**Title**
Aggressive behaviors within and between pairs of Common Myna (Acridotheres tristis)



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# AGGRESSIVE BEHAVIORS WITHIN AND BETWEEN PAIRS OF COMMON MYNA (*ACRIDOTHERES TRISTIS*)

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*Abstract.* Social structures and population ecology can greatly influence individual behaviors in animal societies. The Common Myna (*Acridotheres trisis*) is a social, aggressive bird that is known as one of the world's worst invaders. On the island of Mo'orea, French Polynesia, *A. tristis* is most often found in pairs and groups. It was anticipated that a pair of *A. tristis* would act as a team to increase foraging and defense efficiency. This study examined aggressive behaviors using behavioral observations of *A. tristis* in pairs and groups on two different sites on the island. Food was added to the sites to determine how food availability may affect behavior. The results show that being in a group setting significantly increases aggression. A look at non-aggressive behaviors provided information on the most common behaviors seen in *A. tristis* both in groups and pairs. Furthermore, the addition of food significantly increases aggression. The aggressive behaviors seen were increased with group type and food availability. These behaviors could be mediating the invasive nature of this bird.

*Key words:* Acridotheres tristis; *animal behavior; social structure; foraging pairs; invasive species; Mo'orea, French Polynesia*

## INTRODUCTION

Behavior is the result of an individual's genotype and phenotype integrating with its environment (Kappeler 2010), and can greatly influence social structures. It encompasses a variety of topics, including social behavior, i.e., the interactions among individuals (Hinde 1976). Social behavior, which is based on an individual's characteristics and choices, can dictate many types of relationships, such as parent-offspring bonds, mating pairs, and group dynamics (Wey and Blumstein 2010). The assimilation of behavior, social structure, and the environment directly influence population ecology (Wasserman and Faust 1994). It is important to look at these behaviors on an island setting, because it has been found that an island population may adapt to have different behaviors or social structures compared to those found in the mainland population (Frankham, R. 1998).

Social structures evolve based on optimization of individual reproductive success (Kotrschal et al. 2010). In social species that are found in groups, selection may favor those individuals that stay closer together (Hamilton 1970). This grouping can include long-term pairs, especially in animals involved in sexual or social monogamy, and is often advantageous for defense against predators and a greater combined work output (Griggio and Hoi 2011, Schuiling 2003, Elie et al. 2011, Anderson and Franks 2001). Much of the literature describes long-term pairs in terms of male and female mating pairs, however, other types of pairs, such as teams, do exist as well (Freed 1987, Anderson and Franks 2001). Many vertebrates, such as birds, have been observed using teams and a division of labor especially when foraging and feeding (Anderson and Franks 2001).

The Common Myna *(Acridotheres tristis)* is an omnivorous member of the Sturnidae family, feeding on small insects and fruit (Woodward 2011). The species was introduced to the Society Islands as a biological control (Blanvillain et al. 2003). It is now part of the IUCN's list of 100 Worst Invasive Species Worldwide (Lowe et al. 2000). The breeding season of *A. tristis* is variable; some reports have indicated pairs lasting only through the breeding season, while other describe long term pairs, lasting past the breeding season (Dhanda & Dhindsa 1998, Siddique et al. 1993). *A. tristis* is the most commonly seen bird on Mo'orea, French Polynesia, usually found associating in pairs and groups. These social dynamics of *A. tristis* could greatly affect behavior because as group size is increased, food, space, and time spent foraging may decrease (Pulliam & Caraco 1984). Aggressive behavior in particular could be greatly influenced by the social dynamics of this species on Mo'orea.

Aggressive behavior is important in conveying dominance, finding mates, and keeping territory (Verbeek et al. 1996). *A. tristis* has been shown to be more aggressive during breeding season (Ali and Ripley 1972). Because island populations of *A. tristis* are paired for extended period of time, this increased aggression seen during breeding season could be seen year round on islands. Observing these aggressive behaviors may help explain how aggression mediates the invasiveness problem.

