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Elements that make up the diet of the Cattle Egret (*Bubulcus ibis*) in Hidalgo, Mexico

Elementos que componen la dieta de la garza ganadera (*Bubulcus ibis*) en Hidalgo, México

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Abstract

The Cattle Egret (*Bubulcus ibis*) is an avian species native to Africa that has the ability to adapt to different habitats, environmental characteristics, and available food sources. We collected a total of 2,400 Cattle Egret excreta from four resting colonies during the months of January to March 2020, in the region of Tulancingo de Bravo, Hidalgo, Mexico; in order to identify the elements that make up the diet of the Cattle Egret. Samples were placed in 70% alcohol, and later analysed with a stereoscopic microscope. We identified a total of 1,677 items from 16 taxonomic entities that could be grouped in four categories. Arthropods were the main component in samples (51.8%), particularly insects of the order Orthoptera and Coleoptera. Other components in samples were plant material (26.6%), animal remains (13.9%), and plastic or other non-biological material (7.7%). We also report the first record of the Red-Spotted Toad (*Anaxyrus punctatus*) as a possible component in the diet of the Cattle Egret. The predominance of insects, particularly Orthoptera and Coleoptera, in the Cattle Egret diet in our study reflects the extent of agricultural activities in the region. Our study provides the first report on the diet of the Cattle Egret in an agricultural area or Hidalgo, Mexico, and corresponds with other studies, where variations in diet depend on the region, habitat, climate, and extent of environmental contamination.

Key words: *Anaxyrus punctatus*, arthropods, dietary composition, excreta analysis, feeding habits.

Resumen

La garza ganadera (*Bubulcus ibis*) es un ave nativa de África que tiene la habilidad para adaptarse a diferentes hábitats, características medioambientales y fuentes de alimento disponibles. Colectamos un total de 2,400 muestras de excremento de garza ganadera en cuatro colonias de descanso durante los meses de enero a marzo del 2020, en la región de Tulancingo de Bravo, Hidalgo México; con el objetivo de identificar los elementos que componen la dieta de la Garza ganadera. Las muestras de excremento fueron conservadas en alcohol al 70%, posteriormente fueron analizados con un

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microscopio estereoscópico. Identificamos un total de 1,677 elementos de 16 entidades taxonómicas, que se agruparon en cuatro categorías. Los artrópodos fueron el componente principal en las muestras (51.8%), principalmente insectos de la familia de los Ortópteros y Coleópteros. Otros componentes en las muestras fueron elementos vegetales (26.6%), restos de animales (13.9%), y plásticos u otros materiales no biológicos (7.7%). Adicionalmente, registramos por primera vez al Sapo de Puntos Rojos (*Anaxyrus punctatus*) como posible componente en la dieta de la garza ganadera. Esto coincide con otros estudios en donde la predominancia de los insectos, en particular Ortópteros y Coleópteros, en la dieta de la garza ganadera en nuestro estudio refleja la extensión de actividades agrícolas en la región. Nuestro estudio es el primer reporte sobre la dieta de la garza ganadera en una región agrícola de Hidalgo, México, y corresponde con otros estudios donde variaciones en la dieta dependen de la región, hábitat, clima y nivel de contaminación ambiental.

Palabras clave: Análisis de excretas, *Anaxyrus punctatus*, artrópodos, composición de dieta, hábitos alimenticios.

Introduction

The Cattle Egret (*Bubulcus ibis*) is an avian species native to Africa that belongs to the Ardeidae family (Halidu et al. 2020). During the twentieth century, the species undertook geographical expansion to different continents including the Americas, and now has a cosmopolitan distribution (Abdullahm et al. 2017). The species has been reported in Mexico since 1950 to 1960 (Gómez de Silva et al. 2005, Navarro et al. 2014), and is now widely distributed in the Mexican territory, including Hidalgo state (Martínez-Morales et al. 2007).

The Cattle Egret is a versatile species able to adapt to different environments and food sources (Amat and Soriguer 1981), and is classified as omnivorous (Siegfried, 1971; Mugica et al. 2005). The species is frequently associated with human activities of livestock management, mainly cattle, and occasionally with pigs, sheep, and horses. The Cattle Egret may also be associated with ploughing activities and has been observed near tractors that disturb the earth (Abdullahm et al. 2017, Halidu et al. 2020). Cattle egrets have also been reported foraging in grasslands, and even rubbish dumps (Mohammedi and Ababou 2020).

