



Falconry petroglyphs in Iran: new findings on the nexus between ancient humans and birds of prey

Mahmood Kolnegari¹ · Mohsen Jamali² · Mohammad Naserifard³ · Kamal Ghous⁴ · Mandana Hazrati¹ · Connor T. Panter⁵ · James F. Dwyer⁶

Received: 6 May 2020 / Revised: 2 January 2021 / Accepted: 26 January 2021

© The Author(s), under exclusive licence to Springer-Verlag GmbH, DE part of Springer Nature 2021

Abstract

Ethnoornithology is a multidisciplinary field of study that focuses on human-bird relationships and humans' knowledge of the Earth's avifauna. Falconry (the use of trained birds of prey—usually eagles, falcons, and hawks—to hunt wild animals) is one type of human-bird relationship, with its origins obscured in poorly understood prehistoric times. We hypothesized that falconry would have been memorable enough to prehistoric peoples to be the subject of rock art, and that evidence of prehistoric falconry could be found in the petroglyphs of the Persian Plateau. To assess this hypothesis, we visited 13 major rock art sites in the Persian Plateau, and searched for petroglyphs depicting a person bearing a bird on the forearm. We found, identified, and photographed 11 petroglyphs depicting falconry. Most ($n = 10$) occurred in the archaeological region of Teymareh, most ($n = 7$) showed a falconer mounted on horseback or elephant, and many ($n = 6$) included an accompanying trained canid or cheetah. These tableaux suggest that falconry was but one aspect of a suite of human-animal associations developed and maintained by the prehistoric peoples of the Persian Plateau. Based on previous surveys of the petroglyphs of Teymareh, along with other evidence, we assume that most of the petroglyphs we discovered were inscribed approximately 4000 years ago, likely making them some of the oldest remaining evidence of falconry in the world. We suggest that our work indicates that future research on petroglyphs may be useful in further exploring and understanding the relationship between prehistoric mankind and wildlife.

Keywords Birds of prey · Ethnoornithology · Persian Plateau · Prehistoric rock art · Teymareh · Zoomorphic petroglyph

Introduction

Birds of prey are a species-rich group, with over 500 species widely distributed throughout all continents except Antarctica (McClure et al. 2019). Given their near ubiquitous distribution, birds of prey have a long history with hominins (Hominidae, Hominini) not limited to modern humans (*Homo sapiens*). For example, based

on recent hypotheses, Neanderthals used the feathers, claws, and bones of birds of prey as ornamental items (Finlayson et al. 2012; Radovčić et al. 2015; Rodríguez-Hidalgo et al. 2019).

Modern humans admire birds of prey for their piercing looks, mastery of the sky, and ability to take prey in spectacular maneuvers, epitomizing strength, power, and wealth (Umoh 2014; Greet 2015; Gersmann and Grimm

✉ Mahmood Kolnegari
mahkolnegari@yahoo.com

Mohsen Jamali
jamali@gut.ac.ir

Mohammad Naserifard
iranpetroglyphs@yahoo.com

Kamal Ghous
kamal.ghous@yahoo.com

Mandana Hazrati
mandana.hazrati90@gmail.com

Connor T. Panter
c.panter1@uni.brighton.ac.uk

James F. Dwyer
jdwyer@edmlink.com

Extended author information available on the last page of the article

2018). Studies of birds of prey remains in prehistory and history appear in many contexts, including as musical instruments (Morejohn and Galloway 1983), cultural symbols, art and iconography (David 1989; Holmes 2018; Negro 2018), tools (Gala and Tagliacozzo 2014; Holmes 2018), food (Barrett 1939; Oberg 1973), adornment with feathers (Turney-High 1941; Negro 2018), talismans (Vaughan 1992; Albright 1984), and medicine (Bostock and Riley 1855; Derwent and Mander 2017). In particular, eagles of various species long symbolized heroic characteristics such as courage, leadership, great strength, and freedom for ancient Romans, Greeks, and Persians in the Eastern Hemisphere (Hayes 2014; Greet 2015), and even left their traces in Christian mythology (Collins 1913). Eagles were similarly important to Native Americans (Miller 1957; Lawrence 1993) in the Western Hemisphere, and condors as the largest birds of prey in the world have long held important cultural roles for Andean tribes (Benson 1997). The ancient Egyptians mummified eagles, falcons (Ikram 2005), and kestrels (Ikram et al. 2015) for burial with humans as status symbols and regarded falcons as a sacred deity termed *Horus* or the ‘God of Sky’. *Horus* was often recorded in Egyptian petroglyphs, pictographs, and statues as a human form with a falcon head (Wilkinson 2003; Porter 2011).

