

Birds in Pre-Hispanic Mesoamerica: An Ethnobiological Review

Las aves en la Mesoamérica prehispánica: una revisión etnobiológica

Evelyn Jiménez-Vázquez^a, Fabián Ricardo Gómez-de-Anda^a, Víctor Johan Osvaldo Acosta-Pérez^a, Jorge Luis de la Rosa Arana^b, Jesús Benjamín Ponce Noguez^c,
Andrea Paloma Zepeda-Velázquez^a

Abstract:

Birds played fundamental roles in the social, economic, symbolic, medicinal, and ecological development of pre-Hispanic Mesoamerican civilizations. Yet, their overall contribution to human–bird relationships has rarely been examined from an integrative ethnobiological perspective. This study aimed to document and synthesize the principal uses of birds in pre-Hispanic Mesoamerica, identify the species of greatest cultural significance, and evaluate their roles in ritual practices, medicine, subsistence, trade, political organization, and technological development. We conducted a documentary review following an adaptation of the PRISMA 2020 guidelines for narrative reviews. Bibliographic searches included historical codices, colonial chronicles, archaeological reports, ethnobiological studies, zoological publications, and scientific literature published between 1552 and 2025. From 124 bibliographic records initially identified, 68 references met the inclusion criteria and were incorporated into the final synthesis. The review identified recurring patterns across major Mesoamerican civilizations, demonstrating that birds functioned as multifunctional biological and cultural resources. Species such as the resplendent quetzal (*Pharomachrus mocinno*), golden eagle (*Aquila chrysaetos*), scarlet macaw (*Ara macao*), and turkey (*Meleagris gallopavo*) represented the highest levels of symbolic, economic, medicinal, and political importance. Although many uses were shared among cultures, the Maya emphasized birds as cosmological mediators, whereas the Mexica integrated them into imperial administration, military hierarchy, and tribute systems. These findings demonstrate that birds constituted essential components of Mesoamerican biocultural systems and that their management reflected sophisticated ecological knowledge. Recovering this historical legacy contributes not only to understanding past human–bird interactions but also provides valuable foundations for biodiversity conservation, environmental education, biocultural heritage preservation, and future interdisciplinary research integrating archaeology, ethnobiology, ecology, and biomedical sciences.

Keywords:

Ethnobiology, avifauna, traditional knowledge, Mesoamerica, biocultural heritage

Resumen:

Las aves desempeñaron funciones fundamentales en el desarrollo social, económico, simbólico, medicinal y ecológico de las civilizaciones mesoamericanas prehispánicas; sin embargo, su contribución integral a las relaciones entre humanos y aves ha sido escasamente analizada desde una perspectiva etnobiológica. El presente estudio tuvo como objetivo documentar y sintetizar los principales usos de las aves en la Mesoamérica prehispánica, identificar las especies de mayor relevancia cultural y evaluar su participación en prácticas rituales, medicina tradicional, alimentación, comercio, organización política y desarrollo tecnológico. Se realizó una revisión documental siguiendo una adaptación de las directrices PRISMA 2020 para revisiones narrativas. La búsqueda bibliográfica incluyó códices históricos, crónicas coloniales, informes arqueológicos, estudios etnobiológicos, publicaciones zoológicas y literatura científica publicada entre 1552 y 2025. De un total de 124 registros bibliográficos inicialmente identificados, 68 referencias cumplieron los criterios de inclusión y fueron incorporadas a la síntesis final. La revisión permitió identificar patrones recurrentes entre las principales civilizaciones mesoamericanas y demostró que las aves constituyeron recursos biológicos y culturales multifuncionales. Especies como el quetzal (*Pharomachrus mocinno*), el águila real (*Aquila chrysaetos*), la guacamaya roja (*Ara macao*) y el guajolote (*Meleagris gallopavo*) concentraron la mayor importancia simbólica, económica, medicinal y política. Aunque numerosos usos fueron compartidos entre las distintas culturas, los mayas destacaron por concebir a las aves como mediadoras cosmológicas, mientras que los mexicas las integraron de manera más amplia en la administración imperial, la jerarquía militar y los sistemas tributarios. Estos hallazgos demuestran que las aves constituyeron componentes esenciales de los sistemas

^a Andrea Paloma Zepeda Velázquez, Laboratorio de Fisiología y Patología Clínica, Instituto de Ciencias Agropecuarias, Av. Universidad #133. Col. San Miguel Huatengo. Municipio de Santiago Tulantepec de Lugo Guerrero. CP. 43775 | Tulancingo de Bravo | Hidalgo | México, <https://orcid.org/0000-0001-9289-9831>, andrea_zepeda@uaeh.edu.mx. Evelyn Jiménez Vázquez, <https://orcid.org/0009-0003-2992-4557>, evelynjimenez1391@gmail.com; Fabián Ricardo Gómez de Anda, <https://orcid.org/0000-0001-6314-099X>, fabian_gomez9891@uaeh.edu.mx; Víctor J. O. Acosta-Pérez, <https://orcid.org/0000-0001-9564-659X>, victor_acosta@uaeh.edu.mx. ^b Laboratorio de Investigación Multidisciplinaria en Parasitología, Edificio de Posgrado, Unidad de Investigación Multidisciplinaria, Campus 1, Facultad de Estudios Superiores Cuautitlán, UNAM, Avenida Primero de Mayo s/n, Campus 1, Cuautitlán Izcalli, C.P. 54743 | Estado de México | México. Jorge L. de la-Rosa-Arana, <https://orcid.org/0000-0002-8460-5941>, delarosa.jl@gmail.com

^c Facultad Maya de Estudios Agropecuarios de la Universidad Autónoma de Chiapas. Carretera Catazajá-Palenque Km. 4, C.P. 29980 | Catazajá | Chiapas | México. J. Benjamín Ponce-Noguez, <https://orcid.org/0000-0001-6560-0275>, jesus.ponce@unach.mx

bioculturales mesoamericanos y que su manejo reflejó un profundo conocimiento ecológico. La recuperación de este legado histórico contribuye no solo a comprender las interacciones entre las sociedades humanas y las aves en el pasado, sino también a proporcionar bases para la conservación de la biodiversidad, la educación ambiental, la preservación del patrimonio biocultural y el desarrollo de futuras investigaciones interdisciplinarias que integren la arqueología, la etnobiología, la ecología y las ciencias biomédicas.

Palabras Clave:

Etnobiología, avifauna, conocimiento tradicional, Mesoamérica, biocultura.

1. Introduction

Birds and humans have interacted in diverse ways throughout history, from everyday life to events of broader historical significance. In many societies, birds have consistently been represented as magical or sacred symbols and as important elements in mythological traditions [1]. Birds have long attracted human attention because of their colorful plumage, distinctive vocalizations, and their capacity for flight. However, these characteristics are not the only reasons birds have remained closely associated with human societies. Throughout history, several species have been immortalized in historical narratives. According to Roman tradition, geese warned Rome's inhabitants of an enemy attack through their loud calls. Similarly, miners historically used canaries as early warning indicators of methane gas leaks; when the bird died from gas exposure, miners recognized the danger and evacuated the mine. In another context, carrier pigeons were widely used during wartime to transmit information about enemy positions.

In several ancient civilizations, birds were also perceived as divine beings or as representations of deities. In Tibet, the image of a large mythical eagle with golden wings symbolized the god Garuda, known as the "bird of life," both creator and destroyer of the universe. In ancient Babylon, temples were often built on elevated sites to symbolically approach the realm of eagles. Similarly, in ancient Egypt, several deities were depicted with bird heads, particularly the falcon representing Horus. Birds were also represented in funerary murals, such as those in the Tomb of Menna in the Theban Necropolis (Thebes, Egypt), where species including herons, cranes, and ducks appear in detailed iconographic scenes [2]. Pre-Hispanic Mesoamerica comprised diverse societies that shared several fundamental cultural characteristics, including intensive

agriculture, urban organization, pictographic or hieroglyphic writing systems, ritual calendars, and extensive commercial exchange networks. These civilizations developed across a wide range of ecological environments—tropical rainforests, montane forests, high-altitude lakes, and coastal regions—which directly influenced the interactions between human populations and local fauna, particularly birds. This ecosystem diversity supported numerous avian species, which were integrated into multiple aspects of the social, cultural, and economic life of Mesoamerican societies.

