William Bartram's Observations

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In 1774, while traveling in north Florida, William Bartram made observations on the behavior of the American alligator (*Alligator mississippiensis*), including accounts of their aggressive behavior, mating, bellowing, construction of nests, parental care, and feeding. Bartram later described these observations in his *Travels*, which was published in 1791 (Bartram [1996](#); Van Doren [1928](#)). As little as three years later, the veracity of those observations had become the butt of jokes (Bartram [1996](#):603). Since that time many writers have criticized Bartram's accounts as exaggerated, overly colorful fiction.

For example, Frederick True ([1893](#)) describes Bartram as the eighteenth century,

"... writer who is most loud in denunciation of the Alligator ... Although he begins his account with a query as to how he shall do credit to what he observed without arousing the suspicion of his readers regarding his veracity, his description seems overdrawn."

True should have been more circumspect in his criticism, for Bartram's description has proven correct. In addition, True ([1893](#)) was so poorly informed that in his discussion of the topic "alligators" he did not distinguish between observations on American alligators (*Alligator mississippiensis*) in Florida, American crocodiles (*Crocodylus acutus*) in Cuba, Nicaragua, and Panama, and Orinoco crocodiles (*Crocodylus intermedius*) in Venezuela.

Wilfred T. Neill, a well-known herpetologist who published extensively on southeastern reptiles and amphibians, claimed that Bartram's description of the workings of the alligator's jaws, use of the tail as a weapon, the nest, parental care of the young, and feeding behavior, "created a whole new mythology" (Neill [1971](#):27).

Bartram was human and entirely capable of making mistakes, but his reports on American alligators contain relatively few errors and the ones that are present are easily explained misinterpretations of the facts. However, the majority of Bartram's observations are exceedingly accurate.

Movement of the Jaw: Bartram's ([1996](#):122) report that in the alligator, "...Only the upper jaw moves, which they raise almost perpendicular, so as to form a straight angle with the lower one..." was in error. This mistaken observation did not originate with Bartram for in the fifth century BC, Herodotus wrote in *The Histories* that the Nile crocodile is the only creature, "... which does not move its lower jaw but brings its upper jaw down to meet the lower one" (Waterfield [1998](#):122). Similarly, in the first century AD, Pliny the Elder stated in his *Natural History*, the crocodile, "... is the only land creature ... that bites by pressing with its moveable upper jaw" (Healy [1991](#):118).

Mistaken reports of moveable upper jaws end with Bartram. Ashe ([1808](#)), Ker ([1816](#)), and many other writers repeated the same mistake because none of them understood the limitations that the alligator's physical environment puts on the workings of its jaws. If an alligator on land has its lower jaw resting on the ground, that jaw will not move when the alligator opens its mouth. The ground prevents the jaw from dropping, so the entire skull, together with the upper jaw, rocks backward giving the impression that the upper jaw is

hinged. Neill (1971: 12) accurately described the crocodilian jaw thusly,

"...the upper jaw is a prolongation of the skull to which it is rigidly attached, while the lower jaw is hinged and moveable. Obviously a crocodilian, resting with its lower jaw on the ground, could open its mouth only by tilting the entire skull backward and so lifting the upper jaw. (A man, resting his chin on a mantelpiece, could open his mouth in the same fashion.)"

Guggisberg (1972: 59) gives a comparable explanation,

"An old fallacy, which is revived from time to time will have the lower jaw attached immoveably to the skull, with the upper jaw hinged and movable. This can be disproved by anybody who cares to have a look at a crocodile's skull, but it is easy to see how this erroneous idea originated. A crocodile basking with its mouth open has the lower jaw on the ground, while the upper jaw is held at an oblique angle, creating the distinct impression of being mobile. This position is, however, not achieved by moving the upper jaw, but by tilting the whole head. It is the lower jaw that is hinged to the skull."

Fourth tooth of the Lower Jaw: Bartram (1996: 122) also incorrectly reported, "In the fore-part of the upper jaw, on each side, just under the nostrils, are two very large, thick, strong teeth or tusks ... in the lower jaw are holes opposite these teeth, to receive them..." Glasgow (1991: 31) pointed out that Bartram, "...got the placement wrong. The teeth about which he wrote are in the lower jaw, the holes in the upper."

This is clearly a case of Bartram getting things backwards because he described the tooth structure from memory rather than retrieving accurate anatomical data from fieldnotes.

Bartram had never seen true crocodiles and did not know that the enlarged fourth tooth in the lower jaw is an easy way to distinguish between alligators and crocodiles. In alligators the hole or socket inside the row of teeth in the upper jaw hides the fourth tooth of the lower jaw so it is not visible when the mouth is closed. In crocodiles, the fourth tooth of the lower jaw fits into a notch in the side of the upper jaw so it is visible when the mouth is closed—see [Figure 1](#).



Figure 1. Bartram reported that the enlarged tooth in the front of an alligator's upper jaw fit into a hole in the lower jaw. The opposite is true. In the American alligator (left), the enlarged fourth tooth of the lower jaw fits into a socket inside the teeth of the upper jaw. It is hidden when the mouth is closed. In crocodiles (right), the fourth tooth fits into a notch in the side of the upper jaw and can be seen sticking up when the mouth is closed. Photographs by F. Wayne King.

Using the Tail as a Weapon: Bartram ([1996](#):116; Van Doren [1928](#):117) tells of returning to his campsite with more fish than he had use for and, "...then proceeded to cleanse and prepare my fish for supper; and accordingly ... laid them down on the sand close to the water, and began to scale them; when ... a very large alligator ... with a sweep of his tail, he brushed off several of my fish."

To discredit Bartram and at least seven later writers who similarly reported that the alligator uses its tail to capture prey, Neill ([1971](#): 34) claimed,

"One ancient myth, still credenced in Bartram's day, averred that the Nile crocodile uses its tail to knock prey into its waiting jaws. Accordingly, Bartram claimed that while he was scaling fishes he saw 'a very large alligator, moving slowly towards me. I instantly stepped back, when, with a sweep of his tail, he brushed off several of my fish.'"

Neill points out that Flint ([1832](#)), Williams ([1837](#)), Hinton ([1846](#)), and McIlhenny ([1935](#)), also reported that alligators used the tail to stun or capture prey.