Perhaps one of the most distinctive relationships between humans and wild animals is that of falconry, which has been called the oldest sport known to men (Forsyth 1944). Falconry, or hawking, is defined as ‘the capture of animal quarry in its natural state and habitat by means of trained birds of prey’ (Soma 2013; Gersmann and Grimm 2018), usually with species of the families Falconidae and Accipitridae. Falconry has recently gained much attention, owing to the recent acknowledgement of falconry as an Intangible Cultural Heritage of Humanity by UNESCO (Flynn 2018). In addition, the United Arab Emirates announced the preservation of falconry as part of their sporting and cultural heritage, a service that provides economic and social benefits to local people (Seddon and Launay 2008; Wakefield 2012; Panter et al. 2019) and is a major source of economic revenue for some. Falconry remains relevant today, not only as a link to the cultural history of many peoples, but because many of the historical methods of capturing birds of prey for use in falconry remain foundational to modern capture of birds of prey for conservation research in tracking studies (Bub 1978); moreover, falconry techniques are widely used in the rehabilitation process of birds of prey and for educational purposes (Phillott 1908; Sielicki 2016).

The precise origins of falconry are ambiguous with evidence of falconry practices scattered widely over time and space, and presumably shared across tribes and cultures (Macdonald 2006; Soma 2012; Schafer 2018).

Falconry is thought to have originated in Asia either with the early advanced civilizations of Mesopotamia (parts of Syria and Iraq) (Epstein 1943), or with the peoples of the Persian Plateau (Latham 1633; IAF 2008), or with Eurasian nomads in the eastern steppes (Schafer 2018) where the horse would have been a critical component in the development of falconry (Warmbier 1959). To date, the earliest convincing evidence for falconry is from Tell Chuera, Syria, where a pottery sherd dated around 5000 BP depicts a raptor on the fist with quarry and possible jesses (Epstein 1943; Canby 2002). Jacobson-Tepfer et al. (2006) and Wallis (2014) suggest that the oldest known petroglyphs of falconry are located in the Altai region at the junction of China, Russia, Mongolia, and Kazakhstan, where they were etched around 3000 BP (Kortum 2014). The oldest evidence of falconers on horseback is dated around 1300 BP in Britain and Continental Europe (Wallis 2014). There are also two findings from the Hittite Empire (modern Turkey) which include a 3300-year-old rhyton-style cup and a 2800-year-old gravestone statue, each depicting birds on the hand (Canby 2002; Soma 2012). Though interesting, neither convincingly demonstrates the practice of falconry (Gersmann and Grimm 2018).

Although the precise origin of falconry is difficult to pinpoint, its spread is well documented. For example, several Chinese artifacts dated 2100–2200 BP illustrate the use of birds of prey in hunting, presumably learned from their northern neighbors, the nomads of central Asia (Wallace 2012; Soma 2013; Schafer 2018). Falconry then spread from China to Korea and Japan (Gersmann and Grimm 2018). In southwest Asia, falconry initially traveled from Persia to neighboring Armenians, Aramaeans, and Arabs (Allsen 2006; Epstein 1943) and from there, rapidly expanded into northern Africa and western Europe (Prummel 1997), with ancient mosaics in Tunisia and Portugal depicting falconry as early as approximately 1500 BP (Gersmann and Grimm 2018).

The Persian Plateau (also known as the Iranian Plateau) is located within the proposed spreading pattern of falconry and has even been suggested as one of the likely cradles of falconry where techniques were developed and refined over generations (IAF 2008; Daryae and Malekzadeh 2018). Due to its climate, geology, and long history of human settlement, the Persian Plateau is also a site where numerous petroglyphs have been found (e.g. Naserifard 2009; Jamali 2015; Karimi and Ujang 2015; Kolnegari et al. 2020b). We hypothesized based on the long-standing practice of falconry throughout the Persian Plateau that evidence of falconry should be prevalent in a particular class of petroglyphs, called ‘zoomorphic petroglyphs’. If so, then we expected the results of a focused search for zoomorphic petroglyphs at major rock art sites of the Persian Plateau would

provide new information on the history of falconry, and on the pre-historic relationship—in last 10,000 year—between birds of prey and humankind.