Historically, these civilizations are generally divided into three principal periods: the Preclassic (ca. 2000 BCE–250 CE), the Classic (ca. 250–900 CE), and the Postclassic (ca. 900–1521 CE) [3, 4]. During the Preclassic period, the first ceremonial centers and complex agricultural communities emerged, most notably the Olmec civilization on Mexico's Gulf Coast, as well as early Zapotec and Maya developments. In the Classic period, major urban centers such as Teotihuacan, Monte Albán, and several Maya cities became consolidated, characterized by complex political systems and extensive trade networks [4, 5]. Finally, the Postclassic period was marked by political transformations and the emergence of new regional hegemonies, including the expansion of the Mexica civilization in the Basin of Mexico [6]. Birds played a significant role within these societies, participating in economic, symbolic, and practical activities. Various historical sources, including the Codex Mendoza and the Florentine Codex (1550–1590), document the use of numerous species such as the resplendent quetzal (*Pharomachrus mocinno*) and the domesticated turkey (*Meleagris gallopavo*), highlighting the cultural importance of avifauna in Mesoamerican social organization [7, 8].

This study analyzes, from historiographical, archeozoological, and veterinary perspectives, the

ritual and symbolic, economic and prestige-related, dietary, medicinal, and practical uses of birds in pre-Hispanic Mesoamerica. By identifying the most valued species and the uses that structured the relationship between human societies and avifauna, this study seeks to contribute to a broader understanding of the biocultural heritage associated with birds in ancient Mesoamerican civilizations [1, 2].

2. Materials and methods

A documentary review was conducted following the PRISMA 2020 recommendations for literature identification and selection. Bibliographic research used open-access scientific databases, institutional repositories, digital libraries, historical codices, and specialized books published between 1552 and 2025. The search included historical chronicles, archaeological studies, ethnobiological investigations, zoological references, and ethnographic publications related to the use of birds in pre-Hispanic Mesoamerica. Primary sources included codices and colonial chronicles, while secondary sources comprised ethnobiological and archaeological studies. Selection criteria included relevance to avifaunal use and documented human–bird interactions.

Inclusion criteria: primary historical documents such as codices, colonial chronicles, and early ethnographic records that provided direct or indirect references to the use of birds in Mesoamerican contexts. Additionally, peer-reviewed scientific publications, including articles, books, and book chapters on ethnobiology, archaeozoology, anthropology, and environmental history, were included if they explicitly addressed human–bird interactions. Studies were selected if they documented ritual, dietary, medicinal, economic, or ecological uses of birds, included taxonomic identification of species, or contributed to the understanding of traditional ecological knowledge systems. Only publications in English and Spanish with clear academic relevance and methodological rigor were considered.

Exclusion criteria: sources that lack direct relevance to avifauna or the Mesoamerican cultural context, as well as documents without academic validation, such

as non-peer-reviewed web pages or anecdotal reports without verifiable evidence. Redundant publications that did not provide additional analytical value were also excluded. Furthermore, studies focusing exclusively on modern contexts without historical or ethnobiological connections were omitted, as were sources that presented ambiguous or incorrect taxonomic identifications.

A bibliographic search was conducted across multiple academic databases and digital repositories, including Google Scholar, Scopus, Web of Science, SciELO, Redalyc, and JSTOR. Complementary searches were conducted in institutional repositories such as those of the National Autonomous University of Mexico (UNAM) and the National Institute of Anthropology and History (INAH), as well as in digital libraries including the Miguel de Cervantes Virtual Library, which provided access to historical documents and primary sources.

Search strategies: keywords in both English and Spanish, combined through Boolean operators to maximize retrieval of relevant literature. Terms such as “ethnobiology,” “Mesoamerican birds,” “prehispanic avifauna,” “traditional ecological knowledge,” and “archaeozoology” were used in different combinations. The selection of sources followed a relevance-based approach, prioritizing studies that provided detailed descriptions, analytical interpretations, and reliable documentation of human–bird relationships. All selected sources were evaluated for academic quality, thematic relevance, methodological clarity, and consistency with the study's ethnobiological framework. Information extracted from the sources was categorized by use type (ritual, dietary, medicinal, economic, and ecological), enabling pattern identification and integration into a cohesive analytical framework. We initially identified 124 bibliographic records. After removing 18 duplicate records, 7 incomplete references, and 9 publications unrelated to the study's objectives, 90 records remained for title and abstract screening. Subsequently, 17 publications were excluded because they focused exclusively on unrelated zoological topics, lacked relevance to pre-Hispanic Mesoamerica, or contained redundant information. Consequently, 73 full-text documents

were assessed for eligibility. After the full evaluation, five additional publications were excluded because they lacked sufficient documentary support, could not be independently verified, or did not contribute directly to the review's objectives. Ultimately, 68 bibliographic sources met the inclusion criteria and were incorporated into the final manuscript.

Scientific illustrations. Maps, bird illustrations, and artistic reconstructions of pre-Hispanic scenes were generated using OpenAI's GPT Image model (OpenAI, <https://chatgpt.com>) from author-developed prompts. The authors critically reviewed, edited, and refined all generated images based on anatomical references, pre-Hispanic codices, historical documents, and peer-reviewed scientific literature to ensure biological accuracy, historical fidelity, and scientific relevance. The authors are responsible for the final figures.

3. Results

The History of Birds in Mexico

The historical study of birds in Mexico dates back to antiquity. Colonial chronicles indicate that birds were an important faunal resource for ancient Mexican cultures. Since the Mesoamerican Preclassic period, observations of avifauna have enabled ancient societies to interpret aspects of bird behavior and incorporate this knowledge into a variety of cultural and practical activities. These included agricultural practices, ritual calendars, omen systems, environmental management strategies, ecological indicators, trade networks, mythological and religious activities, song traditions, medicinal or therapeutic uses, the development of featherwork, domestication, and the use of birds as food. Many of these practices have persisted into contemporary Mexican culture [9, 10].

This relationship between humans and birds became further consolidated during the Classic and Postclassic periods, when major urban centers such as Teotihuacan, Tenochtitlan, Palenque, and Monte Albán incorporated birds into both religious iconography and economic organization [11]. During the Postclassic period, birds became especially visible in historical records because of the extensive documentation of their use and presence. The Codex

Mendoza records tributes consisting of feathers and related goods associated with imperial administration and domination [12]. At the same time, the *Florentine Codex* (1590-1682) compiles Indigenous descriptions of animals—including birds—within a broader framework of natural and cultural history [8].

In summary, the ethno-political distribution of societies across different periods helps explain why certain bird species were more highly valued than others. The value attributed to a particular bird was determined by the intersection of three principal factors: the ecological distribution of the species (where the bird lived), the exchange networks through which it could be obtained, and its social meaning (what status or identity was communicated by wearing its feathers or consuming its meat). Primary historical sources—particularly the *Florentine Codex* (1590-1682), the *Codex Mendoza*, and the *Libellus de Medicinalibus Indorum Herbis*—allow researchers to reconstruct in considerable detail the various uses assigned to specific bird species and their distribution across different regions. These sources document species ranging from the resplendent quetzal to the domesticated turkey [13, 8, 7, 14] (Figure 1).



Figure 1. Principal civilizations that formed pre-Hispanic Mesoamerica. The figure also illustrates several bird species used by these civilizations: (a) golden eagle (*Aquila chrysaetos*); (b) falcon (*Falco sp.*); (c) turkey (*Meleagris gallopavo*); (d) Mexican duck (*Anas diazi*); (e) heron (*Ardea sp.*); (f) roseate spoonbill (*Platalea ajaja*); (g) scarlet macaw (*Ara macao*); (h) resplendent quetzal (*Pharomachrus*

mocinno); (i) ocellated turkey (*Meleagris ocellata*); and (j) Montezuma quail (*Cyrtonyx montezumae*) [Created by the authors].

Birds occupied a privileged position in the cultural and ecological history of pre-Hispanic Mexico, as evidenced by their presence in codices, sculptures, early Indigenous chronicles, and archaeozoological remains. These sources indicate that birds were not merely regarded as animals or simple natural resources used in everyday life. Rather, they were perceived as entities closely associated with economic power, spirituality, gastronomy, communication, and concepts of health and well-being. Traditional practices involving the use and management of avifauna in pre-Hispanic Mexico have persisted through time and continue into the present. Thousands of birds are still captured annually from the wild for various purposes [15]. The relationship between birds and Mexican communities—particularly Indigenous communities, but also mestizo populations—operates at multiple levels: as part of traditional ecological knowledge, within systems of cosmology and symbolism, and across several categories of use, including religious or ritual practices (e.g., as amulets), medicinal applications, and recreational activities such as falconry or the keeping of birds as companion animals [16, 17, 18, 19].