Both Bartram and Neill, and the other writers, misinterpreted the actions of the alligator that cause its tail to swing toward and sometimes hit prey. The head of all crocodilians is a heavy mass of bone, which, if moved rapidly, dramatically illustrates Newton's Third Law, "For every action, there is an equal and opposite reaction." When a crocodilian whips its head sideways to snatch prey or threaten an intruder, the action of accelerating that massive skull will cause the body to twist away in the opposite direction were that reaction not counter balanced by swinging the tail in the same direction. Humans do the same thing when they walk or run; they swing forward the arm that is on the side opposite to the leg that is moving forward. The action of swinging the heavy leg forward produces a reaction that causes the human body to twist, but swinging the opposite arm forward at the same time causes the body to twist in the opposite direction thereby counteracting the first twist. When an alligator lunges sideways to grab for prey, both the head and tail swing toward the same side. Occasionally prey or some threatening organism might be close enough to be hit by the counter-swinging tail. If that happens, the prey could be knocked toward the open mouth. But the primary reason for swinging the tail is to counter balance the moving head and stop the body from turning.

If the alligator had swept the fish away with the intent to eat them, it probably would have done so, but that was not what happened. In his 1775 Report to Dr. Fothergill, Bartram ([1943](#):151, [1996](#):473) recounts the incident slightly differently; "...they drew near to us & one rise up & with a sweep of his Tail had like to robbed us of our fish, which we recover'd again...." Bartram's alligator simply made a threatening lunge at him and its counter-swinging tail knocked aside some of the fish he was preparing for supper.

Alligator Nests: Bartram ([1996](#):120; Van Doren [1928](#):121) was fascinated by alligator nests and reported that,

"The nests or hillocks are of the form of an obtuse cone, four feet high and four or five feet in diameter at their bases: they are constructed of mud, grass, and

herbiage. At first they lay a floor of this kind of tempered mortar on the ground, upon which they deposit a layer of eggs, and upon this a stratum of mortar seven or eight inches in thickness, and then another layer of eggs, and in this manner one stratum upon another, nearly to the top. I believe they commonly lay from one to two hundred eggs in a nest ...”

Neill ([1971](#): 19, 26) called this description Bartram’s myth of the many-tiered alligator nest. Neill ([1971](#): 19-23) also shows that Ashe ([1808](#)), Williams ([1837](#)), McCall ([1886](#)), and Smith ([1893](#)), uncritically repeated Bartram’s multi-tiered description.

In truth, individual alligators do not build nests layer by layer with separate clutches of eggs in each layer. The female alligator constructs a nest by scraping together a pile of grass, leaves, stems, and other vegetation debris, sometimes mixed with muck or mud. Once the nest is pulled together, she crawls atop the mound and digs into the nest material with her hindfeet to form a single chamber into which she lays her eggs. She then closes the nest by scraping nest material over the eggs.

However, in seeking out the best spots to build their nests, female alligators frequently use the same nesting sites year after year. This year’s nests may be built atop the remnants of last year’s nest mounds. Occasionally, a female will scrape more vegetation on top of an active nest constructed earlier by another female and already containing her eggs. When this second female lays her eggs in the nest, it becomes a communal nest with multiple clutches of eggs, each occupying a separate egg chamber. Bartram had no way of knowing that the alligator nest he dissected was constructed by more than one female. Had he opened more nests he would have discovered that nest mounds typically contain a single clutch of eggs.

Bartram ([1943](#): 152, [1996](#): 474) gave a slightly different account of alligator nests in his 1775 Report to Dr. Fothergill and made no mention of multiple layers,

“They lay two or 300 Eggs in little mounts in fens & Marshes which they form of mud & rotten weeds & leaves, which I suppose fermenting by the heat of the sun becomes warm enough to hatch their eggs.”

The contents of that communal nest also accounts for Bartram’s mistaken belief that alligators, “...commonly lay from one to two hundred eggs in a nest...” (Bartram [1996](#): 120; Van Doren [1928](#): 121) or “...two or 300 Eggs...” (Bartram [1943](#): 152, [1996](#): 474). A single clutch of alligator eggs contains 20 to 55 eggs, with a mean of around 35 eggs (Garrick and Lang [1977a](#); Thorbjarnarson [1996](#)). If Bartram observed one hundred or more eggs, the nest contained clutches laid by several different females.

Clearly, Bartram described a communal nest, not the nest of a single alligator.

Parental Care: Bartram ([1996](#): 120-121; Van Doren [1928](#): 121-122) also described parental behavior in the female alligators he encountered,

“The water of the river hereabouts was shoal and very clear; the monster came up with the usual roar and menaces, and passed close by the side of my boat, when I could distinctly see a young brood of alligators, to the number of one hundred or more, following after her in a long train. They kept close together in a column without straggling off to the one side or other; the young appeared to be of an equal size, about fifteen inches in length ... The female, as I imagine, carefully watches her own nest of eggs until they are all hatched; or perhaps while she is attending her own brood, she takes under her care and protection as many as she

can get at one time, either from her own particular nest or others: but certain it is, that the young are not left to shift for themselves; for I have had frequent opportunities of seeing the female alligator leading about the shores her train of young ones, just as a hen does her brood of chickens; and she is equally assiduous and courageous in defending the young, which are under her care, and providing for their subsistence”

Neill ([1971](#):29) ridiculed these observations,

“Bartram’s fable, about the mother alligator who leads her brood around the lake, and watches over them like a mother hen over chicks, has survived to modern times ... There is no reliable evidence that the female alligator is mammal-like in caring for the young after they have hatched. She does guard the nest, under normal circumstances. (Guarding the nest is not an unusual activity among reptiles; it is carried on by some snakes and many lizards.) In spite of assertions to the contrary, there is no evidence that the female opens the nest in any fashion.”