The Cattle Egret has a variable diet, including insects (Orthoptera, Coleoptera, Diptera, among others), Arachnids, small mammals, reptiles (saurians) and amphibians (Sánchez-García, 2012), as well as vegetation (Ducommun et al. 2009; Ezequiel-Lorenzón et al. 2012; Abdullahm et al. 2017). Nonbiological elements, such as different types of plastic, are also reported to be consumed by the Cattle Egret (Halidu et al. 2020). Information on the elements consumed by cattle egrets in a particular region enables us to evaluate the adaptation of this species to the changes caused by urbanization. The amount of plastic consumed by cattle egrets may indicate the severity of change caused by environmental contamination (Comăniță et al. 2016), where birds may even identify plastics as new elements in the diet (Mohammedi and Ababou 2020).

Variations in diet of aquatic birds may be indicative of balance in wetlands and natural habitats (Mugica et al., 2005). In the agricultural environment, the Cattle Egret may act as a pest control, but annual variations in agricultural activities and food availability can affect the diet of Cattle Egret in different regions (Mohammedi and Ababou 2020). Based on the above, the purpose of our study was to analyze the excreta of Cattle Egrets in the region of Tulancingo de Bravo, Hidalgo, Mexico in order to identify the elements consumed in the diet during the first three months of the year.

Methods

Study area

The study was carried out within the facilities of the Institute of Agricultural Sciences of the Autonomous University of Hidalgo (20° 03' 47.5" N, 98° 22' 51.8" W), in the region of Tulancingo de Bravo, Hidalgo, Mexico. A temperate dry, and warm climate predominates, with temperatures fluctuating from 10 to 24°C; and a humid forest ecosystem with conifers and oaks predominates (INEGI, 2020). Tulancingo de Bravo has an urban area of 1,639.36 ha and ranks 10th in municipalities with urban expansion (Salinas et al. 2017). The state of Hidalgo is comprised mainly of semi-desert areas, which are located in the Mezquital Valley, where cauliflower, green beans, green alfalfa, agave pulquero and grain barley are sown and produced at national level (SADER, 2019). The study site is located on the outskirts of the city of Hidalgo in a region characterized by extensions of land destined mainly for agriculture, used for planting alfalfa, clo-

ver, grasslands in general, prickly pears, mezcal and corn plants (INEGI, 2017). We collected excreta from four colonies of Cattle Egret, the distance between the colonies and the trees varies from 10 to 50 m, it has been estimated that each colony contains approximately 30 to 70 birds.

Excreta or droppings and their handling

We collected a total of 2,400 Cattle Egret excreta from colony resting areas during the months of January, February, and March 2020, from 07:30 to 08:30 hrs, daily except weekends. Each day, we collected 40 fresh droppings, placing 10 fresh droppings from each of the four colonies in an individual glass jar with 70% alcohol, which was then sealed for conservation and storage until analysis. The jars were labelled with date, time and sequential sample collection number (Jakubas and Mioduszewka 2005, Mohammadi and Ababou 2020). We also collected one pellet of regurgitated content that was found during sampling. Birds were not captured to obtain droppings. Items consumed by the Cattle Egret were classified in four categories: insects, plant material, animal remains, and plastic. We calculated percentage composition of the diet based on the number of items registered for each element identified in samples.

Results

We identified a total of 1,677 items from 16 taxonomic entities that were either semi-digested or undigested (Table 1), in samples of Cattle Egret excreta and one pellet collected in Tulancingo de Bravo, Hidalgo. Over half of the diet was comprised of different types of arthropods (Table 2), mainly insects of the order Orthoptera (31.8%), such as the Cornfield Grasshopper (*Sphenarium purpurascens*) and the Fall Field Cricket (*Gryllus pennsylvanicus*) were most frequently recorded, as well as other types of crickets. Insects of the order Coleoptera were also a frequent diet component (19.2%). These included the Black Beetle (*Stenoscelis brevis*), Agave Weevil (*Scyphophorus acupunctatus*), and June Bug (*Phyllorhaga* spp.) that were frequently recorded (Table 1) and were found in different life cycle phases (larvae, pupae, and adults). Other insects registered in samples included flies and bees, as well as spiders, although less frequently (Table 1).

Plant material (Figure 2a), such as grass, roots, leaves, and seeds, comprised just over a quarter of elements in Cattle Egret excreta (Table 2). Remains of animal origin comprised 14% of items observed



Figure 1. Semi-digested contents of one regurgitated pellet collected at the Cattle Egret colony: 5) Red-Spotted Toad/ Pinto Toad; 6) Spider; 7) (Autumn) Fall Field Cricket; 8) Edible Grasshopper; 9) Two-Spotted Cricket; 11) Night Moth (caterpillar); 13) June Bug (Blind chicken) (larva and pupa); 14) Black Beetle; 15) Domestic Bee; and 16) House Fly. Numbers refer to elements identified in Table 1.

