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Behavior of the Agami Heron (*Agamia agami*)

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Abstract.—The biology and behavior of Agami Herons (*Agamia agami*) are not well known. This paper describes the species' foraging, nesting, plumage, soft-part coloration, courtship, and disturbance response studied during a 28-hour 8-day study period, 11-18 May 2015, in Costa Rica. Agami Herons forage by standing on perches and walking or wading slowly, capturing small prey using a slow neck extension followed by a grasp. Courtship emphasizes its spectacular, short-lived silver crest and other similarly distinctive plumage and soft-part features. Thirteen courtship behaviors described are used by both sexes. The female, rather than the male, retains intense red lores during pair formation. Only two nest change-overs and no chick feeding were observed, which, along with evidence of distant foraging, suggest a nesting strategy accommodating long intervals between chick provisioning. Agami Herons respond to disturbance with a rattling call and by walking away into vegetative cover. This observed sensitivity to disturbance reinforces a conservation strategy for the species emphasizing protection of regionally important nesting colonies and their foraging habitat. *Received 1 July 2015, accepted 9 December 2015.*

Key words.—Agami Herons, *Agamia agami*, breeding behavior, conservation, Costa Rica, courtship, displays, disturbance response, foraging.

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The Agami Heron (*Agamia agami*) is among the more morphologically distinctive herons, having multicolored plumage, exuberant plumes, relatively short legs, and an exceptionally long neck and bill (Kushlan 1978; Kushlan and Hancock 2005; Fig. 1). However, neither its foraging behavior nor the role of its distinctive features in courtship has been well studied; rather it has been described from limited observations (Kushlan and Hancock 2005; Albella-Gutierrez and López-Colon 2008). This paper describes more completely the Agami Heron's foraging, nesting, plumage, soft-part coloration, courtship, and disturbance response during the nesting season. Additionally, this paper offers insights that support conservation measures.

METHODS

The study was conducted 11-18 May 2015 at the Pacuare Nature Reserve, Costa Rica, a private reserve on the Caribbean coast encompassing beach, dune, upland forest, and blackwater evergreen swamp forest described by Stiles *et al.* (1989). The colony site (10° 12' 19" N, 83° 15' 55.49" W) studied was located on an island within a forest-edged lagoon. Nesting occurs from March to September, timing varying somewhat from year to year (D. Herrera, pers. commun.). Rainfall is high, nearby Puerto Limón averaging 340 cm per year; seasonal variation is minor (World Meteorological Organization 2015).

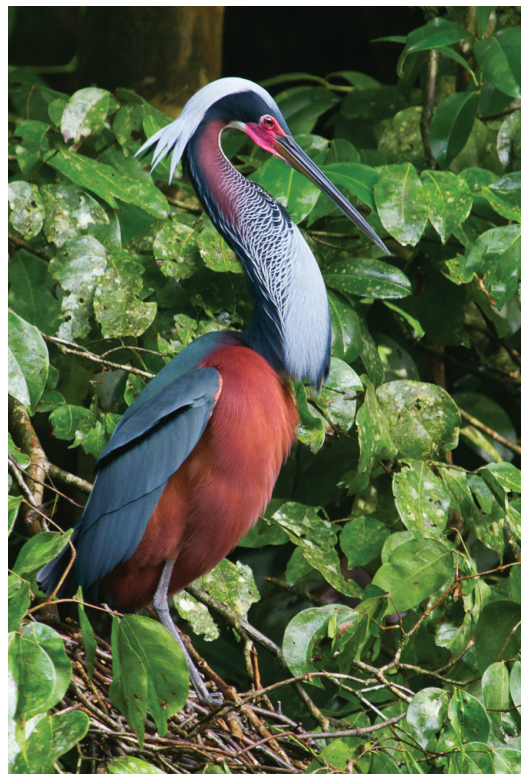


Figure 1. An Agami Heron displaying, showing plumage and soft-part coloration, including chestnut ventrum, red lores, silver crest and neck, and greenish wings with lines formed by the edges of the coverts. Photograph by Kirsten Hines.