Neill’s pedantic condemnation has since been proved wrong and the accuracy of Bartram’s observations has been verified. Parental care is a universal behavior of crocodylians (Lang [1987](#); Shine [1988](#)). In most species the female guards the nest, opens the nest to release the hatchlings, picks the hatchlings up in her mouth and carries them to water, releases them in the water, leads them to a safe vegetated nursery habitat, and protects them from predators. This behavior has been documented in most crocodylian species, including the American alligator (*Alligator mississippiensis* - Garrick and Lang 1977a, 1977b; Hunt and Watanabe [1982](#); Kushlan [1973](#); Lang [1987](#); McIlhenny [1935](#); Shine [1988](#); Watanabe [1980](#)); spectacled caiman (*Caiman crocodilus* - Alvarez del Toro [1969](#); Ouboter and Nanhoe [1987](#); Shine [1988](#); Staton and Dixon [1977](#)); yacare caiman (*Caiman yacare* - Crawshaw and Schaller [1980](#); Shine [1988](#)); black caiman (*Melanosuchus niger* - Shine [1988](#)); dwarf caiman (*Paleosuchus palpebrosus* - Shine [1988](#)); smooth-fronted caiman (*Paleosuchus trigonatus* - Shine [1988](#)); American crocodile (*Crocodylus acutus* - Ogden [1978](#); Ogden and Singletary [1973](#); Shine [1988](#)); slender-snouted crocodile (*Crocodylus cataphractus* - Waitkuwait [1982](#); Shine [1988](#)); Orinoco crocodile (*Crocodylus intermedius* - Shine [1988](#)); Johnstone’s crocodile (*Crocodylus johnsoni* - Compton [1981](#); Shine [1988](#)); Morelet’s crocodile (*Crocodylus moreletii* - Hunt [1974](#), 1975; Shine [1988](#)); Nile crocodile (*Crocodylus niloticus* - Cott [1971](#); Pooley [1974a](#), [1974b](#), [1976](#), [1977](#), [1982](#); Shine [1988](#)); New Guinea crocodile (*Crocodylus novaeguineae* - Shine [1988](#)); mugger crocodile (*Crocodylus palustris* - Lang [1987](#), [1989](#); Lang, Whitaker and Andrews [1986](#); Shine [1988](#); Whitaker and Whitaker [1977](#), [1978](#)); saltwater crocodile (*Crocodylus porosus* - Bustard and Choudhury [1980](#); Shine [1988](#)); dwarf crocodile (*Osteolaemus tetraspis* - Tryon [1980](#); Shine [1988](#)); and gharial (*Gavialis gangeticus* - Bustard [1980](#); Shine [1988](#)). A number of these publications are illustrated with photographs of the particular behavior.

The young alligators tend to remain together in a “crèche” (a nursery group) or “pod” (a number of animals clustered together) for up to a year after hatching (Garrick and Lang [1977a](#), [1977b](#); Hunt and Watanabe [1982](#); Watanabe [1980](#)). Bartram ([1943](#):152, [1996](#):474-475) states,

“... when the Young first appear in shallow water not far from the old nest they are about 12 or 13 Inches long ... they keep together in schooles the first year in the same place. The Old one either Male or female lies near, secreted in the sedge or Weeds to guard & protect the Young, who is very watchful & furious....”

The female protects the crèche for up to a year, and, on occasion, the crèche of young alligators follows behind the protective parent exactly as reported by Bartram ([1996](#):120-121; Van Doren [1928](#):121).

It is not clear what time of year Bartram made his observation, but the 12 to 15 inch size of the young indicates they were larger than typical 8-9 inch hatchlings, possibly yearlings from the previous season. In addition, the estimated 100 or so young alligators that were following the female parent are more than would result from a single clutch of eggs, but as Bartram ([1996](#):121; Van Doren [1928](#):122) points out, "...she takes under her care and protection as many as she can get at one time, either from her own particular nest or others...."

Not every female alligator is so protective. Where alligators have been hunted, wary females stay away from the nest to avoid being killed. They may not open the nest to release the young, may not carry them to water or lead them to a safe area, and rather than protect the crèche of juveniles they may submerge and disappear when humans approach.

If the parent is not around to release them, hatchling alligators usually can dig out of the nest, and if they are lucky enough to avoid predators, will find their way to water. The parental care exhibited by alligators is rather like that seen in many precocial birds; adults are there to help, but young can fend for themselves. Parental care is not surprising. Crocodylians are members of the Archosauria, the subclass of reptiles that gave rise to the birds.

Bellowing: Bartram provides two separate descriptions of the vocal behavior of alligators in his Travels. The first (Bartram [1996](#):114; Van Doren [1928](#):115) reports,

"Behold him rushing forth from the flags and reeds. His enormous body swells. His plaited tail brandished high, floats upon the lake. The waters like a cataract descend from his opening jaws. Clouds of smoke issue from his dilated nostrils. The earth trembles with his thunder."

The second description (Bartram [1996](#):122; Van Doren [1928](#):123) asks,

"But what is yet more surprising to a stranger, is the incredible loud and terrifying roar, which they are capable of making, especially in the spring season, their breeding time. It most resembles distant thunder, not only shaking the air and waters, but causing the earth to tremble; and when hundreds and thousands are roaring at the same time, you can scarcely be persuaded, but that the whole globe is violently and dangerously agitated.

"An old champion ... now swells himself by drawing in wind and water through his mouth, which causes a loud sonorous rattling in the throat for near a minute, but it is immediately forced out again through his mouth and nostrils, with a loud noise, brandishing his tail in the air, and the vapour ascending from his nostrils like smoke. At other times, when swollen to an extent ready to burst, his head and tail lifted up, he spins or twirls round on the surface of the water."

A much more detailed description of bellowing in Bartram's ([1943](#):27, 1996:474) Report to Dr. Fothergill explains,

"As soon as the day appeared the Thunder of the Alegators, roaring all around us, & for many Miles. Their noise is louder then the bellowing of the most furious Bull,

or a Lyon, more like the latter, the water rattling in their throats, which they force out in forth & foam, & makes the earth to tremble, & our little Island shook as by an earth quake; When they roar their Body is swoln like an empty Hogshead on the water, their head & Neck raisd out of the water, his Tail raised 5 or 6 feet in the air, waving too & fro, & lashing the surface of the water in a terrible maner as they utter their terrable Voice, their body sinks gradually in the water, then swelling again rises up, thus alternately as they continue their bellowing."

