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The Effect of Aposematic Coloration on the Food Preference of Aphelocoma coerulescens, the Florida Scrub Jay

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by

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Contents

Abstract

Aposematic coloration, commonly observed in noxious organisms, serves as a warning to predators to avoid attacking specific prey. This coloration is conspicuous in nature, with one of the most common examples being a red and black pattern. The plant *Abrus precatorius* exhibits this warning signal in its seeds, which resemble lady beetles and contain the concentrated toxin abrin. *Aphelocoma coerulescens*, an endemic and federally threatened bird in the state of Florida, shares a similar distribution with *Abrus precatorius*, making interaction between the two species possible. Using an edible model of the *Abrus* seed, this potential interaction was tested in Martin and Palm Beach County populations of *Aphelocoma coerulescens* by presenting a red and white seed to individual scrub jays to determine whether they showed a preference for or avoidance of the red model seed. Results showed a significant tendency by the birds to prefer white over red, indicating that the color, independent of other warning signals, functions aposematically to discourage predation of *Abrus precatorius* seeds.

Introduction

I. Description of Aposematic Coloration

Aposematic coloration is an interesting phenomenon, characterized by the conspicuous coloration of potentially harmful or noxious organisms. Also called warning coloration, this unique patterning of external appearance serves to defend an organism through advertisement of its offensive or hazardous traits (Speed 2000). Color as a defensive mechanism in nature is appealing to study because, though frequently observed, it is unusual in that it functions in a variety of seemingly opposing ways. For example, camouflage, or crypsis, of organisms commonly occurs as protection against predation by blending the potential prey against its natural background. Unlike crypsis, however, aposematic coloration and its generated protection rely on the obvious appearance of an organism against its background.

Why have some organisms evolved this higher visibility? The answer lies in the function of the long-term memory in predators (Speed 2000). When a predator comes in contact with unpalatable or harmful prey for the first time, it will likely have a nasty experience. To avoid repetition of such incidents, it is helpful to the individual predator if it can remember something about the prey to aid recognition in the future. Conversely, it is helpful to the survival of the whole prey species if the predator avoids future encounters; fewer prey will be removed from the gene pool. Conspicuous coloration of the prey reinforces this avoidance learning in predators by providing a memorable signal to associate with the experience. Future sightings of prey bearing the same, or even just similar, aposematic coloration then stimulate memory jogging in the predator, causing it to remember the previous encounter and avoid the prey (Speed 2000).

II. Evolution of Aposematic Coloration

The evolution of aposematic coloration and the interactions between predators and aposematic prey are not clearly understood. However, according to Speed (2000), it is likely that the learning abilities and memory of predators may have contributed to the success and evolution of the bold appearance of noxious prey. Without the ability of predators to recall experiences, warning coloration would serve no adaptive purpose because each encounter would trigger an independent response – a response based on no previous knowledge. Another factor that may have contributed to the adaptive value of aposematic coloration is the aggregation of aposematic prey. It is expected that a predator would have readily attacked a solitary conspicuous individual due to its visibility (Alatalo and Mappes 1996). Distaste for the unusual individual would not have contributed to avoidance learning because there were no other examples of the conspicuous prey to immediately avoid. This absence of repetitive encounters would have mitigated the effects of avoidance learning, providing no evolutionary benefit to the prey species. Aggregation of aposematic prey, on the other hand, would have resulted in predator attack on the prey, rejection based on the unpalatable nature of the prey, and association of that individual with the surrounding group. Thus, the result would have been abandonment of the group for different prey, leaving the brightly colored survivors to pass on their genes and increase the frequency of warning coloration within their species (Alatalo and Mappes 1996). As emphasized by Shettleworth (2001) in a review of animal cognition and behavior, both aggregation of aposematic prey and learning response of predators seem to have played related roles in the advancement of aposematic coloration.

