Avian use of Porcelain berry (*Ampelopsis brevipedunculata*) on the Purchase College SUNY, Campus

by

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Abstract- In an increasingly anthropogenic world, local wildlife species face new environmental changes and challenges, one of them being the introduction of multiple new species of plants and animals that may act as food sources. These nonnative food sources can become invasive and may cause the reduction of the native species that were there originally. In the northeast region, a common invasive species is the *Ampelopsis brevipedunculata*, otherwise known as the Porcelain berry. This invasive is dominant at the Purchase College, SUNY campus in Westchester, New York. I was interested in how bird species on campus use Porcelain berry during the fall season. Over a period of eight weeks, I observed three sites containing Porcelain berry at high, low, and median heights, and recorded bird usage and activity (n= 24). Upon seeing birds present in sites with dense Porcelain berry cover, I captured birds to obtain fecal samples to do stable isotope analysis, to determine whether the birds were eating them. From Oct 21 to 22 2022, I collected fecal matter from 14 birds overall: *Passer domesticus* (House Sparrow), *Cardinalis cardinalis* (Northern Cardinal), *Melospiza melodia* (Song Sparrow), *Haemorhous mexicanus* (House Finch), *Baeolophus bicolor* (Tufted Titmouse), *Setophaga coronata* (Myrtle Warbler), *Zonotrichia albicollis* (White-Throated Sparrow). I also collected Porcelain berries from each low, median, and high sites (3 sites), along with 4 general species of insects (beetles, stinkbugs, crickets, spiders), and three of the main ingredients in the bird seed used on campus (corn, sunflower seed, millet). All of these were evaluated for ^{13}C and ^{15}N to reconstruct the food web of what the birds were eating. Finding support that birds are eating these berries could lead to further research about their nutritional quality and the health benefits of other non-native plant species that local wildlife may feed on. Because the carbon signature of Porcelain berries was similar to that of other native species, I was unable to use stable isotope analysis to determine whether birds were eating Porcelain berries. Due to their high volumes throughout the region, it is likely that a bird will eat a Porcelain berry at some point, especially if it is the only berry option available, making it important to continue research on the potential health benefits or risks the species may pose to local wildlife who may consume it. Unexpectedly, I was able to determine a unique ^{15}N signature for millet and corn from the bird food, which could be used in future studies to understand how birds rely on anthropogenic food sources.

Keywords: Porcelain berries, Stable Isotopes, Biodiversity, Invasive Species

Introduction

Throughout history, trade has carried novel resources such as plants and animals from one place to another, establishing populations of species in environments they would have never been, causing challenges for both the introduced species and the native species with which they interact. Plants have been introduced in various locations around the world, and many tend to outcompete the native plants around them, leading them to be called “invasive species”. Invasive species are a common topic in the world of environmental science and are defined as any species which is nonnative to its present location, causes harm to either the environment, humans, or the economy, and/or outcompetes other species to become the dominant species in the area (Federal Register, 1999). In the face of anthropogenic climate change, many people are concerned about the loss of biodiversity in their local communities and throughout the world, and what it might mean for the future of human health and the health of the planet. The preservation of biodiversity

is an important tool in mitigating the harmful effects of climate change, such as species extinctions, which could disrupt the way the planet provides its' ecosystem services (Pimm., 2021).

It is important to study the potential effects these invasive species may have on local ecosystems. Plants vary in their nutritional composition, and many contain different concentrations of macronutrients such as fats, carbohydrates, and proteins, as well as secondary compounds such as saponins and tannins. The domination by an invasive species almost always means the diminishment of one or more other native species (Gallinat et al., 2020), which means that previously available food sources may no longer be available for local wildlife to consume. It is important that studying the health effects of invasive species be a main priority in invasive species management, because while many invasives may be prevalent, not all of them will be as dangerous to the health local communities as others. Some invasives may even offer ecosystem values, and knowing which species are more important to manage can be aid agenda setting for management options (Gallinat et al., 2020).