Bellowing by male and female alligators throughout the warm months is primarily a vocal announcement of presence. The bellows are loud, 84-92 decibels when 5 meters away, as loud as the roar of a small airplane engine, and are heard at considerable distance from the alligator (Lang [1989](#):106). During the spring mating season, alligators bellow to let the opposite sex know they are present. Frequently this stimulates nearby alligators to bellow in response, producing what has been called a bellowing chorus (Lang [1989](#):106). Bartram ([1996](#):122; Van Doren [1928](#):123) referred to this as "... when hundreds and thousands are roaring at the same time...." Bellowing can also serve the function of announcing the territory of a dominant alligator.

The accuracy of Bartram's descriptions can be seen by comparing them to detailed analyses of alligator bellowing.

ANALYSIS OF BARTRAM'S OBSERVATIONS OF ALLIGATOR BELLOWING

Sequential Component *	'Travels' (Bartram 1996 ; Van Doren 1928)	'Report to Dr. Fothergill' (Bartram 1943 , 1996)
In preparation for bellowing, the alligator inflates its lungs.	"His enormous body swells ... swells himself by drawing in wind...."	
This makes the alligator float high in the water.		<i>This makes the alligator float high in the water.</i>
The alligator then arches its head and tail out of the water.	"His plaited tail brandished high ... brandishing his tail in the air ... his head and tail lifted up..."	<i>"...their head & Neck raisd out of the water, his Tail raised 5 or 6 feet in the air, waving too & fro..."</i>
The alligator then bellows by contracting its abdomen and expelling the air through its larynx, causing the sides of the alligator to vibrate rapidly and make droplets dance on the surface of the water — see Figure 2 .	"...spins or twirls round on the surface of the water"	<i>"...lashing the surface of the water in a terrible maner as they utter their terrable Voice..."</i>

As the air is exhaled during the bellow the alligator sinks lower in the water.		<i>"...their body sinks gradually in the water..."</i>
The alligator may then repeat the process and bellow again.		<i>"...then swelling again rises up, thus alternately as they continue their bellowing..."</i>
* Detailed descriptions of the bellowing behavior summarized here are derived from Garrick and Lang (1977b), Garrick, Lang and Herzog (1978), Vliet (1989), and Watanabe (1980).		

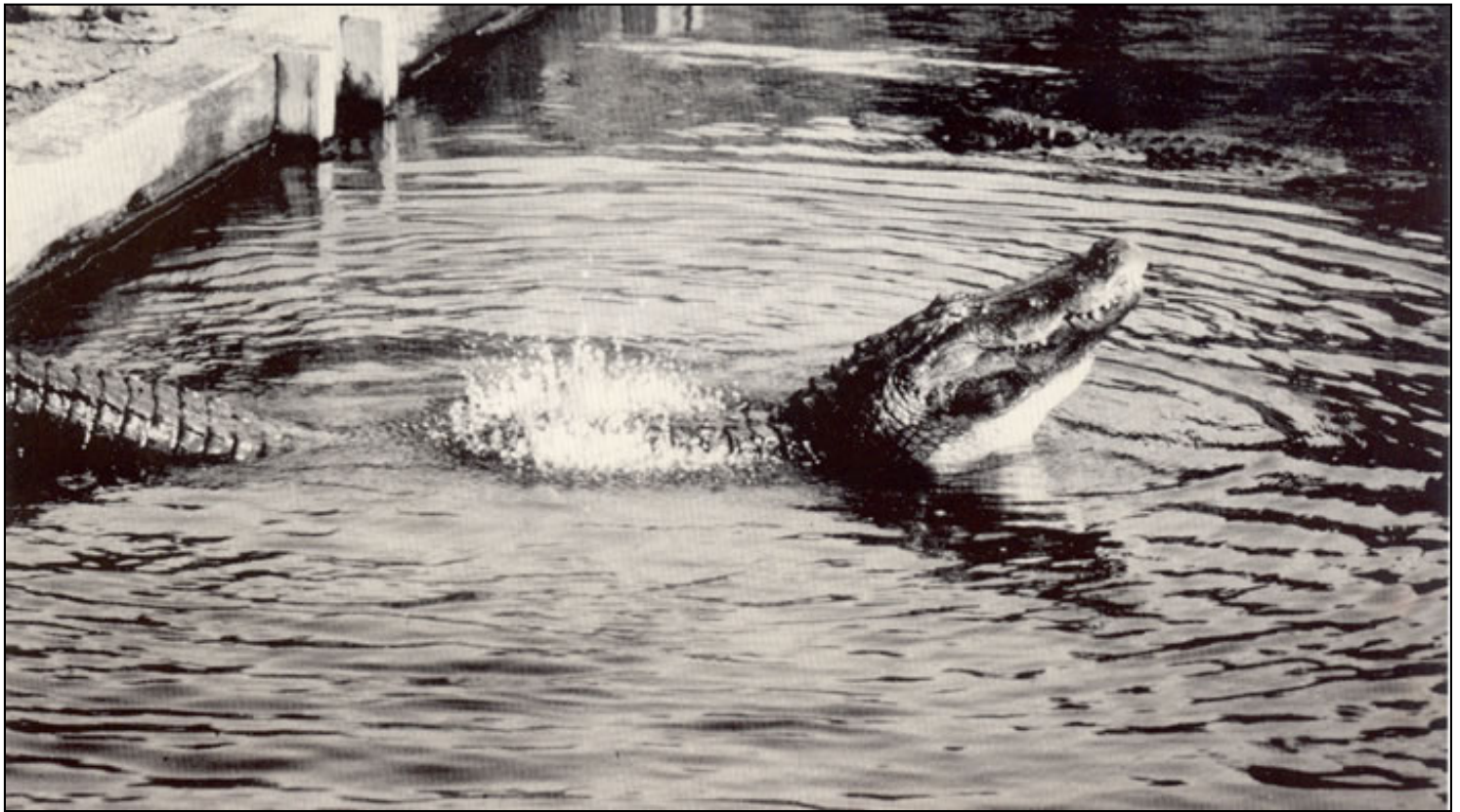


Figure 2. When an American alligator bellows, it inflates its lungs, arches its head and tail out of the water, and forces the air out through the larynx. During the bellow, fast strong vibrations of the alligator's sides breaks the surface of the water into a myriad dancing, fountain-like, droplets. Note the concentric circle of ripples around the alligator. Photograph by John Thorbjarnarson.

