Do Different Clutch Sizes of the Tree Swallow (*Tachycineta bicolor*) Have Varying Fledging Success?

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ABSTRACT

Fifty Tree Swallow (*Tachycineta bicolor*) boxes were monitored over the course of four months. The relationship between clutch sizes and the number of successfully fledged young were compared in order to determine the success rate of fledged young for each clutch size. It was determined that there was a significant difference between the means of successfully fledged young for each clutch size (ANOVA; $\alpha = 0.05$, p-value = 0.03). Further analysis suggested that clutches of 5 to 8 eggs have a higher success rate for producing fledged young. These results suggest that larger clutches have a higher fledging success rate. Larger clutches (over 7 eggs in a clutch) had a slight decrease of fledging success. However, the results were not significant. The data suggests that the higher energy cost to parents associated with producing and raising a large clutch pay off, as bigger clutches have a higher fledging success rate. Additionally, a majority of the clutches consisted of 6 or 7 eggs, suggesting that there may be physical limitations to females that lay clutches of more than 7 eggs.

INTRODUCTION

The efforts individuals put into breeding and raising young varies for each species. The number of offspring resulting from these couplings that successfully reach sexual maturity and are able to reproduce may be significantly lower than the original number of offspring produced (Ingram *et al*. 2013). The Tree Swallow (*Tachycineta bicolor*) is a bird whose habitat consists of open fields. Naturally, they nest in holes already excavated by other species. However, they also are willing to nest in nest boxes when provided. Because Tree Swallows are tolerant and prepared to use nest boxes, this makes them a great species to use in studies (Robertson *et al*. 1992).

Tree Swallow nests are usually made entirely of grass, forming a nest cup that is lined by feathers from other bird species (Stocek 1970). Females are responsible for a majority of nest construction. Males deliver feather material to the nest while females arrange the feathers in the nest once eggs are laid (Cohen 1985). Tree Swallows feed primarily on flying insects, their diet consists mainly of; dipterans, ants, and beetles (Beal 1918). The clutch sizes of Tree Swallows vary, usually they consist of 2 to 8 eggs (Paynter 1954) and clutch sizes laid later in the breeding season are smaller (DeSteven 1978). Females typically lay 1 egg per day (Robertson *et al*. 1992). Eggs turn pure white after 4 days of incubation and are translucent when initially laid (Robertson *et al*. 1992). The incubation period varies from 11 to 19 days (Stocek 1970). Nestlings leave the nest after 15 to 25 days after hatching. However, if a brood consists of more than 4 nestlings, the nestling period tends to be longer as brood size increases (Paynter 1954).

When birds nest in an area that is defined, such as a nest box grid, they demonstrate various social interactions with conspecifics including territorial disputes, competing for nesting material, and dissuading predators. Both males and females defend their nest areas (Harris 1979). They will attack conspecifics and interspecific species by chasing and physically fighting them (Robertson *et al*. 1992). When faced with a predator, Tree Swallows will dive-bomb the treat coupled with producing alarm-calls (Winkler 1991). Furthermore, there are many interactions between parents and their young, once hatched. Nestlings rely on the female for brooding in order to retain a constant body temperature (Marsh 1980). Substantial amounts of brooding by the female are required from hatching until the nestlings reach an age of 3 days. Both the male and female contribute to feeding their young and will continue feeding their young until 3 days after the young leave their nest (Kuerzi 1941).

The energetic input that Tree Swallow individuals put into reproduction are substantial. Furthermore, larger clutch sizes have been shown to increase stress in parents (Shutler *et al*. 2004). Parents of larger broods work harder to care for their young when compared to smaller broods by increasing their feeding rate (Leffelaar and Robertson 1986). Whether the high investment and energetic costs associated with larger clutches (and thereby larger broods) is worth the outcome is the aim of this study. To test this, the number of successfully fledged young was compared to the total clutch size per nest box.

METHODS

This study was conducted at the Beaverhill Bird Observatory (BBO) located 8 km east of Tofield, Alberta during the summer of 2014. Fifty Tree Swallow boxes were set up in the 'new Tree Swallow grid' (Figure 1.). The grid was set up in rows of 10 boxes each and each box was set up to face north-east.

Figure 1. Trail map of the Beaverhill Bird Observatory. The red star indicates approximately where the 'new Tree Swallow grid' is located. Image modified from *Beaverhill Bird Observatory*, Trail Map PDF. http://beaverhillbirds.com/docs/bbo_trailmap.pdf

The nest boxes were strapped to a pole, approximately 5'5" from the ground and spaced roughly 10 meters apart. Nest boxes were constructed to be 6"x11"x5.5" with an entry hole diameter of 1.5". (Fidure 2.). The lid of the box was held on with a thin piece of wire.