The historical evidence study of birds has gained renewed relevance in contemporary contexts. Mexico currently harbors one of the highest levels of avian diversity worldwide, yet it also faces rapid habitat loss and significant illegal wildlife trade. Recognizing that many of these bird species served as cultural pillars in ancient civilizations strengthens public awareness of their historical, cultural, and ecological significance. In this sense, disseminating scientific knowledge about past events in the history of birds not only illuminates the complexity of the pre-Hispanic world but also provides cultural foundations for contemporary biodiversity conservation. Accordingly, the objective of this manuscript is to examine, from historiographical, archaeozoological, and veterinary perspectives, the ritual and symbolic, economic and prestige-related, dietary, medicinal, and practical uses of birds in pre-Hispanic

Mesoamerica, by identifying the most valued species and the uses that structured relationships between human societies and avifauna.

Ritual and Symbolic Uses

Since the Mesoamerican Preclassic period, birds occupied a central place within the worldview, ritual systems, and symbolic structure of pre-Hispanic civilizations. Their ability to fly associated them with the *ilhuícatl* (the sky) and positioned them as intermediaries between the human world and the divine realm. This characteristic gave birds a symbolic role as carriers of vital energy (tonalli) and as visible manifestations of cosmic forces, giving them a prominent role in religious systems. This association became firmly established in the major ceremonial centers of the Classic and Postclassic periods, where avian iconography frequently appears in murals, codices, and ritual sculptures [13, 11, 20]. A notable example of the symbolic role of birds is found among the Mexica, who conceptualized the world as divided into four sections, each represented by a bird: the eagle, the quetzal, the hummingbird, and the macaw. This symbolic association is also reflected in several Mesoamerican toponyms in which birds are the central element of place names. Examples include *Tzintzuntzan* (Purépecha: “place of hummingbirds,” in Michoacán), Cozumel (Maya: “place of swallows,” in Quintana Roo), and Sola (Nahuatl: “place where quails abound,” in Oaxaca) [21].

According to a Maya oral tradition documented in ethnographic studies and reinterpretations of pre-Hispanic cosmology, the gods first created the largest and strongest birds, assigning them tasks such as transporting materials, announcing natural changes, and representing the power of the heavens [22, 23]. One of the most important birds in Mesoamerican symbolism was the golden eagle, which was associated with the sun, warfare, and political authority [11]. Among the Mexica, the eagle represented the solar deity Huitzilopochtli and symbolized the triumph of light

over darkness. This symbolism is reflected in the foundational myth of Tenochtitlan, according to which Huitzilopochtli instructed the Mexica, during their migration from Aztlán, to search for a sign: an eagle perched on a cactus (nopal), holding a serpent in its talons, in the middle of a lake. The location where this sign was found would become the site of the founding of the city of Tenochtitlan, now Mexico City [13, 24].

Archaeological excavations at the Templo Mayor of Tenochtitlan have recovered eagle skeletal remains deposited as dedicatory offerings, often associated with obsidian blades and human hearts. These findings confirm the direct sacrificial use of eagles in ritual contexts, as eagle blood was considered nourishment for the sun and a guarantee of cosmic continuity [25]. The quetzal was another bird of major symbolic importance, particularly among the Maya and Mexica. Its brilliant green feathers represented vegetation, fertility, and the renewal of life, and were described metaphorically as the “petrified breath of the sky” [22]. The bird was closely associated with the deity Quetzalcóatl, linked to wind, knowledge, and creation. Because of this symbolic significance, quetzal feathers were reserved exclusively for rulers and high-ranking priests, reinforcing their role as markers of political legitimacy and divine connection [22, 26].

Representations of quetzals also appear in female ceramic figurines from Teotihuacan associated with themes of love and fertility [27]. In later Mexica interpretations, these figures were associated with the deity Xochiquetzal—sometimes connected with Xochipilli—who was often depicted wearing quetzal feathers as ornaments on her headdress and in her hands [22]. Notably, quetzals were rarely sacrificed; instead, they were captured, their feathers carefully removed, and then released. This practice reinforced the notion of sacred reciprocity between humans and nature [26].

In the case of the hummingbird, this bird was associated with a supreme deity and held a special place within Mesoamerican cosmology. In Yucatec Maya, the hummingbird is known as

ts'unu'um, a term that refers to the distinctive humming sound its wings produce during flight [20]. Within Maya cosmology, the hummingbird was considered a sacred bird created directly by the gods as a messenger between the human and spiritual worlds. It was therefore regarded as a divine entity associated with the movement of the soul, love, and the transmission of thoughts. According to traditional narratives, the hummingbird was created from a piece of jade—a material symbolizing life, vital energy, and the heart of the universe. The jade was carefully carved into the shape of a small bird, which came to life when the gods breathed upon it, transforming the stone into the first hummingbird (Figure 2). This bird's significance lies in its perceived ability to carry thoughts, desires, and messages between humans and deities, a symbolic role attributed to its extraordinary lightness and speed in flight [22].



Figure 2. Representation based on the Maya legend describing the creation of the hummingbird [Created by the authors].

The hummingbird was also associated with the human soul in several Mesoamerican belief systems. It was believed that the spirits of the deceased could temporarily return to the earthly world as hummingbirds to visit their relatives. For this reason, the sudden appearance of a hummingbird near a person was often interpreted as a spiritual visitation or a message of protection.

Among the Mexica, the hummingbird was likewise associated with warrior vitality and the rebirth of fallen combatants. According to Sahagún [13], warriors who died in battle accompanied the sun on its celestial journey for four years before returning to earth as hummingbirds, where they were believed to feed on flower nectar. The association between hummingbirds and warriors was further reflected in hummingbird feathers on military standards and priestly ornaments, as well as in their symbolic connection to the sacrificial fate of warriors on the battlefield [28].

Tropical birds such as the scarlet macaw also possessed important symbolic value. Its brilliant red plumage represented fire and the rising sun, and it was associated with rebirth and the continuity of the cosmic cycle. In Maya culture, the macaw appears in mythological representations connected with the sun and the creation of the world. Its presence in artistic and architectural contexts further demonstrates its importance within the symbolic system of Mesoamerican societies [22]. Aquatic birds, in contrast, were often associated with the underworld and were interpreted by pre-Hispanic societies as symbolic gateways to other realms of the cosmos [29].

Within pre-Hispanic Mesoamerican cosmology, certain bird species were also considered carriers of dark forces or entities linked to the underworld. These birds have sometimes been described as “demonic birds,” referring to species symbolically associated with Mictlan (the Mexica underworld) or Xibalba (the Maya underworld). Both realms were fundamental components of the cyclical conception of life, death, and regeneration within Mesoamerican cosmological thought [13, 30]. Nocturnal birds such as the great horned owl (*Bubo virginianus*) and the ferruginous pygmy-owl (*Glaucidium brasilianum*) held symbolic meanings associated with death, the underworld, and hidden knowledge. Because of their nocturnal habits, these birds were closely linked to Mictlan, the Mexica underworld. Their presence was often interpreted as a message from supernatural forces or as an omen warning of events that required caution. In particular, the owl frequently

appears alongside underworld deities and in funerary contexts, confirming its symbolic role within beliefs concerning death and spiritual transition [11, 31].

According to the Florentine Codex (1950-1982) [8], the owl's call was interpreted as a sign of death or transformation, closely linking it to funerary rituals and ceremonies related to spiritual passage [13]. Within this context, the owl was not simply a negative symbol but rather a necessary agent within the cosmic balance, facilitating transitions between different realms of the universe. Similarly, the barn owl (*Tyto alba*, known in Nahuatl as *tecolotl*) symbolized night and death. Its call was interpreted as an omen announcing the soul's journey toward Mictlan. Ethnohistorical Sources indicate that during the funerals of noble individuals, owl feathers were sometimes placed on the deceased's face to guide their path through the darkness [11].

Scavenger birds, such as vultures, were also considered essential to the natural cycle of decomposition and regeneration. Although associated with death, these birds symbolized the transformation of matter and the maintenance of natural balance. Their presence in ritual contexts reflects the Mesoamerican recognition of death's ecological and cosmological role as a fundamental component of the cycle of life [30, 13]. In this way, birds were not merely animals but visible manifestations of fundamental cosmic principles. Their presence in rituals, artistic representations, and mythological narratives demonstrates that they played a central role in shaping the cultural and spiritual identity of Mesoamerican civilizations [13, 22]. Within this symbolic system, each species occupied a specific place in cosmology, integrating concepts of warfare, death, renewal, and divine legitimacy [11].

Hunting and Diet

The dietary relationship between Mesoamerican societies and birds resulted from a prolonged process of domestication, hunting, and

environmental management. Since the Late Preclassic period, the domestication of the turkey (*huexōlōtl*) significantly transformed the protein intake of agricultural populations. This species is considered the first bird to be captured and domesticated, as individuals were initially attracted to crops and human settlements in search of food. Once captured, they were kept in captivity, where both their eggs and meat were consumed, while their feathers were used for clothing and tribute [32].

