Evolution of false nests in Estrildidae

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Abstract

Some African species within the *Estrilda* and *Amandava* genera of Estrildidae build a "cock's nest," or false nest, on the top of their nest structure. This false nest's function is currently unknown; however, it is thought to be a mechanism used to prevent brood-parasitism by whydahs and indigobirds (Viduidae). There may be an evolutionary relationship between the hosts and their parasites in the selection of these unique structures. Utilizing online databases, I was able to construct a list of all species within Estrildidae which create these false nests and create two phylogenies for each family (Estrildidae and Viduidae). I found that nine species of Estrildidae create these false nests, and six of them are targeted by one brood-parasite, *Vidua macroura*, which also appears to prefer spherical, domed, grounded nests. These results suggest that the false nests may have evolved as an adaptation against nest predation by *Vidua macroura*, specifically.

INTRODUCTION

Brood-parasitism is an unequal relationship between one member (the parasite) and the other (the host), which likely results in an evolutionary arms race. An evolutionary arms race is the ongoing competition of co-evolving genes in both members of the relationship, which evolve to counteract the others' genes, resulting in a constant race to be able to defend or to overcome the others' defenses. The cuckoos (Cuculidae) are another type of avian brood-parasite and have been studied extensively (Poiani and Elgar, 1992; Hughes, 1996; Hughes, 1997).

The waxbills (Estrildidae) are a family of small passerines existing in the Afrotropical, Oriental, and Australasian regions, as well as some tropical Pacific islands. Within the Estrildidae, two genera, *Estrilda* and *Amandava,* include species which construct unique nest structures previously referred to as "cock's nests" (Chapin, 1954; Goodwin, 1982). These structures are open-cupped and built on top of the existing, covered nest structure; their function is unknown (Payne and Bonan, 2018). According to previous observations, only the male spends time in this structure and will rub old droppings into it (Payne and Bonan, 2018).

Some possible explanations for the creation of these false nests are that it is a decoy for predators (Galligan and Kleindorfer, 2008), a sexually selected for trait, or that it may be a decoy for brood-parasites, the last of which this study will focus on.

The Estrildidae are commonly parasitized by the whydahs and indigobirds (Viduidae), which are small, brood-parasitic passerines living in sub-Saharan Africa. They have evolved to specialize on waxbills of the genera *Estrilda* and *Amandava* as their hosts (Payne and Bonan, 2018). This host-parasite relationship and the possible coevolution of the two has been well studied several times (Sorenson et al., 2004; Bonnevie and Oschadleus, 2012; Lansverk et al., 2015).

In brood-parasitism, hosts may evolve several ways of countering parasitism attempts by these kinds of birds, such as abandoning the nest when a known parasite is in the area around the nest or throwing the known parasite out of the nest (Rothstein, 1990). Potentially, the evolution of false nests may be another adaptation against nest predation. I am hypothesizing that this structure may be used as a preventative device against potential brood parasites. To test this, I researched which species within Estrildidae construct these false nests, and how their phylogeny compared to that of the parasite which targets them specifically.

METHODS AND MATERIALS

I used the same list of 60 Estrildidae finch species used in Arnaiz-Villena et al. (2009) with additional finch species (*Estrilda atricapilla, Estrilda paludicola,* and *Estrilda thomensis*) that create false nests not previously included. Utilizing the online database *Handbook of the Birds of the World Alive* (Lynx Edicions, 2018), I searched through the species of the genera *Estrilda* and *Amandava* of Estrildidae and identified nine species which had the term "cock's nest" in their breeding descriptions. Then I searched through the 20 species of the family Viduidae and identified which host species was targeted by each Viduidae species. I utilized Excel to list all hosts for the Viduidae, as well as the parasites for the Estrildidae. Then I used birdtree.org (Jetz et al., 2018) to create the phylogenetic trees by manually entering all of the names of the 60 Estrildidae and the 20 Viduidae, and then using Mesquite (Maddison and Maddison, 2018), I made phylogenetic trees of each, the Estrildidae and the Viduidae. I added to the Estrildidae the character state for the presence of the false nest, as well as nest shape and location.