(Table 2) and included the corpse of a Red-Spotted Toad (*Anaxyrus punctatus*; Figure 2b), half of a rodent's jaw (Figure 2c), remains of a small bird's wing (Figure 2d), human hair, thin rodent hair, and bovine hair balls (Figure 2e).

Finally, plastic items comprised less than 8% of elements collected from samples (Table 2). Different types of plastic items were observed in samples, such as rubber bands, broom bristles, styrofoam balls, transparent silicone, plastic thread, plastic fiber and a small doll's head. Other non-biological elements found in samples included river stones, pieces of orange brick, pieces of wood, and earth.

Discussion

Our results demonstrate that the main food source of the Cattle Egret in our study area was comprised of different types of arthropods that represented more than 50% of all elements identified in Cattle Egret excreta. In a similar study carried out in Nigeria, it was reported that the diet of the Cattle Egret was mainly composed of insects of the order Orthoptera representing 33.3% and only 10.3% of Coleoptera (Halidu et al. 2020). It has even been reported that up to 87% of the diet may be com-

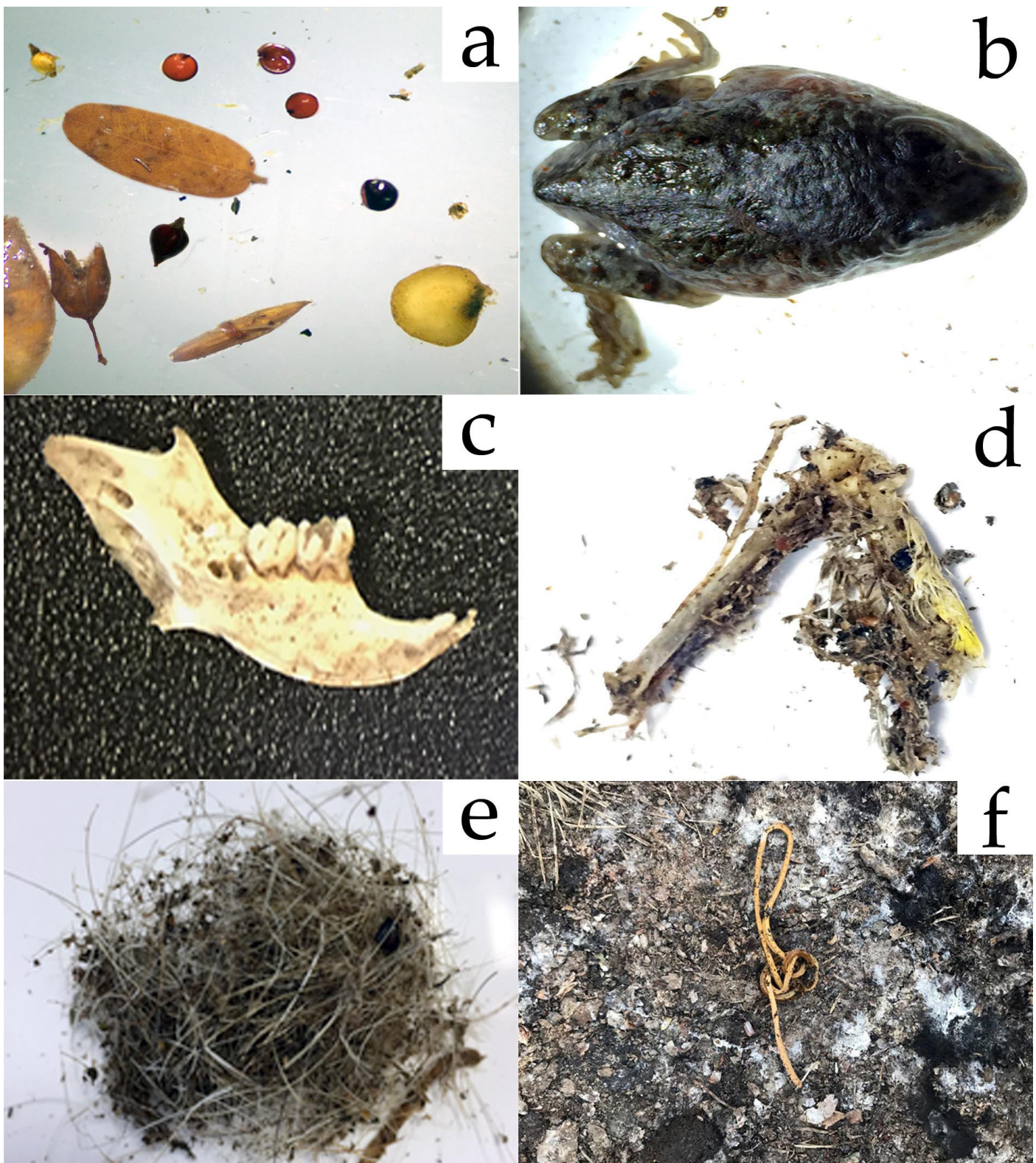


Figure 2. Elements identified in Cattle Egret droppings: a) plant material, leaves and seeds; b) skin of the Red-Spotted Toad*; c) small rodent jaw; d) small bird wing remains; e) bovine hair trichobezoar; and f) rubber band. *Item obtained from regurgitated Cattle Egret pellet.

posed of insects (Seedikkoya et al. 2007). This variation among studies in the percent of insects in the diet and composition of Coleoptera and Orthoptera may reflect differing environmental conditions among geographical areas where cattle egrets occur (Siegfried 1971, Bachir et al. 2001, Ducommun et al. 2009). The cultivation of white grain corn, green

forage oats, alfalfa forage corn, and barley in Tullancingo (SIAP, 2022), may explain the high percent of Orthoptera in the diet of the Cattle Egret. The semi-desert areas of Hidalgo are also used to produce crops like the pulquero agave, facilitating an abundance of beetles such as the Agave Weevil (Cuervo-Parra et al. 2020). Similarly, the dry en-

Table 1. List of elements identified in the excreta of the Cattle Egret (*Bubulcus ibis*), located in Tulancingo de Bravo, Hidalgo, Mexico, from January to March 2020.

ID	Common name	Taxon	No. items	% composition
Arthropods and animal remains				
1	Cornfield Grasshopper	<i>Sphenarium purpurascens</i>	323	19.3
2	Agave Weevil	<i>Scyphophorus acupunctatus</i>	184	11.0