All observations were made over the 8-day period from a 4x2-m blind, built by the Reserve in 2014, located across the lagoon from all but two nests, the nearest nest being 7 m away. Birds were habituated to occupancy of the blind and showed no response to the observers after their arrival. Clutch size was counted where possible from the blind; nest height was estimated against a known height for nests visible from the blind. Nests were counted from a canoe once during the study period, as well as after (D. Herrera, pers. commun.). Observations were made of foraging, nesting, plumage, soft-part coloration, courtship, and disturbance response. Asynchronous nesting permitted observations of a wide range of behaviors from courtship to "brancher" chicks, which had left their nests. Observations were descriptive, made by repeated scanning of the colony to select focus birds to observe for up to 10 min. Generalized behavior patterns are described. Observations were made during 28 hr in 1-4 hr sessions, covering all 24 hr of the day. Observations during three night sessions, covering all darkness hours, were made using ambient lighting or a red spotlight. Individual birds were recognizable by distinguishing features of plumage, size in that the males are larger (Kushlan and Hancock 2005), and site location. Standard terminology for heron behaviors (Kushlan 2011) is used except for those newly described in this paper.

RESULTS

Foraging

Hérons foraged at the edges of the lagoon surrounding the colony site. They fed by walking slowly along and by standing on branches, floating logs, root buttresses, vines, and herbaceous vegetation, or in shallow water. A foraging bird moved slowly, deliberately, pausing for seconds to minutes to scan the water surface before stabbing or moving on. Posture varied from extremely crouched, to crouched, to upright. Other typical heron foraging behaviors were feet first diving (birds landed feet first in the water, grasped the quarry, and flew up to a perch) and standing flycatching (one incubating heron caught a passing dragonfly in its bill).

We observed 38 strikes; all were the same. The bird stretched its neck out gradually, stabbing anywhere in reach from below to far from its body making full use of its neck and bill length. Movement was slow, and the last slow grasping motion moved the bill tip only a few additional centimeters. Prey were captured from at or slightly below the water

surface. Food included small (1-2 cm) fish and other items too small to identify, likely including water striders (Gerridae) (D. Herrera, pers. commun.) common at the site. Upon capturing food, the bird would bite it, sometimes shake its bill, and position it for swallowing.

Nesting Biology

Thirty-six nest sites were visible from the blind: three contained chicks, eight were in various stages from courtship to nest building, and the rest were in incubation. We counted 73 nests in the colony at the time of our study; however, there were 266 individual nests over the entire season (C. Fernandez, pers. commun.). All nests during the study were over water, nearly all on branches of sota caballo trees (*Pithecellobium longifolium*) lining the shore. Nests were an average of 3.4 m (SD = 1.52; $n = 24$) above the water. Nests where the clutch could be seen held one or two eggs, mean = 1.5 eggs (SD = 0.54, $n = 6$).

Nests were started from scratch, although sticks from older nests were sometimes used. After pair formation, both birds gathered sticks and built the nest, but within a day the male primarily gathered sticks and the female inserted them. One nest was followed from the beginning of nest construction, and it took three days before a foundation with no more than a dozen sticks was in place. Sticks were added throughout incubation. Initially, pairs remained together at the site, usually with the male primarily positioned above the female. Nest exchange involved the returning bird using typical display sequences to gain access to the site, a process taking 5-15 min.

After hatching, chicks were attended persistently by an adult for several weeks (based on chick size). The adult often stood over chicks and also shielded them with a wing during rain and sunshine. Chick feeding was not observed, although chicks begged vigorously but unsuccessfully from attending parents, other adults, and other chicks. Attending birds attempted to regurgitate but never produced food. Only two nest change-overs

were observed, both in early morning. Our night-time observations found no movement of birds, no displays or chick feeding, and only individual comfort movements of incubating or roosting birds.

Plumage and Soft-part Coloration

The Agami Heron's plumage during courtship (Fig. 1) is a deep chestnut verging on maroon covering the ventrum, extending along the sides of the back from the neck to the wing, transitioning to a lighter shade of chestnut tending to burnt-orange color along the lower belly extending down the feathered upper leg and also underwing coverts and alula. Chestnut coloration was highly conspicuous during display and in flight. When a bird was perched, chestnut breast feathers flared up conspicuously covering the wing bend.

The crest and back feather color is silver, with a light blue tint. Crest feathers were long, lax and luxurious, sometimes looking like a mop wig covering much of the head and capable of flopping in any direction. By the time chicks hatched, the crest was reduced to the top and back of the head, and dorsal plumes were similarly reduced.

During courtship, a filmy silvery-blue feathering covered much of the sides and front of the neck other than a thin brown vertical central stripe lined in white. These silvery-blue neck feathers were prominent during displays, increasing apparent neck thickness (Fig. 1). Silver dorsal plumes covered the lower back to the tail. Primaries, secondaries and wing coverts were dark with a greenish tint; upper wing coverts were edged in lighter gray, flaring tips creating two parallel lines on the folded outer wing.