RESULTS

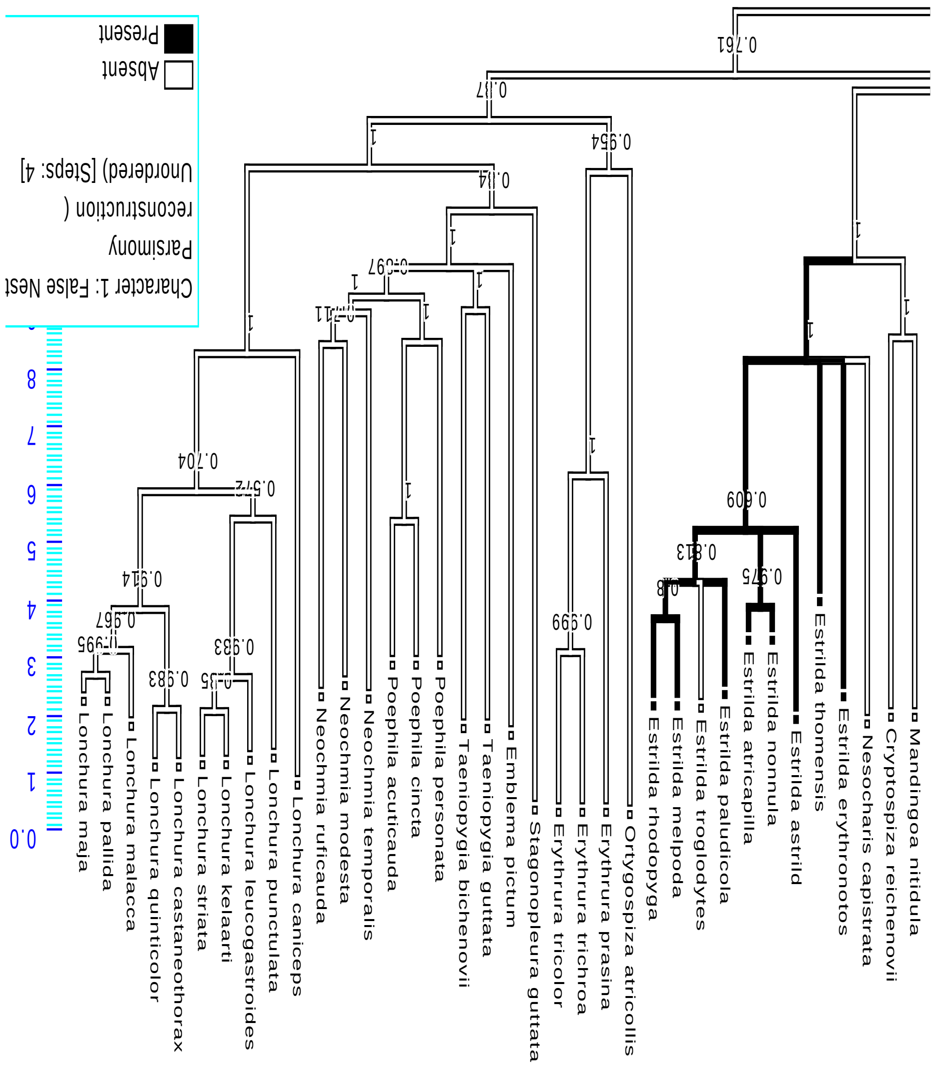
Of the 60 species surveyed of the total 141 species of Estrildidae, nine of them create false nests (Table 1). Of those nine, six are parasitized by one species: *Vidua macroura*. Of the nine false nest species, two are not targeted by any brood-parasites (although one is not described in the wild: *Estrilda thomensis*), and one other (*Estrilda erythronotos*) is targeted by two other species of Viduidae: *Vidua hypocherina* and *Vidua regia.* There is not any information regarding nesting characteristics of *Estrilda thomensis* in the wild, except that in captivity, it makes a false nest.

Table 1. List of Estrildidae species which create false nests and their characteristics.

Species with False Nests	Brood-parasite	Nest Shape	Nest Location
Amandava subflava	*Vidua raricola, Vidua macroura*	Spherical	Grass
Estrilda astrild	*Vidua macroura*	Spherical	Ground
Estrilda atricapilla		Ovoid	Bush
Estrilda erythronotos	*Vidua hypocherina, Vidua regia*	Ovoid ball	Tree
Estrilda melpoda	*Vidua macroura*	Spherical	Ground
Estrilda nonnula	*Vidua macroura*	Ovoid	Bush
Estrilda paludicola	*Vidua macroura*	Spherical	Ground
Estrilda rhodopyga	*Vidua macroura*	Spherical	Ground
Estrilda thomensis		Undescribed	Undescribed