III. Examples of Aposematic Coloration

Observations in nature have played a significant role in understanding and identifying the aposematic predator-prey interactions that exist. A specific example of functioning aposematic coloration in nature is seen in the South American arrow-poison frog. This frog has a bright red and black skin pattern that functions as a warning of its toxicity. After an unpleasant encounter with this frog species, the predator associates the distinct skin coloration with the experience and avoids the frog in the future (Fogden and Fogden 1974). Another example in nature is the monarch butterfly. This butterfly feeds on milkweed, which contains cardiac glycosides. After metamorphosis, the adult monarch retains the glycosides, making it unpalatable. Bright orange wings with black veins serve as warnings to predators. Those that attack the monarch soon learn to avoid the orange and black pattern in future encounters (Kricher 1997). In addition to the monarch butterfly, many other insects, such as the yellow jacket with its yellow and black striping, also elicit avoidance by predators using similar aposematic signals (Beiswenger 1993).

Scientific studies have provided additional information about aposematic signals by examining which specific colors or color combinations commonly elicit avoidance in predators. A study of food preference in frugivorous birds showed that red and black foods were rarely favored by the birds, even though these colors are frequently seen in bird-dispersed fruits (Willson, et al. 1990). Another study involving food preference of birds, specifically northern bobwhite hens, showed that feeds dyed red, orange, blue, and blue-green were commonly avoided (Mastrota and Mench 1994). It was also noted that the hens became habituated to the blue and blue-green dyed feeds after about five days, while they continued to avoid the orange and red, indicating that there was a greater aversion to the latter colors.

In contrast to the evidence provided by these observations and studies, it is important to note that all conspicuous coloration is not necessarily functioning alone to detract predators. Some interactions that appear at first to be the result of aposematic coloration may rely on a combination of signals. For example, in a study by R.W. Whitmore and K.P. Pruess (1982) of pheasant chick response to lady beetles, Coccinellidae, chicks who ingested an unpalatable lady beetle avoided the same type of lady beetles in future encounters, indicating initially that color may have played a role in that avoidance. However, palatable bean leaf beetles, which bear red and black markings similar to those of lady beetles, were not avoided, even after the chick had encountered the unpalatable lady beetles (Whitmore and Pruess 1982).

IV. *Abrus precatorius* – Potential Aposematic Prey

Abrus precatorius, also known as rosary pea or crab's eyes, is a vine-like plant characterized by the presence of small seeds (6-7 mm long) that are bright red with black bases (University of Florida 2002). Small groups of *Abrus* seeds develop in pods that open by early March and begin to drop seeds by late May. These seeds, often called jequirity beans, are highly poisonous and contain the concentrated toxin abrin. If a seed is swallowed whole, it is probable that the seed will pass through the body unnoticed. When ingested by birds, however, the jequirity beans may be swallowed whole but are ground in the gizzard, resulting in release of the toxin into the body. If chewed or the seed coat is penetrated, even one seed is enough to kill most organisms, including adult humans (Hostetler 2001). When the seeds are ingested and the hard shell coat is broken through mastication, abrin is released into the subject, causing severe gastroenteritis followed by coma and death (Hostetler 2001). Within the seed, there are two forms – a and b – of the toxin, and each form is composed of an A and B chain. Once ingested, chain B stimulates abrin to bind to cell membranes, moving the complex with chain A into the cell cytosol. Chain A then removes adenine from positions 4 and 324 of a specific (28S) rRNA, deactivating ribosomes and inhibiting protein synthesis (Patocka 2001). Considering this incredibly noxious nature of the seeds and their striking color pattern, it seems evident that their color could function as a deterrent to approaching organisms, although the specific predator that might be responding to the signal is unknown.

V. *Aphelocoma coerulescens* – Potential Predator

Aphelocoma coerulescens, commonly called the Florida scrub jay, is a nationally classified threatened species of bird endemic to the state of Florida. In 1993, this species was estimated to have lost 90 percent of its original population, resulting in fewer than 4000 breeding pairs remaining throughout its habitat. This decline has been most directly attributed to the rapid loss and destruction of the state's oak scrub habitat, which is essential to the survival of the birds (The Nature Conservancy and Audubon of Florida 2001). Scrub jays prefer to live in habitat characterized by low-growing shrubs, which serve as protection against nest predation from above, and ground that is 15-20 percent exposed sand, a property of the land that allows the birds to cache foods with little difficulty. This habitat preference limits the areas that can sustain scrub jays to only seven locations along the Coastal Ridge of Florida (The Nature Conservancy and Audubon of Florida 2001).