Petroglyphs are prehistoric engravings in rock, found most often on the walls of caves and shelters (Bradley et al. 1994). These engravings range from simple geometric shapes to complex representations of important aspects of daily life (van der Sluijs and Peratt 2010). The study of petroglyphs can provide insight into the tools, cultures, and animal husbandry practices of the people who carved them (Kazemi et al. 2016; Kolnegari et al. 2020a, b). Zoomorphic petroglyphs include illustrations of animals hunted for food, and animals domesticated for food, work, or pets (Ira et al. 1994). For example, petroglyphs of wild goats are particularly common in the rock art of the Persian Plateau (Naserifard 2009; Moradi et al. 2013; Jamali 2015; Karimi and Ujang 2015). We suspected that falconry's combination of animal hunting and animal husbandry may have been a subject of the prehistoric rock art of local peoples, and therefore, of the petroglyphs of today (Konstantinov et al. 2016).

Methods

Numerous zoomorphic petroglyphs have been found in the mountainous regions surrounding the Persian Plateau in Iran (Kazemi et al. 2016; Kolnegari et al. 2020a, b). To identify petroglyphs with potential illustrations of falconry, we conducted field surveys across 13 major rock art sites in seven provinces of Iran covering 652,392 km² and by visiting approximately 42,000 petroglyphs during 2009–2019 in search of rock art depicting a person bearing a bird on the forearm. We chose a person bearing a bird on the forearm because the proximity of human and bird in the drawing would likely exclude other birds in rock art, and because we hypothesized that the memory of a person with a bird of prey perched on the forearm would be memorable enough to observers or participants to become the subject of rock art.

To document the petroglyphs, we followed protocols of preservation through digitization (Landon and Seales 2009). We measured and photographed each petroglyph, and we classified the subjects. The presence of ongoing erosion and growing rock varnish (a natural process of particulate deposition) on some of the petroglyphs we documented caused them to be difficult to distinguish from the rock upon which they were carved, so we also used Adobe Photoshop CC 2015.5 (San Jose, CA, USA) to adjust lighting and contrast to create high-quality permanent records that clearly showed the petroglyphs. In the interest of protecting culturally sensitive sites,

detailed petroglyph locations and original image files are not provided here but are available upon demonstration of legitimate credentials, expertise, and intent. In interacting with local stakeholders and documenting petroglyphs, we followed guidelines developed by the Chartered Institute for Archeologists (CifA) and recorded in the CifA's Code of Conduct document (CifA 2014).

Results

We discovered 11 falconry petroglyphs across three provinces in Iran (Table 1; Figs. 1 and 2). Of these, 10 petroglyphs were located in the vast archaeological region of Teymareh, which extends into portions of Isfahan, Lorestan, and Markazi provinces in central Iran. We also identified one petroglyph in South Khorasan province. The main technique applied in producing these petroglyphs was hammering (direct percussion).

Discussion

We hypothesized that evidence of prehistoric falconry could be found in the petroglyphs of the Persian Plateau, and we subsequently found evidence to support our hypothesis. Retrospective to our hypothesis, the petroglyphs we found can be assessed for age and content to provide new insights into the timing and context of prehistoric falconry. Ideally, we would have assessed our findings with sophisticated dating techniques to estimate creation dates for the petroglyphs we found. Doing so was not possible, because the technologies necessary are not available in Iran due to US sanctions.