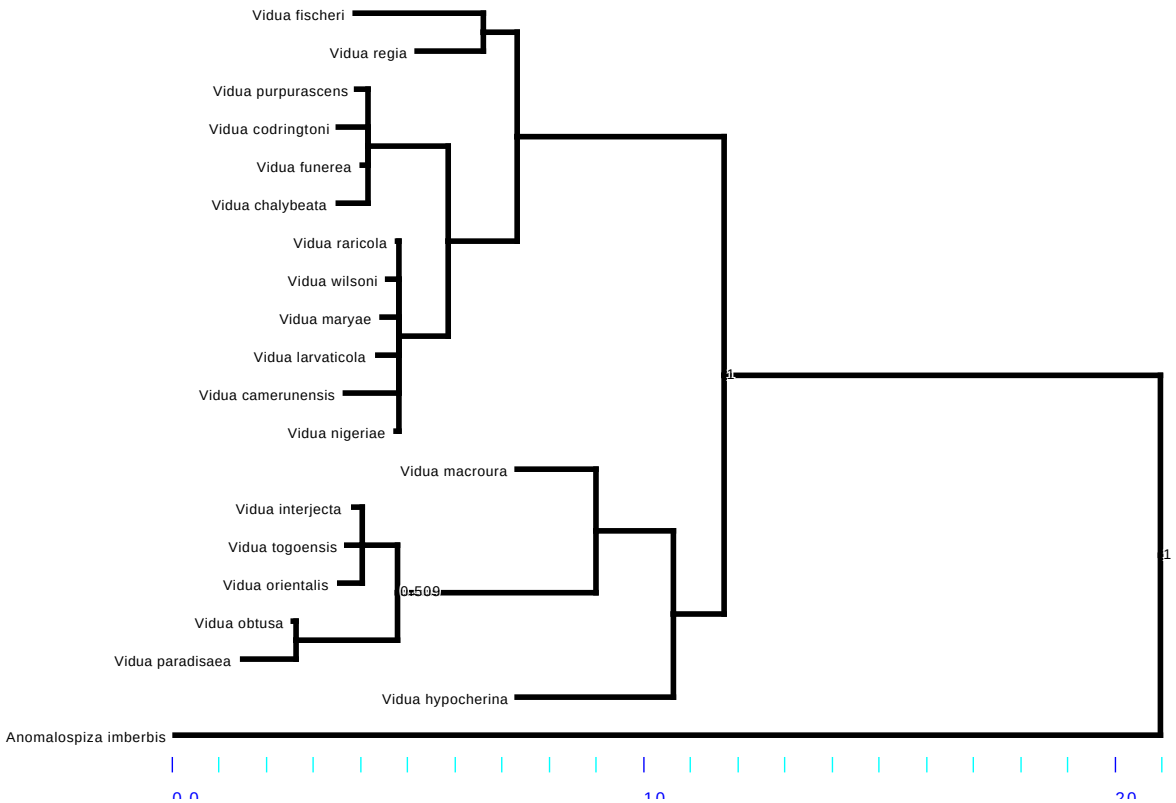
A phylogenetic analysis of the Estrildidae shows the evolution of false nests has evolved twice, independently, and has been lost again three times (Figure 1).

Figure 1. Phylogenetic tree of Estrildidae. Black lines mean false nest is present.



Another phylogenetic analysis of the Viduidae (Sorenson et al., 2004) was used to analyze how the evolutionary histories of the two families match up (Figure 2).

Figure 2. Phylogenetic tree of Viduidae based on Sorenson et al. (2004).



DISCUSSION

Since seven of the nine species that construct these false nests are parasitized, this suggests that the false nests may have evolved as an adaptation against nest parasitism. Specifically, since six of these seven species are parasitized by one single parasite (*Vidua macroura*), there is a strong correlation between the false nests and this specific parasite

($p>0.01$). All of the hosts of *Vidua macroura* share the same nest characteristics: spherical nests and grounded (all except *Estrilda nonnula*). As previously mentioned, the Viduidae are unique among brood-parasites in that they have high host specificity. *Vidua macroura* is the only species of Viduidae which has many more than two or three specific hosts it targets. The non-specificity of *Vidua macroura,* as well as its hosts creating false nests, may suggest an evolutionary arms race. In previous studies regarding host-parasite relationships, coevolution has been observed in the koel cuckoo (*Eudynamics scolopacea*) where males are black like their hosts, crows (Rothstein, 1990). Parasitized species have also evolved characteristic alarm calls used only when a brood-parasite is spotted (Payne, 1967). It would be interesting in future studies to analyze how well *Vidua macroura* does in successfully parasitizing these different hosts.

Another interesting find was that one of the nine species (*Estrilda atricapilla*) which creates a false nest is not parasitized at all, although another species is not described in the wild. One possible explanation for this may be that that species used to be parasitized but was able to outcompete their parasite(s). Future studies could focus on this species to determine if there was potentially a previous parasite that was outcompeted.

Another possible explanation for the false nests is their usage as a deterrent to non-parasitic predation. Galligan and Kleindorfer (2008) found in the Yellow-rumped Thornbill (*Acanthiza chrysorrhoa*), an Australian passerine, that nest predation levels were much higher for those nests without a false nest structure on top of the existing nest. Future studies in these African species may be able to replicate the Galligan and Kleindorfer (2008) study to test this hypothesis.

One last possible explanation for false nests is that they may be a sexually-selected for trait, if males construct this structure. If so, it could be observed if females will choose males with these structures over males without them. Some further information regarding false nests will be necessary to be able to test this hypothesis.

Some possible errors in this study are that not all of the Estrildidae were included nor are all of them described in the wild, which may exclude other potential hosts and potential false nest creators. Future studies may be better to include statistics to determine significance and correlation of results, as well as to look at the entirety of the Estrildidae family.

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