This study examined aggressive behavior within pairs and groups by testing the following hypotheses: (1) aggression will decrease within a pair of *A. tristis* in a group setting because the pair will act as a team against other pairs (2) aggression will increase within a pair of *A. tristis* when food is added because with no other birds present and there is no need to act as a team and share (3) aggression will decrease within a pair of *A. tristis* when food is added in a group setting as the birds will once again act as a team. These questions and hypotheses will be investigated using behavioral observations of pair dynamics seen in the Common Myna.

## METHODS

### *Field Survey*

A survey of the island of Mo'orea, French Polynesia was done in September 2012 with the objective of finding large populations of *Acridotheres trisis* (Appendix A). These birds were found in all areas around the island in large numbers except for areas with dense forest cover. They were most often found in pairs on the sides of roads and in groups in open areas such as fields and in coconut groves.

### *Study sites*

*A. tristis* was observed at two sites on the island of Mo'orea, French Polynesia throughout the months of October to November 2012 for a total of 12 hours. The first site was located at the Richard Gump Research Station, approximately a 1.05 hectare research facility, on the tip of Cooks Bay. The second site was located at Crevettes de Mo'orea, at the mouth of Opunohu Bay, a two-hectare saltwater shrimp farm (Figure 1). These sites were chosen because they were comparable but had different food sources. Both the Gump Station and the Shrimp Farm

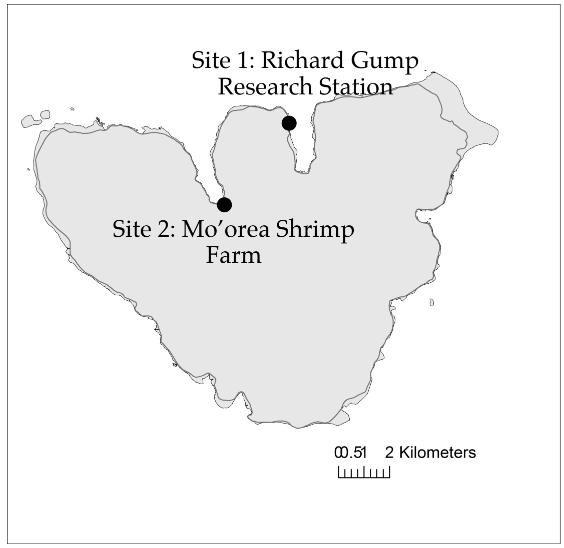


Fig 1: Map of field sites. Site 1: Richard Gump Research Station (17º 29'26 S 149º 49'34W). Site 2: Mo'orea Shrimp Farm (17º 31'05 S 149º 50'56W). Map from UC Berkeley's Geospatial Innovation Facility (GIF). Gif.berkeley.edu

had a large population of birds, with at least 20 birds seen during one walk through each site. Both sites also had human and car traffic throughout the day, were approximately 100 meters away from the ocean, and had open spaces ideal for a large populations of birds.

### *Pair description*

For this study, a pair was defined as two birds that were within a few meters of each other for the majority of the observation. These birds also had the tendency to follow one another when moving, and to do similar behaviors, such as eating, scanning or preening at the same time. Throughout group interactions, these two birds were in closer proximity to each other than any other birds in the group. Groups were defined as more than two birds interacting with one another. When describing interactions concerning the pairs and groups, "within pairs" refers to interactions between the two individuals in a pair, whereas "between pairs" refers to interactions between two sets of pairs (Figure 2). Males and females were not distinguished within pairs as *A. tristis* are not sexual dimorphic and therefore males and females could not be identified from a distance (McLain et al. 1995).

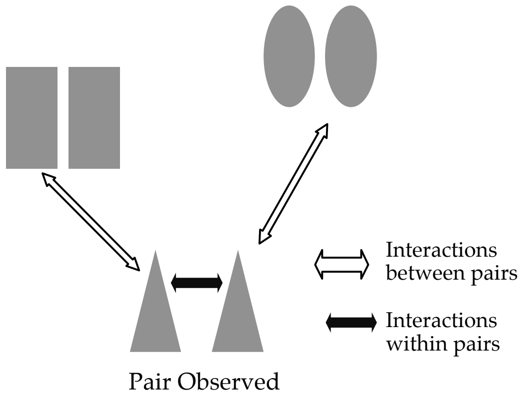


Fig 2: Diagram of pairs and groups interactions. Three pairs interacting as one group shown. Black arrows represent interactions "within pairs" and white arrows represent interactions "between pairs". Both individuals in the "pair observed" are