Wild turkeys are thought to have originally inhabited the temperate forests of the Sierra Madre Occidental and Sierra Madre Oriental [32, 33]. Various authors have proposed different regions for the domestication of this species, including the state of Michoacán, where the Purépecha culture is often suggested as a primary agent of domestication. This hypothesis is supported by the extensive use of turkey bones and feathers in archaeological contexts [34], although some authors have emphasized non-alimentary uses over dietary importance [35]. Additionally, colonial chronicles attribute the domestication of the turkey to the Purépecha people [36].

Valadez [37] reports that turkey bone remains appear in domestic contexts as early as the 4th century CE, confirming their systematic husbandry as a species raised for fattening and production. Turkeys were primarily reserved for special occasions, including religious ceremonies, agricultural rituals, family celebrations, and elite banquets. In the Florentine Codex (1950-1982) [8], Sahagún [13] describes aspects of turkey processing, from decapitation for slaughter to cooking in clay pots and preparation in molli (a thick ceremonial sauce). Within this symbolic framework, consuming turkey was understood as participation in the renewal of the social and cosmic order.

In addition to turkeys, other bird species were hunted to complement the staple diet of pre-Hispanic populations, which was largely based on maize, beans, chili, and squash [38].

Among these, 1) the Montezuma quail (*Cyrtonyx montezumae*) was commonly hunted in agricultural corridors and field margins, as it is associated with grasslands and highland shrublands. During the dry season, when flocks moved into cultivated areas to feed on seeds, hunters employed snare traps, baited cages, and low nets placed along movement routes. A recurrent technique involved driving nets, in which groups of hunters advanced in a semicircle, flushing quail toward a ground-level net and taking advantage of their short, sudden flight behavior [13, 39]. Although valued as a food source for its manageable size and concentrated meat, quail also served ritual purposes and were occasionally used as a minor sacrificial offering, increasing demand during festive periods [13].

2) Mourning doves (*Zenaida macroura*) were abundant in open landscapes near settlements and agricultural fields and were captured using what may be described as “patience-based” methods. These included nets placed at watering sites, baited traps activated by grain, and, in some cases, vegetal adhesives applied to perches. These adhesives were derived from resins, plant sap, and latex—highly viscous and sticky substances—obtained from several plant species, including *Manilkara zapota* (chicozapote), *Castilla elastica* (Mesoamerican rubber tree), *Bursera bipinnata* and *Bursera copallifera* (copal), *Agave salmiana* and *Agave americana* (maguey), and *Ficus cotinifolia* and *Ficus petiolaris* (amate) (Figure 3). These substances were applied to branches or perching sites where birds commonly landed, facilitating their capture [39, 40].



Figure 3. Representation of plant species used by inhabitants of pre-Hispanic Mesoamerica to obtain sticky resins and produce vegetal adhesives employed in bird-trapping techniques. a) Sapodilla or chicle tree (*Manilkara zapota*); b) Mesoamerican rubber tree (*Castilla elastica*); c) Copal tree (*Bursera copallifera*); d) Maguey (*Agave salmiana*); e) Amate or wild fig (*Ficus cotinifolia*) [Created by the authors].

Because these birds were available year-round, they became a strategic resource for rural households. They were commonly hunted at dawn when they approached agricultural fields to feed on crop residues. Due to their relatively small size, many were cooked whole. After being plucked and eviscerated, they were quickly roasted over embers or boiled to produce light broths believed to strengthen convalescent patients [41].

The most complex and technically developed form of bird hunting involved lacustrine ducks inhabiting the lake system of the Basin of Mexico, including: 3) the Mexican duck (*Anas diazi*), a species closely associated with wetlands, tulares (reed beds), and chinampa canals. Capturing these birds requires well-organized aquatic infrastructure, including canoes, large nets, enclosures, and detailed knowledge of internal water currents, winds, and roosting sites [13].

One common technique for capturing aquatic birds involved visiting their resting sites during moonless nights or at dawn. Hunters deployed encircling nets stretched between two points of a canal and then drove the ducks toward the net using noise, paddles, and occasionally torches [13, 38]. Another technique involved the “siege” of roosting areas, where ducks rested within dense vegetation. Hunters would quietly approach via the canals, and when the birds took flight, they were entangled in previously set nets [39].

This hunting activity ensured a steady supply of aquatic birds to urban markets. Markets such as Tlatelolco were known for their regular trade in products from the lake ecosystem, including birds, fish, and axolotls [38]. In royal courts, culinary practices reached notable levels of refinement. Cortés [42] reported that during the banquets of Moctezuma, dishes included “birds stuffed with seeds and honey.” More recent studies suggest that the gastronomic preparation of birds incorporated ingredients such as amaranth, cacao, and chili peppers, anticipating culinary techniques that have persisted in contemporary Mexican cuisine, particularly in the preparation of mole [13].

Medicine: Diagnosis, Healing, and Omens of Disease

Medicine in pre-Hispanic Mesoamerica developed as a complex system that integrated empirical observation with botanical, zoological, and mineral knowledge, alongside a profound symbolic understanding of the human body. Among Nahua, Maya, and Mixtec societies, health was understood as the result of balance among several vital forces, including *tonalli* (solar energy located in the head), *teyolía* (the essence of the heart), and *ihíyotl* (vital breath contained in the liver). When one of these elements was weakened or separated from the body due to physical, emotional, or spiritual causes, illness was believed to result [11].

Medical specialists, known among the Nahua as *ticitl* (physician-healers), combined a variety of

techniques and therapeutic approaches to treat illness. These included basic surgical procedures, medicinal plants, physiological observation, and ritual practices invoking divine forces. Diagnosis relied on several forms of observation and interpretation, including pulse examination, assessment of body temperature, observation of urine, and the interpretation of dreams and omens reported by the patient. Treatments included herbal infusions, ointments, bloodletting procedures, steam baths (*temazcalli*), therapeutic massages, and ritual offerings intended to restore spiritual balance [44].

Within this medical framework, birds played an important role as sources of therapeutic substances—often linked to dietary practices, in which gastronomy and medicine formed a continuous therapeutic system—as well as instruments for diagnosis and messengers of pathological omens [41]. Because birds were associated with the sky through their capacity for flight, they were symbolically linked with purifying and revitalizing forces. For this reason, certain anatomical parts of birds were used in treatments intended to restore lost tonalli.

The *Libellus de Medicinalibus Indorum Herbis* constitutes the most important surviving medical document preserving Indigenous therapeutic knowledge. This manuscript records various medicinal uses of bird products, which functioned as symbolic materials, “active principles,” or as excipients and carriers incorporated into medicinal formulations alongside ingredients of animal, plant, and mineral origin [41]. These preparations were used either as pharmacological treatments or as substances imbued with symbolic power to treat different ailments (Table 1). The turkey was one of the most important therapeutic species in pre-Hispanic medical practice. In the *Códice de la Cruz-Badiano* [41], it is recorded that fat obtained from the bird was heated and mixed with copal resin and powdered dried maguey leaves. Once the mixture reached a warm temperature, it was applied to the elbows and knees, primarily to treat joint inflammation and muscular stiffness, a condition known as *coacihuiztli* (“bone pain”). The warmth and unctuous texture of the preparation were believed to facilitate mobility and relieve pain [41].

Turkey broth was also prescribed for patients suffering from fever and physical weakness. The meat was boiled together with cracked maize, epazote leaves, and lake salt, and the patient was instructed to drink the broth at dawn for four consecutive days [13]. This preparation was commonly recommended for weakened individuals experiencing fever or fatigue, as well as for women recovering after childbirth. According to traditional beliefs, consuming the broth allowed the *bird's tonalli (vital energy)* to transfer to the patient's body, since the turkey was symbolically associated with household sustenance and shared vital energy [45].

In the Maya region, Landa [46] documented the use of powdered macaw bones, which were mixed with honey to alleviate respiratory ailments. Because the macaw was symbolically associated with the rising sun, it was believed to carry vital warmth, and its essence was therefore applied in the treatment of illnesses considered “cold” in nature.

Montezuma quail (*Cyrtonyx montezumae*, *zōlin* in Nahuatl) was commonly used in pediatric treatments. When a child suffered from *tōnallapōhualiztli* (loss of the soul caused by fright) or persistent fever, the *ticitl* would sacrifice a quail and apply small amounts of its blood to the child's fontanelle and chest to “call back the vital energy.” This practice was based on the belief that the bird's lightness and vitality could be transferred to the patient. Afterward, the body of the bird was buried near the family hearth as part of a ritual closure. In some cases, male quails were sacrificed at dawn in ceremonies intended to promote the healing of individuals suffering from bone fractures [47].

