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Ancient symbols and regional biodiversity: Unveiling the world's oldest flag: A historical review and interdisciplinary approach integrating archaeozoology, archaeobotany, and conservation disciplines

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ABSTRACT

Ancient symbols, manifested through motifs in art, architecture, pottery, and other material culture, provide critical insights into the historical relationships between human societies and their environments. Many of these symbols depict regional flora and fauna, reflecting the biodiversity prevalent in specific ecological zones at different times in history. These motifs often served multiple functions spiritual, social, and ecological symbolizing deities, mythological creatures, or natural elements central to cultural identity. Analyzing these symbols allows for the reconstruction of past biodiversity patterns and ecological knowledge systems. They frequently encode information about species of ecological and cultural significance, serving as indicators of historical species distribution and abundance. The Flag of Shahdad, an ancient artifact unearthed at the archaeological site of Shahdad in Southeastern Iran, stands as one of the earliest known examples of flag-like objects in human history. Dating to the third millennium BCE, this artifact offers valuable insights into the cultural, social, and political dynamics of early civilizations on the Iranian Plateau, as well as regional biodiversity. The flag consists of a rectangular bronze plate measuring approximately 22 cm in height and 15 cm in width, mounted on a 128-cm metal axle allowing the flag to turn. At its top is an eagle with outstretched wings. The central portion of the bronze plaque features a series of intricate motifs and patterns, including: (i) symmetrical and repetitive geometric designs demonstrating high-precision craftsmanship; (ii) artistic representations of plant life (floral patterns) possibly symbolizing natural elements; (iii) depictions of animals (faunal figures) that may hold cultural or symbolic significance; (iv) representations of human figures, potentially reflecting societal or ritualistic themes; and (v) abstract, non-representational artistic elements highlighting the artisans' creativity. In this study, by integrating archaeological evidence, historical documentation, archaeozoology, archaeobotany, and comparative analyses, we demonstrate how ancient cultures identified, classified, and interacted with their surrounding ecosystems. This interdisciplinary approach contributes to a deeper understanding of long-term human-environment dynamics, elucidates the ecological worldview of past societies, and highlights the profound connections between biodiversity and cultural identity. Such integration underscores the importance of combining ecological and cultural perspectives in archaeological research, enriching fields such as archaeozoology, ethno-zoology, archaeobotany, ethno-botany, and conservation science.

Keywords: Biological Diversity, Zooarchaeology, Architecture, Ancient Art, Western Asia.
Article type: Review Article.

INTRODUCTION

Studying biodiversity involves understanding the variety of life on Earth, including the diversity of species, ecosystems, and genetic variation within species. It is a multidisciplinary field that combines biology, ecology,

genetics, geography, geology, economy and environmental science. The study of biodiversity can be conducted at various scales, ranging from genetic diversity within a single population to the diversity of ecosystems across the globe. Each scale provides unique insights into the complexity and interconnectedness of life on Earth (Wilson 1988; Gaston & Spicer 2004; Magurran 2004). Since ancient times, communities across the globe have relied on their indigenous knowledge of natural resources including fauna and flora to fulfil a wide range of needs (Hounkanrin *et al.* 2022). This traditional knowledge has provided them with the means to interpret the origins and characteristics of the various components of their environments. Such knowledge is often encapsulated in stories, fables, and the experiences of elders, offering solutions to challenges faced in the past and transmitted across generations (Hounkanrin *et al.* 2022). Nature is perceived in diverse forms, and its representation can vary significantly across cultures and contexts. Local art often serves as a medium through which human perceptions of nature are expressed, encapsulating cultural imagination, wisdom, and interactions with the natural environment (Vidal *et al.* 2024). For example, the depiction of fish in artistic works across different cultures can provide valuable insights into the species present in local ecosystems, their ecological and cultural significance, and historical events associated with them (Overduin-de Vries *et al.* 2023). Art can thus serve as a tool for accessing information on historical occurrences, species abundance, ecological dynamics, and behavioral patterns. Furthermore, it can be used to establish ecological baselines by examining temporal and spatial variations (Begossi & Caires 2015). The dynamic relationships between humans, their cultures, and the natural environment, particularly focusing on how different societies perceive, classify, use, and manage biological resources is subject of an interdisciplinary scientific field, ethnobiology (Alves & Souto 2015). It combines elements of anthropology, biology, ecology, and linguistics to explore the ways in which human communities interact with and understand the living world around them (Alves & Souto 2015). The relationship between biodiversity and ancient art is a fascinating area of study that reveals how human cultures have interacted with and represented the natural world throughout history (Miller & Taube 1993; Wilkinson 1994; Bahn & Vertut 1997; Moradi, 2015; Vidale 2017; Corrado 2022). Ancient art often serves as a visual record of the biodiversity present in a region at a given time, providing insights into species that may have been significant culturally, economically, or ecologically (Miller & Taube 1993; Wilkinson 1994; Bahn & Vertut 1997). Biodiversity has served as (i) a source of inspiration: ancient artists often depicted local flora and fauna, reflecting the biodiversity of their environment and its importance to their culture (Miller & Taube 1993; Wilkinson 1994); (ii) biodiversity in religious and mythological contexts (Zimmer 1946; Boardman 1996); (iii) biodiversity as a record of extinct or endangered species e.g., in ancient art cave paintings and Roman mosaics can provide evidence of species that are now extinct or endangered, offering clues about past ecosystems (Toynbee 1973; Bahn & Vertut 1997); (iv) biodiversity in symbolism and iconography (symbolic representations; animals and plants in ancient art often carried symbolic meanings related to power, fertility, or protection e.g., the dragon, a composite of various animals, symbolized imperial power and natural forces in China and the lion and sun motif, representing strength and sovereignty, often appeared in ancient Persian art (Canby 1993; Sullivan 1984); (v) biodiversity in daily life and economy: ancient art often depicted species that were economically significant, such as domesticated animals and crops in Mesopotamian and Incan arts (Burger 1992; Frankfort 1996); (vi) biodiversity in artistic techniques and materials e.g., use of natural materials/ biodiversity-derived materials, such as plant dyes, animal hides, and mineral pigments by ancient artists including use of papyrus for painting and writing, and natural pigments like ochre and lapis lazuli in Egyptian art, and use of plant-based dyes and animal bones in native American and aboriginal art (Lucas 1962; Berlo & Phillips 1998; Cuzman *et al.* 2011); (vii) biodiversity in ancient environmental awareness including ecological knowledge: ancient art sometimes reflects an understanding of ecological relationships and the importance of biodiversity depictions of hunting scenes and animal tracks, showing knowledge of animal behavior and ecosystems in aboriginal rock art, and frescoes of marine life in Crete, demonstrating an appreciation for the biodiversity of the Mediterranean Sea in Minoan art (Marinatos 1984; Chaloupka 1993); (viii) biodiversity in ancient urban landscapes: ancient art often depicted cultivated landscapes, reflecting human efforts to shape and preserve biodiversity in gardens and parks including reliefs of royal gardens in Nineveh, showcasing exotic plants and animals in Assyrian art, and paintings of imperial gardens, featuring carefully curated biodiversity as is seen in Chinese art (Keswick 1978; Dalley 2013); (ix) biodiversity in ancient trade and cultural exchange: ancient art sometimes depicted species introduced through trade/exotic species reflecting cultural exchange and the spread of biodiversity e.g., depictions of peacocks and parrots, imported from India and Africa in the Roman art, and representations of camels and horses, central to trade along the silk road as observed in the silk road art (Toynbee

1973; Whitfield 2004); (x) biodiversity in ancient conservation practices including using sacred groves and protected areas by some ancient cultures to preserve biodiversity e.g., depictions of sacred groves, where certain species were protected for religious reasons in the Indian art, and representations of sacred forests dedicated to gods like Artemis in the Greek art (Gadgil & Vartak 1976; Hughes 1994); and (xi) biodiversity usage in decoration (the animal motifs in the Avesta in the decoration of the Sassanian metal dishes such as horse, cow, ewe, hen and grain, goat, cock, tiger, hog, rams, eagles, lions, and simorgh (Kazempour & Hosseyni 2021). Depictions of animals and plants in ancient art represent some of the most prevalent and meaningful motifs, illustrating the profound relationship between humans and the natural world across historical periods. Such artistic representations offer critical insights into the cultural, religious, economic, and ecological dimensions of ancient civilizations. These studies underscore the intricate links between biodiversity and ancient artistic expression, revealing how art functions as a lens through which to examine humanity's historical engagement with the natural environment (Smith *et al.* 2020). Mythological creatures, such as griffins or sphinxes, or the lion-bull motifs of Persepolis combined animal features to convey complex ideas. For example, in the Greek art, the sphinx, with a lion's body and a human head, symbolized mystery and wisdom (Boardman 1996), and the lion-bull of Persepolis has been considered as symbol of the time cycle of the day, with lion representing the sun and bull the night (Sathe 2012). Both traditional methodologies and modern analytical techniques offer complementary perspectives on the diversity, ecology, and evolutionary dynamics of ancient life forms, regional biodiversity, and the reconstruction of historical landscapes (Jia *et al.* 2022; Roy *et al.* 2024). Traditional analyses of past biota are often constrained by the availability of biological remains or non-genetic molecules preserved within stratigraphic layers or sediments. While fossil proxies such as pollen, macrofossils, diatoms, ostracods, chironomids, and pigments have been extensively utilized to trace historical community changes (Shen *et al.* 2020), these morphology-based proxies typically lack the resolution to identify taxa at a high taxonomic level (e.g., species level) and often exclude taxa that do not leave well-preserved or recognizable fossil remains in sediments (e.g., fish, mammals, and bacteria; Wischnewski *et al.* 2011, 2014; Li *et al.* 2019; Ma *et al.* 2020). Ancient DNA (*aDNA*) and osteological analyses (Boilard *et al.* 2024), sedimentary ancient DNA or sedaDNA (Özdoğan *et al.* 2024), 18S metabarcoding of ancient environmental DNA in study of ancient marine biodiversity (Holman *et al.* 2024), low-Invasive sampling method with tape-disc sampling (Fabrizi *et al.* 2024), fecal lipid markers or FLM (Fiedler *et al.* 2025), species distribution modelling and ecological niche modelling (Yousef *et al.* 2020; Frazier *et al.* 2024; Yaworsky *et al.* 2024), next-generation DNA sequencing (ddRADseq) and machine learning (Vasconcellos *et al.* 2024), are advanced analytical approaches for studying past environments that have strengthened interdisciplinary collaboration between archaeology (e.g., zooarchaeology), genetics, ecology and geosciences. Archaeological investigations employing diverse methodologies and tools have significantly enhanced our understanding of past civilizations, encompassing their cultural, religious, economic, and political situation, as well as ancient environmental conditions and biodiversity. Among these ancient civilizations, the Shahdad civilization, located in Southeastern Iran, stands out as a prominent Bronze Age Center (Fig. 1). Discovered in 1968 on the western fringe of the Dasht-e Lut within the Iranian Plateau, it is notably associated with the world's oldest known flag. In this study, we used available data to analyze and describe the biodiversity elements represented on this flag, aiming to achieve the following objectives: (I) documenting biodiversity depictions (systematically identify and catalog the flora, fauna, and ecological elements represented on the Shahdad flag, providing detailed descriptions and visual analyses); (II) deciphering symbolic and cultural significance (investigating the roles of these biodiversity motifs in conveying religious beliefs, social hierarchies, or mythological narratives within the ancient culture that produced the flag); (III) reconstructing historical ecology (analyzing how the depicted species reflect the local environment, climate, and human interactions with nature during the era of the flag's creation e.g., domesticated species, regional flora/fauna); (IV) comparing artistic traditions (situating the Shahdad flag within broader regional artistic practices by comparing its biodiversity motifs with those in contemporaneous artifacts e.g., Mesopotamian, Indus Valley, or Elamite art); (V) to bridge art history and ecology (demonstrating the value of interdisciplinary approaches, integrating archaeology, art history, and environmental science to interpret ancient artifacts); (VI) highlighting conservation relevance (connect historical depictions to modern biodiversity conservation, emphasizing cultural heritage as a tool for raising awareness about species preservation and ecological shifts over time; (VII) exploring socio-economic contexts (examining how depicted species relate to ancient livelihoods, such as agriculture, trade, or resource management, to infer socio-economic practices of the period); (VIII) advocating heritage preservation (stress the importance of safeguarding artifacts like the Shahdad