The Porcelain berry *(Ampelopsis brevipedunculata*; Fig. 1) is a common species in the Northeast Region. Originally from Japan, it was brought to America primarily for its beautiful colors and as an ornamental plant (Young, J., 2009). This species has adapted very well to its' new environment, using its vine-like features to cover entire bushes, climb trees, and cover forest floors, and is considered to be highly invasive. Little is known about the nutritional content of the berry, for example whether it may be harmful to any animals who eat it. At Purchase College, SUNY campus, the Porcelain berry is widespread.

Birds, the focus of the study, are known to choose their food sources based on the macronutrients, secondary compounds, and how easy they are to consume. For example, they usually prefer high profitability foods; foods high in protein and fats, yet easy and fast to consume and digest. Birds commonly eat berries, nuts, seeds, and arthropods, but will eat whatever is available when stocks of preferred foods become low (Ehrlich et al., 1988). Birds are also highly intelligent and know how to avoid certain secondary compounds such as tannins or saponins that may be detrimental to their health (Molokwu et al., 2011).

Since berries are a common part of avian diets, I set out to confirm whether the birds on our campus are eating Porcelain berries using field observations and stable isotope analysis of fecal samples (Kelly, 2000). With access to insects, berries, bird seed, and anthropogenic waste, it is likely that the birds on our campus consume various amounts of different foods, but with such a high concentration of Porcelain berries right near a large feeder at the Native Plant Garden, I suspect these berries have made their way into the diets of local birds. My goal is to observe and confirm the presence of our local bird species at Porcelain berry sites and use stable isotope analysis of avian fecal matter to find evidence that they are being consumed.

Figure 1. Images of Porcelain berries taken during the observation period.

Methods

*Study Site***.** The first step in assessing if birds were eating the Porcelain berries was observing their presence at sites with high densities of berries (Fig. 2). I set up three observation sites with high Porcelain berry coverage at different heights, low (0-1m), median (1m-3m), and high (3m+), located near the Native Plant Garden on the northern side of campus (Fig. 2). Each site was measured ten meters across and five meters back into the vegetation and marked with flags to standardize the field of view for observations. From September 15, 2022, to November 11, 2022, I periodically observed bird usage at each of the three sites for the same amount of time per day, at various times of day, for a total of 8 observation days (n=24; Table 2). I used binoculars to observe and identify the species of birds seen at each site. On each observation day, I collected berries from around each area at low, median, and high locations and froze them for later analysis.

Figure 2. A map of the study location for this project, located in the Native Plant Garden at SUNY Purchase College; including three observation sites, two mist net sites, and 1 bird feeder site where Potter traps were placed below. Mist Net Site 1 was 12m across, while Mist Net Site 2 was only 6m. Each observation site was 10x5m in area and ranged in height from 0-5+ meters.

Sample Collection. The next step in assessing if the birds are eating the berries is to examine their fecal matter. From October 21 to 22, 2022, I collected fecal samples from birds using both mist netting (12x3.5m on October 21st, then 6x3.5m on October 22nd) and potter trapping (both days) (Fig. 2). Upon capture, I placed the birds in paper bags to allow them to defecate. Once or if the bird defecated, I gently scraped the fecal matter from the bag into sterile glass jars and stored them in a desiccator cabinet (Rhul et al., 2016). On October 22, using a beating sheet and an insect collector vacuum, I collected small invertebrates from Porcelain berry vines and froze them until further analysis, to preserve the chemical composition of their bodies for stable isotope analysis.

Laboratory Analysis. I first organized the frozen arthropods by general species group (spiders, crickets, beetles, and one stinkbug), washed them with deionized water, and then placed them in a dehydrating oven at 50°C in glass vials until completely dehydrated. I organized the previously frozen berries by levels of ripeness (ripe, underripe, and overripe) and washed them

with deionized water. I chose the ripest berries from each site and placed them in aluminum weighing boats to be dehydrated at 50°C from December 8 to December 12. To rule out bird feed in our stable isotope analysis, I also washed three main food sources in the bird feed used in the Native Plant Garden, including millet, sunflower seed (with husk), and corn, and dried them at 50°C from January 19 to January 23, 2023 (Rhul et al., 2020). All samples (n=24) were sent to the University of Utah's Stable Isotope Ratio Facility for Environmental Research for stable isotope analysis of ^{13}C and ^{15}N concentrations and ratios. Once the lab data was sent back to us, I used R-studio to present and analyze our data.