Due to our inability to accurately date the petroglyphs we discovered, we could not infer the commencement of falconry within the Persian Plateau. In the absence of a dating approach, we can only note that most of the previously studied petroglyphs of the Teymareh were carved approximately 4000 BP (Naserifard 2009), but some are apparently as old as 40,000 BP (Samuels 2016). Taking into account the latest findings regarding the onset of horse domestication (Schietecatte and Zouache 2017) and elephant taming (Sukumar 2011), we suggest that the petroglyphs we found depicting falconry paired with horseback riding and elephant riding were probably created later than 9000 and 4500 BP, respectively. Based on iconography of the swords depicted in Fig. 2 f and k, we suggest that the rock art described herein dates to the later prehistoric period, probably to the middle to late Bronze Age or early Iron Age (Moradi et al. 2013). Rock varnish, a term describing the natural deposition of windblown

Table 1 The characteristics of 11 zoomorphic petroglyphs depicting prehistoric falconry in the Persian Plateau. See Fig. 2 for photographs (Fig. 2a through k) of each petroglyph

No., Fig.	Depiction	Size (cm)	Locality, Province	Credit*
1, 2a	A horse-riding falconer with a bird of prey on the forearm and a ring-tailed saluki-like hound pursuing a large felid	13×51	Golpayegan, Isfahan	MJ
2, 2b	A horse-riding falconer with a bird of prey on the forearm followed by, probably, a domesticated dog	15×28	Golpayegan, Isfahan	MJ
3, 2c	A horse-riding falconer with a bird of prey on the forearm; reproduced in black and white to improve clarity	10×7	Khusf, South Khorasan	KG
4, 2d	A horse-riding falconer with a bird of prey on the forearm and, probably, a ring-tailed hound, pursuing, perhaps, a large felid	25×54	Golpayegan, Isfahan	MJ
5, 2e	A horse-riding falconer with a bird of prey on the forearm; reproduced in black and white to improve clarity	15×7	Golpayegan, Isfahan	MJ
6, 2f	A falconer bearing a bird of prey on the left forearm and the right forearm	21×11	Golpayegan, Isfahan	MJ
10, 2g	A master falconer and servant, the former bearing a bird of prey and the latter bearing (possibly) a kind of perch on the forearm	15×38	Golpayegan, Isfahan	MJ
11, 2h	Master falconer and servant, with a bird of prey and, probably, a leashed Asiatic cheetah (<i>Acinonyx jubatus venaticus</i>)	27×54	Golpayegan, Isfahan	MJ
7, 2i	A horse-riding falconer with a bird of prey on the forearm and a domesticated dog pursuing, probably, a gazelle (<i>Gazelle</i> sp.)	17×19	Khomein, Markazi	MN
8, 2j	Two falconers, one with a bird of prey on the forearm, riding an elephant and pursuing an unidentified mammal	19×22	Khomein, Markazi	MN
9, 2k	A falconer bearing a bird of prey on the forearm, and flanked by two domesticated dogs pursuing a wild goat (<i>Capra aegagrus</i>)	20×24	Khomein, Markazi	MN

* Credit for discovering, identifying, and photographing petroglyphs: MJ = Mohsen Jamali, KG = Kamal Ghous, MN = Mohammad Naserifard

Fig. 1 Locations of the zoomorphic petroglyphs depicting prehistoric falconry in Iran. Left: map of Iran indicating the location of the Teymareh rock art sites (with ten falconry petroglyphs) labelled 'T', and the location of the Khusf petroglyph labelled 'K' (with one falconry petroglyph). Right: distribution of ten falconry petroglyphs in Teymareh rock art sites. Bottom: a view of the Teymareh region in the Persian Plateau. Note that the Khusf petroglyph labelled 'c' in Fig. 2 was found at South Khorasan outside the Teymareh rock art sites