flag as critical records of both cultural and natural history); and (IX) educating on cultural-environmental interplay (illustrating how ancient art serves as a testament to humanity's enduring connection to biodiversity, fostering appreciation for this relationship in contemporary audiences).

Fig. 1. Middle Asia map with the location of Sahdad and main protohistoric centres (Source: Microsoft Encarta).

MATERIALS AND METHODS

This study employs an interdisciplinary approach to decode the ecological and cultural significance of motifs on the Flag of Shahdad. The methodology integrates: (i) archaeological analysis (examination of the flag's structure); (ii) iconographic decoding (systematic classification of motifs e.g., floral, faunal, human, abstract using comparative art historical frameworks), and cross-referencing with regional symbology (Mesopotamian, Indus Valley) to identify shared or unique cultural themes; (iii) archaeobotanical & archeozoological analyses (identification of species depicted in motifs (e.g., eagle, lion, plants) through morphological comparison with historical biodiversity records and available literatures; (iv) historical and ethnographic correlation (review of textual records such as myths and rituals) from contemporaneous civilizations to interpret symbolic meanings (e.g., eagles as divine symbols); and (v) interdisciplinary synthesis (integration of data streams to reconstruct the flag's role in societal-ecological dynamics e.g., as a ritual object, political emblem, or biodiversity record).

RESULTS AND DISCUSSION

By integrating historical disciplines (archaeology, archaeobotany, archaeozoology, and cultural studies) with modern biodiversity data from Iran and surrounding regions, this study establishes a framework for interpreting ancient artifacts as biocultural archives. This approach provides deeper insights into the region's past biodiversity, structured under the following themes:

Biodiversity and ancient art in Iran

Iran is one of the rich biodiversity countries in West Asia that supports unique and immense aquatic and terrestrial diversity. In Iran, approximately 37,500 animal species have been reported (Norri *et al.* 2024). There are over 2294 terrestrial, marine and freshwater vertebrate species (Owfi 2021; Darvish *et al.* 2023; Norri *et al.* 2024; Sayyadzadeh & Esmaeili 2024; Safaei-Mahroo *et al.* 2025). This includes 1275 fishes including 975 marine species from the Persian Gulf, Strait of Hormuz and Oman Sea, and 300 freshwater/inland water species (Owfi 2021; Sayyadzadeh & Esmaeili 2024), 559 birds (Kaboli *et al.* 2016; Khaleghizadeh *et al.* 2022), 241 reptiles (Rajabizadeh 2018; Safaei-Mahroo 2019; Norri *et al.* 2024), 196 mammals (Yusefi *et al.* 2019; Darvish *et al.* 2023; Norri *et al.* 2024), and 23 amphibians (Safaei-Mahroo *et al.* 2025). This high diversity is due to (i) the climatic, topographic, and geographic diversity of Iran; (ii) high habitat diversity, including 16 terrestrial ecoregions (Olson 2001; Safaei-Mahroo & Ghaffari 2020), 19 freshwater ecoregions, and two marine ecoregions (Spalding *et al.* 2007); (iii) its geographical position as a biogeographical transition zone where three of the world's biogeographical realms (Palearctic, Saharo-Arabian/African, and Oriental) converge (Sayyadzadeh & Esmaeili 2024; Norri *et al.* 2024); (iv) intersecting with two major global biodiversity hotspots: the Caucasus and the Irano-Anatolian regions (Sayyadzadeh & Esmaeili 2024; Norri *et al.* 2024); and (v) its past geological events

and climatic fluctuations: mountain uplifting, past climatic oscillations, and sea level change (Kehl 2009; Yousef *et al.* 2023; Norri *et al.* 2024). These factors had outstanding impacts on evolution, speciation, and diversification of biodiversity in the country. Based on the available literature, four major time periods played a large role in the current setup of the country's faunal diversity starting 4600 million years ago (MYA). Some of the biodiversity representatives of Iran are well illustrated and presented in Iranian art, which represents one of the most profound and diverse artistic traditions globally, encompassing a wide range of disciplines, including architecture, painting, textile weaving, pottery, calligraphy, metalwork, and rock art (Moradi 2015). Throughout its history, Iranian art has maintained an intrinsic connection with nature, particularly through the depiction of plants and animals, which have been central motifs across various periods (Moradi 2015). Furthermore, its integration with poetry and literature has enriched its aesthetic and expressive qualities, contributing to its enduring beauty and cultural significance over time (Moradi 2015). Use of plant and animal imagery, especially fish, in the ancient works such as stone, clay, bronze and fabric (textile) have a long history of several thousand years and they have been used as a symbol of religion, culture, social relationships and economy (Moradi 2015). Silver bowls, bronze bowls, bronze pins, stone baths, pottery (including vats and rhytons), bone artifacts, decorative hilts, coins, glazed golden bowls, silk kilims (Moradi 2015), and flags (Pittman 1984; Majidzadeh 2003) have been used for depicting plant and animal imagery.

Flags and biodiversity

Flags have historically served as effective symbols, embodying the beliefs and values of the people they represent. Throughout Iranian literature and texts, there are numerous references to flags, highlighting their ancient origins and their profound cultural, political, military, and religious significance. For instance, in the Avesta and Zoroastrian traditions, banners are described as broad, raised, open, and even blood-stained, symbolizing their sacred and martial roles. Similarly, Ferdowsi, in the Shahnameh, vividly portrays the banners of heroes and military leaders, detailing their colors and designs with great care (Ferdowsi 1010 CE/Ferdosi, 2006). Archaeological discoveries of flags from various periods in Iran reveal a rich array of motifs, including geometric patterns, botanical elements, animal figures, human representations, and abstract designs. These motifs not only reflect the beliefs and ideologies of the people of those times, but also showcase the natural environment, including the flora and fauna of the regions where these flags originated (Pittman 1984; Majidzadeh 2003; Sathe 2012). The archaeological discoveries uncovered the oldest know flag with plant and animal symbols in Shahdad civilization, an ancient civilization on the edge of the Lut Desert, the Iranian Plateau, thrived in the third millennium BCE.

Shahdad civilization

The formation of ancient civilizations is a complex process influenced by a combination of natural and human factors. Civilization represents the collective lifestyle of a group of people inhabiting a specific geographical area during a particular historical period, characterized by shared goals and notable achievements (Ghazanfarpour *et al.* 2022). Lifestyle is a fundamental component of civilization, which is influenced by various factors that either propel its progress or hinder its development. These factors can be categorized into two main groups: natural and human parameters (Ghazanfarpour *et al.* 2022). Natural parameters play a significant role in shaping civilizations and include geographical location, topography, fault lines, climate, hydrology, lithology, slope direction, rivers, precipitation, temperature, humidity, altitude, geological structure, water resources, soil quality, and land capability. These factors not only influence the establishment of human settlements, but also shape the physical and cultural characteristics of the people inhabiting these regions (Ghazanfarpour *et al.* 2022). Human parameters, on the other hand, encompass the establishment and stability of social interactions, trade relations, and the creation of conditions conducive to permanent settlement, thereby preventing displacement. These factors are crucial for the formation and continuity of civilizations (Ghazanfarpour *et al.* 2022) including those formed in Great Persia. The Southeastern Iranian Plateau, shaped by intricate interactions among the Southwest Indian Ocean Summer Monsoon, the Mid-Latitude Westerlies, and the Northeast Siberian Anticyclone, witnessed the emergence and evolution of early Bronze Age settlements. These settlements later developed into Iron Age communities and eventually transitioned into urban centres, culminating during the era of the Persian Empire (Sharifi et al. 2015; Hamzeh *et al.* 2016; Vaezi *et al.* 2019, 2023). Kerman Province in the Southeastern Iranian Plateau is widely recognized as a region of historical significance. It is, in fact, the cradle of ancient and prehistoric civilizations dating back more than six thousand years. The province is home to rich archaeological sites, such as the Jiroft civilization in Southern Kerman and the Khabis site in Shahdad, which have provided remarkable resources for