Scrub jays practice a unique behavior called cooperative breeding, in which offspring remain with the parents and share the responsibilities of gathering food and caring for the next season's young. Only when they find a mate do they leave the cooperative breeding unit to begin one of their own. They commonly feed on a wide range of food sources that varies according to whether or not it is the breeding season. During non-breeding months, the species feeds primarily on large acorns, seeds, fruits, and nuts, many of which are stored earlier in the season. Their diet is expanded during the breeding months between March and June to include small insects and invertebrates as well as bird eggs and nestlings of other species (Ehrlich et al. 1988). This diet indicates that *Aphelocoma coerulescens* shows interest in seeds and legumes and, therefore, would possibly respond to the warning signals of noxious seeds like those of *Abrus precatorius*.

VI. The Study – Potential Aposematic Coloration Predator-Prey Interaction

This research focuses on ideas similar to those presented earlier: namely the avoidance of red and black color patterns by predators and the association of those patterns with potential danger. However, the present study deals with an interaction that has not been evaluated: that is, the interaction between *Abrus precatorius* and *Aphelocoma coerulescens*. Both species have comparable distributions throughout Florida, making the likelihood of contact with each other plausible. The study examines the effect that red and black color patterns, similar to those of the aposematic jequirity beans, have on the food choice of scrub jays. Through the use of constructed model seeds, it assesses the interaction based on color alone, with no other interfering signals. This detail, combined with known information about aposematic color signals and their functions, makes it is possible to predict the responses of *Aphelocoma coerulescens* and to interpret the significance of those responses. If the birds avoid the red and black patterned model seeds, it serves as an indication that the same aposematic color pattern in *Abrus precatorius* is a sufficient signal to warn predators not to attack. If, on the other hand, the birds do not discriminate against the red and black seeds, it suggests that the color pattern does not autonomously evoke avoidance, but depends on a combination of other signals. Thus, this research is designed to determine if the coloration of *Abrus precatorius* is aposematic.

Materials and Methods

For the first portion of the study, potential scrub jay sites were surveyed in Palm Beach County and Martin County, Florida. Information about local scrub jay nesting sites was obtained at a lecture, given by the director of The Nature Conservancy's Lake Wales program, on the habitat of the Florida scrub jay. Based on conversations with both the director and local Martin and Palm Beach County residents, I compiled a list of sites where the species had frequently been observed. Over a period of four days, from March 13 through March 16, 2002, I visited the sites and documented the number of scrub jays seen as well as the presence or absence of *Abrus precatorius* in the nesting area. This was important to note because it placed the two species in close proximity to each other, indicating that the birds could regularly view the beans of *Abrus precatorius* during daily activities. Also during this time, I began looking for a model bean to present to the birds during trials. Using a sample of the bean obtained from my supervising professor, I matched the size and shape of the bean to an edible substitute. I finally chose to use navy beans and sorted through the beans, setting aside those that were closest in appearance, with the exception of color, to the jequirity bean. I then presented the beans, through hand feeding, to the scrub jays at one of the potential sites to determine whether they showed any interest in the food prior to alteration for the actual experimentation. Acceptance of the bean was essential to establishing a favorable control for the study.

The second portion of the research consisted of creating the jequirity bean mimics. Creation of the model beans proved to be, perhaps, the most difficult task of the entire experiment. The difficulty arose when attempting to find a non-toxic dye that would adhere to the waxy coat of the navy beans. I first tried painting the beans with red-orange children's finger paint, but the water in the paint caused the bean skins to wrinkle, eliminating the smooth surface necessary to mimic the jequirity beans. The next attempt involved dipping the beans in dyed paraffin. The paraffin was melted in a metal pot over a stove burner and red-orange tempura paint was added to give it color. Straight pins were stuck into the ends of the beans and they were hand-dipped, like candles, into the wax. When they were removed from the wax, they were smoothly coated but with no color. Because paraffin is non-polar and tempura paint is water based, the two would not mix. Thus, I had to find a dye that would mix with the paraffin. The problem with this was that most oil-based paints are toxic because they contain heavy metals. The solution to this problem came unexpectedly when my father made a comment about how I, as a child, chewed on crayons. I then gathered several red-orange Crayola crayons and melted them in a metal pot as done previously with the paraffin. Beans were dipped as before using straight pins. I found that if the melted crayon were too hot, the crayon would slide off of the beans before hardening. To solve this problem, the crayon wax was brought to a boil and allowed to cool for approximately 30 seconds before dipping the beans. The beans were placed on wax paper to dry and were left for about an hour. After drying, the black ends were painted using non-toxic water base finger paint. The controls were prepared by dipping beans, using the method described above, in clear paraffin. This gave both types of beans a synthetic waxy coat.

