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Fruits used in two rural communities of the Sierra Madre Oriental region, Mexico, to acclimate capture *Myadestes* spp. birds

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ABSTRACT

The diet of wild and captive Slate-colored Solitaire (*Myadestes unicolor*) and Brown-backed Solitaire (*M. occidentalis*) had not been studied before. In the Sierra Madre Oriental region in México, people from rural communities involved in the capture, maintenance in captivity, and sale of these birds (known as *pajareros*) have ethnobotanical knowledge of fruits that provide food for wild populations of solitaires, which they also use to feed the birds during their acclimation in captivity. To contribute to the biological knowledge of these birds, we identified the fruits used by bird keepers for feeding captured solitaires during their acclimation. Using ethnobiological methods, in August 2016 and June 2017 we identified the fruits through guided tours and informal conversations in the rural communities of Roca de Oro, Veracruz, and Amixtlan, Puebla, and defined the bird trader's socioeconomic profiles through interviews held in 2013 and 2016. Fruits were identified in interviews and by collection of plants during field exploration guided by key informants, including four bird-capturer men and one bird-keeping woman at each community. 23 families, 32 genera, and 36 species of plants, most of them native, were used. The information about the diet of these little studied Neotropical bird species is part of the traditional ecological knowledge of local people and contributes to the nutritional biology of wild populations of solitaires.

Keywords: Ethnobotany; Feeding in captivity; Ethno-ornithology; Slate-colored Solitaire; Brown-backed Solitaire.

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SIGNIFICANCE STATEMENT

The diet of wild and captive slate-colored Solitaire (*Myadestes unicolor*) and brown-backed Solitaire (*M. occidentalis*) had not been studied before. Fruits used to feed captive solitaire birds for acclimation in México are presented in this study. The information about the diet of these little studied Neotropical bird species is part of the traditional ecological knowledge of local people and a valuable contribution to the nutritional biology of these birds by providing a proxy to the plant species on which wild populations of solitaires feed.

INTRODUCTION

Communities from many countries have traditionally used the wild fauna for self consumption (e.g. Johan Iskandar et al 2016; Santos-Fita et al. 2012 a; Alves et al. 2009) and alive wild birds are a widely used biocultural resource (Toledo 2013) in different regions of the world. The knowledge required for using the wild fauna forms part of diverse cultures and, throughout the history of humanity, societies have developed techniques needed for the extraction and use of natural resources (Santos-Fita et al. 2012b; Albuquerque y Alves 2016). Specifically, in order to achieve the proper adaptation of alive birds from wildlife to captivity, it is necessary to know, collect and offer the same natural diet during the first days in captivity. For this reason, people who catch wild birds know, collect and offer a diet equal to or like the natural one, and can provide ornithological clues to the diet of wild birds little studied by ornithology.

Alive wild birds provide clear examples of the diversity of autochthonous uses of animals, and Mexico is one of the countries in which the use of the fauna in general, and birds in particular, are an important cultural and subsistence activity (Roldán-Clarà et al. 2017; González-Herrera et al. 2018). Birds have been kept in captivity as pets (Iñigo-Elias, 1991; Thomsen 1991) due to their beauty, lively colors, melodious songs, capability to imitate words, attachment to humans, or for all the latter reasons (Gobbi 1996 and López-Medellín 2003), making them highly valued species since pre-Hispanic time (Sahagún 1969; Gómez et al. 2005; Indranil y Bandyopadhyay 2017). The people that have traditionally used alive birds as resources are known in Spanish as *pajareros*, who maintain the culture of capturing, keeping, and selling birds; a trade that, according with several historical sources (Sahagún 1969; Barros and Buenrostro 2007), had a pre-Hispanic origin.

At present, the most used birds belong to the order Passeriformes (Indranil and Bandyopadhyay 2017; González-Herrera et al. 2018), characterized by their syringes –the organ allowing the production of melodic vocalization (Navarro y Benítez 1995). In Mexico, birds from a dozen families in the order Passeriformes have been traded since the mid 20th century. The families of Passeriformes with the largest number of commercialized species are Cardinalidae, Icteridae, Corvidae, Fringillidae, Thraupidae, and Turdidae (Gómez et al. 2005; Zamora-Suárez 2013; González-Herrera et al. 2018). The more commonly traded birds in the Turdidae family are the bluebirds (*Sialia sialis* and *S. mexicana*), thrushes (*Catharus* spp., *Turdus* spp.), and solitaires (*Myadestes* spp.). Species of the Turdidae family are well known for their rich variety of complex songs (Harris 2009; Howell and Webb 1995), and are commonly used as cage birds in Mexico, Brazil (Alves et al. 2013, Silva et al 2022), and other countries like Sumatra (Putranto et al. 2020) and China (Dai and Zhang 2017). This worldwide distributed bird family in the highlands of the temperate regions –especially in humid, evergreen, and pine forests– includes 176 species, 12 of which belong to the genus *Myadestes* (Clements 2007).