Exhaling smoke: In the first description of bellowing cited above, Bartram (1996:114) refers to "Clouds of smoke" issuing from the alligator's nostrils. This is illustrated in Bartram's sketch of "The Alegator of St. Johns" (Bartram 1943: Fig. 24, 1996: Plate 9), which shows billowy clouds rising from the nostrils of two alligators.

Neill (1971:27) points out that alligators do not exhale smoke from their nostrils,

"At no time in reality is there any visible emanation from the alligator's nostrils ... and even the comparatively credulous readers of Bartram's day were not much taken with his hint that the alligator was a sort of dragon, spewing clouds of smoke from dilated nostrils."

Guggisberg (1972:109-110) questions the "clouds of smoke," but offers a possible explanation,

"This description has sometimes been held up to ridicule, specially the 'clouds of smoke' coming from the saurian's nostrils—but let us remember that it was written in 1791 and about an animal very little known and much feared at that time ... What Bartram called 'smoke' in the parlance of his time may have been ... watery vapour puffed out into the cooling night air...."

Many of Bartram's descriptions refer specifically to vapor. His first reference, cited above (Bartram 1996:114; Van Doren 1928:115), was to "clouds of smoke." His second reference (Bartram 1996:122; Van Doren 1928:123) was to "vapour ascending ... like smoke." A third (Bartram 1996:118; Van Doren 1928:119) was in relation to alligators that were feeding on fish, "...floods of water and blood rushing out of their mouths, and clouds of vapour issuing from their wide nostrils...." A fourth reference (Bartram 1996:119; Van Doren 1928:120) involves an attacking alligator, "...emerging upright on my lee quarter, with open jaws, and belching water and smoke that fell upon me like rain in a hurricane". This alternate characterization of what was emanating from the alligator's nostrils suggests that Bartram knew that the exhalant vapor was not smoke, was not the product of combustion, and was using the parlance of his time to describe misty vapor. Such use is not unique to Bartram. A dictionary definition of "smoky" is 1) emitting smoke in large quantities, 2) having the characteristics of or resembling smoke, or 3) suggestive of smoke. The word "smoke" is often used to refer to something that obscures, e.g., the convection fog that is known as Arctic sea smoke, or the humid mist that gave the name to the Great Smoky Mountains, the six Smokey Lakes, five Smokey Hollows, four Smokey Springs, four Smokey Creeks, and the various Smokey Acres, Buttes, Canyons, and Valleys in the United States.

Cooperative Feeding: Harper, who believed Bartram was the victim of unwarranted criticism, stated, "Probably the severest criticism to which Bartram the naturalist has been subjected is based upon his account of the bellowing and other remarkable activities of the Alligators ..." in the vicinity of Lake Dexter on the St. Johns River (Bartram 1943:186(90-93)).

What Bartram (1996:117-118; Van Doren 1928:118-119) said that was so controversial was that alligators had arrayed themselves in a close phalanx across the entrance to Lake Dexter so fish that were trying to pass could be easily grabbed,

"... I soon accounted for the prodigious assemblage of crocodiles [American alligators] at this place, which exceeded every thing of the kind I had ever heard of.

"How shall I express myself so as to convey an adequate idea of it to the reader, and at the same time avoid raising suspicions of my veracity? Should I say, that the river (in this place) from shore to shore, and perhaps near half a mile above and below me, appeared to be one solid bank of fish, of various kinds, pushing through this narrow pass of the St. Juan's [St. Johns River] into the little lake, on their return down the river, and that the alligators were in such incredible numbers, and so close together from shore to shore, that it would have been easy to have walked across on their heads, had the animals been harmless? What expressions can sufficiently declare the shocking scene that for some minutes continued, whilst this mighty army of fish were forcing the pass? During this attempt, thousands, I may say hundreds of thousands, of them were caught and swallowed by the devouring alligators. I have seen an alligator take up out of the water several great fish at a time, and just squeeze them betwixt his jaws, while the tails of the great trout [largemouth black bass] flapped about his eyes and lips, ere he swallowed them ... This scene continued at intervals during the night, as the fish came to the pass. After this sight, shocking and tremendous as it was, I found myself somewhat easier and more reconciled to my situation; being convinced that their extraordinary assemblage here was owing to the annual feast of fish; and that they were so well employed in their own element, that I had little occasion to fear their paying me a visit."

Bartram's ([1943](#): 152, [1996](#): 473-474) described this event in his Report to Dr. Fothergill, although less eloquently,

"It is scarcely credible what an immense number of Fish these monsters destroy, especially at these passes, the River being here[,] as I observed before[,] very Narrow. The Trout [largemouth black bass] who pass here in their way to & from the numerous lakes & endless Lagoons & Marshes towards the head of this Vast River, where they go to spawn. The Alegator post themselves forming a line across whe[re] we see them opening their voracious Jaws into which the fish are intrap't. They heave their heads and upper part of their body upright[,] opening their throats to swallow them, & I have seen them with two or three great Trout in their mouth at a time[,] chopping them up[,] the fishes tail hanging out."

True ([1893](#)) believed that Bartram's description was overdrawn, exaggerated. Neill ([1971](#): 25) doubted that Bartram actually saw this gathering of alligators. He states, "As this episode took place at night, the scientist must ask by what light it was observed in such exciting detail. The report must have been constructed in large part from the imaginative interpretation of night sounds." Similarly, Glasgow ([1991](#): 31) commented, "Bartram's version certainly wins, hands down, any contest for colorful alligator writing ... His description was of alligators congregated in the shallows, all lying in wait with their mouths open to collect schools of fish..." Others wrongly interpreted the aggregation as evidence of the abundance of alligators in 1774 (Florida Game and Fresh Water Fish Commission [1989](#); King [1969](#), [1972](#); Reese [1915](#)).