*Behavioral observations*

In accordance with the animal use protocol, no animals were handled throughout the study; all data was based on observations in the field (UCB Animal Use Protocol T042-0813). Observations were done between the hours of 0600 and 1800 using the naked eye. In the field, site number, weather, and time were recorded. Depending on distance from the birds, video camera or binoculars were used. Videotaping was done using a Nikon AW100 Camera, or using Bushnell Powerview 7-15x25 Binoculars and an Olympus VN 5200PC Digital Voice Recorder. To avoid altering behaviors, observations were taken as close as possible while hidden. If birds were close, the video camera was used to visually record interactions while I quietly narrated different behaviors shown. If birds were farther away, binoculars and the voice recorder were used to document interaction. Observations were then transcribed and behaviors were counted using an ethogram (Appendix B).

The ethogram was made based on initial observations of behaviors. Different behaviors were split into the following behavior categories: aggressive, foraging, mating, ground movement, stationary and vocalization. The aggressive behaviors were described as chasing, flapping, pecking, and biting (Haythorpe 2012). Number of behaviors and duration of behaviors were measured.

When birds were found in pairs, both birds were observed and recorded simultaneously. When observing these groups, one pair interacting in the group was followed and both individuals in that pair were observed simultaneously. If it was not possible to follow the pair, a single individual that was part of a pair was observed.

Using the first *A. tristis* seen, the bird was observed until it was out of sight or after ten minutes had passed. Any observation less than five minutes in length was not included, as it was not a good representation of a full interaction. Using behaviors from the ethogram, each behavior for both of the birds being observed was tallied. After ten minutes, the observation was ended and a summary of events was recorded including group size, number of birds seen, and number of pairs seen. The next observation was then done in a different location at the field site, or if birds were clustered, ten minutes was given between observations to avoid observing the same bird repeatedly. When this was the case, after ten minutes, another pair was observed and recorded in the same fashion

*Food addition experiment*

The food manipulation was accomplished by putting a piece of baguette bread and a piece of fruit out side by side in an area of the study site and observations were recorded in the same fashion as the observational study. The bread and fruit were cut into approximately 10cm cubes, and different fruits such as papaya, mango, pineapple and banana were used. Observations began with the first *A. tristis* that came up to the food. Once again, the observations between five and ten minutes were counted.

*Behavioral comparisons*

Four behavioral comparisons were studied using the behavioral data found throughout the study. JMP 10 Statistical Software (SAS Institute, 2012) was used to conduct all statistical analyses. T-tests were used to compare means. An analysis of variance (ANOVA) conducted to find interaction terms between different parameters such as: group type, site, and the addition of food on behaviors. The four comparisons were as follows:

- *Aggression in groups versus pairs:* Mean aggression between and within pairs and groups was compared. Linear regression was used to test the effect of group size on aggression.

- *Aggressive behaviors with the addition of food:* Food was added as described in *food addition experiment* and aggressive behavior data with two group types was analyzed.
- *Non-aggressive behaviors in groups versus pairs:* Non-aggressive behaviors were also counted throughout the study. The most common behaviors were analyzed in both group types.
- *Non-aggressive behaviors with the addition of food:* The effect of the addition of food on non-aggressive behaviors was analyzed.

## RESULTS

*Aggressive behavior in groups versus pairs*

During observations, 84.5% of all *Acridotheres tristis* were seen in pairs. Aggressive behaviors were significantly more prevalent in groups versus pairs (T-test, DF=158, p<0.0362) (Figure 3). Of these aggressive behaviors, chasing and pecking were significantly higher in groups versus pairs whereas flapping did not follow this trend (Chasing: T-test, DF= 158, p<0.0382, Pecking: T-test, DF=158, p<0.0065, Flapping: T-test, DF=18, p<0.6825) (Figure 4). A linear regression was used to see that there was no relationship between group size and aggression (Linear regression, DF=79, $R^2$= 0.02702, p<0.2582) (Appendix C). An ANOVA was used to test the interaction terms of group type and site showing that group type, although not statistically significant, had the largest influence on aggression. However, site did not influence the aggression seen within or between pairs. There was no significance in the interaction term between the group type and the site (ANOVA, Group type: DF=1, p<0.0736, Site: DF=1, p<0.7232, Group Type*Site: DF=1, p<0.4515) (Figure 5).