After the model beans were finished, I again traveled to Florida, this time to conduct the first set of trials. This portion of the study was conducted from May 19 to May 24, 2002, during the early nesting period of the scrub jays. I chose to hand feed the birds after observing that some have an unusual affinity for human contact. There were four sites identified by location near landmarks, including parks and roads. The first site was located near a walking trail at Carlin Park in Palm Beach County. At this site, one breeding pair of scrub jays was located. This was expected, as breeding jays tend to be very territorial when nesting. Territorial behavior is typically directed at conspecifics. The female was chosen as the first test subject, while the male was excluded from the study because he was being treated by local bird watchers for an illness called pock. The second site was situated off the intersection of County Line Road and Old Dixie Highway in Palm Beach County. As with the Carlin site, only one pair of jays was found nesting at that site. The next pair of scrub jays was found at Site 3, which was a scrub land plot on St. Jude Drive in Palm Beach County. The fourth and final site for the first set of trials was in Martin County off County Line Road. This site, added two days before the last scheduled sampling day, was unlike the others in that it had the most natural habitat. This particular piece of land bordered part of Jonathan Dickenson State Park and consisted of denser scrub forest. Also unique for this site was the presence of five scrub jays. Two made up a single male-female breeding pair as seen at the other sites, while the remaining three showed behavior demonstrating the cooperative breeding unit. Two of the three made up the breeding pair, while the third, likely one of their offspring from the previous season, assisted in defending the territory.

Weather permitting, the trial data for this study was collected during morning and late afternoon "cool down" periods. Morning field experiments were performed between 7:00 a.m. and 10:00 a.m. Afternoon experiments were performed between 4:00 p.m. and 6:00 p.m. Trials were conducted by placing two beans, one red model and one white control, in the palm of either my hand or that of my field partner. The hand was then raised at or slightly above eye level, fully outstretched. After a bean choice was made by a scrub jay, two new beans were placed in the hand. During trials, bean location in the hand was varied to eliminate the possibility that the birds chose based on a preference for moving the head in one direction over another. Each trial was counted as one repetition. I assumed each trip to the hand was independent and thus a new response from the bird. Trials were scored either "red" or "white", depending on which bean a jay chose. A successful trial was determined based on a jay's removal of the bean from the hand, not ingestion of the bean on site. Because scrub jays commonly cache their food, removal of the bean was sufficient to display a preference for the food source.

The second set of trials was conducted later in the summer, from July 28 to August 1, 2002. This was during the end of the breeding season and after the main nesting period. The procedure for gathering data was altered due to a lack of response to hand feeding by several of the birds during the first trials. After evaluating the behavior of the birds during the May study, a more efficient testing procedure was developed using a clear plastic tray divided into four separate sections. The edges and dividers of the tray served as perches for the scrub jays during feeding. Also during this trial set, I decided to eliminate sites used previously that exposed the jays to frequent human interaction and activity. It seemed that this exposure caused the jays to do one of two things. In busy areas near streets, the birds would not interact at all, and in park areas, the birds were too accustomed to being fed by humans to show caution of choice when presented a food source. The sites used during this portion of the study were the Martin County site, used during the last two days of the first trials, and a new site at Juno Beach off of US Highway 1 in Palm Beach County. This site was chosen based on information obtained from a local resident. Juno Beach happened to be the site of a large scrub jay habitat restoration project. Because access to the land was limited, I was able to locate only one family unit of scrub jays that was comprised of an adult male, adult female, and four juveniles which were too young to sex. Sampling periods were during the same times as the first study – morning and late afternoon. This time, the tray was placed on the ground, allowing the natural sandy substrate to serve as a background against which to place the beans. A red bean and white bean were placed in each of the four sections of the tray. Since the birds approached and observed one section of the tray at a time, each individual section was a potential trial. When a scrub jay chose a bean from a section, the remaining bean was discarded, and two new beans were placed in the tray section. Again, as in the earlier study, the positions of the beans in the section were varied.