archaeological research. One of the most notable ancient civilizations emerged on the shores of the Lut Plain, representing one of the oldest human settlements in the fifth millennium BC. This civilization, later was identified as the Shahdad civilization, stands as a testament to the region's historical and cultural importance (Ghazanfarpour *et al.* 2022). The paleo geographical factors and elements in the formation of Shahdad civilization using animation technique systems have been already documented. Ghazanfarpour *et al.* (2022) conducted a comprehensive analysis of key environmental and human factors influencing the formation of the Shahdad civilization, utilizing historical-exploratory methods involving documentary and archaeological data, as well as reconstructions of past environmental conditions. Their findings identified altitude, geographical location, moderate climate, higher precipitation levels, freshwater lakes and rivers, and fertile plains as the primary natural factors contributing to the development of this civilization. Additionally, they highlighted agriculture, strategic positioning along major trade routes, and diverse interactions with neighboring societies as the most significant human factors shaping the emergence of the Shahdad civilization (Ghazanfarpour *et al.* 2022; Sheikh Shariati Kermani *et al.* 2022). Although the Shahdad basin is presently characterized by an arid climate, geological evidence (applying geomorphologic signs for reconstructing the old environment and climate during the last period of the maximum Expansion of glaciers) reveals the presence of distinct glacial features, including glacial terraces, cirques, and moraines, which indicate that the region historically experienced cooler temperatures and substantially higher levels of precipitation compared to its current climatic conditions (Ghazanfarpour *et al.* 2020). It has been shown that using the presence of natural resources, such as a vast freshwater lake and its clay-rich shores, which were utilized in pottery production, encouraged human settlement in this area (Ghazanfarpour *et al.* 2022; Sheikh Shariati Kermani *et al.* 2022). The Shahdad civilization can be unequivocally characterized as an urban civilization. The existence of residential structures, industrial complexes, temples devoted to deities, and royal palaces serves as compelling evidence of its advanced urban nature (Ghazanfarpour *et al.* 2022; Sheikh Shariati Kermani *et al.* 2022). On the other hand, climate change, reduction of precipitation and elevation in temperature caused a drop in water level of the lake, its salinization increased, the economic and communication activities decreased, and finally the civilization was destroyed (Sheikh Shariati Kermani *et al.* 2022). The rich archaeological site of Shahdad presents a large necropolis including many spectacular grave goods, such as impressive human statuettes, elaborate metal objects such as a bronze standard, numerous stone and ceramic containers and ornamental finds (Salvatori & Vidale 1982; Hakemi 1997; Kaboli 1997; Eskandari 2017), in addition to an industrial area and two architectural complexes, which greatly increase our understanding of the layout of the site of Shahdad. One of the unique archaeological artifacts of Shahdad is a flag (Drafsh).

Flag features

The Flag of Shahdad (Figs. 2-4) is a unique archaeological artifact discovered in the 1970s during excavations in the ancient Shahdad City (Hakemi 1997; Majidzadeh 2003). The flag, made of bronze, is widely recognized as an ancient banner and is considered the oldest known flag in the world. Its intricate design and symbolic elements have sparked significant interest among archaeologists and historians, offering a glimpse into the artistic, religious, and political practices of its time (Pittman 1984). The flag is a rectangular bronze plate measuring approximately 22 cm in height and 15 cm in width (Hakemi 1997), mounted on a 128-cm metal axle which the flag can turn over it (Eskandari 2021).

This flag is composed of the following distinct elements: (i) a square-shaped bronze plaque, engraved with some designs which has undergone oxidation over time, resulting in a greenish patina that underscores its antiquity; and (ii) staff, hinge, and handle (metal axle) which are these functional parts, constructed from bronze, and were designed to support the flag and allow for its movement or display.

An eagle with opened wings which is in a landing position can be seen on top of the axle. The central portion of the bronze plaque features a series of intricate motifs and patterns, including: (i) symmetrical and repetitive designs (geometric patterns) that demonstrate a high level of precision; (ii) artistic representations of plant life (floral patterns) possibly symbolizing natural elements; (iii) depictions of animals (faunal figures), which may hold cultural or symbolic significance; (iv) representations of human forms (human figures), potentially reflecting societal or ritualistic themes; and (v) non-representational artistic elements (abstract designs) that highlight the creativity of the artisans. These motifs were meticulously crafted using chiseling techniques, with relatively deep grooves that emphasize the skill and artistic sophistication of the ancient craftsmen (Hakemi 1997; Eskandari 2021).

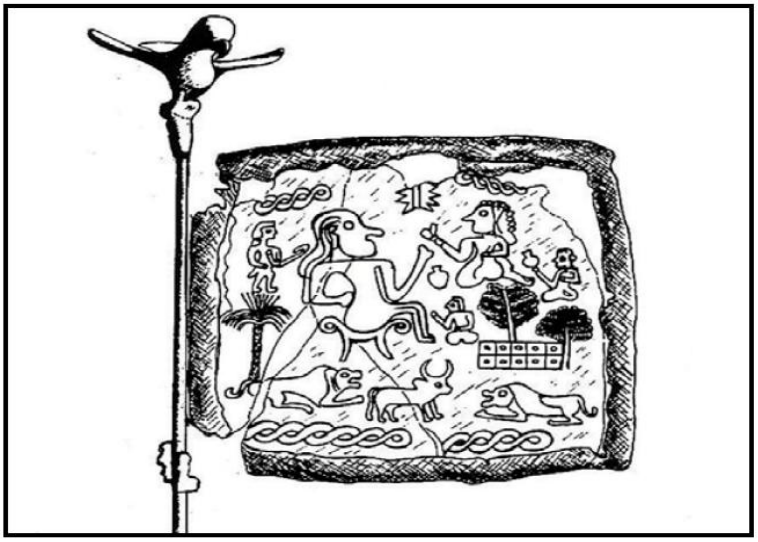

Fig. 2. Drawing of the sense of the Standard of Shahdad (after Hakemi 1997).

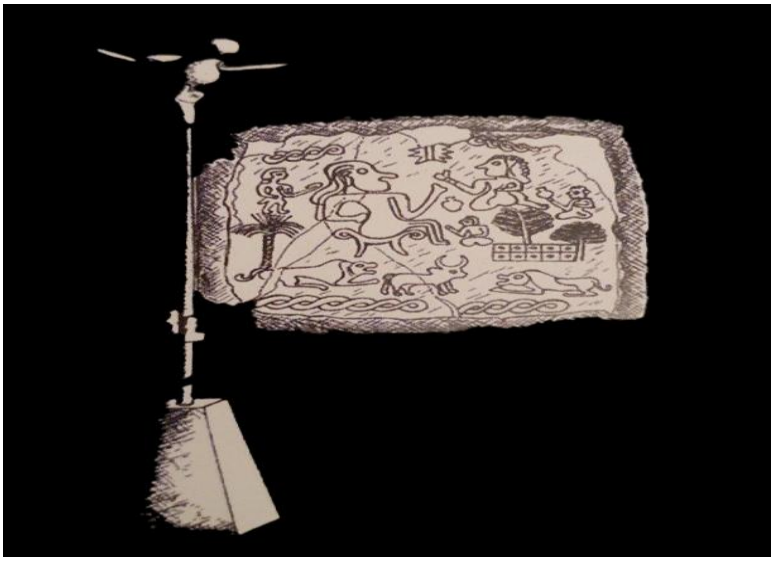

Fig. 3. Redrawing of the sense of the Standard of Shahdad.

Fig. 4. Redrawing of the sense of the Standard of Shahdad showing upper part of metal axle and the plate.

Symbols

The Shahdad flag is richly adorned with a combination of narrative, natural, and symbolic imagery (five humanoids, two lions, a cow, a bird, several snakes, a palm tree, and two more trees). The central scene is set within a garden landscape featuring palm and broadleaf trees, surrounded by figures depicted in seated and kneeling positions. These individuals are believed to represent dignitaries of the Khabis (Shahdad) government, a historical entity that once thrived in the northeastern region of Kerman, near the periphery of the Lut Desert. The sun which is a symbol of life, light, and power is depicted on the upper part of the plate. This imagery provides valuable insights into the life diversity, cultural and political framework of the Khabis civilization, which is recognized for its significant presence in this ancient region (Hakemi 1997; Eskandari 2021).

Human

The Shahdad flag represents figures of five humanoids, *Homo sapiens* (Fig. 5). The central focus of the flag is a meticulously detailed scene dominated by a long-haired man seated on a stool embellished with spiral motifs. This figure is intentionally rendered larger than the surrounding elements, emphasizing his significance, and is depicted extending his left hand to receive an object, likely a cup, from the individual positioned before him (Potts 2012). The figure facing the man is interpreted as a woman seated on the ground (Fig. 5). A pitcher is placed in front of her, and she holds a cup in her right hand, which she appears to be offering to the man (Amiet 1980). Behind the woman, a smaller figure, likely representing a maid, is shown seated on the ground, preparing another pitcher to present to the woman (Pittman 1984). In front of the seated man's feet, another small figure, possibly a servant, is depicted raising his hand toward the man (Porada 1965). Additionally, a fifth individual stands behind the seated man, holding an object, likely a staff, which suggests a position of authority or high status based on comparative analysis of reliefs from this period (Collon 1987). Hakemi (1997) provides a detailed description of the five humanoids, identifying the recipient as a goddess and suggesting that all individuals presenting gifts are female, thus interpreting the scene as spiritual in nature (Hakemi 1997). However, this interpretation is challenged by the absence of typical feminine features, such as breasts, among the depicted figures, a notable contrast to other representations of women on Shahdad seals, where females are often distinguished by pronounced breasts (Hakemi 1997). In contrast, Amiet (1986) identifies the recipient as a male figure, offering an alternative perspective. A more significant question arises regarding the spiritual nature of the scene. While Hakemi (1997) argues that it represents a spiritual ceremony, there is no definitive evidence to support this claim (Eskandari 2021). Notably, none of the figures in the scene exhibit divine attributes, such as crowns or horns, which are commonly associated with deities in Shahdad iconography (Eskandari 2021). This absence raises doubts about the spiritual interpretation and calls for further analysis of the scene's symbolic and cultural context (Eskandari 2021).