Feathers of the barn owl (*Tyto alba*, *tecolotl*) were used in protective rituals against illnesses believed to have spiritual origins. When a child experienced convulsions or nocturnal crying, owl feathers were sometimes incorporated into infusions intended to treat insomnia and night fears, as it was believed that the owl—being a creature that dominated the darkness—could “teach the patient to sleep without disturbance from spirits” [41]. In other cases, owl feathers were placed on the patient's bed to ward off underworld entities believed to steal the *tonalli* during

sleep [11]. In this context, the therapeutic function was primarily ritual, yet it formed an integral part of Indigenous medical practice. Owls were also considered birds of omen: when an owl called near a dwelling, it was interpreted as a sign of severe illness or imminent death. If the call were heard for three consecutive nights, the *ticitl* would perform a purification ceremony involving copal incense and the sacrifice of a small bird to divert the ominous fate [11, 13].

The hummingbird (family *Trochilidae*, *huitzilin*) was used in amulets intended to counteract extreme fatigue and loss of vitality. Small talismans were made using hummingbird feathers and placed on the chest of the patient to restore the *yōllōtl* (vital spirit). The therapeutic effect was symbolic, rooted in the bird's tireless energy [48, 22]. Lacustrine ducks such as the Mexican duck (*Anas diazi*) were used as a source of medicinal fat, which was mixed with fine ash to treat skin dryness and burns, promoting wound healing. When patients suffered from respiratory problems, duck feathers were sometimes used to guide steam toward the patient's face to facilitate inhalation—a practice reminiscent of empirical humidification techniques. In addition, feathers served as practical medical instruments, for example, to clean wounds or apply ointments, taking advantage of their fine, absorbent texture [13, 49].

The Quetzal was considered an animal reserved primarily for spiritual use. Its feathers were placed on the chest of patients suffering from *yōllōtl tlacacōlli* ("sorrowful heart"), a condition comparable to depression or loss of will, with the intention that the divine breath of Quetzalcóatl would restore inner harmony [14, 45]. Birds also played a role in diagnosing conditions attributed to *mal aire* (*ehecatl cualoni*, harmful wind), which was believed to be carried by certain nocturnal air currents capable of bringing illness. If, following a cold wind, a flock of owls or crows (*Corvus* sp.) appeared nearby, the illness was interpreted as having been caused by *mal aire*. Treatment involved a ritual cleansing using feathers of eagle or macaw, followed by a steam bath (*temazcalli*) intended to expel the harmful influence [13, 46].

Taken together, pre-Hispanic medical practice integrated knowledge derived from birds in both material and symbolic dimensions, incorporating them as therapeutic elements, diagnostic indicators, and spiritual mediators [14, 11]. This medical system did not separate physiology from symbolism; healing was understood as restoring harmony between the body, the soul, and the cosmos [45].

Such practices reflect a holistic worldview in which the human body, vital energy, and nature were perceived as inseparable components of a unified system. The persistence of practices such as preparing and consuming turkey broth or ritual cleansings with feathers in contemporary Indigenous communities demonstrates the continued vitality of this biocultural knowledge. Far from being mere superstition, these practices combined empirical observation, natural pharmacology, and a sophisticated theory of vital balance [11, 49].

Miscellaneous Uses: Captivity and Domestication

Birds also played fundamental roles in economic, political, technological, and ecological contexts. Their value derived primarily from their plumage, natural behavior, and ability to adapt to diverse ecological environments. These characteristics allowed Mesoamerican societies to develop complex production systems, establish extensive feather trade networks through sophisticated markets, and reinforce social organization [50, 26]. One of the most important uses of bird feathers was the creation of prestige goods and material objects. In cultures such as the Mexica, Maya, and Mixtec, featherwork developed into a highly refined artistic tradition known as the "feather art." In Tenochtitlan, a district known as Amantlán was inhabited by the *amanteca*—master feather artisans who specialized in the technique known as *tōntli*, or feather mosaic [26, 38]. Featherwork achieved remarkable levels of technical and aesthetic sophistication in the production of garments and ceremonial objects, including cloaks, fans, banners, shields, and other elements associated with authority and political power. These objects symbolized prestige, material wealth, social hierarchy, and elite status within Mesoamerican societies [38].

Valuable feathers were obtained through several principal channels:

a) Tribute acquisition. Feathers were commonly collected as tribute from subordinate provinces. These regions sent shipments of feather “bundles” classified by color and type, reflecting a structured system of state accounting and supply management intended to provide materials for the imperial court and its artisans [38, 13]. Tribute consignments frequently included feathers of the resplendent quetzal, scarlet macaw, and green macaw (*Ara militaris*). Such materials were delivered to the huey *tlatoani* as tribute payments, since feathers were regarded as high-prestige luxury goods. Their color, lightness, and rarity associated them with the celestial realm, granting them a symbolic and economic value comparable to jade or cacao [11, 13].

b) Market exchange. Trade in feathers represented an important economic activity within Mesoamerican commercial networks. Many bird species with highly valued plumage inhabited tropical environments, so societies in the Central Highlands depended heavily on exchange with communities in rainforest and coastal regions [38, 26]. Feathers circulated through market exchange either as raw materials or as already manufactured featherwork items. Berdan [51] emphasizes that the system did not depend on a single mechanism: tribute and market exchange operated simultaneously and complemented each other. Long-distance trade often involved the participation of *pochteca*, professional merchants who served as specialized agents responsible for obtaining exotic goods from distant regions, including feathers from tropical areas, and integrating them into interregional trade routes. Feathers from species such as the scarlet macaw, the resplendent quetzal and various parrots and parakeets (family *Psittacidae*) were especially valued due to their brilliant coloration and durability [38].

Among the most frequently traded and prized feathers were those of the resplendent quetzal, scarlet macaw, roseate spoonbill (*Platalea ajaja*), blue cotinga (e.g., *Cotinga amabilis*, often referred to in discussions of blue feathers as *xiuhtototl*), green parrots and parakeets, and eagle down (*Aquila*

chrysaetos), which was used in military insignia [51,52].

The value of feathers depended on several factors:

- i. Ecological rarity and distance of origin (the farther the source, the higher the value).
- ii. Political control over the region of origin, especially in the case of tribute from provinces supplying fine feathers.
- iii. Color and brilliance, since highly saturated colors—such as iridescent greens, intense reds, yellows, and blues—produced a luminous visual effect associated with prestige and with *tonalli* (vital energy).
- iv. Size and structural suitability, for example long intact feathers used in headdresses and fine down used for decorative borders and finishing details; and
- v. Method of acquisition, since birds were not always killed to obtain their feathers. In some cases, management strategies in captivity were implemented to maintain a continuous supply and ensure stable feather production [52, 53].

c) Elite reciprocity. Feathers and featherwork objects also circulated through diplomatic exchanges and prestige redistribution among elites. These items could be given as gifts between rulers or awarded to distinguished warriors, reinforcing existing social hierarchies and political alliances [51, 52].

One of the most notable examples of feather art is the so-called headdress of Moctezuma, also known as the *quetzalapanecáyotl* (Late Postclassic period). Its most distinctive element consists of long iridescent feathers of the resplendent quetzal, which form the semicircular rear section and produce the characteristic emerald-green coloration with bluish reflections [54, 55].

The headdress also incorporates feathers from the scarlet macaw, cotinga (*Cotinga amabilis*), and possibly species of trogons and parrots, contributing red, blue, and yellow tonalities that create the hierarchical chromatic effect characteristic of Mexica featherwork [56, 57]. The base of the headdress consists of a support made from vegetal fibers covered with textiles and decorated with mosaics of

turquoise, resins, hammered gold sheets, shells, leather, and beads made from jadeite or other semiprecious stones [55] (Figure 4).



Figure 4. Representation of the headdress of Moctezuma (*quetzalapanecáyotl*), highlighting the use of resplendent quetzal feathers [Created by the authors].

Bird feathers played an important role in military contexts, particularly among the Mexica (Aztecs), who used them as insignia of military rank. These feathered insignia allowed for the rapid identification of a warrior's status, prestige, battlefield experience, and position within the military [56, 58]. They were commonly incorporated into headdresses and zoomorphic helmets representing symbolic animals such as the eagle and the jaguar (*Panthera onca*). Warriors wearing these costumes used feathered headdresses that evoked the characteristics of these animals, which were regarded as manifestations of solar power, strength, and dominance [59].

Feathers of the resplendent quetzal were particularly valued because of their rarity and their association with divine power and noble status. As a result, their use was restricted primarily to the military elite and high-ranking individuals [59]. Feathers were also incorporated into military standards (*pāmitl*), which allowed commanders and specific military units to be identified during battle, as well as into shields (*chimalli*) and ceremonial battle attire. In these contexts, feathers served both tactical and psychological functions, increasing the visibility of the warrior while projecting an image of authority and intimidation toward the enemy [58].