Although Bartram did not understand the significance of the behavior, he accurately described cooperative feeding in American alligators. Neither Neill, nor Glasgow, nor any of the many other critics were aware that, under the right circumstances, crocodilians feed cooperatively. Pooley and Gans ([1976](#)) first explained cooperative feeding behavior, in Nile crocodiles (*Crocodylus niloticus*), in the mid-1970's,

"Another example of cooperation may be seen in the early spring, when rivers rise and the water flows into channels leading to pan, or natural depressions, along the river. Subadult crocodiles often form a semicircle where a channel enters a pan,

facing the intrushing water and snapping up the fish that emerge from the river. Each crocodile stays in place and there is no fighting over prey. Any shift in position, of course, would leave a gap in the crocodiles' ranks through which the fish could escape, so that what might be a momentary advantage for one crocodile would be a net loss for the group."

Pooley ([1989](#): 88-90) later described this behavior in greater detail,

"In Lake St. Lucia, Natal, South Africa, there are annual migrations of shoal fish out of and into the lake from the Indian Ocean either to spawn or to feed. Species include kob, spotted grunter but more importantly, striped mullet (*Mugil cephalus*). The annual movement of the mullet shoals is fairly constant, and between mid-April and mid-May each year large numbers of crocodiles move down from northern and open stretches of the lake in response to the fish shoaling; others move up from river systems to the south.

"They congregate in an area known as the Narrows, a channel less than 500 meters (550 yards) in width. Numbers peak during May but decrease rapidly thereafter. Examples of cooperative feeding can be observed with several crocodiles spreading out in a semicircular or line formation, which blocks the passage of the fish. Each crocodile maintains its place in line and snaps at approaching fish. There is no fighting over prey; shifting position and leaving a gap in the ranks would lessen the chances of successful prey capture.

"In other Zululand rivers similar behavior may be seen in summer when rivers flood and water spills into channels leading to natural pans. The crocodiles form a barrier where a channel enters the pan, facing the intrushing water and snapping up river fishes such as bream (genus *Talapia*) and catfish."

Schaller and Crawshaw ([1982](#)) described similar behavior in yacare caiman (*Caiman yacare*) in Brazil,

"Adjoining ponds sometimes had connecting channels, and ... Usually only one or two caiman occupied a particular passage, but once, when heavy rain created a wide riffle between ponds, 7-15 caiman fished in it all day ... Pooley and Gans ([1976](#)) noted that subadult African crocodiles 'often form a semicircle where a channel enters a pan, facing the intrushing water and snapping up the fish that emerge from the river.' The authors considered this an example of cooperative hunting. We observed similar behavior when caiman gathered at road culverts ... Such behavior is a form of proto-cooperation ... rather than cooperation in the sense of a joint action in the performance of a defined task; any help fishing crocodilians gave each other seemed inadvertent."

Yamashita ([1991](#)) observed and photographed yacare caiman (*Caiman yacare*) feeding cooperatively in Brazil,

"Many social interactions occur in shallow open ponds during the dry season when very large concentrations of this species congregate in the limited habitat. Among these are social fishing behavior shown in the photograph."

Yamashita's photographs, [Figures 3-6](#), of yacare caiman, clearly illustrate the feeding behavior that Bartram observed in American alligators at Lake Dexter in 1774.



Figure 3. Yacare caiman feeding cooperatively in Brazil. The caimans array themselves in a semicircular line across the current flowing through this channel. They remain in close ranks with their mouths open ready to snap up any fish that tries to swim through their ranks. There are twelve caimans in the front row of this phalanx, with an additional six caimans behind them ready to move into any gaps in the row. Photograph by Carlos Yamashita.



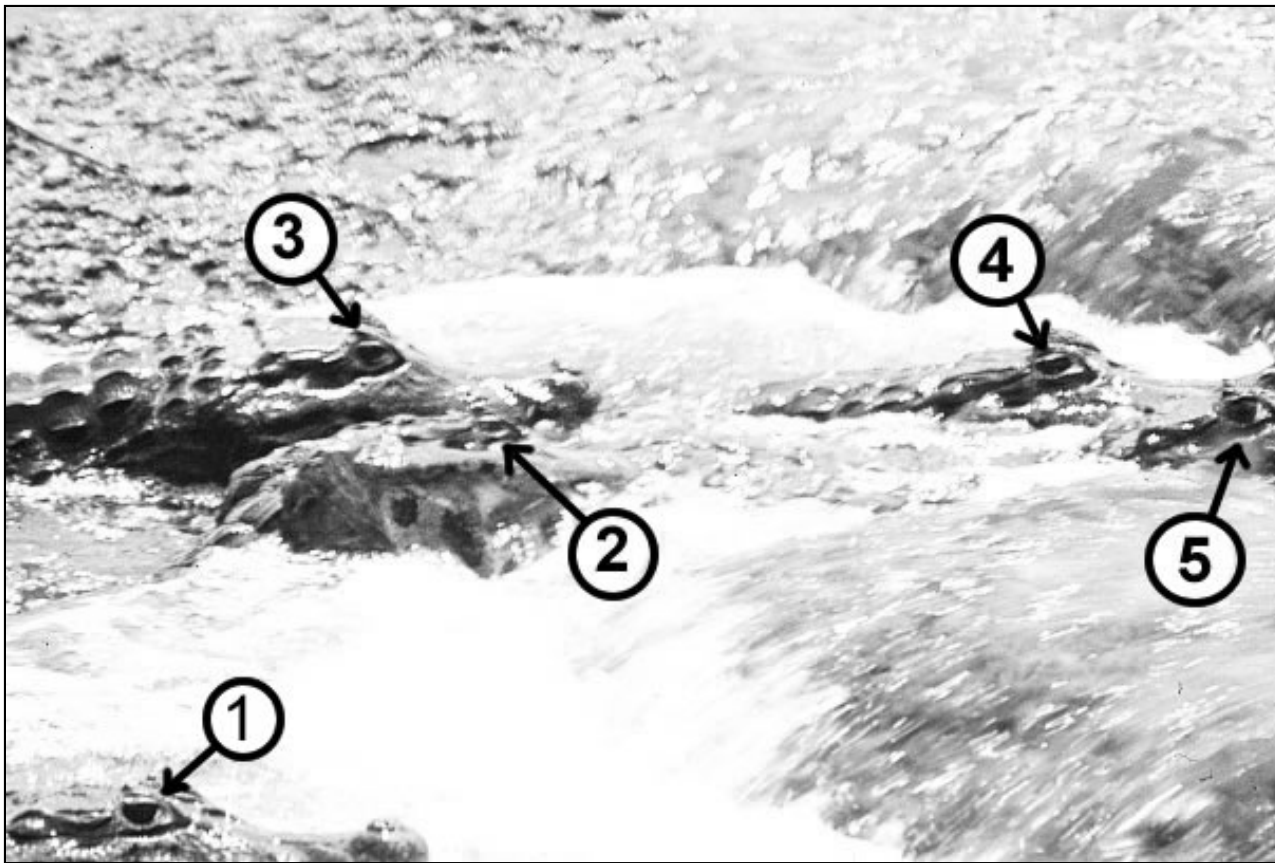
Figure 4. William Bartram described a "prodigious assemblage" of American alligators posted in a line across the St. Johns River at the entrance to Lake Dexter in 1774 gorging on fish that were moving downstream. A similar line can be seen in this group of twenty yacare caiman feeding cooperatively in the Pantanal of Brazil. Photograph by Carlos Yamashita.