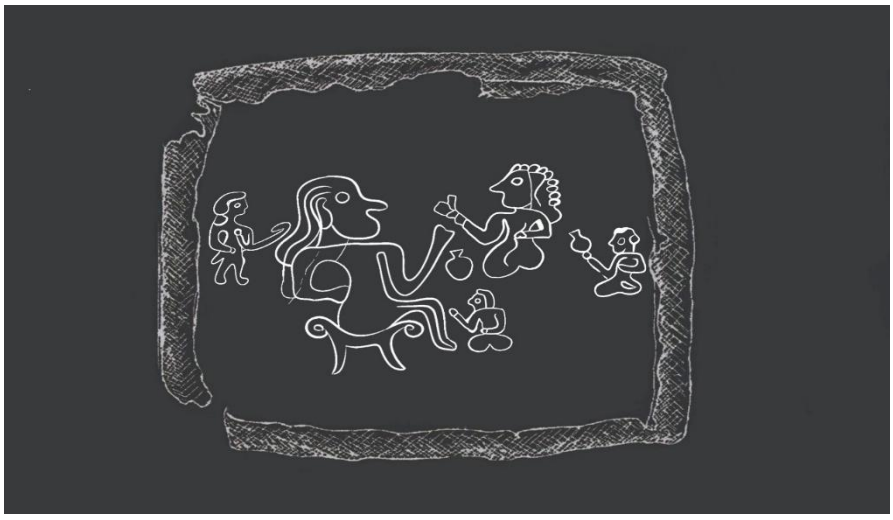

Fig. 5. The Shahdad plate represents five humanoids, *Homo sapiens*.

The origin of modern humans *Homo sapiens* Linnaeus, 1758 (Hominidae: Hominine) living in the Iranian Plateau including the Lut Desert is closely tied to the broader narrative of human migration out of Africa and the subsequent dispersal across Eurasia. Modern humans originated in Africa around 300,000–200,000 years ago (Hublin *et al.* 2017). The primary dispersal out of Africa, often referred to as the Out of Africa event, is estimated

to have occurred around 70,000–50,000 years ago (Pagani *et al.* 2016). Iran's geographical position made it a natural and key corridor for human dispersal, with the Zagros Mountains, fertile plains, and access to water sources providing favourable conditions for early human settlement (Petraglia *et al.* 2010). Archaeological evidence, such as stone tools and fossil remains, suggests that Iran was inhabited by early humans as early as 70,000–50,000 years ago, coinciding with the initial wave of *Homo sapiens* dispersal (Vahdati Nasab *et al.* 2013). Genetic studies of ancient and modern populations in Iran reveal a complex history of migration and admixture (Lazaridis *et al.* 2016). Ancient DNA (aDNA) from Iranian archaeological sites shows genetic links to both early hunter-gatherers and later Neolithic farmers (Broushaki *et al.* 2016). Early migrants to Iran carried Y-chromosome haplogroups (e.g., F-M89 and C-M130) and mitochondrial DNA haplogroups (e.g., M and N), which are associated with the initial dispersal of modern humans out of Africa (Underhill *et al.* 2001; Macaulay *et al.* 2005). Archaeological sites such as Shanidar Cave and Yafteh Cave in the Zagros Mountains of Iran have provided evidence of early human occupation, including stone tools and fossil remains (Solecki 1971; Otte *et al.* 2007). These archaeological sites also highlight the cultural and technological innovations of early human populations in the Zagros region, which served as a corridor for human migration and interaction between the Near East, Central Asia, and South Asia. The Zagros region is particularly significant, as it was one of the earliest centers of agriculture and animal domestication, influencing the spread of Neolithic cultures into Central Asia and beyond (Zeder 2008). During their dispersal, *H. sapiens* likely encountered other hominin species, such as Neanderthals, *Homo neanderthalensis* (late Pleistocene taxa: see Olsen & White 2025), who were present in the region (Green *et al.* 2010). Genetic studies show that modern non-African populations, including Iranians, carry 1–2% Neanderthal DNA, indicating interbreeding during this period (Vernot & Akey 2014). Neanderthals occupied western Eurasia from around 430,000 years ago until their extinction around 40,000 years ago (Skove *et al.* 2022). After the initial dispersal, Iran continued to be a hub for human migrations and cultural exchanges (Dyson & Howard 1989). The region saw movements of populations during the Neolithic, Bronze Age, and Iron Age, including the spread of Indo-European-speaking groups (Narasimhan *et al.* 2019). Genetic studies of ancient Iranian populations, such as those from Tepe Hasanlu and Shahr-i Sokhta, reveal a mix of local and external or foreign genetic influences, reflecting Iran's role as a crossroads of civilizations (Gallego-Llorente *et al.* 2016). Recently, Shoaee *et al.* (2023) provided paleoclimatic routes and opportunities for hominin dispersals across Iran. They highlighted environmentally mediated routes which likely played a key role in Late Pleistocene hominin dispersals, including the expansion of *H. sapiens* and Neanderthals eastwards into Asia. Combined analyses carried out by Shoaee *et al.* (2023) indicates that, during MIS 5, there were opportunities for hominins to traverse a northern route through the Alborz and Kopet Dagh Mountains and the Dasht-I Kavir desert owing to the presence of activated fresh water sources. They also recognized a new southern route along the Zagros Mountains and extending eastwards including Southeastern Iran (Lut desert) towards Pakistan and Afghanistan. The data provided by Shoaee *et al.* (2023) supports the idea that the Lut Desert in South-central Iran being a huge endorheic basin that once contained a large paleolake (Lut Lake with an area of 16,226 km^2). Hence, paleoenvironmental records, paleohydrological modelling, paleoecological data, facial morphologies, ancient DNA analysis and symbols in ancient art (Hakemi 1997; Gallego-Llorente *et al.* 2016; Lazaridis *et al.* 2016; Mehrjoo *et al.* 2019; Heydari-Guran & Ghasidian 2020; Eskandari 2021; Andreeva *et al.* 2022; Shoaee *et al.* 2023; Vaezi *et al.* 2023; Olsen & White 2025) shed light on human evolution, dispersal patterns, climate, and civilizations in Western Asia, including the Iranian Plateau where Shahdad region is located.

Lion

The lion (Carnivora: Felidae) has been a powerful and enduring symbol in ancient art across various cultures, representing strength, royalty, protection, and divinity. Its depiction in art and iconography provides insights into the cultural, religious, political, and biodiversity values of ancient societies. In ancient Mesopotamia, the lion was closely associated with kingship and authority. It was often depicted in royal art, such as the famous Lion Hunt of Ashurbanipal reliefs from the Neo-Assyrian period (circa 668–627 BCE), where the king is shown hunting lions to demonstrate his courage and dominance over nature (Collins 2008). Similarly, in ancient Egypt, lions symbolized pharaonic power, as seen in the sphinxes and lion-headed statues guarding temples and tombs (Wilkinson 1999). In many ancient cultures, the lion was also linked to deities and served as a protective symbol. For example, in ancient Mesopotamia, the lion was associated with the goddess Ishtar, who was often depicted standing on lions, symbolizing her power and ferocity (Black & Green 1992). In ancient Persia, lion motifs were used in architectural elements, such as the Apadana Palace at Persepolis, Iran, where lion griffins symbolized

protection and royal authority (Root 1979). The symbolic significance of the lion is further exemplified in the Shahdad flag (Fig. 6), where approximately one-third of the lower section is dedicated to a scene depicting two lions stalking a Bactrian cow. This motif holds profound cultural and astronomical meaning. In historical Persia, including during the Elamite and Achaemenid periods, such depictions were used to represent celestial events. The ancient Elamites associated winter with the bull and summer with the lion. Thus, the lion's attack on the bull symbolized the sun entering the zodiac sign of Aries, marking the beginning of spring and the vernal equinox (Hansman 1975). This symbolic battle is also evident in artifacts such as a soapstone weight from the Jiroft civilization highlighting the widespread use of lion motifs to convey cosmological and seasonal transitions in the ancient Iranian art. The Achaemenid rulers of ancient Persia favored images of lions with their mouths open in a snarl or roar (Fig. 7). On these gold jewelry elements, the lions are shown complete or as heads only, in both fairly realistic and highly decorative forms (Koch 2008; Curtis & Talis 2012; Asadi & Darvishi 2020). The gold head of a bull, seems almost placid in comparison. The pin decorated with an ibex, or wild mountain goat, was used to fasten garments (Koch 2008; Curtis & Talis 2012; Asadi & Darvishi 2020).

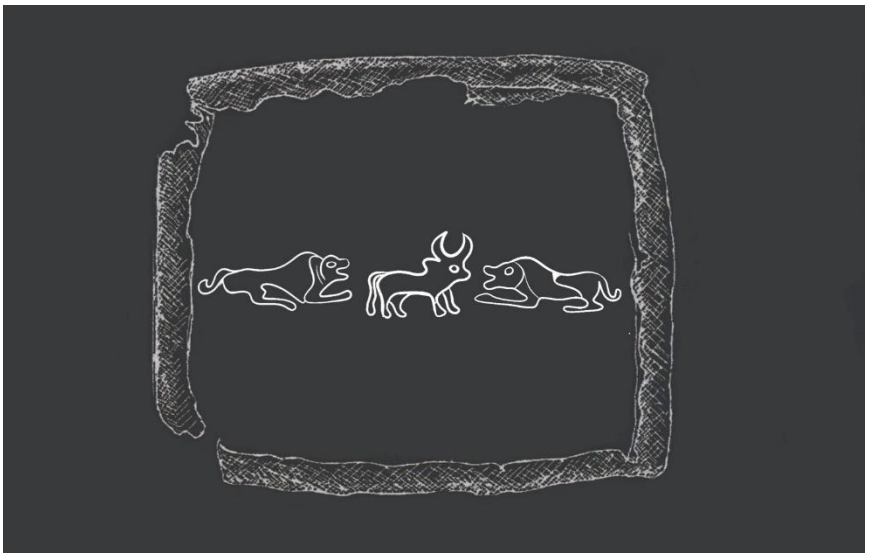

Fig. 6. The Shahdad plate illustrates a scene featuring two lions stalking humped bull/cattle.