Feather mosaics—created through layering and adhesive techniques—required careful selection of fragments that maintained brilliance and structural stability. This technique was commonly used in ceremonial garments and shields, where artisans prioritized the density and durability of down feathers and contour feathers [52]. Quetzal and heron feathers were also used to create headdresses and garments associated with divine representations. Such feathered adornments were incorporated into the attire of deities including Tezcatlipoca, the creator god; Tlaloc, the rain god; and Huitzilopochtli, the solar and war deity and patron of Tenochtitlan [60].

Feathers also served practical purposes. They were sometimes used as insulating materials in clothing, helping protect individuals from cold conditions in highland regions. This use reflects empirical knowledge of the physical properties of feathers, including their light weight and thermal insulation capacity [26]. Due to the fragility and organic nature of feathers, however, relatively few feathered artifacts have survived to the present day [61].

Birds also played practical roles in material production. Feathers were used as tools in the creation of codices, functioning similarly to brushes for applying pigments or as decorative components in pictographic manuscripts. Their light weight facilitated transport and preservation, making them a portable symbolic medium [26]. In addition to feathers, bird skulls, beaks, and bones were used in the production of ornaments and tools, demonstrating the comprehensive use of avian materials beyond purely decorative purposes [21].

From an ecological perspective, birds also functioned as environmental indicators. Their presence or absence allowed communities to identify changes in ecosystems. For example, ducks and herons served as indicators of lake and wetland conditions, while their absence could signal drought. The arrival or departure of migratory birds also indicated seasonal changes, enabling agricultural societies to synchronize maize planting and develop precise ecological calendars that supported sustainable environmental management. Birds were also observed as predictors of natural phenomena and as natural controllers of pests, since they

consumed insects and rodents in agricultural fields, markets, and domestic spaces [11, 37].

Observation of bird behavior constituted an important form of empirical knowledge. Priests specialized in divination, known as *tlamatini* ("wise men"), interpreted bird songs, flight directions, and the times of day when certain species appeared to predict political or natural events [8]. For example, when barn owls (*Tyto alba*) were observed near a dwelling, they were considered harbingers of death, and their nocturnal calls were interpreted as warnings of illness or warfare. In contrast, the morning appearance of the quetzal was regarded as a sign of political legitimacy, reinforcing the perception of birds as messengers of the gods.

The domestication of birds in pre-Hispanic Mexico encompassed several species that ancient Mesoamerican societies were able to manage and breed in captivity. Archaeological and ethnohistorical sources report the construction of cages made from adobe and other local materials, where birds were maintained for reproduction. This practice implies a form of domestication that was not necessarily oriented toward food production but rather toward religious purposes, including ritual sacrifice and the use of feathers in ceremonial attire and symbolic objects [37 26].

Birds were also used as messengers in a more literal sense. Some early colonial chronicles mention the use of trained wild pigeons to transmit messages between allied cities during the so-called "flower wars." Although this practice was not systematic, it demonstrates an early awareness of animal-assisted communication in Mesoamerican societies. Some of the bird species, their names, and their documented uses during the pre-Hispanic period (Table 2).

Table 2. Bird species recorded in pre-Hispanic sources and early colonial documents.



*Huexōlōtl
** Turkey
***Meleagris gallopavo



Cuāuhtli
Golden eagle
Aquila chrysaetos



Quetzalli
Resplendent quetzal
Pharomachrus
mocinno



Tecolotl
Barn owl
Tyto alba



Pīpiān
Mourning dove
Zenaida macroura



Cōcōtli
Inca dove
Columbina inca



Tlahuequechol
Roseate spoonbill
Platalea ajaja



Acolotl
Great egret
Ardea alba



Tzinitzcan (maya)
Motmot
Momotus momota



Moan (maya)
Great horned owl
Bubo virginianus



Cuitlacoche
Curve-billed thrasher
Toxostoma curvirostre



Xiuhtototl
Red-crowned parrot
Amazona viridigenalis



Acacalotl
Peregrine falcon
Falco peregrinus



Miztötötł
Sharp-shinned hawk
Accipiter striatus



Tlahuequecholi
American flamingo
Phoenicopterus ruber



Tötölin
Ocellated turkey
Meleagris ocellata



Ayauhcihuatl
Yellow-crowned night
heron



Cacötötł
Keel-billed toucan

Nyctanassa violacea



Huitzilin / Tzunun
Hummingbird
Amazilia tzacatl

Ramphastos sulfuratus



Aquetzalli
Scarlet macaw
Ara macao



Cōyōtl
Raven
Corvus corax



Atl tōtōtl
Mexican duck
Anas diazi



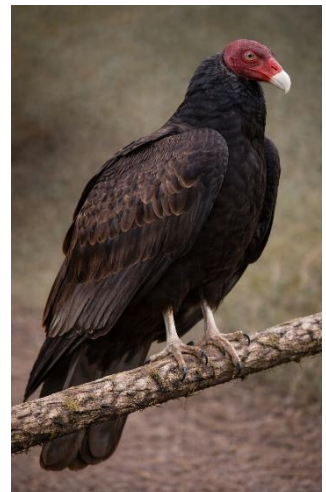
Zōlin
Montezuma quail
Cyrtonyx montezumae



Atlauhquechol
White ibis
Eudocimus albus



Tēcolōtl ītzcuīntli
Ferruginous pygmy owl
Glaucidium brasilianum



Papan
Turkey vulture
Cathartes aura

* Pre-Hispanic name; ** Common name; *** Scientific name.

[Created by the authors].



Cozcatototl
Parakeet
Aratinga spp.



Chachalac (Maya)
Chachalaca
Ortalis vetula

Maintaining aviaries also functioned as a symbol of political power. Several bird species have been documented in these controlled environments: (a) various species of psittacids kept primarily for ornamental purposes; (b) the scarlet macaw, which was symbolically associated with the sun and fire; (c) the green macaw, to which judicial symbolism was attributed, as it was believed that if the bird cried out during a legal proceeding, the accused individual would be condemned to death; (d) the Montezuma quail (*Cyrtonyx montezumae*), regarded as a companion of the sun; (e) the trogon (*Trogon mexicanus*), known among the Mexica as *Tzinitzcan*,

valued for its striking plumage and raised in cages for religious purposes, with its feathers used to create ornaments for festivals, warfare attire, and ritual dances; (f) the golden-fronted woodpecker (*Centurus aurifrons*), believed to be used by sorcerers and diviners to reveal a person's destiny; (g) various songbirds (Passeriformes), which were highly valued because their songs were associated with rainfall and interpreted as omens of future events—agitated or harsh calls were thought to foretell death, whereas melodic songs signaled joy and prosperity; and (h) the northern mockingbird (*Mimus polyglottos*), known as the ceniztli, admired for its melodious song and its remarkable ability to imitate both human voices and the calls of other birds [62, 63, 64].

For these reasons, birds were often captured using snare traps or nets and then transported in cages to households or markets. Specialized occupations existed for individuals involved in bird husbandry and trade. The term *Totocalli* referred to aviaries or places where birds were kept; Totolnamacac referred to bird sellers; and Totoltenamacac referred to individuals who sold bird eggs (such as those of turkeys or ducks). The earliest archaeozoological records of bird management come from sites in central Mexico, including Temamatla and Tlatilco, dating to approximately 3,000 years ago [65, 8, 42]. Maintaining such aviaries requires a logistical network of hunters, caretakers, and food suppliers, reflecting the degree of administrative organization and control over natural resources.

The Florentine Codex contains detailed descriptions of numerous bird species present in Mesoamerica [8]. Additionally, in a letter addressed to Charles I of Spain, Hernán Cortés described the imperial aviaries. They explained how each species was fed according to its specific dietary requirements by specialized caretakers [42]. According to early chroniclers, these aviaries contained a remarkable diversity of species—including aquatic birds, tropical birds, and raptors—indicating extensive knowledge of bird management and reproduction [37]. Bernal Díaz del Castillo, in *Historia verdadera de la conquista de la Nueva España* (1576–1632), also describes Moctezuma's famous zoo [66]. (Figure 5). Ethnohistorical studies based on Spanish accounts report that the collections included ducks (Anatidae),

herons (Ardeidae), cracids (Cracidae), and several species of parrots (Psittacidae) and passerines (Passeridae) [64].



Figure 5. Representation of Moctezuma's Zoo, showing different bird species kept in captivity and under domestication [Created by the authors].