The genus *Myadestes* (solitaires) are generalist feeders, so the diet in this genus must be diverse and different depending on the bird species and habitat. Their diet includes worms and arthropods, and virtually all of its species feed on fruits when available (Sibley 2001) and they play an important role in seed dispersal during forest succession (Hernández-Ladrón de Guevara et al. 2012). *M. occidentalis* (Brown-backed Solitaire) is the most distributed species in mountains in northern, western, and southern Mexico; and *M. unicolor* (Slate-colored Solitaire) lives in humid forests from southern Mexico to Guatemala and Honduras (Clements 2007; Escalante 2014; Berlanga 2015; Peterson and Chalif 1989; Howell and Webb 1995). Both birds are preferred for their use in religious rituals in Mexico and are assigned symbolic value in catholic pilgrimages taking place in several cities and towns (Roldán–Clarà et al. 2018) so that they are the most favored birds for their use and management by *pajareros* and their customers in Mexico (Gómez et al. 2005; Zamora-Suárez 2013; De la Cruz et al. 2014; Roldán-Clarà et al. 2017). But despite the relevance of their use, the capture of these birds is not allowed in the country (SEMARNAT 2017; 2018) because they are in the list of species in risk in México (NOM-059): Brown-backed Solitaire listed in the subject to special protection category and Slate-colored Solitaire in the threatened category (SEMARNAT 2010). It should be noted that few studies have been made of these birds, both in wilderness as in captivity, and their diet in nature is largely unknown.

The *pajareros* and their families are in charge of capturing, acclimating, keeping, caring, and selling the birds, and possess the needed expertise that is acquired and developed through the cosmovision, knowledge, and practices involved in the trade (Toledo and Alarcón 2012, Toledo 2002, 2013). Because of this, we can obtain relevant information from the ancestral traditional ecological knowledge of *pajareros* (Berkes 1999) including sacred meanings (Kosmus), expertise (Corpus), and subsistence activities practiced during the use of natural resources (Praxis) like in the case of capturing and keeping birds. Traditional ecological knowledge is useful to obtain information through cooperation between scholars and communities, which undoubtedly know the local biodiversity (Ulicsni et al. 2019). *Pajareros*, and specifi-

cally *clarineros* (from the Spanish word *clarines*) have for centuries captured, acclimated, and fed solitaires with wild food during the early stages of the transition period of their adaptation to captivity. To achieves their adequate adaptation from wildlife to captivity, it is necessary to give adequate nutrition during early acclimation. During the first days or weeks after their capture, birds must be adapted to change their diet from wild food to other foodstuffs (Roldán-Clarà et al. 2017). For this reason, a gradual change of the food that the birds have in their free life must be made and offered during the first stage of captivity or taming period and progressively changed with other domestic foods. Therefore, *clarineros* know, collect and offer during the first days in captivity a diet equal to or like the natural one (Roldán-Clarà et al. 2017). Knowledge of how birds are fed during the first days after their capture provides a valuable proxy of their diet in nature. Frugivorous birds first need to be fed berries from several plant species that they eat in the wild. The process consists of initially feeding them a mixture of wild berries and a paste made with plantains (*Musa balbisiana*), chicken food, and boiled egg. In the following days, the proportion of plantain paste is increased. The above description of the acclimation tasks performed by specialists in the trade demonstrates their deep knowledge and extreme care.

Consequently, our goals in this research is to identify the diet provided to Slate-colored Solitaire and Brown-backed Solitaire during the first days after their capture by *pajareros*, and describe the socioeconomic profiles of the people who capture the birds. The obtained information provides knowledge about the traditional use of fruit from plants in the local flora for acclimating captured birds, and is as a proxy for knowing the birds' diet in nature.

MATERIAL AND METHODS

Study area

The research was made in two rural communities in Mexico, Roca de Oro (19° 52' N, 96° 47' W) in the municipality of Yecuatla, Veracruz, and Amixtlan (20° 02' N, 97° 47' W) in the municipality of Amixtlan, Puebla. Roca de Oro, at an average elevation of 1,000 m a.s.l. and a surface of 135.72 km^2, belongs to the municipality of Yecuatla with borders with the municipalities of Colipa to the northwest, Chiconquiaco to the south, and Misantla to the west (Lascuraín 2011). The climate in the municipality is warm with a mean annual temperature of 22.5∘C and a mean precipitation of 1,764 mm (Lascuraín et al. 2007; Lascuraín 2011). The type of vegetation in the municipality of Yecuatla is cloud forest (Cortés 2009), which according to Köeppen (1948), is characteristic of temperate humid with year round precipitation climates.

According to the 2010 census, the municipality of Yecuatla had 11,357 inhabitants, 49.1% male and 50.9% female, with a mean age of 27 years. There were 2,977 households, 20.9% of which had earthen floors. 44.8% had piped water supply, 89.1% had sewage, and 95.1% had electric service. 25.0% of the homes in the municipality had telephone service, 30.5% of the inhabitants had mobile phone service, 8,3% owned a computer, and 1.7% had access to the Internet (INEGI 2010). Of every 100 inhabitants aged 12 years and older, 44 were economically active; of this population, 96% were employed and 56% were economically inactive. Of the population aged 15 years and older, 16.2% were illiterate, 67.7% had basic education, 10.7%, intermediate education, 5.3%, advanced education, and 0.1% did not specify their educational level. Among the population aged 15-24 years, the literacy rate was 96.6%, while in the population aged 25 and older, it was 74.2%. In the municipality, 161 inhabitants aged 5 years and older spoke an originary language, which represented 2.0% of the total population. The most frequently spoken originary languages were Totonac (86%) and Nahuatl (9.3%) (INEGI 2010).