Results

Are birds active in Porcelain berry Sites?

We saw a total of 11 different species and 40 total birds during our observations. I caught three birds during our capture days that were not seen during the observation periods but are still common to the area and our campus (Northern Cardinal, Myrtle Warbler, White-throated Sparrow). Figure 3 is a stacked bar graph of birds observed per hour, a calculation done to standardize the numbers, as the lengths of observations varied between 15 minutes to 40 minutes per site per day, more details on the observation period can be found in Table 2. Figure 4 is a set of bar graphs showing the species observed per day for each site. Birds were most active during the month of October, even when data was standardized (Fig. 3). The high site saw the most birds overall (n=21), and the highest levels of species diversity (Fig. 4). Table 1 contains the code names for each bird in the study. Table 2 shows all data recorded during observations, as well as the species of birds caught on both capture days.

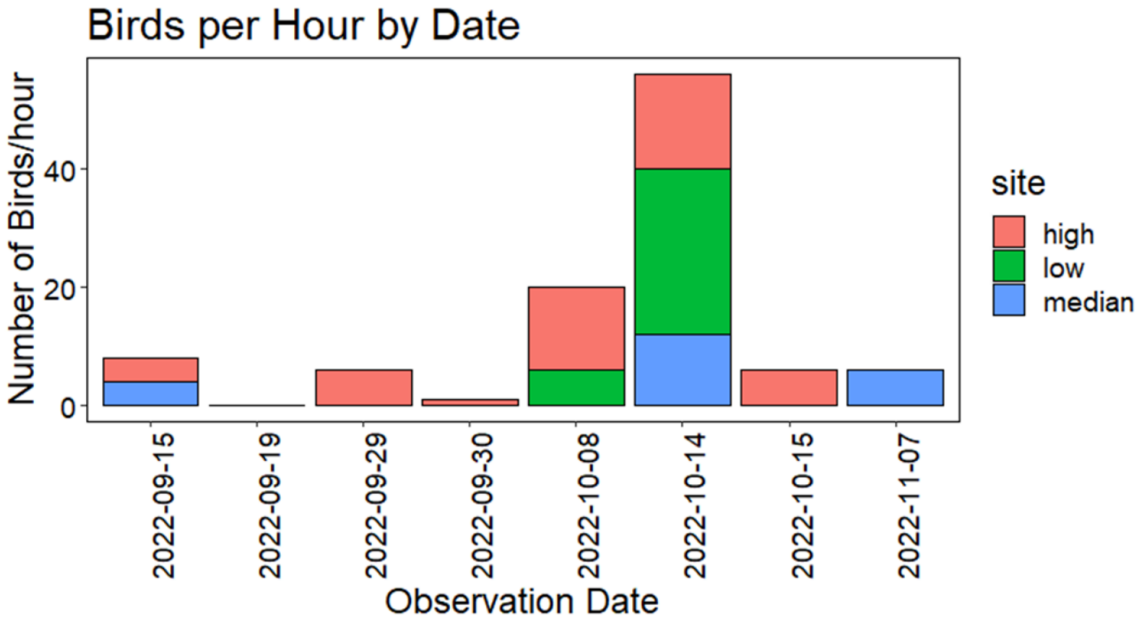

Figure 3. Number of birds observed per hour (standardized) in each site, organized by date. Since time spent observing varied by day, birds per hour has standardized the data,

showing clearly that the high site was the most visited by birds, and the month of October was most active for avian sightings at Porcelain berry sites.