After all trials were completed and choices were scored, the results were analyzed using the Chi Square One Sample Test for Goodness of Fit and the Chi Square Test for Independence between Two or More Samples. The first test was based on both sets of trials, including all jays, and then on the family unit of the second set, excluding the trials from the Martin County site. The observed numbers were compared to the expected numbers based on the assumption that, with no preference taking place, there is a 50 percent chance that red beans will be chosen and a 50 percent chance that white beans will be chosen. Chi square values were calculated and compared to appropriate critical values to determine significance and rejection or acceptance of the null hypothesis, which stated that there is no significant difference between the expected and observed numbers of model aposematic beans chosen by *Aphelocoma coerulescens*. The second test was based on the second trials, first with all jays and then with only the members of the family unit. This test assessed whether there was a difference between the response of juveniles and the response of adults. A Chi Square One Sample Test for Goodness of Fit was used to test the null hypothesis stating that there was no significance between the number of model aposematic beans chosen by adults and juveniles of the species *Aphelocoma coerulescens*.

Results and Discussion

In the first set of trials, the female scrub jays were the only individuals to participate in the study. Males were regularly seen in sentinel positions at high points above or near the nests of their young but would not fly down to gather food. It appeared that, by the males fulfilling this job, females were free to look for food without risking the safety of their young. Figure 1 shows the bean color choices for each adult female. As depicted in the figure, the most interactive female (i.e. the one from which the most trials were obtained) was Adult 1 at the Carlin Park Site. She participated in 17 trials, 13 of which resulted in a white bean choice and 4 of which resulted in a red bean choice. Adult 2 at the St. Jude site participated in 4 trials, all of which showed a white bean preference. Adult 3 at the Old Dixie Hwy./County Line Rd. site participated in 3 trials, all of which also favored white beans. At site 4, County Line Rd. in Martin County, none of the scrub jays would approach. This was likely attributed to the fact that this site is more secluded than the other sites and provides little opportunity for regular human interaction. On the other hand, Adult 1 at Carlin Park seemed to show an unusual affinity for hand feeding. This began to create a problem during the study because she was willing to eat anything that was offered. On four occasions, trials had to be discarded because she took both beans in her beak at once, indicating no particular preference in those cases. Adults 2 and 3, on the other hand, were wary of hand feeding, resulting in a low number of trials for the same amount of effort as that put into the trials obtained from Adult 1. Unlike Adult 1, however, Adults 2 and 3 made no red bean choices, indicating no preference for that color, though to gain a more accurate understanding of their preference, more trials would be needed.

Because from the first trial the Chi Square value of 10.7 was higher than the critical value of 3.84, as shown in Table 1, the null hypothesis was rejected, supporting that there is a significant difference between the observed and expected number of model aposematic beans chosen by *Aphelocoma coerulescens*. This means that the total number of red beans chosen was significantly smaller than expected indicating a preference for white beans and an avoidance of red.

In the second set of trials, both adult males and females, as well as juveniles, served as subjects in the study. Unlike during the first portion of the study, males were not as diligent sentinels as earlier in the breeding season. This was likely due to the fact that the young were now able to fly and forage on their own and, therefore, did not require as much protection. One thing to note, however, was that the adults at the Juno site came down to the tray to feed first. After a few trials, they then flew to a nearby tree and called to the juveniles who came from within a dense shrub and began to feed from the tray. After that point, the adults no longer came to feed. Figure 2 shows the bean choices for each of the scrub jays in the second set of trials. As seen in the figure, white beans were more frequently chosen by all of the birds. The Juveniles 1 and 3 each chose 11 white beans and 1 red, while Juveniles 2 and 4 chose white beans only. Adult 1 chose 9 white beans, while Adult 2 chose 6. Neither adult chose any red beans. At site 2 in Martin County, an adult pair was observed with three juveniles. In contrast to the first visit to this site in May, there were no longer two groups of jays in July. May observations had revealed several violent interactions, including vocal threats and physical intimidation, between the two breeding units. Apparently, the three-member unit had chosen to find a new territory, perhaps due to their being forced out by the other unit. Of the remaining jays, only the male adult interacted during the study. The female adult and juveniles resided within the densest part of the scrub forest during my visits and observed from a distance. Several times, though, the male would make a selection and take it to the spectator jays, returning after delivery to make another choice. As shown, the male chose 18 white beans and no red.