The community of Amixtlán has an elevation of 1,246 m a.s.l. (Google Earth 2018). At that altitude, the type of vegetation corresponds to cloud forest (Rzedowski 2006), in which the mean annual precipitation is above 1,000 mm and the mean annual temperature goes from 12 to 23°C. According to the Köeppen climate classification (1948), the climate is temperate humid with year round precipitation. In 2015, the population in the municipality of Amixtlán was 5,004 inhabitants, 47.4% males and 52.6% female. The median age of the population was 22 years or less. The municipality has 1,242 households, of which 33.5% had earthen floors, 20.5% had telephone service, 18% had mobile phone service, 3.9% had a computer, and 2.4% had access to the Internet. 32.6% of the population was illiterate, 51.1% had basic education, 12.9%, intermediate education, 4%, advanced education, and 0.4% did not specify their educational level. The illiteracy rate of the population aged 15 to 24 years was 95.3%, and that rate was 53.3% in the population aged 25 years or older. Totonac (99.7%) and Nahuatl (0.1%) were spoken by 74% of the total population above 5 years of age (3,344 inhabitants), 31% of them not speaking Spanish (INEGI 2015).

The tropical montane cloud forest habitat is present in both studied communities. In Mexico, cloud forests have a limited and fragmented distribution determined by climatic variations. They are present in the uneven, steep-sloped relief of mountainous and humid areas, at altitudes ranging from

400 –in central Veracruz– to 2,700 m a.s.l. –in the Sierra Madre Oriental, with mean annual precipitation above 1,000 and up to 3,000 mm, and a mean annual temperature between 12 and 23°C. Cloud forest soils are rich in organic matter (Rzedowski 2006). Rzedowski (2006) described four sub provinces of cloud forest in Mexico, both of the studied communities belonging to two of these sub provinces: Roca de Oro, located in Central Veracruz, is within the Sierra Madre Oriental sub province, while Amixtlán in the state of Puebla is within the Trans-Mexican Volcanic Belt sector of the Meridional Mountain Ranges sub province.

A rich floristic diversity is present in cloud forests in Mexico, with over 6,790 plant species in 1,625 genera belonging to 238 families, which accounts for an important percentage of the country's plant diversity. 20.3% of the plant species in cloud forests are endemic to Mexico, making this type of vegetation the third with the highest percentage of endemic species, only surpassed by the xerophilous scrub and the tropical deciduous forest (Villaseñor 2010). Cloud forests are characterized by having several arboreal strata, two shrub strata, and a poorly diverse herbaceous strata. The most frequent tree species are several species of *Quercus* and *Pinus*, *Clethra mexicana*, and *Liquidambar macrophylla*, among others. The most represented plant families in the herbaceous level are Acanthaceae, Rubiaceae, and Euphorbiaceae, among others. Epiphytic plants belonging to the families Orchidaceae and Bromeliaceae are frequent and Pteridophytes are well represented (Rzedowski 2006). According to Rzedowski (2006), the most represented plant family is Orchidaceae, followed by Asteraceae, Rubiaceae, Melastomataceae, and Fabaceae, in some associations species of Lauraceae being abundant. *Pinus*, *Podocarpus*, and *Abies* are among the most common gymnosperm genera, and cycad genera like *Ceratozamia*, *Dioon*, and *Zamia* are present. The favorable climatic conditions for productive activities in cloud forest areas has caused the replacement of the original forest by productive systems, mostly for agriculture (Rzedowski 2006).

Field study methods

The socioeconomic profiles of *pajareros*, called themselves *clarineros* who mainly capture, and acclimated Slate-colored Solitaire and Brown-backed Solitaire (*clarines* as a Mexican name) were obtained from their answers in structured interviews held in both communities between 2013 and 2016. Permission was sought from all interviewees. Plants were collected in the field in August 2016 and June 2017 applying the guided tour, field informant, or walk-in-the-woods technique (Albuquerque et al. 2014), based on the participation of *clarineros* and key informants members of both communities, who shared their knowledge about the local flora and avifauna.

Structured interviews

To describe the socioeconomic profile of *clarineros*, were applied to 32 interviewees, 14 in Roca de Oro (six women, eight men) and 18 in Amixtlán (12 women and six men). The question guide contained information about year and place of birth, gender, educational level, ethnic origin, years in bird trade, and participation of other household members in the activity. In this interviews there were not directed questions about the plants used.

Plant collection

The botanical and ethnobotanical methodologies of Silva (2014), Albuquerque et al (2014), and Cunningham (2001) were followed for plant collection. In each community, 10 key informant *clarineros* (eight bird trapper men and two women involved in bird acclimation) who were previously interviewed, identified the collected plants by their local names (Albuquerque et al. 2014). All plant collections were leaded by the informants during field exploration guided by them, so they indicate locations and plants. The criteria for determining which plants to collect was to ask the key informants to locate the plants and fruits that they use to capture and feed the birds. The collection stopped when the information was saturated (Hernandez et al. 2007), that is, when the informants did not identify more plants used in the tours. We indicated for each plant collected its collection site (homegarden or cloud forest) and life form and we ask the key informant the local name of the plant, its use (capture and/or feeding) and seasonality of fructification.