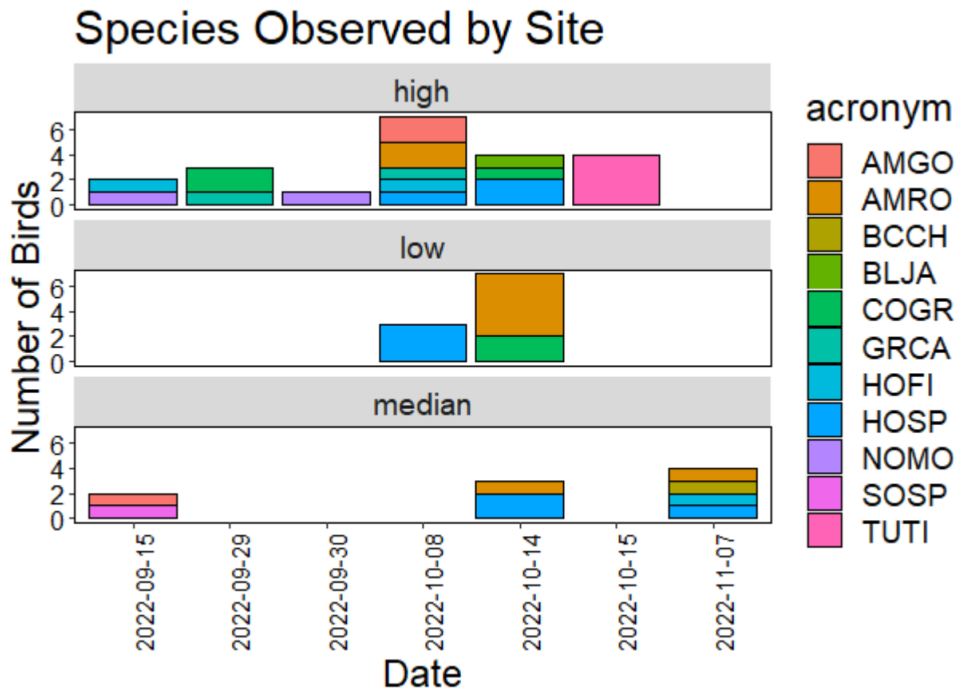

Figure 4. Species observed by site per day. The high site was the most popular for avian visits (total # birds observed= 21), followed by the low (n=10), and then median site (n=9). Highest concentrations of birds were seen during the month of October (n=28).

Table 1. Bird name codes

BIRD SPECIES NAME CODES	
CODE	SPECIES NAME
AMGO	American Goldfinch
AMRO	American Robin
BCCH	Black Capped Chickadee
BLJA	Blue Jay
COGR	Common Grackle
GRCA	Gray Catbird
HOFI	House Finch
HOSP	House Sparrow
NOMO	Northern Mockingbird
SOSP	Song Sparrow
TUTI	Tufted Titmouse
WTSP	White-throated Sparrow
NOCA	Northern Cardinal
MYWA	Myrtle Warbler

Table 2. A table containing data on the dates, times, time spent, temperature, species sighted, and general notes for each observation date and location.