Today, resplendent quetzals inhabit isolated forest areas in the Verapaz region of Guatemala and adjacent regions of Honduras, El Salvador, and Chiapas in southern Mexico. Their distribution also extends farther south into Nicaragua, Costa Rica, and Panama [67]. According to early colonial records, killing a quetzal was severely punished [13]. Paradoxically, Spanish colonial regulations may have indirectly helped protect the species from extinction. In 1625, colonial authorities prohibited the use of quetzal feathers because they were closely associated with pre-Christian ritual practices, effectively ending their collection and trade [68].

4. Final Considerations: History, Biocultural Memory, and Avifaunal Conservation

The study of bird uses in pre-Hispanic Mexico transcends purely historical or archaeological interest; it offers a privileged perspective for understanding the depth of the relationship between society and nature in Mesoamerica.

Across the civilizations examined, several consistent patterns emerged regarding the relationships between humans and birds in pre-Hispanic Mesoamerica. Regardless of cultural affiliation, birds were not regarded solely as food but as multifunctional components of society, fulfilling ritual, symbolic, medicinal, economic, technological, and political roles. Species

possessing conspicuous plumage, striking vocalizations, or distinctive behavioral traits were consistently assigned greater symbolic value than those used exclusively for subsistence. Among the most culturally significant species were the resplendent quetzal, whose feathers symbolized divine authority and political legitimacy; the golden eagle, representing warfare, solar power, and military prestige; the scarlet macaw, associated with the sun, fire, and elite ceremonial attire; and the turkey, which was unique in combining dietary, medicinal, domestic, economic, and ritual functions.

Although many patterns were shared throughout Mesoamerica, notable cultural differences were identified. The Maya emphasized birds as mediators between the human and supernatural worlds, particularly through the symbolic importance of the quetzal, hummingbirds, and trogons within cosmological narratives. In contrast, the Mexica integrated birds more directly into state organization, military hierarchy, tribute systems, and imperial ideology, as reflected by the extensive use of feathers in political insignia, ritual offerings, and elite regalia documented in the Codex Mendoza and the Florentine Codex. The Zapotec and Mixtec traditions likewise incorporated birds into religious iconography and ceremonial attire. In contrast, evidence from the Olmecs suggests an earlier symbolic association among raptors, waterbirds, and concepts of fertility, rulership, and the natural order. Collectively, these findings indicate that the cultural significance of birds increased with the complexity of sociopolitical organization, demonstrating that avifauna constituted a fundamental component of Mesoamerican biocultural systems rather than merely a natural resource.

Understanding this history allows us to recognize that present-day Mexican biodiversity is not only the result of natural processes but also of a biocultural legacy constructed over millennia. The controlled husbandry of turkeys, the ritual but non-lethal capture of quetzals, and the maintenance of imperial aviaries demonstrate that early forms of

wildlife management existed. Although embedded within religious cosmologies, these practices reveal empirical conservation strategies that can inform modern approaches to environmental protection, expand knowledge of avian diversity, and support conservation efforts.

Today, Mexico faces a rapid decline in bird populations due to deforestation, illegal wildlife trafficking, and habitat fragmentation. Recovering the historical memory of birds' symbolic, economic, and dietary importance provides a powerful tool for promoting contemporary social awareness. When communities recognize that certain species were integral to their cultural identity, a stronger sense of belonging and responsibility toward their protection emerges.

Integrating this knowledge into educational programs, museum exhibitions, and science communication initiatives allows history to become not merely a static body of knowledge but a tool for environmental action. Teaching about the ancestral relationship between humans and birds fosters a citizenry capable of understanding that biodiversity is not merely ornamental but a structural component of collective memory.

Consequently, historical research on pre-Hispanic avifauna does more than reconstruct the past; it also informs the future by providing cultural foundations for conservation strategies, environmental legislation, and ecological education. In doing so, it helps preserve Mexico's bird diversity while safeguarding an irreplaceable part of the civilization that gave these species their cultural significance.

Despite the substantial historical and ethnobiological information synthesized in this review, several important knowledge gaps remain. Much of the current understanding of bird use in pre-Hispanic Mesoamerica relies on colonial chronicles and iconographic interpretations. In contrast, direct archaeological, archeozoological, and biomolecular evidence remains comparatively scarce for many regions and cultures. Future research should prioritize interdisciplinary approaches integrating

zooarchaeology, ancient DNA, stable isotope analysis, residue chemistry, and paleoproteomics to verify species identification, trade routes, captive breeding practices, and the geographic origin of feathers recovered from archaeological contexts.

Likewise, the medicinal use of birds described in colonial codices represents an underexplored field that could benefit from pharmacological, toxicological, and ethnomedical investigations to evaluate the biological properties of avian-derived materials and to distinguish empirical therapeutic practices from symbolic healing traditions. Comparative studies among Indigenous communities may also help determine the extent to which ancestral knowledge concerning birds has persisted, transformed, or disappeared following European colonization. Additionally, future investigations should explore how traditional ecological knowledge associated with birds can contribute to modern conservation biology, particularly regarding community-based wildlife management, environmental education, and the protection of culturally significant species.

From a biomedical perspective, historical records describing avian-derived remedies provide opportunities to investigate their potential nutritional, antimicrobial, anti-inflammatory, or wound-healing properties using modern experimental approaches. Integrating historical, archaeological, ecological, veterinary, and biomedical disciplines will not only improve our understanding of past human–bird interactions but also strengthen the application of biocultural knowledge to contemporary conservation strategies, public health, and sustainable wildlife management.

5. Conclusiones

The analysis of ritual, economic, dietary, and practical uses of birds in Mesoamerica reveals that avifauna constituted a fundamental axis of pre-Hispanic life. Each species occupied a defined place within cosmology, social hierarchy, and imperial economy. The quetzal symbolized sacred legitimacy;

the eagle embodied solar warfare; the owl guided the dead; and the turkey sustained both ceremonial and everyday nourishment, among many other examples. These relationships generated systems of management, trade, and symbolism that inseparably integrated nature and culture.

Understanding this historical interaction allows us to recognize that contemporary biodiversity is the result of a long tradition of coexistence. The memory of these relationships provides a strong cultural foundation for promoting the appreciation and protection of Mexican bird species. Thus, studying the past not only reconstructs ancient civilizations but also provides essential tools for addressing contemporary challenges related to biological conservation and the preservation of Mexico's biocultural heritage.

Acknowledgments

The authors thank the Consejo Nacional de Humanidades, Ciencias y Tecnologías (CONAHCYT) for the scholarship awarded under CVU 2078686, which supported the completion of the master's degree in animal science and animal health at the Autonomous University of the State of Hidalgo.

Conflict of Interest

The authors declare no conflicts of interest.

Funding statement

The author(s) received no financial support for the research, authorship, and/or publication of this article.

References

- [1] Navarro, A. G. (1994). Historia de la ornitología en México. En T. P. Ramamoorthy et al. (Eds.), *Diversidad biológica de México* (pp. 391–421). UNAM.
- [2] American Research Center in Egypt. (2026). Tomb of Menna (TT69) in the Theban Necropolis [Visita virtual]. <https://my.matterport.com/show-mds?m=vLYoS66CWpk>
- [3] Berdan, F. F. (2006, January 21). Circulation of feathers in Mesoamerica. *Nuevo Mundo Mundos Nuevos*, Colloques. <https://doi.org/10.4000/nuevomundo.1387>