As mentioned before, in both studied localities, plants used by *clarineros* were collected from the two spaces where they obtain fruits to feed birds: Homegardens, and cloud forest areas. The collection sites were described in general. Homegardens were considered as areas in which the composition of the vegetation was altered either by plant populations management or perturbation due to logging or fire (e. g. Ellis y Martínez 2010). In this study, the modifications in the vegetation have been caused by the introduction of exotic plants like coffee (*Coffea* sp.), banana (*Musa* sp.), and the scarlet firethorn (*Pyracantha coccinea*). The visited homegardens in both communities included plants introduced for self consumption or sale, and maintained components of the natural vegetation, for which homegardens might include managed coffee groves. Cloud forest areas were

a priori considered as conserved vegetation with little alteration of its composition and structure. In a field notebook, the plants chosen by informants and the collection areas were described in general. The recorded data were: Date of collection, community, municipality, state, geographic coordinates (latitude and longitude), altitude, a priori determined type of area (cloud forest or homegarden), and observed vegetation. Also, the seasonality of fructification of the plants used to acclimate and capture birds reported by the *clarineros* was asked. Four replicate samples were collected from plants chosen by *clarineros* having fruits and/or flowers, and the vegetative structures required for species identification.

Plant identification

The plant samples collected in the field were identified to species in the herbarium laboratory of the Faculty of Biology of the Universidad Michoacana de San Nicolás de Hidalgo using a stereoscopic microscope and the dichotomous keys in *Flora del Bajío y comunidades adyacentes* (Alameda 1993; Rzedowski and Calderón de R. 2005; Steinmann 2005; Molina-Paniagua and Lorea-Hernández 2011), *Flora de Veracruz* (Nash and Moreno 1981, Martínez-García 1984; Soejarto 1984; Fernández 1986; Nee 1986; Croat and Acebey 2015), *Flora Fanerogámica del Valle de México* (Rzedowski et al. 2005), and Trees and Shrubs of Mexico (Standley 1920-1926). The replicates of the identified voucher specimens were mounted, labeled, and deposited in the Herbario de la Facultad de Biología de la Universidad Michoacana de San Nicolás de Hidalgo (EBUM); Herbario del Instituto de Ecología, A.C. Centro Regional Bajío (IEB), and the Herbario Nacional de México, Instituto de Biología, UNAM (MEXU). Fruits of some of the identified species were deposited in the fruit collection of EBUM (Carpoteca de la Universidad Michoacana de San Nicolás de Hidalgo). An Excel database was made with the information gathered during plant collection in the field and identification to species as suggested by Belda and collaborators (2012).

Elaboration and distribution of a quick field guide for *clarineros*

A quick guide for plants used for feeding the birds during acclimation was designed and printed according to the Principle of Reciprocity, Mutual Benefit and Equitable Sharing in the ethics code established by the International Society of Ethnobiology (ISE 2006). The guide contained color photographs of plants identified to species and information about their botanical family, scientific name, local name, life form, and if they are endemic or exotic. The printed guide was handed to several *clarineros* in the studied communities as a way to share with them the systematized information in acknowledgement for the traditional knowledge they shared with us.

RESULTS AND DISCUSSION

Socioeconomic profile of *pajareros*

The results from the questionnaires applied to *clarineros* in both communities provided their socioeconomic patterns. The average age in Roca de Oro and Amixtlán was 57 (17,9 standard deviation) and 46 years (15,7 standard deviation), respectively. The *clarineros* in the studied communities had an average schooling period of a little over three years or less, meaning they had not completed elementary school and had received limited formal education, as observed in other studies in Mexico (Roldán-Clarà et al. 2017) and Brazil (Souto et al. 2017). Most *clarineros* in Amixtlán (83%) spoke Totonac, contrasting with Roca de Oro where they only spoke Spanish. In both communities, they had ample experience in the trade, which they stated to practice for an average of 28.4 years in Roca de Ora and 16.7 years in Amixtlán (Figure 1). This difference is due to the younger age of the *clarineros* in the latter community. The trade of *clarineros* involves their families, half of them stating that at least one relative participated in the activity, which allows them to expand their experience by their introduction to the trade as children (Roldán-Clarà et al. 2017). The involvement of families in bird trade agrees with findings of other studies made in Mexico (Harguindeguy and Cano González 2016 and Roldán-Clarà et al. 2017). In both communities, men were in charge of capturing the birds and women in charge of acclimation of recently captured birds (Jiménez-Díaz et al. 2014; Retana et al. 2014; Roldán-Clarà et al. 2017). The most captured bird was *M. unicolor* according to our direct observations.