3	Black Beetle	<i>Stenoscelis brevis</i>	120	7.1
4	(Autumn) Fall Field Cricket	<i>Gryllus pennsylvanicus</i>	119	7.1
5	Thick bovine hair	<i>Bos Taurus</i>	121	7.2
6	Fine and thin hair	Rodentia	110	6.5
7	Two-Spotted Cricket	<i>Gryllus bimaculatus</i>	50	3.0
8	Domestic Cricket	<i>Acheta domesticus</i>	42	2.5
9	June Bug (Blind chicken) (larva and pupa)	<i>Phyllophaga</i> spp.	18	1.0
10	Spider	Araneae	5	0.3
11	Night Moth (caterpillar)	<i>Trichoplusia</i> spp.	3	0.2
12	Domestic Bee	<i>Apis mellifera mellifera</i>	2	0.1
13	House Fly	<i>Musca doméstica</i>	2	0.1
14	Bone remains and feathers of a small bird	Passeriformes	1	0.1
15	Mouse jaw	Rodentia	1	0.1
16	Red-Spotted Toad/ Pinto Toad	<i>Anaxyrus punctatus</i>	1	0.1
Vegetal material				
1	Grass	Poaceae	341	20.3
2	Roots	N/A	65	3.4
3	Seeds	N/A	21	1.2
4	Leaves	N/A	18	1.0
Plastic material				
1	Elastic cord	N/A	62	3.7
2	Silicon piece	N/A	41	2.5
3	Styrofoam balls	N/A	11	0.6
4	Plastic red thread	N/A	7	0.4
5	Thinner plastic fiber	N/A	5	0.3
6	Plastic fiber (broom bristles)	N/A	3	0.2
7	Doll head	N/A	1	0.1

vironment of the Mezquital Valley in the state of Hidalgo facilitates the growth of columnar cactus, known as garambullo (*Myrtillocactus geometrizans*), which produces berry-like fruits for human consumption, and provides a refuge for a variety of arthropods of the orders of Hymenoptera, Coleoptera and Diptera (Sanjuan-Trejo et al. 2020). These factors may explain the high contribution of Coleoptera in the diet of the Cattle Egret in Tulancingo de Bravo.

Plant material was the second-most frequently found component in the diet of the Cattle Egret in Hidalgo, probably due to the large extent of agricultural land in the region. Other studies have identified agricultural or aquatic plants in the diet of the Cattle Egret, including cotton plants Malvaceae spp., Neem plants or Indian Margosa *Azadirachta* spp. (Halidu et al. 2020), aquatic plants (Beltzer et al. 1987), and pasture in general (McKilligan 1984, Ducommun et al. 2009). Vegetation may even be

absent from the diet of the Cattle Egret in areas that are extensively urbanized, or where refuse dumps are the main source of food (Seedikkoya et al. 2007). We also found different elements of animal origin in Cattle Egret excreta in Hidalgo, where bovine and rodent hair were most frequent. Shiels et al. (2020) determined that the Cattle Egret is capable of consuming small rodents, such as mice, as undigested remains of rodents were observed near to Cattle Egret nests. This is consistent with our results, where we observed fine-hair balls and the jaw of a rodent.