Fig. 7. Achaemenid gold ornaments showing lions with open mouth, Brooklyn Museum (Achaemenid; Persian. Dress Ornament, 6th–5th century B.C.E. Gold, 1 13/16 × 2 5/16 in. (4.6 × 5.8 cm). Brooklyn Museum, Gift of Mr. and Mrs. Alastair Bradley Martin, 70.142.11. Creative Commons-BY).

The Lion and Sun motif (Šir-o Xoršid) which was national symbol on the Iran flag (Fig. 8), has its roots in ancient Iranian art, where the lion symbolized strength and solar divinity (Soudavar 2003).

The lion (*Panthera leo*), a carnivorous mammal of the family Felidae, plays a critical ecological role as a top predator, regulating populations of dominant herbivores. It is also one of the most iconic species on Earth

(Broggini *et al.* 2024). While lions are now confined to parts of Africa and India, they were once widely distributed across the Northern Hemisphere during the late Pleistocene (LP). Large and morphologically diverse lion populations thrived in Europe, northern Asia, and North America until approximately 11,000 years before present (bp), when they became extinct as part of the end-Pleistocene megafaunal mass extinction event (Martin & Steadman 1999). The causes of their extinction are debated, with potential factors including human hunting, environmental changes, and climatic shifts associated with the Last Glacial Maximum (LGM; 22,000–18,000 bp) and the transition out of the Pleistocene (Barnosky *et al.* 2004).

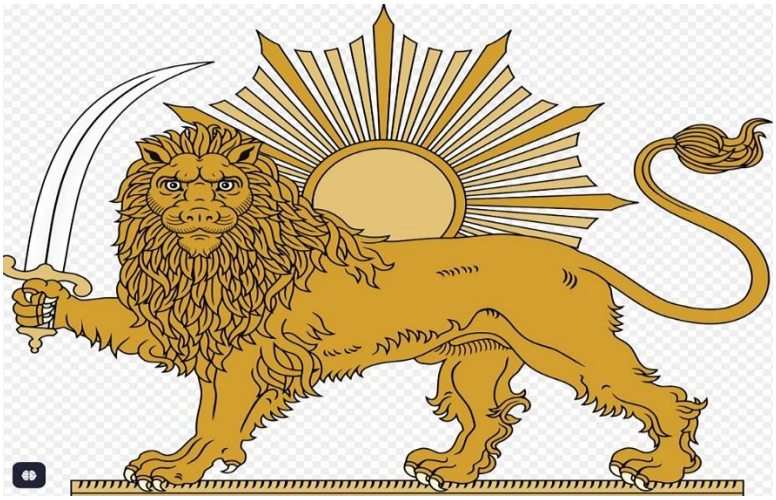

Fig. 8. The Lion and Sun, a symbol featured in Iran's national flag until the 1979 revolution.

During the LP, three distinct lion lineages existed: (i) the American lion (*Panthera atrox*), (ii) the cave lion (*P. spelaea*), and (iii) the ancestors of the modern lion (*Panthera leo*; Kurtén & Anderson 1980; Ersmark *et al.* 2015; Sabol & Puzachenko 2024). The phylogenetic relationships among these taxa remain controversial. Mitochondrial DNA (mtDNA) analyses suggest that *P. atrox* and *P. spelaea* form sister clades (Barnett *et al.* 2009). However, morphological and genetic evidence also supports a closer relationship between the cave lion and the African lion, suggesting they may be sister species (Burger *et al.* 2004; Sotnikova & Nikolskiy 2006; Mazák 2010; Ersmark *et al.* 2015).

The American Lion (*Panthera atrox*)

The American Lion (*P. atrox*) was a key component of the Pleistocene megafauna, reflecting the ecological complexity of North American ecosystems during this period (Kurtén & Anderson 1980). It inhabited diverse environments, including grasslands, forests, and mountainous regions, with fossils found from Alaska to Mexico, indicating its broad distribution (Kurtén & Anderson 1980; Barnett *et al.* 2009). As a top predator, *P. atrox* likely preyed on large herbivores such as bison, horses, camels, and young mammoths (Kurtén & Anderson 1980). It may have hunted both solitarily and in groups, similar to modern lions (Christiansen & Harris 2009). This species became extinct around 11,000 years ago, during the Quaternary extinction event, likely due to climate change, habitat loss, and the decline of prey populations caused by human activity and environmental shifts (Barnosky *et al.* 2004).

The Cave Lion (*Panthera spelaea*)

The cave lion (*P. spelaea*) was one of the most widespread and well-documented predators of the Late Pleistocene in Eurasia. Its remains, including mummified specimens from Siberia, and its depictions in prehistoric cave art provide valuable insights into its appearance and behavior (Bocherens & Kirillova 2025). This species ranged from the British Isles and Iberian Peninsula in the west to Alaska and Yukon in the east, inhabiting lowlands, mountains, and alpine regions (Sabol & Puzachenko 2024). Morphological and genetic analyses suggest the existence of two clades: *P. s. spelaea* in Europe and western Siberia, and *P. s. vereshchagini* in Beringia (Stanton *et al.* 2020; Bocherens & Kirillova 2025). Ancient DNA studies confirm that *P. spelaea* was genetically distinct from modern lions and experienced a demographic decline in Beringia during Marine Isotope Stage 3 (MIS 3; Ersmark *et al.* 2015). Cave lions were larger than modern African lions, with notable differences in cranial and dental morphology, though their overall body proportions were similar (Turner 1997; Sotnikova & Nikolskiy 2006; Christiansen 2008; Mazák 2010). Their diet included horses (*Equus ferus*), steppe bison (*Bison priscus*),

reindeer (*Rangifer tarandus*), giant deer (*Megaloceros giganteus*), red deer (*Cervus elaphus*), and musk oxen (*Ovibos moschatus*; Stuart & Lister 2011). Stable isotope analyses indicate dietary specialization in some individuals, with a preference for reindeer or juvenile cave bears (Bocherens *et al.* 2011). Competition with other predators, such as the cave hyena (*Crocuta spelaea*) and brown bear, may have influenced their solitary behavior, particularly in regions where hyenas were absent (Bocherens & Kirillova 2025).

The Modern Lion *(Panthera leo)*

The modern lion (*P. leo*) is a keystone predator that regulates herbivore populations and is among the most charismatic species on Earth (Broggini *et al.* 2024). Originating in Tanzania between 3.46 and 1.2 million years ago (MYA), lions became the most widespread carnivorous mammal, inhabiting Africa, Europe, and Asia (Broggini *et al.* 2024). Today, however, lions are largely restricted to Africa, with significant populations surviving only in protected reserves and parks in southern Africa due to habitat fragmentation and human impact (Bertola *et al.* 2015). Phylogeographic studies classify African lions as a single subspecies (*Panthera leo leo*), while the remaining Asian population is considered a distinct subspecies (*P. l. persica*; Bertola *et al.* 2016). Mitochondrial DNA analyses of museum specimens, including the extinct Barbary lion (*P. l. leo*) and Iranian lion (*P. l. persica*), reveal highly supported, monophyletic lion clades. These lineages began diverging in the Late Pleistocene, with equatorial rainforests isolating southern and eastern African populations, while West African lions expanded into Central Africa during periods of rainforest contraction (Barnett *et al.* 2014). Two separate incursions into Asia from North Africa are also documented, first into India and later into the Middle East (Barnett *et al.* 2014). The International Union for Conservation of Nature (IUCN) recognizes two extant lion subspecies: the African lion (*P. l. leo*), found in Sub-Saharan Africa, and the Asian lion (*P. l. persica*), now restricted to the Gir Forest in India (Kitchener *et al.* 2017). Recent genetic studies using cytochrome b (*cytb*) mtDNA markers identify two primary subspecies: *P. l. leo* (including haplogroups A, B, and C) and *P. l. melanochaita* (including haplogroups D, E, and F). The Asian lion (*P. l. persica*) is considered a haplogroup of *P. l. leo* that migrated out of Africa approximately 31,000 years ago (Broggini *et al.* 2024). The ancestral modern lion mitogenome (LiAM) likely originated in Southern Africa around 151,000 years ago, with subsequent migrations shaping the current distribution of lion populations (Broggini *et al.* 2024). The Asiatic lion disappeared from Syria, Turkey, and Iran in the 19th century, held on longer in Iraq until the 20th century (Black 2016) and, despite approaching extinction, still survives as a population of several hundred animals in the Gir Forest and adjacent pockets of habitat down to the shores of the Arabian Sea in the state of Gujarat, India (Black 2016). In brief, the lion's multifaceted symbolism as a representation of imperial power, religious guardianship, astronomical significance, and seasonal renewal highlights its central role in the art and mythology of ancient Iran, Mesopotamia, and Egypt.