Almost all of the interviewees received income from activities different from bird trade like working as day laborers, caring for their crops and livestock, or harvesting coffee, among others (Table 1). This diversified activity, which has been found in other studies (e.g. Pimentel et al. 2006; Zamora-Suárez 2013; et al. 2017; Harguindeguy and Cano González 2016), is part of a precapitalist model in which people are involved in an expanded social reproduction process (Coraggio 2009), activities that are considered as informal by governments and are essential for satisfying the needs of the local people (Harguindeguy and Cano González 2016). Alternation of productive activities is related to bird capture being seasonal, because the availability of wild fruits and the reproductive period of birds have seasonal patterns, and because the time

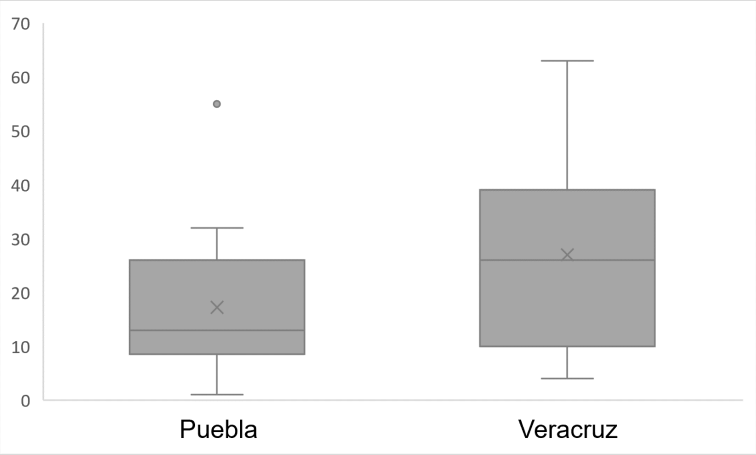

Figure 1. Box-plot graph showing years of experience in the bird trade in Amixtlan (Puebla) and Roca de Oro (Veracruz).

of the year in which bird trapping is allowed is traditionally restricted to the open season (Roldán-Clarà et al. 2017).

Plants used in bird acclimation

We recorded 50 plants used for acclimation of captive Slate-colored Solitaire and Brown-backed Solitaire, 18 used in Amixtlán, 21 used in Roca de Oro, and 11 used in both communities. Among these plants, we identified 23 of the 208 monocot and dicot families reported for cloud forests (Villaseñor 2010), 32 genera, and 36 species. Three of the collected plants were not identified for lack of flowers or fruits (Table 2). This result verifies the richness of plants used to feed captive solitaire during their acclimation period (Figure 2). Vouchers of 29 out of the 37 identified plants (78%) were deposited in three herbaria (see supplementary material).

The ranking of plant families by number of used species was: Melastomataceae, Solanaceae, and Primulaceae with five each (10.6%); Urticaceae with four (8.5%); Araliaceae, Rubiaceae, and Adoxaceae with three species each (6.38%); Dipentodontaceae, Oleaceae, and Rhamnaceae with two (4.25%); and Actinidiaceae, Arecaceae, Araceae, Boraginaceae, Cannabaceae, Salicaceae, Malvaceae, Phrymaceae, Phytolaccaceae, Rosaceae, Rutaceae, Lamiaceae, and Vitaceae with one (2.12%). The families Araceae, Rubiaceae, Melastomataceae, Solanaceae, and Urticaceae were represented in the plant taxa used in both communities. The list of identified plants includes genera considered to be exclusively or preferentially present in cloud forests like Chamaedorea, Miconia, Parathesis, and Saurauia, and genera of quantitatively important cloud forest trees like Dendropanax and Oreopanax (Rzedowski 1996) (Table 2).

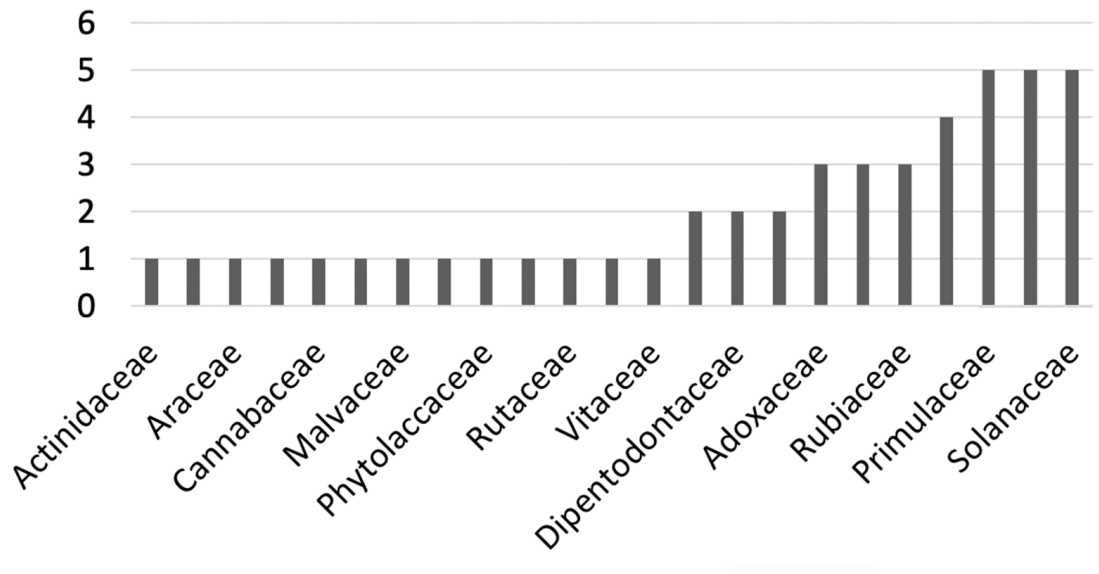

Figure 2. Number of species in plant families used to acclimated Slate-colored Solitaire and Brown-backed Solitaire.