DATE	SITE	TEMPERATURE	START TIME	END TIME	TIME SPENT	SPECIES	NOTES
9/15/2022	LOW	71°F	4:15PM	4:45PM	30MIN	none	berries interspersed with Goldenrod plants
9/15/2022	MEDIAN		5:30PM	6:00PM	30MIN	Song Sparrow, American Goldfinch	Lots of other species present. Including: a young Tulip Poplar tree, and Mugwort and Goldenrod interspersed throughout berries
9/15/2022	HIGH		4:50PM	5:20PM	30MIN	Northern Mockingbird, House	Berries are growing on a Callery Pear Tree
9/19/2022	LOW	82°F	12:10PM	12:25PM	15MIN	none	
9/19/2022	MEDIAN		11:35AM	11:50AM	15MIN	none	cleared some of the goldenrod and mugwort to enhance view of porcelain berries
9/19/2022	HIGH		11:53AM	12:08PM	15MIN	none	lawn mower usage by staff scares away birds
9/29/2022	LOW	62°F	11:40AM	12:10PM	30MIN	none	
9/29/2022	MEDIAN		12:43PM	1:13PM	30MIN	none	
9/29/2022	HIGH		12:11PM	12:41PM	30MIN	2 Common Grackle, Gray Catbird	lawn mower again, may be due to similarity in time of observation
9/30/2022	LOW	55°F	10:40AM	11:40AM	1HR	none	
9/30/2022	MEDIAN		1:09PM	2:09PM	1HR	none	mugwort & goldenrod persist, joined now by vervain, burnweed, and multiflora rose.
9/30/2022	HIGH		11:45AM	12:45PM	1HR	Northern Mockingbird	
10/8/2022	LOW	57°F	5:25PM	5:55PM	30MIN	3 House Sparrow	
10/8/2022	MEDIAN		4:00PM	4:30PM	30MIN	none	
10/8/2022	HIGH		4:40PM	5:10PM	30MIN	2 American Robin, 2 American Goldfinch, Gray Catbird, House Sparrow, House Finch	Bird feeder seems to be preferred location
10/14/2022	LOW	62°F	1:57PM	2:12PM	15MIN	5 American Robin, 2 Common	
10/14/2022	MEDIAN		1:41PM	1:56PM	15MIN	2 House Sparrow, American Robin	
10/14/2022	HIGH		1:25PM	1:40PM	15MIN	Common Grackle, Blue Jay, 2 House Sparrow	
10/15/2022	LOW	67°F	4:05PM	4:45PM	40MIN	none	
10/15/2022	MEDIAN		3:20PM	4:00PM	40MIN	none	
10/15/2022	HIGH		5:00PM	5:40PM	40MIN	4 Tufted Titmouse	
10/21/2022	CAPTURE DAY	62°F				4 House Sparrow, Northern Cardinal, Song Sparrow, House Finch, Tufted Titmouse, Myrtle Warbler, White Throated Sparrow	
10/22/2022	CAPTURE DAY	66°F					
11/7/2022	LOW	71°F	11:40AM	12:20PM	40MIN	none	hottest day since september
11/7/2022	MEDIAN		11:00AM	11:40AM	40MIN	American Robin, House Sparrow, House Finch, Black-Capped Chickadee	no seed in bird feeders today
11/7/2022	HIGH		10:20AM	11:00AM	40MIN	none	

Can I use stable isotopes to tell if birds are eating Porcelain berries?

I could not tell that birds were eating Porcelain berries by using stable isotope analysis of fecal and food source samples. The carbon and nitrogen signature of the Porcelain berries was too close to the signature of other native food sources, such as the common C3 plants growing due to the season, as well as invertebrates (Fig. 5). Without differentiation between food sources, I could not determine if birds were eating Porcelain berries specifically.

I did find interesting results related to the anthropogenic food source (bird seed). The nitrogen content in the bird food was higher than what is normally seen in naturally occurring corn, millet, and sunflower. Also, because millet and corn are C4 plants, their stable isotope signature was very different than what would be naturally growing during this season (Dickerson et al., N. D.). Figure 6 contains circles that encompass the general isotope signature ranges of C3 and C4 plants, and the samples that fell within them. Because of this, I can tell that certain species are focusing more on millet and corn (specifically House Sparrows). The ^{15}N of the Myrtle Warbler fecal sample is to be expected as they are predominantly insectivores.