*Aggressive behaviors with the addition of food*

A T-test was used to compare mean aggressive behaviors per minute with food and no food added in pairs, adding food had no effect on the aggression seen in pairs (T-test, DF= 75, p<0.6276)(Figure 6). Unlike the pair setting, the addition of food when in groups caused a significant increase in aggression (T-test, DF= 78, p<0.0331) (Figure 6).

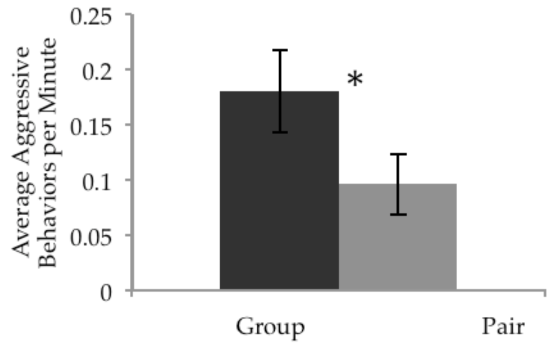


Fig 3: T-test comparing average aggressive behaviors per minute in groups and pairs. Error bars created using 1 standard error. Aggression is more prevalent in groups versus pairs. (T-test, DF=158, p<0.0362.) *Indicates statistical significance.

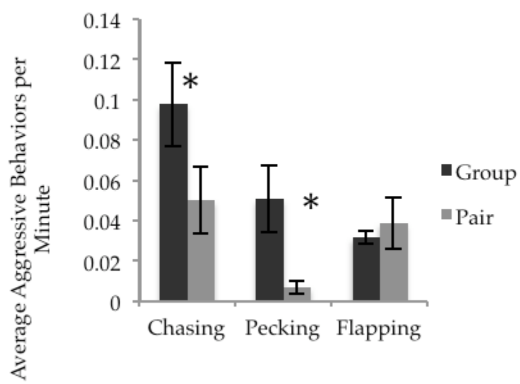


Fig 4: T-tests comparing the average aggressive behaviors of chasing, pecking and flapping in groups and pairs. Error bars created using 1 standard error. (Chasing: T-test, DF= 158, p<0.0382, Pecking: T-test, DF=158, p<0.0065, Flapping: T-test, DF=18, p<0.6825.)

Using an ANOVA, it can be seen that food significantly influences aggression and although not statistically significant, group type does somewhat influence the aggression seen. The interaction term between group type and food was not significant. (ANOVA, Group Type: DF=1, p<0.0772, Food: DF= 1, p<0.0269, Group Type*Food: DF=1, p<0.2246) (Figure 6).

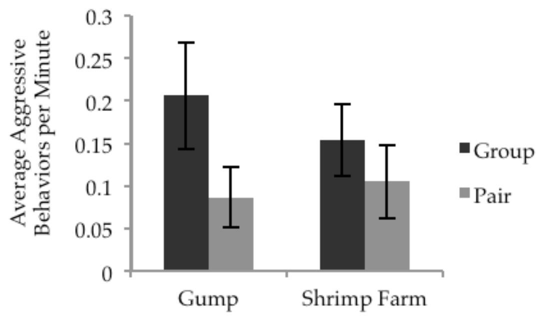


Fig 5: Two-way ANOVA comparing average aggressive behaviors in groups versus pairs in two sites, the Gump Station and the Shrimp Farm. Group type has an influence on aggression, site has no influence on aggression and interaction term was not significant (ANOVA, Group type: DF=1, p<0.0736, Site: DF=1, p<0.7232, Group Type*Site: DF=1, p<0.4515.)