Table 1: Socioeconomic profile of clarineros in Roca de Oro, Veracruz, and Amixtlán, Puebla. The data were obtained through interviews applied in both communities to individuals and groups of clarineros between 2013 and 2016.

Community (number of interviews)	Average age (years)	Average school years	Speakers of originary language	Years in the trade	Family involved in the trade	Diversified production[a]
Amixtlán (n=18, M:6/F:12)	46	3.3	83%	16.7	53%	94%
Roca de Oro (n=14 M:8/F: 6)	57	3.4	0%	28.4	50%	100%
Total (N=32)	51	3.3		21.8		

Abbreviations: **n**, total number of interviewees per community; **N**, total number of interviews; **M**, male; **F**, female. **Note:** [a] Percentage of clarineros receiving income from other productive activities (pluriactivity).

Table 2. List of plants used to capture and acclimate for both Slate-colored Solitaire and Brown-backed Solitaire in Roca de Oro, Veracruz, and Amixtlán, Puebla, with their life form, site and use type.

Family	Scientific name1001055869/	Life form	Local name		Site / Locality	Use
			Roca de Oro, Veracruz	Amixtlán, Puebla		
Arecaceae	*Chamaedorea* sp.	P		Tepejilote	F	A
Actinidiaceae	*Saurauia scabrida* Hemsl.	T	Moquillo	Acalama	F	A
	Sambucus mexicana C. Presl ex DC.	T	Sauco manso	Sauco	H/VF/P	C, A
Adoxaceae	Sambucus sp.	T	Sauco cimarrón		H	C, A
	Viburnum rhombifolium (Oerst.) Hemsl.	T	Papalotillo		F	A
Araceae	*Xanthosoma robustum* Schott.	H		Malvarón, hoja elegante	F	A
	Dendropanax sp.	T		Olivo	F	A
AraIiaceae	*Oreopanax capitatus* (Jacq.) Decne. and Planch.	T	Tablillera		F	A
	Oreopanax xalapensis (Kunth) Decne. and Planch.	T	Mazorquilla	Cinco hojas, fruta de mazorca	F	A
Boraginaceae	*Tournefortia glabra* L.	T	Granicillo		H	A
Cannabaceae	*Trema micrantha* (L.) Blume.	T	Matacaballo	Chaca	F	A
Dipentodontaceae	*Perrottetia longistylis* Rose.	T		Palo de agua	H	A
	Perrottetia ovata Hemsl.	T		Palo de agua	F	A
Lamiaceae	*Cornutia grandifolia* (Schltdl. and Cham.) Schauer.	T	Sompante	Tabaquillo	F	A
Malvaceae	*Sterculia* sp.	T		Maculishuatl	F	A
	Conostegia xalapensis (Bonpl.) D. Don.	T		Mugut, Mugüit	H	A
	Miconia glaberrima (Schltdl.) Naudin.	T	Teshuate blanco	Fruta blanca	F	A
Melastomataceae	*Miconia lonchophylla* Naudin.	T	Teshuate duro		F	A
	Miconia sylvatica (Schltdl.) Naudin.	T		Fruta negra, mugot cimarrón	F	A
	Miconia sp.	T	Teshuate azul		F	A
Oleaceae	*Ligustrum lucidum* W.T. Aiton.	T		Trueno	F	A
	▲	T	Chinillo		F	A
Phrymaceae	*Hemichaena fruticosa* Benth.	H	Fruto de reventón		F	A
Phytolaccaceae	*Phytolacca rivinoides* Kunth and C.D. Bouché.	H	Jorja	Yamol	H/PF/V	C, A
	Ardisia compressa Kunth.	T	Capulín de mayo		H	C, A
	Ardisia sp.	T		Artalagua cimarrón	F	A
Primulaceae	*Myrsine coriacea* (Sw.) R. Br. ex Roem. and Schult.	T		Chililllo	F	A
	Parathesis psychotrioides Lundell.	T	Capulín rojo	Artalagua roja, Artalagua negra	H	C, A
	Parathesis sp.	T	Negrillo		F	A
Rhamnaceae	*Colubrina greggii* S. Watson.	T		Jonote colorado	H	A