Agami Herons changed lore color within seconds to minutes from white to yellow to red (see Alvarado 1992 for time spans and other details). However, red color also was held for hours and day after day during pair formation. Although both sexes changed soft-part colors, during pair formation engagement the female held the red lore color more persistently; the male's lores remained

yellow. The red gular area, set off by yellow at the side, was fluttered, complementing the red lores. At the approach of a female to a male at his display site, the red-colored soft-parts were presented conspicuously from a submissive posture.

Courtship

Displays observed during courtship are listed and defined in Table 1. The display site (future nest site) was selected by the male, which stood at the site and defended it with forward behavior, bill stabs and bill duels. Rocking, head shake, side touch, wing touch, wing preen and standing were used by displaying birds. Body shake, although a comfort movement common to herons, was used frequently highlighting the flexible crest and back plumes. Tail flipping accentuated the silver back plumes laying against the tail. Displaying birds frequently bill snapped, either alone or during a wing preen or head shake. Snapping sounds were heard continuously in the colony when undisturbed.

Males spent most of their time standing, preening or using one of the pseudo-preening displays. Sequences typically involved rocking, head shake, side preen, and bill snap. An example of a specific sequence was recorded as: rock left, rock right, rock left, rock right, head shake, rock right, rock left, head shake, rock left, rock right, rock left, rock right, rock right, rock left, head shake, tall stand, wing preen left, and bill snap.

Females displayed facing or turned away from a male or without a male obviously nearby. Approaching a male at its display site, the female performed display sequences, as above, ending in a submissive crouched presentation, displaying her colored lores toward the male. The male initially repulsed her with bill stabs and eventually just stood by allowing her approach. This iterative process of gaining entrance into a male's site took three days in the one observed case. After pair formation and copulation, both birds used rocking and head shaking sequences simultaneously or separately at the site.

Table 1. Courtship behaviors of Agami Herons.

Behavior	Description
Rocking	Stands tall, and sways, turning slightly from side to side smoothly and even rhythmically, showing off the chestnut belly, expanded silvery-blue neck feathers, long silver crest, and distinctive wing covert lines. The lores are red; red and yellow gular area fluttered.
Head Shake	Shakes its head from side to side, emphasizing the movement of its long, lax crest feathers.
Side Touch	Runs its bill down either side of its breast, the bill being closed or slightly open, not biting feathers, ending bowing low.
Wing Touch, Wing Preen	Moves its bill downward to its chest and under its wing (Wing Touch) or across and down the outer feathers of its closed wing (Wing Preen).
Bill Snap	Sharply closes its bill with a snapping pop. This can be done at the bottom of the Wing Preen, during a Head Shake, and at other times. Snapping sounds are often heard in the colony.
Standing	Stretches upward and stands tall.
Forward	Leans forward, head and neck extended. Unlike other herons, the Agami Heron's Forward is quite slow and does not appear to include a serious strike.
Bill Stab, Bill Duel	One bird stabs at another, or two birds stab at each other (Alvarado 1992) without contact.
Crouched Presentation	Female crouches low, slightly opens wings, extends neck and head, keeping lores toward the male.
Tail Flipping	Flicks its tail up and down.
Body Shake	Shakes its body vigorously, causing the feathers to flop conspicuously.

Disturbance Response

At both nesting and foraging sites, herons responded to disturbance with a persistent clacking "krrr" sound. The call was given by birds attending nests or alone in response to a person approaching or natural noises from the forest. When a bird continued to be disturbed, it stopped calling and silently walked from its nest, courtship site, or feeding site into the adjacent vegetation. Disturbed birds stayed away from their site for minutes to hours. In one case, a nest with eggs left unattended after disturbance was invaded by another heron within hours and picked apart by stick-seeking birds over the next two days. The herons also gave a loud screeching distress call. We heard this twice in response to loud noises from the forest.

DISCUSSION

It had been surmised that this branch-and bank-feeding heron feeds by springing off the fulcrum provided by its short legs

and reaching with its long neck and bill for a quick strike, similar to and perhaps an exaggeration of a typical heron "bill stab" (Kushlan and Hancock 2005). This was not the case. We observed that an Agami Heron feeds by stretching its neck and bill toward a prey item, and then carefully picking it up, like using a precision pair of tweezers. The smallness of the observed food may be characteristic of the species' prey base, as the rather gentle prey capture approach would be ineffective for large, fast or deep fish.