The Chi Square Test for Goodness of Fit indicated that the null hypothesis again be rejected. Also, due to the fact that only the juveniles chose red beans, the food preference of juvenile as opposed to adult birds was examined. This was done using the Chi Square Test of Independence. Results of this test indicated that the age groups were not independent of each other and showed similar preferences. If the test had shown independence, it might have suggested that the birds learn from experience as they age.

Considering the entire study, the best representation of the data was shown through the interactions of the family unit at Juno Beach in July. This site provided the most biologically meaningful sampling because it involved the response of all birds present at the site. Other sites provided interactions with single birds, only yielding less complete data for those sites. Because of the nature of the family interactions, both chi square tests were run using only the data from the members of the family unit. Those results are shown in Tables 4 and 5. These results indicate (1) that there is a significant preference for white beans and (2) that the adults and juveniles within the family do not function independently of each other.

Figure 1 Relationship between the number of red beans and white beans chosen for each scrub jay from the first trials, using hand feeding method.

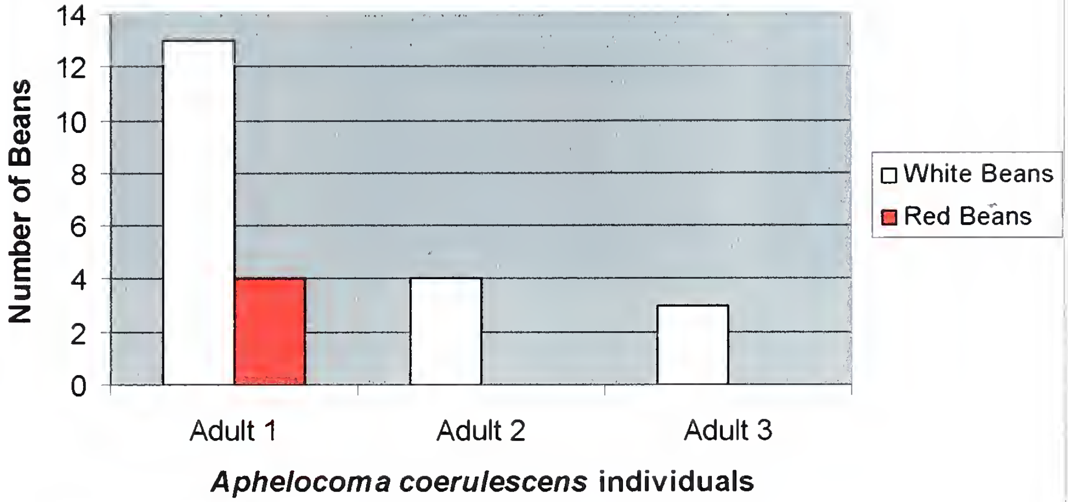

Figure 2 Relationship between the number of red beans and white bean chosen for each scrub jay from the second trials, using tray feeding method.