Family	Scientific name1001055869/	Life form	Local name		Site / Locality	Use
			Roca de Oro, Veracruz	Amixtlán, Puebla		
	Rhamnus sp.	T		Palo amarillo	H	A
Rosaceae	*Pyracantha coccinea* M. Roem.	T	Pingüica o manzanilla	Pingüica, manzanilla	H	C, A
	Chiococca pachyphylla Wernham.	T		De árbol	H	A
Rubiaceae	*Hamelia longipes* Standl.	T	Verdenase	Corpus	F	A
	Psychotria trichotoma M. Martens and Galeotti.	T	Cafecillo silvestre		F	C, A
Rutaceae	*Zanthoxylum melanostictum* Schltdl . and Cham.	T	Maicillo		F	A
Salicaceae	*Casearia* sp.	T	Palo frío		F	C, A
	Cestrum elegans (Brongn.) Schltdl.	T	Aretillo con pelos		F	A
	Cestrum endlicheri Miers.	T	Aretillo hoja lisa		F	A
Solanaceae	*Cestrum nocturnum* L.	T	Huele de noche		F	A
	Cestrum racemosum Ruiz and Pav.	T	Chacuaco		F	A
	Witheringia solanacea L'Hér.	T		Jaltomate	F	A
	Urera caracasana (Jacq.) Griseb. Fl. Brit. W.	T	Malhombrillo		F	A
Urticaceae	*Urera glabriuscula* V.W. Steinm.	T	Malhombrillo rojo		F	A
	Urera rzedowskii V. W. Sterinm.	T	Malhombrillo		F	A
	identified to family	T	Mora		H	A
Vitaceae	*Vitis tiliifolia* Humb. and Bonpl. ex Schult.	W	Uva	Uva	F	A
	identified to family	T		Chataí	F	A
Family undetermined	undetermined	T		Carboncillo cimarrón	F	A
	undetermined	T		Triquillo	F	A

Abbreviations: Life form: T, Tree; H, Herbaceous; P, Palma; W, Woody vine. Collection site/Locality: H, Homegarden; F, Cloud forest / P, Amixtlán, Puebla; V, Roca de Oro, Veracruz; Use type: A, Acclimatation; C, Capture.

Geographic affinities of used species

Most of the plant species recorded were native, except for two exotic plants –introduced either intentionally or by accident (Quiroz et al. 2009). In Roca de Oro, *Ligustrum lucidum*, a tree native to China (Naturalista 2021a) was present in the conserved vegetation, and in both communities. The *clarineros* cultivated *Pyracantha coccinea* (shrubs native from southeast Europe to south central China, Naturalista 2021b); a practice they said was motivated by the convenience of avoiding the need to go to the forest to find fruits for the birds (expressed in Spanish as "ir al monte"). In Costa Rica, Menacho-Odio and Oviedo-Pérez (2013) observed that local *pajareros* fed Black-faced Solitaires (*Myadestes melanops*) with fruits either collected from wild forest plants or from plants cultivated in their homegardens.

The *clarineros* in Roca de Oro also used endemic and quasi-endemic plant species like *Cestrum elegans* –quasi-endemic from the state of Veracruz– and *Cestrum endlicheri*, a strict endemic from the Sierra de Chiconquiaco in the central part of the same state (Nee 1986). According to Nee (1986), fruits of *Cestrum endlicheri* were unknown; however, we collected them in cloud forest vegetation in Roca de Oro and a sample was deposited in the fruit collection of EBUM.

Source of fruits, life forms, and ecological characterization of used plants

That *clarineros* collected fruits from 20 of the 23 identified families in cloud forest (conserved vegetation) and nine in homegardens (disturbed vegetation), underscores that forest conservation is essential for the presence and growth of a higher diversity of useful species. The predominant life form was tree (39 plants), followed by six shrubs, three herbs, one woody climber, and one palm (Table 2). Some of the fruit plants used are actively involved in the ecological succession of cloud forests as *Trema micrantha* (Cannabaceae), a pioneer tree (Witmore 1989) playing an essential role in reforestation and restoration of disturbed sites (Vázquez-Yanes 1999), and *Conostegia xalapensis* (Melostomatacea), a small tree or shrub that commonly colonizes disturbed sites and remains for several years in the secondary succession of fallow areas (Alameda 1993).

Wealth use, and seasonality of fruits in communities

Both communities shared 11 plant species (22%) used to feed solitaires: *Saurauia scabrida* (Actinidiacea), *Oreopanax xalapensis* (Araliaceae), *Sambucus mexicana* (Adoxaceae), *Miconia glaberrima* (Melastomatacea), *Pyracantha coccinea* (Rosaceae), *Hamelia longipes* (Rubiaceae), *Phytolacca rivinoides* (Phytolaccaceae), *Trema micrantha* (Cannabacea), *Vitis tiliifolia* (Vitaceae), *Cornutia grandifolia* (Lamiaceae), and *Parathesis psychotrioides* (Primulaceae). Of the total plants identified in both communities, the fruits from 42 species (84%) were used to acclimate captive birds and the fruits from eight species (16%) were used in Roca de Oro both for bird acclimation and for attracting birds for their capture.

The use of fruits from different species to effectively attract and capture birds was known to occur in other regions of Mexico (Roldán-Clarà et al. 2017; Roldán-Clarà and Toledo 2017). In southeastern Spain, Belda and collaborators (2012) observed the use of fruits to capture birds in the family Fringillidae.

The seasonality of fructification of the plants used to acclimate and capture birds reported by the *clarineros* in Roca de Oro and Amixtlán is shown in Figure 3. The coincidence of the seasonal peak of fruit availability and the period of reproduction and recruitment of solitaire birds during May and June was also observed in Oaxaca by Watson (1999) in the case of Brown-backed Solitaire. This synchrony is essential for food provision for the new recruits in bird populations.