The consumption of rodents, as well as insects such as crickets, grasshoppers, moth caterpillars and black beetles, means that the Cattle Egret may play a role in pest control in some agricultural systems. Indeed, in Africa the Cattle Egret has been used to control Diptera infestations in cattle (Seedikkoya et al. 2007, Abdullahm et al. 2017). The insects consumed by the Cattle Egret are characteristic of crops and agricultural areas, causing problems for plants and crops (Siegfried 1971). In this sense, the Agave Weevil is known to generate secondary bacteriological infections in the agave-plant, caused by *Proteus* spp., *Pseudomonas* spp., *Erwinia* spp., among others (Cuervo-Parra et al. 2020). Therefore, the consumption of these insects by the Cattle Egret favours the elimination of pests in regions with agricultural activities.

In the present study, we recorded the presence of the Red-Spotted Toad in a regurgitated pellet of the Cattle Egret in Hidalgo. This finding is relevant because this toad species has not previously been reported in the diet of the Cattle Egret, and the distribution of this toad occurs in the northern region of the state of Hidalgo (AmphibiaWeb 2020), with no distribution records for the Red-Spotted Toad in our study area. It may be that colder temperatures in the north, and the existence of natural areas such as the Sierra Gorda Biosphere Reserve, the Marmoles National Park, and the Barranca de Metztitlán Biosphere Reserve, could be favouring the expansion and distribution of the Red-Spotted Toad in areas of southern Hidalgo with comfortable temperatures, bodies of water, and rocky crevices that provide refuges (Rausch et al. 2008, Kiesow and Griffis-Kyle 2017). Some authors have reported toads in the diet of cattle egrets, such as the Oak Toad (*Anaxyrus quercicus*), the Southern Toad (*Anaxyrus terresres*) (Jenni 1973), Asian Common Toad (*Duttaphrynus melanostictus*) (Vyas and Parasharya 2016), and the

Eastern Spur Toad (*Scaphiopus holbrookii*) (Fogarty 1973). The constant mobility of the Cattle Egret over varied habitats and geographical areas, as well as their adaption to different items in the diet (Ducommun et al. 2009), could increase the probability of encountering the Red Spot Toad, and incorporating this in the diet. However, additional studies are necessary to affirm this hypothesis.

Notably, we identified a variety of plastic items in Cattle Egret excreta, particularly rubber bands, broom bristles, and Styrofoam balls. Other studies have also noted plastic elements in the diet of cattle egrets in different parts of the world (Siegfried 1971, Ducommun et al. 2009, Halidu et al. 2020, Mohammedi and Ababou 2020). The amount of plastic found in bird droppings will depend mainly on the environment and the food source that the bird explores (Ducommun et al. 2009). Plastic pollution around the world is an issue that has acquired greater importance as increased amounts of plastic elements that pollute terrestrial and aquatic environments leads to prolonged exposure to different chemical elements that can cause health problems for animals, plants and even humans (Comăniță et al. 2016). Waterfowl can play a role in the mobility of plastic remains, since these may be consumed in one place, and excreted in another, favoring the mechanical transfer of the different types of plastics consumed (Grant et al. 2021). Easily accessible places, such as garbage dumps that are mostly located in urbanized areas, are potential sources of food for omnivorous cattle egrets, but are also sources of different plastic elements that may be consumed in the diet (Seedikkoya et al. 2007). This indicates that the process of urbanization and reduction of natural areas, brings with it not only the modification of the natural environment, but also the inclusion of new synthetic materials that may be consumed by birds or used in the construction of nests (Esquivel et al. 2020), with yet unknown consequences.

In conclusion, the diet of the Cattle Egret in Tulancingo de Bravo was mainly composed of insects, particularly Orthoptera and Coleoptera, probably due to the cultivation activities undertaken in the region. This also means that presence of the Cattle Egret, an invasive avian species, could contribute to control of insects that can be harmful to agricultural production. Plant and animal material were also frequent in the diet of the Cattle Egret, and we present the first report of the Red-Spotted Toad as a food item in the diet of cattle egrets. Variations in the diet

of the Cattle Egret found in this and other studies illustrate that the diet of these birds depends greatly on the region, habitat, climate, and extent of plastic contamination..

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