Cow/Humped cattle

Depictions of humped cattle are often found on pottery, seals, flag, and other artifacts. These depictions highlight the importance of cattle in the daily life, economy, and possibly the religious practices of the ancient Shahdad civilization (Hakemi 1997). About one-third of the lower section of the Shahdad flag is dedicated to a scene depicting two lions (wild felids) stalking a Bactrian cow or humped cattle (Fig. 6). This scene holds symbolic significance. In historical Persia, including during the Elamite and Achaemenid periods, such motifs were used to represent astronomical events. The ancient Elamites associated winter with the bull and summer with the lion. Thus, the lion's attack on the bull was seen as a symbolic representation of the sun entering the zodiac sign of Aries, which marks the beginning of spring and the vernal equinox (Hinz 1380). This battle can even be observed in a soapstone weight from the Jiroft civilization. The depiction of the cow in the artistic traditions of civilizations is well-documented, underscoring its widespread influence on the beliefs and cultural practices of numerous societies globally (Moradgholi & Mortazavi 2021). This indicates that the reverence for the cow among ancient peoples was not limited to a particular geographic area but held considerable importance even in distant civilizations (Moradgholi & Mortazavi 2021). The cow has consistently held a significant place in Iranian art, and its representation is similarly prominent in other civilizations, such as Mesopotamia and India, where it is depicted as a winged bull or a bull-man (Moradgholi & Mortazavi 2021). The humped cattle depicted on the Shahdad flag (Figs. 3 and 6) is characterized by presence of prominent hump over the shoulder, robust and well-built body, strong legs supporting the animal's robust body, two long curved horns, a long tail, and no sign of a prominent dewlap (a fold of loose skin hanging under the neck). These characteristics are found in the domesticated Indian zebu cattle *Bos indicus* Linnaeus, 1758 (Artiodactyla: Bovidae: Bovinae).

Available evidence, including data from the Bronze Age, indicates that the southeastern humped cattle of Iran, known as Sistani cattle, were present during this period. In terms of breed characteristics, these cattle possess a genetic background (*Indicine*) and exhibit a general body morphology similar to humped cattle (*Bos indicus*) found in regions such as India and Pakistan. Furthermore, numerous figurines of humped cattle, both intact and fragmented, crafted from clay, pottery, and stone, have been unearthed at archaeological sites in Southeastern Iran, including the Shahdad and Sistan regions (Andreyevich 2019; Moradgholi & Mortazavi 2021). The familiarity of the inhabitants of Shahdad with zebu cattle is substantiated by archaeological artifacts (Fig. 9), including chlorite vessels, stone vessels, copper plates, seals and flag featuring carved depictions of humped cattle (Andreyevich 2019).

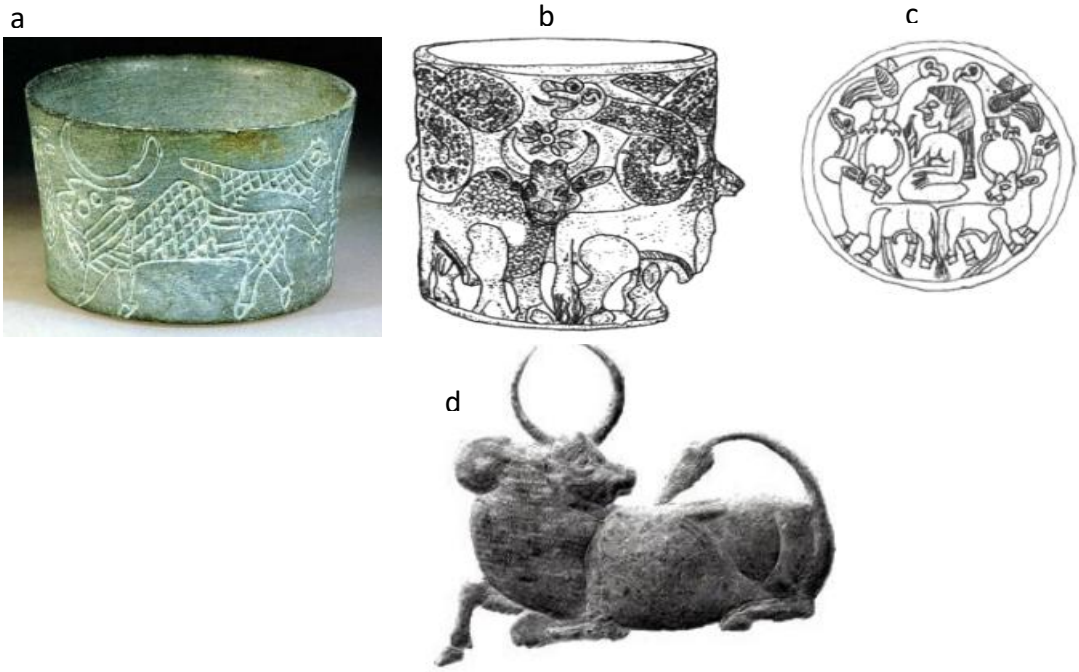

Fig. 9. a) a chlorite vessel with a carved image of cattle from Shahdad (2900–2600 BC); b) a stone vessel with zebus with relief protruding snouts carved on it from Kerman; c) a seal with images of two humped bulls come from Kerman; d) a copper plate with a lying zebu embossed on it dating back to 2500–2000 BC originates from Shahdad (see Andreyevich, 2019).

At the present there are two modern extant ungulates of the genus *Bos* Linnaeus, 1758 in northwestern South Asia including India, Pakistan and Iran: (i) zebu/ indicine cattle or humped cattle *Bos indicus* Linnaeus, 1758, that are found primarily in India and tropical areas of Asia, America, and Australia; and (ii) cattle or taurine cattle *Bos taurus* Linnaeus, 1758 that are found primarily in Europe and temperate areas of Asia, the Americas, and Australia. Archaeological findings suggest that zebu cattle were domesticated 8,000–9,000 years ago (B.P.) and dispersed throughout northwestern South Asia by 6,000 years before present (Upadhyay *et al.* 2017). South India may have been an additional centre for cattle domestication, as may have been Gujarat in Western India. An extensive survey of modern cattle suggests that the maternal zebu cattle lineage likely originated from the domestication of local wild cattle (*Bos namadicus*) in northwestern South Asia (Upadhyay *et al.* 2017). Animals of this lineage may have spread through South Asia (≈5,500–4,000 years B.P.) and beyond the Subcontinent eastwards to Southeast Asia and southern China (by ca. 2,500 B.P.; Upadhyay *et al.* 2017). *Bos namadicus* is an extinct species of auroch that inhabited West Asia and the Indian subcontinent from the Late Pleistocene until its eventual extinction during the South Asian Stone Age (Turvey *et al.* 2021). According to Turvey *et al.* (2021), it is known to have survived well into the Holocene. Genetic studies of cattle domestication have pointed out that *B. taurus* resulted from *B. primigenius*. The domestication of *B. taurus* has occurred in the Near East from where it expanded into Europe (Upadhyay *et al.* 2017).

Bird symbol

Birds are among the most diverse and fascinating groups of animals on Earth, with over 10,000 species (Avibase 2025) inhabiting nearly every ecosystem, from polar regions to tropical rainforests. Birds play critical roles in

ecosystems as pollinators, seed dispersers, and predators, contributing to the balance of natural environments. Beyond their ecological importance, birds have held profound cultural, symbolic, and spiritual significance across human civilizations. From the eagle, a universal symbol of power and divinity, to the dove, representing peace and purity, birds have been integral to human expression and imagination (see Delfno 2024). Since the dawn of human history, birds have stirred our imagination, inspiring and challenging our ideas about science, faith, art, and philosophy. We have worshipped birds as gods, hunted them for sustenance, adorned ourselves with their feathers, studied their wings to engineer flight, and, more recently, attempted to protect them (Birkhead 2022). Throughout history, humans have maintained a profound and multifaceted relationship with birds, as evidenced by archaeological and cultural studies (Delfno 2024). Research into the role of birds in human societies offers critical insights into the enduring connections between humans and avian species, shedding light on their symbolic, cultural, and ecological significance (Gal 2006; Delfno 2024). By analyzing bird remains, artifacts, and iconographic representations from archaeological contexts, scholars can reconstruct the dynamics of human-bird interactions, including their symbolic roles, cultural practices, and ecological settings in ancient societies (Kost & Hussain 2019; Delfno 2024). In Mesoamerica, archaeological investigations have revealed bird remains and artifacts linked to ritual practices, highlighting the importance of birds in ceremonial and spiritual activities (Tappan 2020). The extensive use of feathers, avian imagery, and bird sacrifices in these contexts underscores the deep symbolic and spiritual ties between birds and indigenous cultures, reflecting their integration into religious and cultural frameworks (Caplan & Sousa 2020; Delfno 2024). The eagle is a bird that holds significant cultural and symbolic importance across various civilizations and belief systems (Filipek 2023). Historically, it has been imbued with rich symbolic meanings, often appearing in antiquity as a royal bird and a mythological embodiment of deities. In the Christian tradition, the eagle symbolizes rebirth and is even associated with Christ himself (Filipek 2023). It has been prominently featured in Christian art and culture, as well as in Greek liturgy, where it serves as a symbol of salvation (soteriology), baptism, and the Eucharist. Christian theologians and writers have extensively explored its symbolism, drawing interpretations from biblical texts and medieval bestiaries. The eagle has also been a recurring motif in painting and sculpture across numerous historical periods, playing a vital role in ritual, religious, and cult practices. Even today, the eagle remains a powerful cultural symbol, serving as the national emblem of many modern states, often tracing their origins and identity to legends and myths in which this majestic bird features prominently (Filipek 2023). The symbolism of the eagle in culture, beliefs, and art of various nations has been thoroughly presented by Filipek (2023). The eagle design on the Darafsh of Shahdad (Fig. 3) is a significant archaeological artifact that provides insights into the cultural and artistic practices of ancient civilizations in the region. The Darafsh, a type of standard or banner, features intricate designs, including the eagle, which symbolizes power and divinity in many ancient cultures (Pittman 1984; Hakemi 1997). The eagle motif on the Darafsh of Shahdad is believed to represent a connection between the earthly and the divine, reflecting the spiritual beliefs of the people of Shahdad during the Bronze Age (Amiet 1986; Vidale 2018). This interpretation is supported by the presence of similar eagle motifs in other contemporary artifacts from the region, suggesting a shared cultural symbolism (Potts 1999; Vidale 2018). The craftsmanship of the eagle design on the Darafsh indicates a high level of skill and artistic achievement, which is characteristic of the metallurgical traditions of the Shahdad culture (Pittman 1984; Hakemi 1997). The use of advanced techniques in metalworking, such as lost-wax casting, is evident in the detailed rendering of the eagle's feathers and other intricate elements (Amiet 1986; Vidale 2018). In addition to its artistic significance, the eagle design on the Darafsh of Shahdad may also have ecological implications. The depiction of the eagle could reflect the biodiversity of the region during the Bronze Age, indicating the presence of raptors in the local ecosystem (Potts 1999; Vidale 2018). This connection between art and biodiversity provides a unique perspective on the interplay between human culture and the natural environment in ancient times. Overall, the eagle design on the Darafsh of Shahdad is a multifaceted artifact that offers valuable insights into the cultural, artistic, and ecological aspects of ancient Shahdad. Further research and interdisciplinary studies could enhance our understanding of this remarkable piece and its significance in the broader context of archaeology and biodiversity. Based on sources, the primary banner of the Achaemenids was adorned with a golden bird known as the Shahbaz (Shahbazi 1977; Daryaee 2012). Richard Francis Burton, a British orientalist, suggested that the inspiration for the Shahbaz was a species of raptor known as the Tarlan. The Eurasian Shahbaz/ Eurasian goshawk *Astur gentilis* (Linnaeus, 1758; Accipitriformes: Accipitridae) is a species of medium-large bird of prey in the family Accipitridae, a family which also includes other extant diurnal raptors, such as eagles, buzzards and harriers. (Burton 1875; Shahbazi 1984). However,

others have proposed that the Shahbaz was modelled after another bird, the imperial eagle (Potts 1999; Curtis & Tallis 2005). The imperial eagle might be now a common name for *Aquila heliaca* Savigny, 1809 (Accipitriformes: Accipitridae).