Figure 2. Tree Swallow nest box number 1. Photo taken by Victoria Giacobbo at the Beaverhill Bird Observatory.

Boxes were determined to belong to Tree Swallows by the presence of grass , cup-shaped nests that were lined with feathers and containing white eggs (once laid). Once a week, from May 11 to August 10, each box was checked and data was recorded on the contents of each box. The stage of nest, number of eggs, temperature of the eggs, the species utilizing the nest box, the number of hatched young, and the age of the young were recorded. Nest boxes were considered 'empty' if there was no evidence of a nest or if only feathers were present in the box. A nest was considered 'partial' if there was grass in the box, but was not cup-shaped. A 'full' nest was a grass, cup-shaped nest lined with feathers. Egg temperature was determined by feeling the eggs to see if they were warm or could to the touch. House Wren nests were determined by the presence of twigs in the nest box and pink-coloured eggs. Tree Swallows were aged by examining the progression of the feathers (Figure 3.). Once the feathers were beginning to come out of their sheaths, the chicks were banded. At the end of the study, old nesting material was removed from the boxes.

Figure 3. Tree Swallow nestlings, almost ready to fledge. Photo taken by Victoria Giacobbo at the Beaverhill Bird Observatory.

Data was analyzed using Microsoft Excel. Fledging success was calculated by determining the ratio of successfully fledged young per clutch size for each box (clutch sizes varied from 3 to 8 eggs per clutch). The data was compared using a one-way ANOVA and t-Tests. House Wren clutches were excluded from analysis. Additionally, nest box 50 and the second clutch of nest box 41 were not included in the analysis. Box 41 had eggs from a previous clutch in the nest and it is unclear if the new pair of breeding Tree Swallows removed the eggs or just laid their own eggs with the old. Similarly, several eggs in box 50 were kicked out and new ones were laid in segments over the course of the study. It is unclear whether one or several pairs of Tree Swallows parented each egg or how many eggs were laid in the completed clutch. In both cases, none of the eggs hatched.

RESULTS

There was a significant difference between the means of the fledging success rate for each clutch size (ANOVA; $\alpha = 0.05$, p-value = 0.03). There was no significant difference of fledging success between clutches of 6 and 7 eggs (t-Test; $\alpha = 0.05$, one-tailed p-value = 0.41, two-tailed p-value = 0.83) or clutches of 7 and 8 eggs (t-Test; $\alpha = 0.05$, one-tailed p-value = 0.28, two-tailed p-value = 0.56). There was a slight difference between clutches of 5 and 7 eggs (t-Test; $\alpha = 0.05$, one-tailed p-value = 0.03, two-tailed p-value = 0.07). There was a significant difference between clutches of 4 and 7 eggs (t-

Test; α = 0.05, one-tailed p-value < 0.01, two-tailed p-value = 0.01) and between 4 and 6 eggs (t-Test; α = 0.05, one-tailed p-value = 0.02, two-tailed p-value = 0.03). There was no significance for fledging success between clutches of 5 and 6 eggs (t-Test; α = 0.05, one-tailed p-value = 0.07, two-tailed p-value = 0.15).

DISCUSSION

Tree Swallow clutches had a significantly higher fledging success rate in clutches of over 5 eggs. However, in clutches of over 7 eggs, the success rate dropped slightly (Figure 4.). This is likely due to the poor representation of clutches consisting of 8 eggs in the population. Most of the females laid 6 or 7 eggs (Figure 5.). However, the low number of females that successfully laid 8 eggs (Figure 5.), suggests that there are limitations to egg-laying females. Previous studies suggest that female Tree Swallows whose diets have been supplemented with calcium, produced larger clutches (Bidwell *et al*. 2005). This suggests that only females with high fitness are able to produce larger clutches. Furthermore, a single Tree Swallow egg can make up roughly 9% of the adult female's total mass (Wiggins 1990). This suggests that producing larger clutches required high food intake by the female. Furthermore, clutches consisting of 5 eggs have been shown to have a higher egg mass than in clutches of 3 or 4 eggs. Additionally females that laid larger clutches were in better physical condition and were typically older than females that laid smaller clutches (Wiggins 1990). This suggests that larger broods require more energy input from the egg-laying female. The lower numbers of females that laid clutches of 3 or 4 eggs (Figure 5.) may be explained by poorer fitness of these individuals, however female physical condition was not analyzed in this study.