Contribution of the knowledge of *pajareros*

Our work adds to the few available publications containing information about the diet of passeriform birds kept in captivity. Belda and collaborators (2012) listed 97 plant species in 31 families used in southern Spain to capture and feed finches (family Fringillidae) in captivity, and Menancho-Odio and Oviedo-Pérez (2013) reported seven local wild plants used in Costa Rica to feed Captive black-faced Solitaires (*Myadestes melanops*), but unfortunately, the authors only provided the common name of the plants impeding making comparisons with our results. According to Villaseñor (2010) we found that the 1.4% of the cloud forest plants are known and used by *clarineros* in Roca de Oro and Amixtlán to capture, acclimate, and feed captive birds of two little studied Neotropical bird species.

Knowing which plants and fruits are consumed by birds in their natural habitats is essential for successfully acclimating, feeding, and ensuring their survival in captivity (Mellink et al. 1988; Roldán-Clarà et al. 2017). This information is also valuable because it contributes to the ornithological knowledge and biology of Slate-colored Solitaire, and Brown-backed Solitaire, and also, because it demonstrates that ethnobiological information can contribute to biological

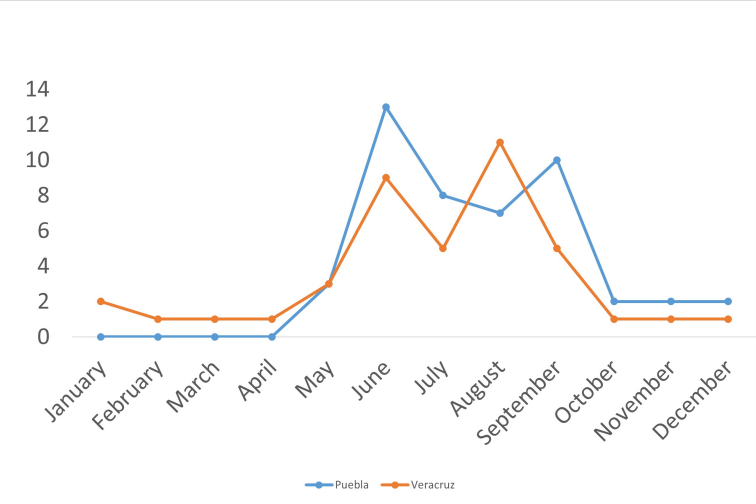

Figure 3. Seasonality of fructification of the plants used by clarineros in Roca de Oro, Veracruz, and Amixtlán, Puebla, based on the information they provided.

knowledge of species largely overseen by scientists at present. There is a close relationship between the value of use of wild fauna and flora species and the traditional knowledge held by local communities about their natural environment and about the richness and diversity of the animals and plants they use (Monroy and Ayala 2003; Puc and Retana 2012); a knowledge that is part of the biocultural heritage of communities that is transmitted through generations (Belda et al. 2012; Belda et al. 2013).

Quick guide to plants used in the study area for acclimation and capture of birds

The printed quick guide we produced included 23 plant species reported by local *clarineros* to be used for capturing and acclimating solitaire birds. We distributed the printed guide among them in both communities intending to return them systematized data of the local knowledge they shared with us and express our acknowledgement. *Clarineros* agreed with the scientific names assigned to the plants.

Regulation of traditional use of solitaire birds in Mexico

Despite the fact that the capture of birds in the genus *Myadestes* is not allowed in Mexico, some *pajareros* continue to do so, claiming they refuse to abandon this traditional activity transmitted to them by their progenitors (Roldán-Clarà and Espejel 2022). Their unwillingness to comply with the prohibition of capturing these birds is sustained by Article 15 of the International Labour Organization Convention No. 169 that endorses the rights of indigenous people to use local natural resources, regardless of whether they are legally considered indigenous, since it applies to "who retain some or all of their own social, economic, cultural and political institutions". The species in the genus *Myadestes* have special cultural value for bird traders in Mexico because they are used in pre-Hispanic rituals in several places of the country (Roldán-Clarà et al. 2018), for which they could be considered as species with ritual importance in Mexico (CONABIO 2020).

CONCLUSION

The *clarineros* from the communities with whom we collaborated are mainly adults from rural or indigenous communities with little schooling and years of experience in the temporary capture and care of Slate-colored Solitaires and Brown-backed Solitaire.

In this work, the species of plants that are used for capture and acclimated to captivity of two neotropical birds species with high cultural value for the *clarineros* are listed. Most of the plants used are native and come from the tropical montane cloud forest, although there are also planted in the homegardens from exotic or native origin. Some of the plants and fruits used to feed solitaires are shared in both comunities and others are used excluvisely in one of the comunities.

Our work in two communities in the Sierra Madre Oriental region, Mexico, documented the local knowledge of people involved in traditional bird trade about the fruits used to feed captive solitaire birds for acclimation. The information about the diet of these

little studied Neotropical bird species is part of the traditional ecological knowledge of local people and a valuable contribution to the nutritional biology of these birds by providing a proxy to the plant species on which wild populations of solitaires feed.

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DATA AVAILABILITY

The data used to support the findings of this study are available from the corresponding author upon reasonable request.

CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

CONTRIBUTION STATEMENT

Conceived of the presented idea: BRC Carried out the experiment: REHN, BRC
Carried out the data analysis: REHN, BRC
Wrote the first draft of the manuscript: REHN
Review and final write of the manuscript: BRC
Supervision: BRC

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