Snake symbol

Snakes with about 4,177 species belong to the suborder Serpentes, within the order Squamata, which also includes lizards (Reptile-database 2025). They inhabit diverse ecosystems ranging from deserts and forests to oceans in every continent except Antarctica. Snakes stand out for its semiotic potential that induces awe and fear in equal measure (Rodríguez Pérez 2021). They hold significant cultural and symbolic importance in the mythologies of numerous tribes and nations, often appearing in diverse forms. In the Egyptian mythology, the serpent Apep symbolized chaos, while the Uraeus (a cobra) represented royalty and divine authority (Wilkinson 2003). In the Greek and Roman art, snakes were associated with healing gods like Asclepius and Hermes (Edelstein & Edelstein 1998). The feathered serpent god Quetzalcoatl was central to Aztec and Mayan beliefs in the Mesoamerican cultures (Miller & Taube 1993; Langhorne 2025), and for Indians, snakes, or *nagas*, are often depicted as protectors or deities (Vogel 1926). In the ancient Middle East, among agricultural communities, the serpent was a symbol of water (Golan 2003), and the image of two intertwined serpents symbolized fertility, prosperity, and wealth (Van Buren 1934). In Iran, a substantial portion of artistic motifs is dedicated to the snake (Rashed Mohasel & Shakiba 2012; Shakiba 2018). Although ancient peoples depicted and engraved snake imagery on artworks and reliefs, it appears that these representations carried specific meanings, serving as symbols deeply intertwined with religious and spiritual beliefs. This observation has prompted researchers to investigate the role of snake motifs in the surviving artifacts of Elam and neighboring regions, such as Jiroft (Southeastern Iran), and to explore their distinctions from Zoroastrian religious traditions (Rashed Mohasel & Shakiba 2012). In Elamite art, the snake motif predominantly symbolizes associations with divinity, water, fertility, and the afterlife. In contrast, Jiroft artifacts frequently depict interconnected, coiled, and looped snake designs, as well as scenes of conflict between snakes and other animals. Subsequently, with the rise of Zoroastrianism in Iran, the symbolic role of the snake underwent a profound transformation, evolving into a representation of evil, marking a stark departure from its earlier connotations (Rashed Mohasel & Shakiba 2012). The upper and lower borders of the Shahdad flag are adorned with motifs commonly referred to as "hair weaving." Some researchers, based on findings from the Jiroft civilization (Fig. 1), which was contemporary with Shahdad at times, interpret this design as two intertwined snakes, while others consider the woven bands at the top and bottom to symbolize flowing water.

Plants

Plants have played a significant role in human life, not only as sources of food, materials, and medicine but also as powerful symbols in art and religion. Ancient civilizations frequently incorporated plant motifs into their artistic expressions, imbuing them with profound cultural and spiritual meanings. In ancient Iran, certain plants were particularly revered and regarded as sacred. During the Achaemenid era, when Iranian art developed a cohesive style, plant symbols were prominently featured, aligning with the teachings and beliefs of Zoroastrianism. The Sassanid Empire, considering itself the cultural heir to the Achaemenids, continued to incorporate and preserve these plant symbols and myths in their diverse artistic expressions. The sanctity of plants in the land of Iran has a long and historical background (Mobini & Shafei 2016). Cyrus, the king of Iran, established the Persian garden or paradise, and in Persian culture, one of the attributes of the king was being a good gardener (Mobini & Shafei 2016). The conquests of Cyrus and Darius the Great during the Achaemenid era led to the blending of traditions and the grand cultures of the Iranian plateau (Mobini & Shafei 2016). There are controversial debates about plant species in ancient Persia. An examination of the documentation, primarily focusing on monuments from the two principal capitals of Darius I, Persepolis and Susa, carried out by Caneva *et al.* (2023) revealed the consistent presence of specific recurring motifs. These include rosettes (composed of Asteraceae capitula and *Nymphaea* flowers), date palms (*Phoenix dactylifera*, symbolizing the tree of life), pines, floral arrangements, and metamorphic elements (Caneva *et al.* 2023). They identified several plants within Persian iconography for the first time, such as *Mandragora officinalis* L., depicted in offering scenes as a symbol of fertility and protection against malevolent forces, *Pinus brutia* var. *eldarica* (Medw.) representing immortality and divine ascension, and the capitula of *Matricaria/Leucanthemum*, which serve as solar symbols. Additional noteworthy elements include *Myrtus* cf. *communis* in certain crowns and likely *cf. Ephedra* sp. in offering scenes (Caneva *et al.* 2023). Achaemenid art was profoundly shaped by the Zoroastrian religion of ancient Persia, which emphasized a deep reverence for nature, as well as by cultural exchanges with neighbouring Mesopotamian and Egyptian

civilizations. Many of these motifs were also linked to psychotropic or medicinal properties, further solidifying their role as symbols of power and authority (Caneva *et al.* 2023). The genus *Pinus* is detectable by the typical cones, long acicular leaves, and scaly, fissured, patterned bark (its pyramidal shape led to it being mistakenly interpreted as a cypress). The Calabrian pine *Pinus brutia* var. *eldarica* belongs to the family Pinaceae (Pinopsida: Pinales) with a native range of Transcaucasia to NW Iran. It is a drought-resistant tree that grows on dry rocky and stony slopes (Caneva *et al.* 2023). Its represented part in the ancient art of Iran was whole tree as Assyria symbol (Adelzadeh & Pashayi 2015; Caneva *et al.* 2023). The cypress tree has held a special place among Iranians and is recognized as a botanical symbol. Known as the "Tree of Life," this tree, due to its resilience in harsh climatic conditions and its evergreen nature, has come to symbolize life, joy, endurance, and freedom in Iranian art and literature. The cypress or pine is often associated with the sun, although in some instances, it has also been linked to the moon. The cypress trees, which also had symbolic importance for Zoroastrianism, acquiring a cosmic function as the tree of the good spirit that helps the believer 'to ascend to heaven' (Adelzadeh & Pashayi 2015; Caneva *et al.* 2023). The pyramidal form of the cypress also reminds us of the flames that rise from earth to heaven, thus perfectly symbolizing the Zoroastrian doctrine itself (Djamali *et al.* 2017; Caneva *et al.* 2023). *Cupressus sempervirens* L. (Cupressales: Cupressaceae) commonly referred to as the Mediterranean cypress (also known as Italian cypress, Tuscan cypress, Persian cypress, or pencil pine), is a species of cypress indigenous to the Eastern Mediterranean region and Iran. In Persian, *C. sempervirens* is referred to as "Sarv-e Nāz" (Graceful Cypress) and holds a prominent place in Persian culture, poetry, and garden design. It carries numerous symbolic meanings, including representing the "slender figure and dignified posture of the beloved." Iranians have historically regarded the cypress as a sacred relic tied to Zoroaster. According to a Zoroastrian tradition documented by Daqiqi, King Vishtaspa, upon embracing Zoroastrianism, commanded that a cypress tree, believed to have been brought from paradise by Zoroaster, be planted near the first fire temple (Mobini & Shafei 2016). The Hōm/Hoom plant (also spelled Haoma or Homa) also holds a significant place in ancient Iranian art, culture, and religious practices, particularly in Zoroastrianism, the ancient pre-Islamic religion of Iran (Boyce 1975). It is a sacred plant deeply intertwined with spiritual and mythological symbolism, often associated with healing, immortality, and spiritual strength (Dhalla 1938). It is recognized both as a deity (a god or goddess) and as a sacred plant in the religious tradition. It has been proposed that Hoom might be a member of the genus *Ephedra* Tourn. ex L. (Ephedrales: Ephedraceae; Kochhar 2001). It seems that three species of *Ephedra* had been demonstrated in the Iranian ancient art: *Ephedra procera* C.A.Mey., *E. sinica*, and *E. vulgaris* Willk (now *Ephedra nebrodensis* Tineo; Ostovar *et al.* 2013; Caneva *et al.* 2023). *Ephedra* had a divine origin in Zoroastrianism and possessed healing and life-giving properties (Mona 2018; Caneva *et al.* 2023). According to Ghavam & Soleimaninejad (2020), in Iran, Hoom was a well-known name for *Ephedra distachya* L. that has been well-known to Iranians since 2,800 years ago, and Zoroastrian Moghan used it in special ceremonies. It is a plant with a history of several thousand years. The ancients struck the stems of the Hoom in the mortar, took it, and drank it as a pure beverage or with milk and other additives. This practice gradually took on a religious form, and later, even without a Hoom, it was used to beat the mortar, and to invite people to the prayer ceremony (Ghavam & Soleimaninejad 2020). The Hōm plant is central to Zoroastrian rituals, where it is believed to have divine and purifying properties (Boyce 1975). It is associated with the deity Haoma, who embodies the plant's essence and is linked to healing, immortality, and spiritual strength (Darmesteter 1880). The plant is also connected to the concept of Chinvat Bridge, the bridge of judgment in Zoroastrian eschatology, symbolizing the transition between the material and spiritual worlds (Corbin 1971). In ancient Iranian art, the Hōm plant is sometimes stylized, with its leaves and stems depicted in a way that emphasizes its vitality and sacredness (Root 1979). It may appear in scenes of royal ceremonies, religious rituals, or as part of decorative motifs in architecture (Schmidt 1953). It is often compared to the Vedic Soma, a sacred plant in ancient Indian traditions (Falk 1989).