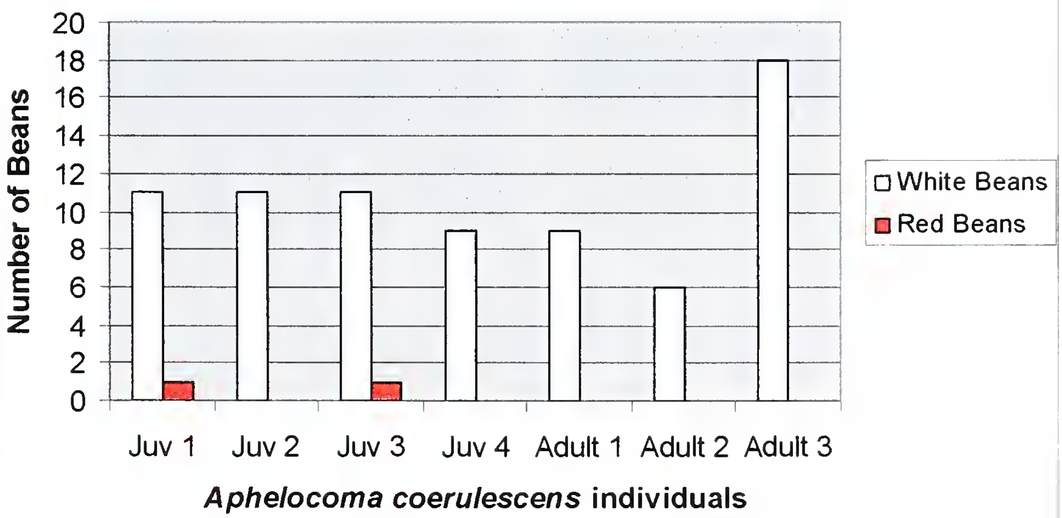

Table 1 X^2 One-Sample Test for Goodness of Fit for first trials.

	Red	White
Observed	4	20
Expected	12	12
X^2	10.7	
Df	1	
Critical Value	3.84	

Table 2 X^2 One-Sample Test for Goodness of Fit for second effort, including all scrub jays.

	Red	White
Observed	2	75
Expected	38.5	38.5
X^2	69.2	
Df	1	
Critical Value	3.84	

Table 3 X^2 One-Sample Test for Goodness of Fit for second trials, cooperative breeding unit only.

	Red	White
Observed	2	57
Expected	29.5	29.5
X^2	51.3	
Df	1	
Critical Value	3.84	

Table 4 χ^2 Test of Independence between Two or More Samples for second trials, including all scrub jays.

		Red	White	Row Totals
Adults	Observed	0	33	33
	Expected	0.86	32.14	
Juveniles	Observed	2	42	44
	Expected	1.14	42.86	
Column Totals		2	75	77
X^2	1.54			
Df	1			
Critical Value	3.84			

Table 5 χ^2 Test of Independence between Two or More Samples for second trials, family unit only

		Red	White	Row Totals
Adults	Observed	0	15	15
	Expected	0.51	14.49	
Juveniles	Observed	2	42	44
	Expected	1.49	42.51	
Column Totals		2	57	59
X^2	0.71			
Df	1			
Critical Value	3.84			

Conclusion

Based on the evidence provided in this study, it appears that there is a significant tendency of *Aphelocoma coerulescens* to avoid red and black color patterns, similar to those displayed by the beans of *Abrus precatorius*. This information supports the previously stated idea that the aposematic coloration of *Abrus precatorius*, independent of other possible warning signals, serves as a warning to predators to who might otherwise choose them as a food source. It also presents questions addressing the direct evolutionary relationship between the coloration of the jequirity bean and the response of *Aphelocoma coerulescens*. Because the jequirity bean is noxious enough to kill during the first ingestion by the predator, there is no opportunity for avoidance learning to take place, not in the lifetime of that individual at least. One possible explanation for this is that the beans of *Abrus precatorius* have evolved to mimic other noxious organisms with the same color pattern, perhaps lady beetles. This is plausible because it explains how *Aphelocoma coerulescens* could learn to avoid the bean without a fatal consequence. This only works, however, if the bird encounters the lady beetle prior to encountering the bean. However, the fact that juveniles in this study did not show a significantly different response than the adults supports the hypothesis that they do not rely on direct experience with the aposematic signal to develop an aversion to the red and black color combination. If they did rely on that interaction to learn avoidance, the young birds would not discriminate against the color at as great a frequency as the adults, resulting in a significantly higher number of red bean choices. Another possible explanation for the relationship is that, through witnessing the death of other predators after ingesting the bean, *Aphelocoma coerulescens* has developed an adaptive internal instinct to avoid the jequirity bean. This indicates that *Aphelocoma coerulescens* has evolved an innate aversion to *Abrus precatorius* by being born with the aversion.

Though the explanation for the evolution of the specific relationship between *Aphelocoma coerulescens* and *Abrus precatorius* is not exactly known, there is sufficient evidence provided by this study to support that an aposematic predator-prey relationship does exist between the two species.

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