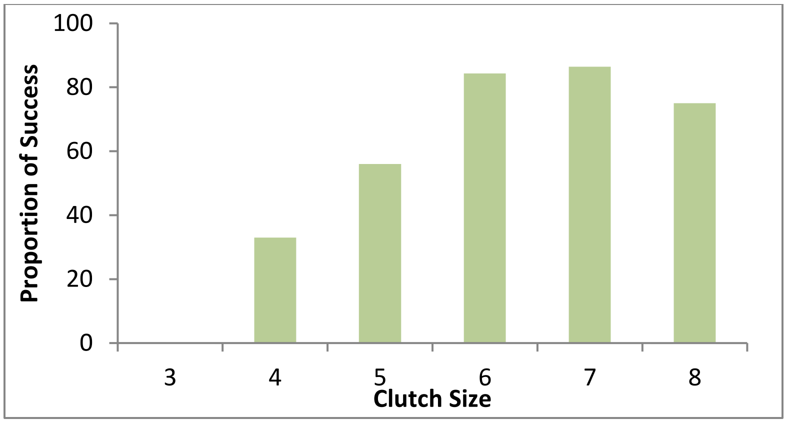

Figure 4. The percentage of chicks that successfully fledged per clutch size. Clutch size refers to the number of eggs that were lain in the completed clutch.

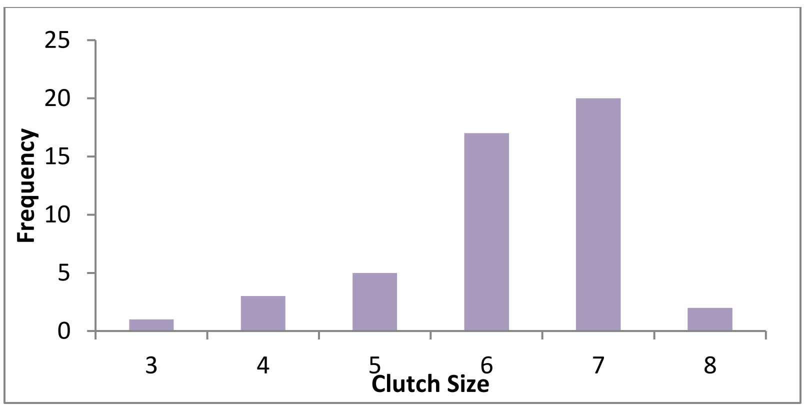

Figure 5. The frequency of boxes that contained each clutch size. Clutch size refers to the number of eggs that were lain in the completed clutch.

Laying smaller clutches may be more risky for reproducing parents. For instance, if in a clutch of 4 eggs, 2 do not hatch, that would result in a 50% loss to the clutch. However, if in a clutch of 6 eggs, 2 eggs do not hatch, there would only be a 33% loss to the clutch. Eggs are not only susceptible to parasitism or poor weather conditions, they are also susceptible to other bird species (Robertson *et al*. 1992). They are particularly vulnerable to House Wren (*Troglodytes aedon*) activity. House Wrens are capable of demolishing Tree Swallow eggs and nestlings. Furthermore, by placing twigs into Tree Swallow nests, House Wrens can cause nest abandonment (Finch 1990). One box in the 'new Tree

Swallow grid' (box 10) had twigs placed over the old Tree Swallow nest. However, this was after the Tree Swallow chicks had fledged. Furthermore, there was evidence of House Wren activity in nests containing Tree Swallow eggs. Over consecutive weeks eggs would disappear from certain boxes. These eggs were likely kicked out by House Wrens.

CONCLUSIONS

The findings of this study suggest that clutches of 5 to 8 eggs have the highest success rate for fledged young. These findings demonstrate that most clutches consist of 6 or 7 eggs. This suggests that clutches consisting of 6 or 7 eggs are more favorable for breeding females. Clutches of less than 5 eggs suffer more from loss of siblings, as losing 1 egg in a clutch of 4 is more detrimental than losing 1 egg in a clutch of 6 eggs. Even though larger clutch sizes require more energy expenditure from the parents, particularly females, these clutches yield more successfully fledged young than smaller clutches.

FUTURE WORK

Previous work suggests that different latitudes have varying clutch sizes (Dunn *et al*. 2000). Their work suggests that higher latitudes have bigger clutches because they have less breeding individuals compared to resource level. It would be interesting to compare resource level to the clutch sizes of Tree Swallows. Furthermore, it would be interesting to compare the size of young in larger broods to those of smaller broods. Previous studies show that the amount of food per nestling is less in bigger broods when compared to smaller broods (Leffelaar and Robertson 1986).

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