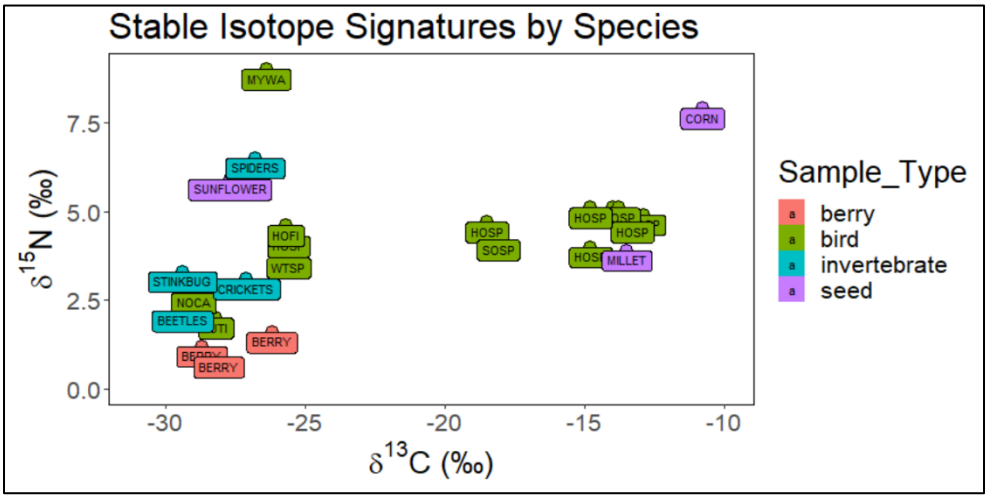

Figure 5. Stable Isotope signatures of each sample, organized by type. The three Porcelain Berry samples are labeled 'berry' and fall within the expected range of C3 plants and other berries (Van Hemert. 2012). The insects and spiders also fall within their expected isotope signature ranges; but while ^{13}C ranges were similar to expected, the ^{15}N was slightly higher than expected (Biology Dictionary.

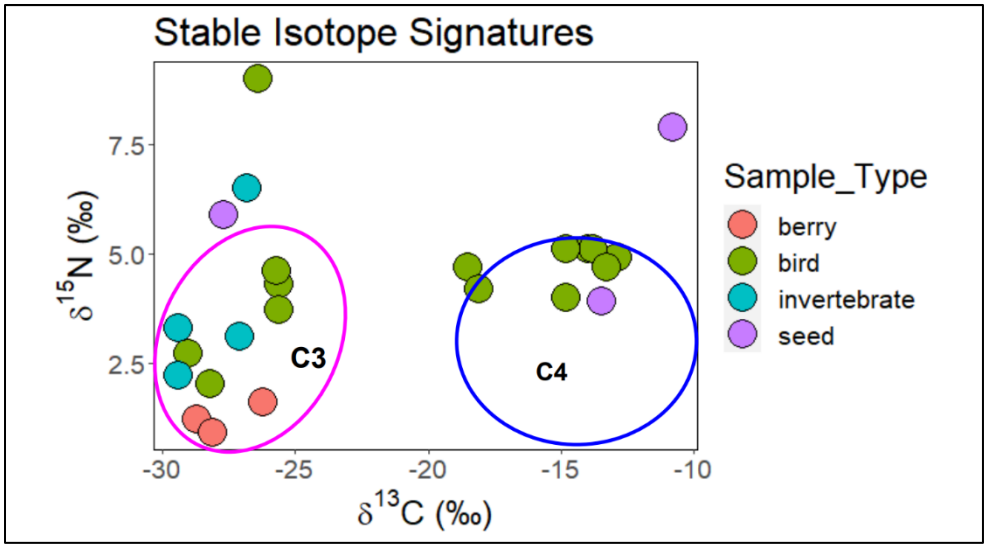

Figure 6. Results from Stable Isotope Analysis, labeled and grouped by diet source (C3 or C4 plants/wildlife). Some birds fell within the common ranges of herbivores who eat C3 plants such as berries, but I was unable to prove that birds were eating Porcelain berries specifically. Birds whose fecal isotopic signatures fell within higher Carbon content ranges are most likely to eat more bird feed than anything else, which contains C4 plants such as corn and millet. Insects are generally found within C3 ranges as well. (Van Hemert. 2012)

Discussion

Although I was not able to demonstrate that our local avian species were eating the invasive Porcelain berry, our study found important information about avian diet during the non-breeding period. Through observations, I know that many bird species are using Porcelain berry as habitat. While stable isotopes were not able to differentiate between Porcelain berries and native vegetation, I obtained valuable information about which species focus on anthropogenic food sources (millet and corn) versus those that may rely more on invertebrates or other natural food sources and will continue to use stable isotope analyses to study dietary trends and diet composition of our local wildlife.