Figure 5. Bartram reported American alligators at the entrance to Lake Dexter "...were in such incredible numbers, and so close together from shore to shore, that it would have been easy to have walked across on their heads, had the animals been harmless...." Compare Bartram's report to this phalanx of yacare caiman feeding cooperatively in Brazil. Photograph by Carlos Yamashita.



Figure 6. Five Brazilian yacare caiman feeding cooperatively in the current rushing through a rocky riffle. Bartram reported American alligators feeding this way caught thousands of fishes in the pass into Lake Dexter in 1774. The eyes of the caiman can be seen below. Photograph by Carlos Yamashita.



Thorbjarnarson ([1991](#)) reported cooperative feeding in spectacled caiman (*Caiman crocodilus*) in Venezuela,

"In shallow, moving water caiman would use two techniques for catching prey. Both of these feeding behaviors were seen principally at night when it was difficult to make extensive observations without disturbing the animals. The first technique was to orient the body parallel to the flow of water and capture prey by making rapid sideswipes. This behavior was observed several times, including once when seven caiman were oriented in two rows facing into the current (31 December 1984), with their mouths slightly opened and their heads elevated in the water."

Cooperative feeding occurs where masses of fish are moving downstream with the current flowing through a channel into or out of a body of water. The crocodilians line up side-by-side in a close array across and facing into the current. Their ranks may be sufficiently close to give the impression that you could walk across the channel on their heads or backs. Fighting over prey is infrequent. If one crocodilian moves out of position, another moves in to fill the gap in the phalanx. Finally, intensity of feeding is so great that initially the crocodilians may pay little attention to humans and other intruders.

Understanding this behavior, documented in a number of other crocodilian species, allowed us to verify for the first time the accuracy of Bartram's description of the alligator assemblage at Lake Dexter (King, Thorbjarnarson and Yamashita [1998](#)).

Understanding the behavior also enabled us to search the literature and locate other early accounts of large feeding aggregations of American alligators, some feeding cooperatively and some fighting for the fish.

Dowler ([1846-1847](#):327) reported an alligator cooperative feeding event in Louisiana,

"Dr. Lindsay has often observed, in midsummer, when the inundation is subsiding, and swamps, lakes, lagoons, and bayous, are becoming dry or too shoal, for not only alligators, but the fish, that a general migration commences. When thousands of square miles, submerged for several months of the year, are about to become desiccated, these knowing animals begin to travel. When the water subsides rapidly, there are currents through narrow channels, from the higher to the lower basins and streams, to which the alligators repair, in great numbers, and turn their heads up stream. The large buffalo [*Ictiobus* sp.], and still larger cat-fish, with many other fishes of the lower Mississippi, in their migrations, through these straits, are thus devoured; often, very few escape."

The great numbers of the alligators present faced into the current to capture fish in the narrow channels. And the alligators were not fighting.

Harper ([1926](#):417-418, [1930](#):57) reported another alligator feeding event witnessed by Allen Chesser in 1890 in Buzzard Roost Lake in Okefenokee swamp in Georgia,

"Now I want ter tell yer erbout a sight er Alligators I seed one time ... That occurred at the Buzzard Roost Lake ... Hyere the lake [at this point Chesser scratched a diagram on the ground], an' hyere's a little run [a channel] goes out erbout thirty yards broad. An' right hyere at the en' is a little round lake. These Alligators, I suppose, they must 'a' driv all the fish out er this big lake, an' down this road [the outlet]. It 'us in between daylight and sunrise. I heerd the racket before I got there ... The Alligators cared nothin' fer us. There must 'a' ben three hundred uv 'em. They'd ketch fish that long [indicating about a foot and a half]. Ef they'd ketch a perch, yer'd hear 'im flutterin' in their mouth—thrr, jest like a-that. An' the funny part, there'd be a Gator sometimes that high [indicating about a yard] out of er the water—an' ernother un on ter 'is tail. He'd think it 'us a fish.

"When he'd ketch a fish, jest stick 'is haid up thataway, an' ernother un tryin' ter get it away from 'im. They'd pay no attention ter us. We stayed there till the sun wuz erbout an hour high.

"We fell ter shootin', an' it wuz either fourteen er sixteen we killed before they took any notice a-tall. An' when they did take a notion ter get away, there wuz a sight ter look at—when they commenced smellin' the blood. They started down that road [the outlet]. They wuz that thick, I could 'a' walked down that road on Gator haid."

This was probably a cooperative feeding event, but we cannot be certain. A low water level could have concentrated the fishes and attracted the alligators, but no mention was made of any low or drying water that brought the alligators together. It is not clear from Chesser's description that there was a current flowing through the channel between the two lakes or that the alligators were all facing upstream. However, the unlimited number of fishes on which the estimated 300 alligators were feeding probably rode a current into the channel. That is typical of cooperative feeding. The alligators were competing for the fish, trying to take them away from each other, which is unusual in cooperative feeding. Finally, as is normal in cooperative feeding, the alligators were so busy catching fish that they ignored the presence of the humans until more than a dozen of them had been killed.