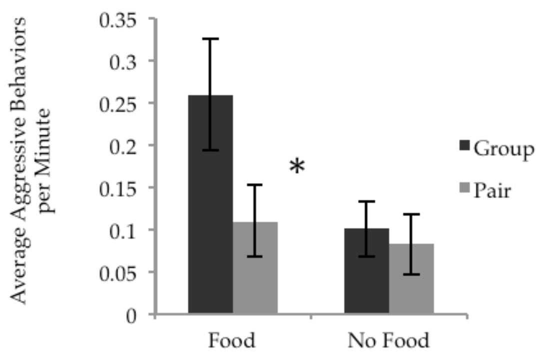


Fig 6: Average aggressive behaviors per minute in groups versus pairs in both food and no food treatments. Food significantly influences aggression seen. Although not statistically significant, group type does slightly influence the behavior and the interaction between food and group type has no effect on mean aggression. (ANOVA, Group Type: DF=1, p< 0.0772, Food: DF= 1, p< 0.0269, Group Type*Food: DF=1, p< 0.2246.)

*Non-aggressive behaviors in groups versus pairs*

Of all behaviors observed, the most common non-aggressive behaviors were flying, walking and running, preening, vocalizing, and scanning. There was no significant difference in the mean aggression per minute of any of these behaviors between groups and pairs. (Flying: T-test, DF=156, p<0.4122, Walking/Running: T-test, DF=158, p<0.0337, Preening: T-test, DF=157, p<0.1366, Vocalizing: T-test, DF=156, p<0.5903, Scanning: T-test, DF=155, p<0.4532) (Figure 7).

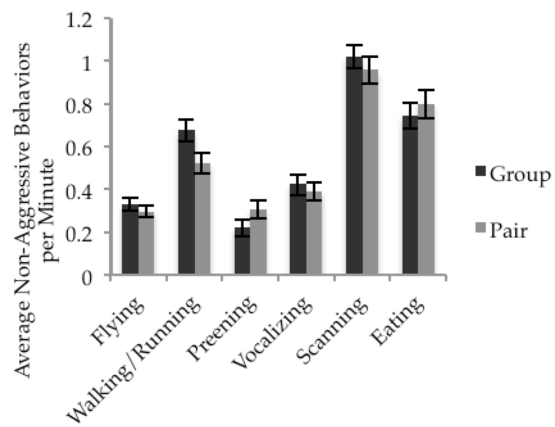


Fig 7: T-test comparing average non-aggressive behaviors per minute versus groups and pairs. Non-aggressive behaviors include flying, walking/running, preening, vocalizing, scanning, and eating. No significant difference between groups or pairs for any of the behaviors. Flying: T-test, DF= 156, p<0.4122, Walking/Running: T-test, DF=158, p<0.0337, Preening: T-test, DF=157, p<0.1366, Vocalizing: T-test, DF=156, p<0.5903, Scanning: T-test, DF=155, p<0.4532.

*Non-aggressive behaviors with the addition of food*

The non-aggressive behaviors of eating and scanning were significantly different with the addition of food (Eating: T-test, DF= 145, $p<0.0001$, Scanning: T-test, DF=157, $p<0.0023$). Although not statistically significant, the behaviors of preening and vocalizing were more prominent when food was added (Preening: T-test, DF=157, $p<0.1710$, Vocalizing: T-test, DF=156, $p<0.0960$. Flying and walking showed no signs of change when food was added (Flying: T-test, DF=158, $p<0.5536$, Walking/Running: T-test, DF=157, $p<0.8308$). A trend is seen with behaviors associated with food increasing when food is added.

## DISCUSSION

This study focused on aggressive behaviors in pairs and groups of Common Myna. Further information on the behavior of solitary birds was also of interest, however in over 200 observations, only 5 solitary birds were observed. One explanation for the lack of solitary birds is that solitaries cannot defend themselves against pairs. During observations, pairs often defended resources by having one bird attack while the other guarded. A solitary bird would be at a disadvantage to defend against an attack of this nature. The lack of solitary birds may have also been a result of the breeding season. As there was no information in the scientific literature about the specific breeding season of *A. tristis* on Mo'orea. If the birds were breeding during the months of September to November 2012 then presence of solitary birds would be much less likely.

*Aggressive behavior in groups versus pairs*

Aggressive behavior strongly depended on group type. Groups were found to be significantly more aggressive however the data collected included aggressive behaviors between pairs, which could account for much of the aggression seen in groups. This does not support the hypothesis that aggression would decrease within the pair. Nevertheless, aggression increases when *A. tristis* is in groups. Of the aggressive behaviors noted, chasing, pecking and flapping were the most commonly seen. During observations, chasing was seen most often and was usually the first aggressive behavior displayed. If chasing was not successful, pecking and flapping were used. One possible cause for this tendency is that chasing could be the least energetically taxing aggressive behavior and this therefore used the most frequently.