- [4] Nichols, D. L., & Pool, C. A. (2012). The Oxford handbook of Mesoamerican archaeology. Oxford University Press.
- [5] Evans, S. T. (2004). Ancient Mexico and Central America. Thames & Hudson.
- [6] Smith, M. E. (2013). The Aztecs (3rd ed.). Wiley-Blackwell.
- [7] Berdan, F. F., & Anawalt, P. R. (1992). The Codex Mendoza. University of California Press.
- [8] Sahagún, B. (1950–1982). Florentine Codex. School of American Research.
- [9] Navarro-Sigüenza, A., Ortiz-Pulido, R. & Townsend, P. (2008). Un panorama breve de la historia de la ornitología mexicana. ORNITOLOGIA NEOTROPICAL 19 (Suppl): 367–379
- [10] Martínez, E. C. (2008). Las aves como recurso curativo en el México antiguo. Arqueología Mexicana, 16(94), 28–33.
- [11] León-Portilla, M. (2006). La filosofía náhuatl estudiada en sus fuentes. UNAM.
- [12] Berdan, F. F., & Anawalt, P. R. (1992). The Codex Mendoza. University of California Press.
- [13] Sahagún, B. (2000). Historia general de las cosas de Nueva España. CONACULTA.
- [14] Badiano, M. (1991). *Libellus de Medicinalibus Indorum Herbis*. UNAM
- [15] Retana-Guiascón, G. O. (2014). Fauna silvestre de México. FCE.
- [16] Gómez-Álvarez, G., Valadez-Azúa, R., Álvarez, Solano-Teutli C. y Reyes-Gómez, R. S. 2005. Manejo en cautiverio de psitácidos utilizados como aves de ornato y compañía. Handling in-bondage parrots used as ornament and company birds., AMVPEE, 16: 5-7
- [17] Trejo-Pérez, L.J. 2006. Aprovechamiento de las aves Silvestres en Boca del Cerro, Municipio de Tenosique, Tabasco, México. Kuxulkab. Revista de Divulgación. XI. 22, p.59-63.
- [18] Gómez-Álvarez, G., & Reyes-Gómez, S. R. (2010). Colibríes comercializados como productos medicinales en el Distrito Federal. El Canto del Centzonle, 1, 103–108.
- [19] Vázquez-Dávila, M.A., Jerez-Salas, P. Camacho-Escobar, A.M. 2012. Las diversidades ornitológica, cultural y agro-ornitológica en Oaxaca: antecedentes y perspectivas. En: Vázquez-Dávila M.A. y Lope-Alzina G.D. Aves y Huertos de México Marco A. Vázquez-Dávila Diana G. Lope-Alzina. D.R. Instituto Tecnológico del Valle de Oaxaca/Carteles Editores/Red de Etnobiología, Oaxaca, México p.38-39
- [20] Lacunza, M. (2025). Colibrís: ¿solo aves o mensajeros de los dioses?. https://unamglobal.unam.mx/global_revista/colibris-solo-aves-o-mensajeros-de-los-dioses/
- [21] Navarrijo-Ornelas, M. L. 1995. Toponimia ornitológica mexicana. Cuad. Ins. Biol. UNAM 28: 78.
- [22] Coe, M. D., & Houston, S. D. (2015). The Maya (9th ed.). Thames & Hudson.
- [23] Anderson, E. N. (2017). Birds in Maya imagination: A historical ethno-ornithology. Journal of Ethnobiology, 37(4), 621–638.
- [24] Smith, M. E. (2013). The Aztecs (3rd ed.). Wiley-Blackwell.
- [25] López Luján, L. (2005). The offerings of the Templo Mayor of Tenochtitlan. University of New Mexico Press.
- [26] Townsend, R. F. (2010). Featherwork in Aztec Mexico. Dumbarton Oaks.
- [27] Sugiyama, N. (2005). Human sacrifice, militarism, and rulership. Cambridge University Press.
- [28] Navarrijo-Ornelas, M. L. (1997). Las aves en el imaginario mesoamericano. Cuadernos del Instituto de Biología UNAM, 45, 48–53.
- [29] Espinoza, G. (1994). Las aves acuáticas como medio de interpretación del cosmos. Revista Ciencias UNAM, (34).
- [30] López Austin, A. (1994). Tamoanchan, Tlalocan: Places of mist. University Press of Colorado.
- [31] Sharpe, A. E. (2014). A reexamination of the birds in the central Mexican codices. Ancient Mesoamerica, 25(2), 317–336. <https://doi.org/10.1017/S0956536114000297>
- [32] Meléndez, J. (2018). Antecedentes en la avicultura en México. BM Editores. <https://bmeditores.mx/entorno-pecuario/antecedentes-de-la-avicultura-en-mexico-1551/>
- [33] Camacho-Escobar, M. A., Jiménez-Hidalgo, E., Arroyo-Ledezma, J., Sánchez-Bernal, E. I., & Pérez-Lara, E. (2011). Historia natural, domesticación y distribución del guajolote (*Meleagris gallopavo*) en México. Universidad y Ciencia, 27(3), 351–360. http://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S0186-29792011000300009
- [34] Leopold, A. S. (1959). Wildlife of Mexico. University of California Press.
- [35] Crawford, R. D. (1990). Origin and history of poultry species. In R. D. Crawford (Ed.), Poultry breeding and genetics (pp. 1–23). Elsevier.
- [36] Lozada J (1976) El guajolote silvestre en México. Memorias de la Segunda Reunión Anual. Secretaría de Agricultura y Ganadería, julio 4-8; México, D. F., Dirección General de Avicultura y especies menores, 128-130 pp.
- [37] Valadez, R. (2014). Arqueozoología mesoamericana. INAH.
- [38] Berdan, F. F., & Anawalt, P. R. (1992). The Codex Mendoza. University of California Press.
- [39] Valadez, R. (2015). Arqueozoología mesoamericana. Instituto Nacional de Antropología e Historia.
- [40] Bye, R., & Linares, E. (2000). Plantas útiles de México. UNAM.
- [41] Badiano, M. (1991). *Libellus de Medicinalibus Indorum Herbis*. UNAM.
- [42] Cortés, H. (1986). Cartas de relación. Biblioteca Ayacucho.
- [43] Florescano, E. (2012). El mito de Quetzalcóatl. FCE.
- [44] Ortiz de Montellano, B. R. (1990). Aztec medicine, health, and nutrition. Rutgers University Press.
- [45] López Austin, A. (1988). The human body and ideology. University of Utah Press.
- [46] Landa, D. de. (1986). Relación de las cosas de Yucatán. Historia 16. <https://www.cervantesvirtual.com/obra/relacion-de-las-cosas-de-yucatan/>
- [47] Ortiz de Montellano, B. R. (1990). Aztec medicine, health, and nutrition. Rutgers University Press. <https://archive.org/details/aztecmedicinehea00orti>
- [48] Olguín Lacunza, M. (2025, marzo 25). Colibrís: ¿solo aves o mensajeros de los dioses? UNAM Global. https://unamglobal.unam.mx/global_revista/colibris-solo-aves-o-mensajeros-de-los-dioses/
- [49] Martínez, E. C. (2008). Las aves como recurso curativo en el México antiguo. Arqueología Mexicana, 16(94), 28–33.
- [50] Suárez, D. (2004). Comercio y redes económicas en Mesoamérica prehispánica. INAH.
- [51] Berdan, F. F. (2006). Circulation of feathers in Mesoamerica. Nuevo Mundo Mundos Nuevos. <https://doi.org/10.4000/nuevomundo.1387>
- [52] Caplan, A. (2024). The cotinga and the hummingbird. In The Routledge Companion to Global Renaissance Art. Routledge. <https://doi.org/10.4324/9781003294986-38>
- [53] Somerville, A. D., Nelson, B. A., & Knudson, K. J. (2010). Isotopic investigation of pre-Hispanic macaw breeding in northwest Mexico.

- Journal of Anthropological Archaeology, 29(1), 125–135.
<https://doi.org/10.1016/j.jaa.2009.10.001>
- [54] Cabrera, R. (2012). El penacho de Moctezuma: Historia, técnica y simbolismo. INAH.
- [55] Weltmuseum Wien. (2020). The Aztec feather headdress.
<https://www.weltmuseumwien.at/en/object/aztec-feather-headdress/>
- [56] Aguilera, C. (1985). *El penacho de Moctezuma*. Instituto Nacional de Antropología e Historia
- [57] Berdan, F. F. (2014). Aztec archaeology and ethnohistory. Cambridge University Press.
- [58] Hassig, R. (1988). Aztec warfare: Imperial expansion and political control. University of Oklahoma Press.
- [59] Boone, E. H. (2000). Stories in red and black: Pictorial histories of the Aztecs and Mixtecs. University of Texas Press.
- [60] Sahagún, B. de. (1927). *Einige Kapitel aus dem Geschichtswerk des Fray Bernardino de Sahagún* (E. Seler, Trans.; C. Seler-Sachs, Ed.). Strecker und Schröder.
- [61] Moreno Guzmán, M. O., Korn, M. R., & Filloy Nadal, L. (2022). Chimalli. Escudos mexicas emplumados. En *Bajo el signo del Sol: Plumas, pieles e insignias de águila* (pp. 54–58). Instituto Nacional de Antropología e Historia.
- [62] Azúa, J. (1994). Aves y simbolismo en Mesoamérica. UNAM.
- [63] Blanco, A., et al. (2009). Aves y cosmovisión en Mesoamérica. *Revista Mexicana de Biodiversidad*, 80, 123–135.
- [64] Corona-Martínez, E. (2002). Las aves en la historia natural novohispana. INAH.
- [65] López Luján, L. (2005). The offerings of the Templo Mayor of Tenochtitlan. University of New Mexico Press.
- [66] Díaz del Castillo, B. (1984). Historia verdadera de la conquista de la Nueva España. Porrúa
- [67] BirdLife International. (2023). *Pharomachrus mocinno*. The IUCN Red List. <https://www.iucnredlist.org/species/22682727/209353309>
- [68] Houston, S. D., & Newman, M. E. (2023). Cultural transformations and avian symbolism in colonial Mesoamerica. *Journal of Anthropological Research*, 79(2), 215–238.