Not all groups of alligators frantically catching fish are feeding cooperatively. Bartram

([1996](#): 180-181; Van Doren [1928](#): 178) described one incident in which fish were greedily eaten by a swarm of alligators in the sinkhole that drains the eastern end of the Alachua Savanna (= Paynes Prairie Preserve State Park, Alachua county, Florida):

"In and about the Great Sink, are to be seen incredible numbers of crocodiles [alligators] ... they are so abundant, that, if permitted by them, I could walk over any part of the bason and the river upon their heads, which slowly float and turn about like knotty chunks or logs of wood, except when they plunge or shoot forward to beat off their associates, pressing too close to each other, or taking up fish, which continually crowd in upon them from the river and creeks, draining from the savanna, especially the great trout [largemouth black bass], mudfish, catfish, and various species of bream ... Thousands are driven on shore, where they perish and rot in banks, which was evident at the time I was there, the stench being intolerable, although then early in the summer."

A plethora of fishes running with the current into the Alachua Sink might provide the incentive needed to initiate cooperative feeding in alligators, but these alligators were not cooperating. They were turning about, not all facing into the current. They also were beating off competitors that got too close, while aggressively availing themselves of the opportunity to gorge on fish, many of which were dead or dying.

John James Audubon ([1827](#)) also reported large numbers of alligators feeding together in Louisiana,

"When alligators are fishing, the flapping of their tails about the water may be heard at half a mile ... There, at a sight, hundreds of alligators are seen dispersed over the lake, their head, and the upper part of the body, floating like a log ... It is then that you see and hear the alligator at his work ... You see them lying close together. The fish that are already dying by thousands, through insufferable heat and stench of the water, and the wounds of the different winged enemies [herons, egrets, ibis] constantly in pursuit of them, resort to the Alligator's Hole to receive refreshment, with a hope of finding security also, and follow down the little currents flowing through the connecting sluices; but no! for, as the water recedes in the lake, they are here confined. The alligators thrash them and devour them ... You plainly see tails of the alligators moving to and fro, splashing, and now and then, when missing a fish, throwing it up in the air."

Were these alligators feeding cooperatively? Audubon mentions hundreds of alligators lying close together, which suggests cooperative feeding. He also describes fish dying from the heat and falling water levels, which intimates that the alligators are simply exploiting fish that had been trapped as the summer heat dries the lake.

It is puzzling that there are not more reports of cooperative feeding in alligators. American alligators are still feeding cooperatively today, but most people that see it do not recognize what the alligators are doing.

One of the best places to see cooperative feeding today is where a current of water flows swiftly out of a culvert under a road or through a dike in state and national parks and other protected areas where the alligators have not been harassed. If alligators occur in the vicinity, three or four of them line up across the current and feed on the fish it brings to them (King, Thorbjarnarson and Yamashita [1998](#)). Sadly, a small number of alligators does not have the visual impact the mob-like assemblage of alligators at Lake Dexter had on Bartram, but the behavior is the same.

In summary: Careful analysis shows that William Bartram's observations on the natural history of the American alligator contain some mistakes. Some are misinterpretations of what was seen, but many are accurate descriptions of behaviors since verified.

Bartram's reports that the alligator's upper jaw is hinged and that the large tooth in the front of the upper jaw fits into a socket in the lower jaw are in error. It is the lower jaw that is moveable and it is the enlarged fourth tooth of the lower jaw that fits into a socket in the upper jaw.

Bartram was not wrong in reporting that he lost several fish to the sweep of an alligator's tail. Swinging the tail to the side to counter balance the lunging head could easily knock fish off a pallet.

Bartram was unaware that the alligator nest he dismantled was a communal nest constructed by several females. As a consequence, he wrongly stated that a single female constructed the nest and laid multiple clutches of eggs in it. And he was wrong in reporting the female laid more than 50 eggs. Except for his thesis that nests were constructed in layers, everything else Bartram reported would have been correct for a communal nest.

For alligators not harassed to the point of avoiding humans, Bartram's description of parental care is accurate. The female parent guards the nest. She opens the nest and releases the hatchlings. She picks the young up and carries them to the water. She releases them in the water and then leads them to a protected nursery area. She defends the crèche of young for up to a year.

Bartram's description of alligator bellowing is accurate as an early report, though recent research has documented more details of the various components of this vocal behavior.

Bartram's alternated references to alligators exhaling vapors and exhaling smoke, suggests he knew the difference but was using poetic license in his descriptions. Bartram's detractors criticized him for characterizing exhalations as smoke, but did not attack him for describing a bellowing male alligator with, "His plaited tail brandished high..." (Bartram [1996](#):114; Van Doren [1928](#):115). The adjective 'plaited' does not denote an alligator's tail is composed of braided elements, but rather that scales on the alligator's tail give it a braided appearance.

Finally, Bartram observed and accurately described cooperative feeding in a large phalanx of alligators across the entrance to Lake Dexter on the St. Johns River. His description is accurate, but it was widely doubted and disputed until cooperative feeding was discovered and described in other crocodylians in the mid-1970's to 1990's.

The majority of William Bartram's descriptions, among the first ever made on alligator behavior, are surprisingly accurate. What makes his descriptions truly remarkable is that Bartram was a botanist and lacked formal zoological training. Possibly his skills as a biological illustrator enabled him to mentally record details that most people miss in their casual observations.

Bartram continuously marveled at what he discovered in nature and he was able to capture that sense of wonder in his vivid descriptions. Those descriptions were sufficient to inspire a number of contemporary writers, including Samuel Taylor Coleridge, William Wordsworth, Dorothy Wordsworth, Thomas Campbell, Charles Brockden Brown, James Fenimore Cooper, Felicia Hemens, John Muir, Robert Southey, Henry David Thoreau, and Alexander Wilson. But those same graphic depictions condemned Bartram in the eyes of his critics, whose pedantry

wanted naturalists to write stodgy, prosaic verbiage. In the two hundred years since Bartram reported his observations on the American alligator, the scientific community has corroborated most of them, quieted many of his critics, and stimulated continued research.

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