Group size had no influence on the amount of aggressive behavior seen. Although a number of birds would account for more competition, and therefore more aggression, this trend was not seen. The largest groups had eight birds, and those groups had little to no aggression, whereas groups of three had almost the highest average aggression seen. One reason for this could be that larger groups were seen less often and therefore could have skewed the data.

Site had no influence on the aggressive behaviors seen in *A. tristis*. During an initial survey, the population of birds at the Shrimp Farm was found to be much higher than that of the Gump Station. Despite the differences in population and environment, the same trends in behavior were seen in both sites. Because these behavior trends were evident in both sites it may be that this behavior could be seen in many sites throughout the island.

*Aggressive behaviors with food added*

Along with group type, the addition of food had the largest effect on the amount of aggression observed. It was anticipated that the addition of food to a pair would increase aggression within the pair as the two birds would not act as a team and would compete within the pair. However, when food was added, there was no significant change in the amount of aggression seen. One explanation for this trend is that when food was added to the field site, a medium sized piece of bread and fruit were offered to the birds. This was probably more food than any singular bird could eat, therefore the pair was able to share the food equally and not compete for the food source.

The combination of groups and added food sources caused the largest increase in aggression. Because aggression between pairs was also counted, a large amount of the aggression seen in the group was due to behaviors towards other pairs. During observations, as anticipated, the pairs acted as teams to claim food sources. It was often seen that pairs would have one member of the pair stay in close proximity to the food while the other member would be more aggressive towards other pairs. This strategy is similar to behavior seen in other studies focused on division of labor among animal societies (Anderson and Franks 2001) and could be a good indicator of why these birds stay in pairs, as it helps them defend resources more efficiently.

The treatments of food and no food had great affects on behavior. In the case of no food added to a group, the amount of aggression did not change. By adding food to the site, resources go from being uniformly distributed, to clumped. Studies have shown that food distribution and abundance can greatly increase aggressive behaviors because of an increase of interference competition (Isbell 1991). With this information it can be extrapolated that food availability could be a limiting resource for the population of *A. tristis* on Mo'orea.

*Non-aggressive behaviors in groups versus pairs*

*A. trisits* spent the majority of observation time using non-aggressive behaviors. The most common of these behaviors was flying, walking and running, preening, vocalizing and scanning. Throughout different group types, and sites these behaviors were constant. As many of these were foraging behaviors, both groups and pairs would spend equal time doing these activities. This illustrates that these behaviors are vital for all individual birds for daily survival and are noteworthy behavioral qualities.

*Non-aggressive behaviors with food added*

With the addition of food the non-aggressive behaviors changed dramatically. Eating and scanning was significantly higher when food was present. This was expected as eating and scanning are common foraging behaviors that are necessary when feeding. Preening and vocalizing became more prominent as food was added as well. Preening and vocalizing are social behaviors and would increase in a group setting, especially when food was added as more birds were interacting. Flying and walking are not affected by food addition and therefore showed no change in the average amount of behaviors. There was a spectrum of change in the average amount of non-aggressive behaviors associated with how closely linked the behavior was to food and foraging.

*Acridotheres trisits* is one of the world's most successful invasive species and is considered a pest in many areas (Lowe et al. 2000). Learning more about this birds behavior and ecological roles can help us understand the effects of any plans for their control or possible eradication (Saavedra 2010). *A. trisits* is often found in agricultural areas feeding on crops, which can cause significant economic damage (Sengupta 1976). By looking at the different habitat choices and changes in behaviors at these sites, better methods can be taken to decrease their economic toll. Many studies have attempted to show how aggression in *A. tristis* leads to its highly invasive ability (Bates 2011, Haythorpe et al. 2012), while other studies have focused on general biology and group roosting (Mahabal 1997, Sengupta 1976). This study combines the group dynamics and the aggressive nature of *A. tristis* to help understand how aggression is mediating the invasive problem.