Because the lengths of observation times were different between observation days, I standardized the data to birds per hour to account for the time differences. I was unable to tell through observation that birds were eating berries, but able to confirm their usage of sites with high concentrations of berries. Usage of these sites may be a result of other activities besides foraging, such as offering dense vegetation for nest making and avoiding predators. I suggest that future studies on this topic use trail cameras or spotting scopes to accurately confirm that birds are eating the berries, not just using the sites.

I was unable to find evidence that birds were eating the Porcelain berries at our observation sites due to its similarity in stable isotope signature to other common species that grow in the area (Van Hemert et al., 2011). The location of the Porcelain berries' isotope signature indicates that they are a C3 plant, like many other plants in the natural world and in the Northeast Region where the study was conducted. C3 plants use slow, 3 step processes in their

carbon cycles due to adequate exposure to water, while C4 plants have special functions and enzymes that preserve water loss during photosynthesis (Meacham-Hensold., 2018), which leads to a distinct difference in Carbon isotope concentrations (Basu et al., 2015). Some examples of C3 plants include spinach, berries, and rice, while C4 plants include species like maize (corn), millet, and sorghum.

Likely reasons for our inability to confirm Porcelain berry presence in the diets of avian species are: 1) bird feeders are usually preferred when present as they save the energy required for foraging, 2) the stable isotope signature for the Porcelain berry is too similar to common C3 plants in the area and therefore could not be distinguished from other berries and vegetation, and therefore was not the best choice for pinpointing such a specific berry in the fecal matter of the birds. After discussing this study with fellow ecologists, some new ideas came up for investigating whether birds are eating the berries, such as loading a unique isotope into a growth of berries, observing for avian presence, and then doing stable isotope analysis on birds' fecal matter to determine if the isotope is present. Another idea is using DNA analysis of both the berry and avian fecal matter instead of stable isotopes or collecting and analyzing fecal matter for presence of Porcelain berry seeds within. It is important that I continue to study not only this berry but many other invasive or nonnative species that are likely to be consumed by local wildlife.

We found that most of our species were eating a balanced diet between our different food source samples, aside from the (also invasive) House Sparrows, whose diets were predominantly made up of bird food. It is also interesting is that the ^{15}N values of the bird food (sunflower, corn, and millet) was higher than what is normally expected of naturally occurring maize, millet, and sunflower plants, and may be due to application of agricultural fertilizers, (Robb et al., 2011).

An important factor to consider when studying the health factors of a novel plant species is their macronutrients, such as fats, proteins, and carbohydrates, as those can be cross analyzed with their growing periods and the diets of any species of interest to determine whether those nutrients are beneficial to the animal. Although I do not know the contents of the Porcelain berry, it is important that I continue to research them, as the health hazards for local wildlife should be cause for prioritization in invasive management. This also implies that the chances of a bird eating the Porcelain berry for the first time are very high, even in our study site, on days where our bird feeders are empty.

We collected insects from the areas where I found the Porcelain berries in order to rule out the chances that birds are eating the species that inhabit the berry vines and not the berries themselves, but this could be the basis for further studies as well, opening the doors to what insects certain plant species might attract, and what the effects of that might be. One important note to make is that the bugs used in our analysis were originally dried in their glass vials with the caps on and dehydrated properly after this discovery. The potential for mold growth during this period means that isotopic ratios may have been skewed but since the data still fell within the average range for arthropods, this was likely not the case.

Conclusions

Further studies are needed to determine the nutritional value of the Porcelain Berry, as well as any potential health risks the species may pose to birds and other local wildlife species. While the effects of many invasive species on their new environments are not yet known, it is important that invasive management programs analyze the level of harm they cause to the environment, wildlife, or people around them, putting health concerns first and aesthetic concerns later.

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