The Tree of Life. In Mesopotamia, the Tree of Life is a composite of various plants that are considered sacred due to their longevity, beauty, and utility. Examples include the cedar tree, *Cedrus*, a genus of coniferous trees (Pinaceae: Abietoideae) whose wood is highly valued; the date palm, *Phoenix dactylifera* L., which yields dates; the grapevine of the genus *Vitis* L. (Vitales: Vitaceae) bearing clusters of grapes; and the pomegranate tree, *Punica granatum* L. (Myrtales: Lythraceae), symbolizing fertility, as its fruit contains hundreds of seeds (Ghavam & Soleimaninejad 2020).

In ancient civilizations across the world, the Tree of Life has been regarded as a symbol of fertility, growth, and a medium of blessings and abundance. Its leaves were believed to possess healing properties capable of alleviating

human suffering. This motif, particularly in decorative and symbolic art, has been used in Mesopotamia since 3500 BCE and in Iran during the Sassanid era. In ancient myths, the sacred tree is often equated with the Tree of Life, sharing the same meaning and significance (Ghavam & Soleimaninejad 2020). The date palm, *Phoenix dactylifera* L., a dioecious species in the family Arecaceae (Angiosperms: Arecales) has a historical distribution stretching from Mauritania in the west to the Indus Valley in the East. It is a major fruit crop in hot and arid regions of North Africa and the Middle East and one of the earliest domesticated tree crops (Sallon *et al.* 2020). Archaeobotanical records suggest that the earliest exploitation and consumption of dates is from the Arabian Neolithic some 7000 years before the present (yr B.P.; Tengberg 2012; Sallon *et al.* 2020). Evidence of cultivation in Mesopotamia and Upper Persian Gulf approximately 6700 to 6000 yr B.P. support these centers as the ancient origin of date palm domestication in this region, with a later establishment of oasis agriculture in North Africa (Tengberg 2012; Flowers *et al.* 2019; Sallon *et al.* 2020). The date palm was considered a sacred tree in ancient Iran, and numerous examples of it can be seen in the stucco reliefs of Bishapur from the Sassanid period (Ettinghausen & Yarshater 2000; Mobini & Shafei 2016). One of the primary reasons for the sacred status of the date palm in ancient Iran was its association with fertility, and it was known as the "Tree of Life" during the Achaemenid and Sassanid eras. In addition to symbolizing fertility, the date palm also represented kingship (Ettinghausen & Yarshater 2000; Mobini & Shafei 2016). It appears that the motif of the date palm in ancient Iran was influenced by Egypt and Mesopotamia. In Egypt, there was a symbolic connection between the king and the royal palm. Darius, who had served as Cambyses' spear-bearer and had traveled to Egypt to familiarize himself with the region, returned to the country in 525 BCE as the Great King (Ettinghausen & Yarshater 2000; Mobini & Shafei 2016). According to Parker-Mallowan (1983), Tengberg (2012), Dahlén (2019), and Caneva *et al.* (2023), the entire palm tree was depicted as a sacred symbol associated with the god Mithra, representing Mithraic power and authority. It was also utilized in Zoroastrian religious ceremonies. There is a representation of a palm tree along with two other trees on the Shahdad flag. The date palm symbol on the Shahdad standard is a fascinating artifact that provides insight into the cultural and symbolic significance of the date palm in ancient Iran. The date palm, with its abundant fruit, symbolized fertility, growth, and prosperity in ancient Iranian culture. Its presence on the Shahdad standard likely reflects its association with life and sustenance (Hakemi 1997). In ancient Near Eastern cultures, including Iran, the date palm was often linked to kingship and divine authority. Its depiction on the standard may signify the ruler's connection to divine blessings and the natural world (Amiet 1966). The motif of the date palm on the Shahdad standard may also indicate cultural exchanges between ancient Iran and neighboring regions, such as Mesopotamia and Egypt, where the date palm held similar symbolic importance (Potts 1999). The date palm is depicted in a stylized manner on the standard, showcasing the artistic sophistication of the Shahdad civilization. Its inclusion highlights the integration of natural elements into symbolic and ceremonial art (Majidzadeh 2003). Date Tree (*Phoenix dactylifera*), a type of palm tree, are highly valued for their versatility. Here's a breakdown of their uses: 1. Food Production including (i) dates: the primary product, eaten fresh, dried, or processed into date syrup/molasses (natural sweetener); date sugar (ground dried dates); date vinegar (fermented dates); jams, spreads, and energy bars; (ii) sap: harvested to make palm wine (lagmi) or boiled into syrup; and (iii) seeds: ground into animal feed or roasted as a caffeine-free coffee substitute. 2. Material Uses including (i) leaves: woven into mats, baskets, fans, and roofing (thatch); midribs used for brooms, fences, and furniture; (ii) trunks: durable wood for construction, beams, and traditional boats; (iii) fibers: from leaf bases to make ropes, brushes, handicrafts; and (iv) seeds: used as charcoal or crushed for cosmetic scrubs/oils. 3. Cultural & Symbolic Roles: (i) religious significance: mentioned in the Quran, Bible, and Torah (e.g., Palm Sunday in Christianity); (ii) symbolizes abundance, hospitality, and resilience in Middle Eastern cultures; and (iii) festivals: central to celebrations like Ramadan (breaking fast with dates) and weddings. 4. Environmental Benefits: (i) desert adaptation: thrives in arid climates, stabilizing sand dunes and preventing erosion; (ii) shade provider: protects understory crops (e.g., citrus, vegetables) in oasis farming; and (iii) habitat: supports birds, bats, snakes, lizards and insects. 5. Economic & Commercial Value: (i) global export: major cash crop in the Middle East, North Africa, and California; and (ii) livelihoods: supports farmers, harvesters, and date-processing industries (e.g., packaging, syrup production). 6. Medicinal & Health Uses: (i) nutrition: high in fiber, potassium, and antioxidants; natural energy booster; (ii) traditional medicine: used to treat digestive issues, anemia, and fatigue; and (iii) date seed oil: rich in antioxidants, used in skincare products. 7. Other Applications including (i) landscaping: ornamental value in gardens and urban arid zones; and (ii) biofuel: research into date seed oil as a renewable

energy source. In addition, date palms are drought-tolerant and require minimal water compared to other crops, making them eco-friendly for dry regions.

Garden motif

The Shahdad standard, features a garden motif depicting palm trees (*Phoenix dactylifera*) and broadleaf trees, underscoring the cultural and symbolic significance of gardens in ancient Iranian civilization. These trees likely symbolized fertility, abundance, and the connection between nature and divinity (Hakemi 1997), while the garden motif itself may reflect ceremonial or ritual contexts, embodying the idealized concept of a sacred or paradisiacal space (Amiet 1966). This aligns with broader traditions in ancient Near Eastern art, where gardens and trees frequently carried spiritual and cosmological meanings (Potts 1999). Persian gardens are renowned for their harmonious fusion of natural and human elements, symbolizing the cultural and artistic achievements of Persian civilization in a manner that reflects unity with nature (UNESCO 2011). Since the excavation of Pasargadae by David Stronach in 1967, scholarly interest in Persian gardens has grown significantly. This includes studies on Mughal and Islamic gardens, popularized by Western scholars such as Elizabeth Moynihan, Donald Wilber, and Vita Sackville-West, as well as Iranian researchers (Mahdizadek 2015). The design of Persian gardens was not merely intended to create green spaces but also to foster a deeper interaction between humans and nature. These gardens served multiple functions and promoted Persian culture through their intricate design elements, which integrated aesthetics, spirituality, and practicality (Mahmoudi Farahani *et al*. 2016).

CONCLUSION

The Flag of Shahdad stands as a remarkable artifact that not only illuminates the cultural, political, and religious life of one of the earliest civilizations on the Iranian Plateau but also reflects the rich biodiversity and conservation values of ancient Iran. Its intricate design and symbolic elements, deeply rooted in the natural world, underscore the sophistication of the Jiroft culture and its harmonious relationship with the environment. As a symbol of authority, spirituality, and identity, the flag serves as a testament to the enduring legacy of the Shahdad region, highlighting its contributions to human history and its early awareness of ecological balance and conservation. This artifact reminds us of the timeless connection between cultural heritage and the natural world, offering valuable insights for contemporary conservation efforts. The symbolic elements of ancient artifacts not only reflect the biodiversity of the Iranian Plateau, but also serve as a cultural lens to understand ecological shifts over time. By connecting these historical representations to modern biodiversity conservation, cultural heritage becomes a powerful tool for raising awareness about species preservation. It underscores the enduring relationship between humans and nature, offering valuable lessons for contemporary conservation efforts and fostering a deeper appreciation for the region's ecological and cultural legacy. As an example, although the Asiatic lion held profound symbolic value as a representation of power and strength for ancient Iranians, a combination of natural and anthropogenic factors such as habitat loss, hunting, and human-wildlife conflict has led to the extinction of this large felid species within its historical distribution range and disappeared from Syria, Turkey, and Iran in the 19th century, held on longer in Iraq until the 20th century. This tragic loss underscores the critical importance of biodiversity conservation and highlights the urgent need for proactive measures to protect endangered species. By learning from the past, we can work to prevent further extinctions and preserve the rich ecological heritage of the region for future generations.

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Notes on contributor

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No datasets were generated or analysed during the current study.

Competing Interests

The authors declare no competing interests.

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