By looking into the social structure of *A. tristis* and daily behavior, there is now a better understanding of what may be making this bird such a strong invasive species. Although an exact breeding season was not found, this study shows that on the island of Mo'orea, pairs can be found throughout the months of September to November. These findings are similar to those of other studies that have observed *A. tristis* breeding year round or staying in pairs for long periods unlike in their home range (Siddique et al. 1993). Behaviors of pairs of *A. tristis* have never been described before and this study can provide information about pair dynamics and common behaviors. On the island of Mo'orea, no factors that could limit population were observed. There were no obvious predators, but there was an abundance of food and nesting sites. However, as this study shows, both food and group type can influence behavior and population sizes.

This study could have been improved by tagging or somehow identifying individual birds to ensure there was no replication of individuals. Furthermore, providing information about the sex of each bird in the pair could allow more information to be extrapolated about breeding pairs. Many of the results show an increase in aggression in groups versus pairs. The data recorded included aggressive behaviors between pairs as well as within pairs, which could account for much of the aggression seen in groups. In future studies, aggression between pairs should be counted separately. Finally, although the Gump Station and the Shrimp Farm were different, the addition of more field sites could strengthen the hypothesis that these behaviors can be seen among all Mynas on Mo'orea.

Important future research could include looking at limiting factors of the Common Myna on island settings like Mo'orea. Finding limiting factors, if any, to *A. tristis* populations, could be important for the impact this bird has on the ecosystem in the future. Because of the low variation in temperature on the island, recording breeding seasons would be a great step in further understanding the behavior and ecology of the species. Although there is a sizeable population of *A. tristis* on Mo'orea and most of the Society Islands, there are none found on Bora Bora or Tetiaroa (R. Mohan, personal observation). It could be of interest to take a further look into the habitat preference and see why these birds are able to populate some islands so well and not populate others at all. Further research into social structures, especially in the lab could be highly beneficial. These studies can take a closer look at the types of pairs seen, to describe them as mating, foraging, or same sex pairs. Seeing how group dynamics change when certain birds are removed or added to the pair or group could provide great insight into the ecology of these animals and the roll they play in the close-knit island ecosystem. Lastly, looking into immigration and emigration within areas and populations would also give a good idea of the bonds between individuals in a population of *A. tristis*

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## LITERATURE CITED

Ali, S. and S. D. Ripley. 1972. Handbook of the birds of India and Pakistan. Oxford Univ. Press, Bombay.

Anderson, C., and N. R. Franks. 2001. Teams in animal societies. Behavioral Ecology **12**: 534-540

Blanvillain, C., J.M. Salducci, G. Tutururai, and M. Maeura. 2003. Impact of introduced birds on the recovery of the Tahiti Flycatcher (Pomarea nigra), a cricically endangered forest bird of Tahiti. Biological Conservation **109**:197-205.

Elie, J. E., N. Mathevon, and C. Vignal. 2011. Same-sex pair-bonds are equivalent to male-female bonds in a life-long socially monogamous songbird. Behavioral Ecology and Sociobiology **65:**2197-2208

Frankham, R. 1998. Inbreeding and Extinction: Island Populations. Conservation Biology, **12**: 665–675

Freed, L. A. 1987. The Long-Term Pair Bond of Tropical House Wrens: Advantage or Constraint? The American Naturalist **130**:507-525

Griggio, M., H. Hoi. 2011. An experiment on the function of the long- term pair bond period in the socially monogamous bearded reedling. Animal Behaviour **82:**1329-1335

Hamilton, W.D. 1971. Geometry for selfish herd. Journal of Theoretical Biology **31**:295–311

Haythorpe, K. M., D. Sulikowski, and D. Burke. 2012. Relative levels of food aggression displayed by Common Mynas when foraging with other bird species in suburbia. EMU **112**, 129–136.

Hinde, R.A. 1976. Interactions, relationships, and social-structure. Man **11**:1–17

Isbell L. A., Contest and scramble competition: patterns of female aggression and ranging behavior among primates. 1991. Behavioral Ecology **2**:143-155

Kappeler, P. M. 2010. Animal Behaviour: Evolution and Mechanisms. Heidelberg Germany Springer.