That all nests were placed over water agrees with Reynaud and Kushlan (2004). Nest building appeared to be exceptionally prolonged and continuing through the nesting period. These elongated birds appeared to take full advantage of their long necks and bills in defending nest sites and otherwise separating themselves from other birds. No contacts were observed during bill duels or bill stabs, suggesting that this threatening behavior is quite ritualized.

The near instantaneous lore color change, analyzed by Alvarado (1992), occurs

in other herons such as the Snowy Egret (*Egretta thula*) but is not typical among herons (Kushlan and Hancock 2005). That it is the female rather than the male that holds the red lore color persistently during actual pair formation is contrary to Alvarado's (1992) interpretation.

The extent of the bright silver dorsal and crest plumes, featuring prominently in displays, are exceptional among herons (Kushlan and Hancock 2005). The visual impressiveness of the crest, made more obvious by any head movement, cannot be overstated. The fullness of the development of the crest and back plumes may not have been appreciated because observations during the courtship period are few and the feathers are reduced after pair formation leaving much shorter plumes that are variable among individuals.

Alvarado (1992) described the primary Agami Heron courtship behavior as "dance and bow." Our observations showed that each component action was used independently in varying sequencing and so are separate behaviors, although dance and bow is descriptive of the overall ceremony. That during actual pair formation the female used courtship behaviors more frequently and persistently than the male is contrary to Alvarado's (1992) interpretation. Although the overall process of accessing the male's display site is similar among colonial herons, it seemed particularly difficult for female Agami Herons.

Although some of the behaviors used by Agami Herons were similar to those of other herons (Kushlan 2011), others were not. The principal courtship display, rocking, is quite different from the stretch display used in the same situation by most other herons. Bill snapping is not typically used as a display behavior by herons. Perhaps most similar is the Boat-billed Heron (*Cochlearius cochlearius*), which also uses bill duels and bill pops (Mock 1975; Alvarado 1992; Kushlan and Hancock 2005) and sports an extensive crest during courtship (Hancock and Kushlan 1984). That Agami and Boat-billed herons, along with tiger herons (*Tigrisoma* spp.), represent lineages distinct from other

extant herons (Kushlan and Hancock 2005) may account for the distinctiveness of their behaviors from those of other herons.

During the present study, early nests, eggs, and chicks up to 1-2 weeks old were never without an attending adult heron when undisturbed, whereas Reynaud and Kushlan (2004) reported adults absent during the day. The colony they reported on was not habituated, and it seems likely that the birds left their nests when disturbed by the researchers who did not use a blind. Reynaud and Kushlan (2004) also reported that juveniles were not fed by the parents, suggesting feeding occurred at night. However, our night-time observations did not support this suggestion. Chicks were prepared to eat, as they frequently begged, but the carefully studied attending adult bird, which was not relieved at its nest for a week, was not observed to feed its chick and the chick did not appear to grow, suggesting that Agami Heron chicks endure long periods of fasting. However, chicks are capable of growing quickly once fed (do Nascimento 1990). Reynaud and Kushlan (2004) suggested and A. Stier (pers. commun.) observed that these herons can forage far from their colony site. These observations together suggest a growth strategy based on intermittent feeding, reminiscent perhaps of the strategy of distant-foraging seabirds (Schreiber and Burger 2001).

The Agami Heron's "Grr" call (sounding more like a "krrr") has been well studied and suggested to be a contact call (Alvarado 1992; Reynaud and Kushlan 2004). However, we found it to be a mild disturbance call. A further response to disturbance was birds just quietly walking away from their nest, perch, or feeding site. The "walk away" response while foraging may explain why these birds have seldom been observed feeding for any substantial period of time. No doubt a long-lived bird, Agami Heron life history strategy appears to tilt toward prioritizing adult survival through risk avoidance.

That Agami Herons appear to nest mostly in large colonies of dozens to over a thousand nests (Reynaud and Kushlan 2004; A. Stier, pers. commun.) implies that such col-

onies accumulate birds coming from long distances and that each colony is of regional importance (A. Stier, pers. commun.). Management at the Pacuare Nature Reserve, where the study was conducted, may be an encouraging model for effective colony protection. Conservation emphasis for this species has been placed on protecting colonies from human and other disturbances (Kushlan and Hafner 2000; Kushlan 2007; Stier and Kushlan 2015). The Agami Heron's sensitivity to disturbance during nesting shown in this study supports that approach.

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