Kotrschal, K., I.B.R. Scheiber, and K. Hirschenhauser. 2010. Individual performance in complex social systems: the graylag goose example. Animal Behavious: Evolution and Mechanisms. Heidelberg Germany Springer 119-148

Pulliam, H. R., and T. Caraco. 1984. Living in Groups: Is there an Optimal Group Size? In J. R. Krebs, & N. B. Davies (Eds.). Behavioural ecology: An evolutionary approach (2nd ed., pp. 128-130). Sunderland, Mass: Sinauer Associates

Schuiling, G.A. 2003. The benefit and the doubt: why monogamy? Journal of Psychosomatic Obstetrics and Gynecology **1:**55-61.

Siddique M., M. Mushtaq-ul-Hassan, and M.A. Beg. 1993. Breeding behaviour of Common Myna (Acridotheres tristis). Pak. J. Agri. Sci. **30**:337-342.

Wasserman, S. and K. Faust. 1994. Social Network Analysis: Methods and Applications. New York: Cambridge University Press.

Wey, T. W., and D. T. Blumstein. 2010. Social cohesion in yellow-bellied marmots is established through age and kin structuring. Animal Behaviour **79**:1343-1352.

Wilcox, R. S. 1984. Male copulatory guarding enhances female foraging in a water strider. Behavioral Ecology and Sociobiology **15**: 171-174.

Verbeek, M., A. Boon, and P.J. Drent. 1996.Exploration, aggressive behavior and dominance in pair-wise confrontations of juvenile male grate tits. Behaviour **133:**945-963.

## APPENDIX A

A pair of *Acridotheres tristis* photographed at the Gump Station, a piece of baguette bread between the two birds. Photo by J. Hurley.

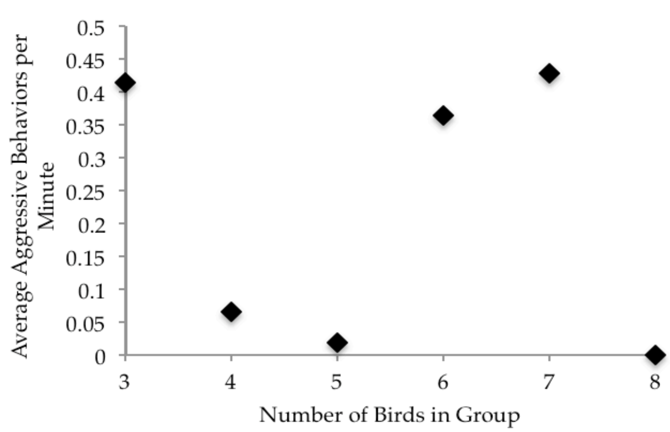
**APPENDIX B**

Ethogram used to define behaviors observed in *Acridotheres tristis*

| Behavior Grouping | Behavior Name | Behavior Description |
|---|---|---|
| Aggressive | Chasing | Running or flying towards another bird |
| Aggressive | Flapping | Flapping wings at another bird |
| Aggressive | Pecking | Beak pecking at another bird |
| Aggressive | Biting | Beak opening or closing at an organism |
| Flight | Flying | Flying at a medium elevation wings flapping |
| Flight | Diving | Flying down towards the ground |
| Ground Movement | Walking | Walking at medium pace |
| Ground Movement | Running | Running at a fast pace |
| Stationary | Sleeping | Legs folded under body, head under wings |
| Stationary | Resting | Sitting or standing, not moving |
| Stationary | Preening | Using beak to move feathers, cleaning beak |
| Vocalizing | Calling | Calling out |
| Vocalizing | Singing | Calling out with a melody |
| Vocalizing | Crackling | Low pitch crackling noise |
| Vocalizing | Squawking | Loud, repeated yells |
| Foraging | Scanning | Head moving and looking around |
| Foraging | Eating | Pecking at ground, food in beak or swallowing |
| Mating | Copulation | Physical contact of genitalia |
| Mating | Crouching | Mating stance, shivering, crouching, mounting |

**APPENDIX C**

Effect of Group Size on Aggression




Appendix C: Linear regression showing effect of group size on aggression. No relationship between group size and aggression was seen. (Linear Regression, DF=79, $R^2$=0.02703, p<0.258