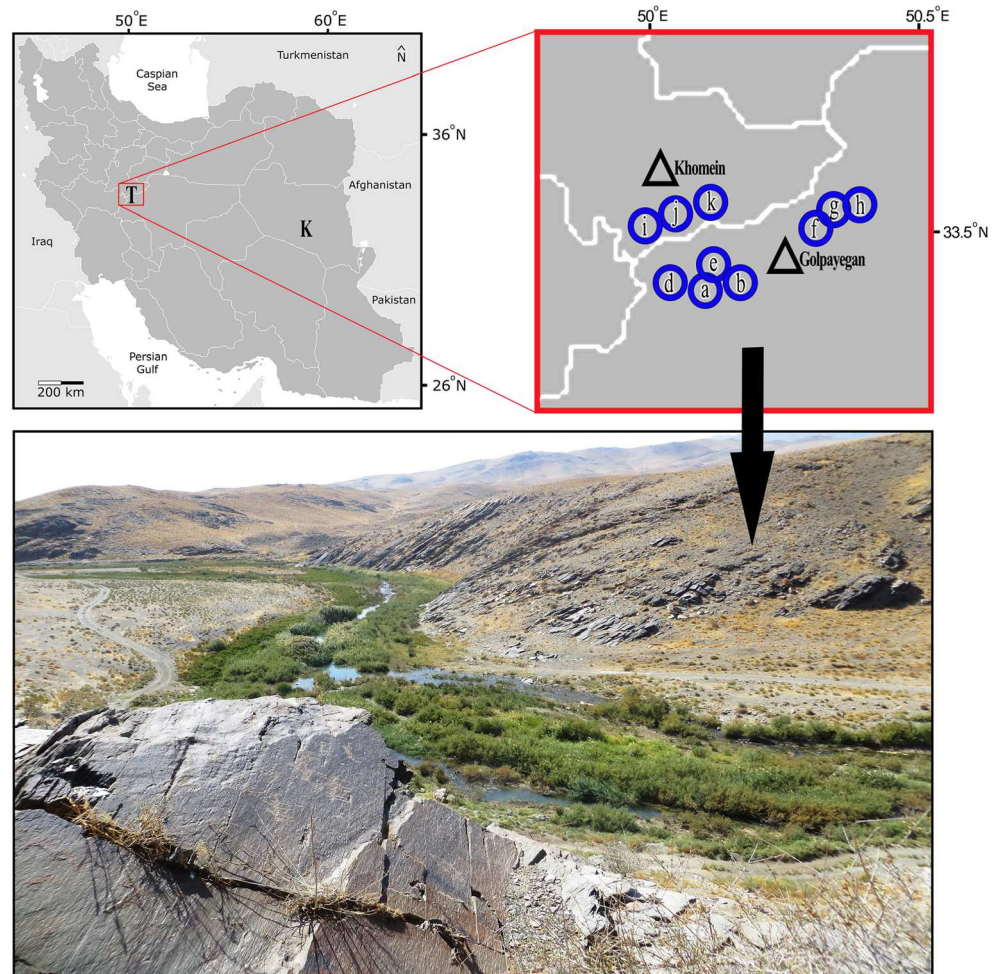


Fig. 2 a–k Eleven zoomorphic petroglyphs depicting prehistoric falconry in the Persian Plateau. See Table 1 for detailed information (depiction, size, location, and discoverer-photographer) describing each image



particles onto stable rock not exposed to frequent precipitation, fracturing, or wind abrasion, can also be used to assess the relative age of petroglyphs (Welsh and Welsh 2000; Moradi et al. 2013). In our data, the colour of most of the petroglyphs retains an obvious dichotomy from the rock varnish, though the petroglyphs in Fig. 2 b and e show some rock varnish, and the petroglyph in Fig. 2d is almost completely covered with varnish, suggesting that Fig. 2d, which depicts falconry by a bowman (archer), is the oldest petroglyph in our data.

From the viewpoint of falconry history, the importance of the Teymareh region seems considerable, as 91% of the falconry petroglyphs in our study were documented from the Teymareh, and because falconry continues in the Teymareh today. For example, in the Mighan Wetland, the Haftad-Gholeh Protected Area, and the Mouth Wildlife Refuge, each areas of conservation focus near the Teymareh, illicit trapping of birds

of prey for use in falconry, particularly Barbary Falcons (*Falco pelegrinoides*), Saker Falcons (*Falco cherrug*), and Peregrine Falcons (*Falco peregrinus*), remains prevalent today (Kolnegari and Hazrati 2018). In these areas of high diversity at the intersection of the Zagros Mountains and the Dasht-e Kavir Desert (Tavassoli 2016), prehistoric peoples likely interacted with a considerable breadth of birds of prey, and of prey species, perhaps forming a cornerstone for the development of falconry in the Persian Plateau.

The style and theme used in Teymareh petroglyphs show similarities where multiple petroglyphs occur in close proximity to one another. Specifically, four petroglyphs (Fig. 2 a, b, d, and e) in the vicinity of Kucheri village are less than 200 m from each other, and all depict falconers on horseback, each with a distinct triangular body and each with a bird of prey on the left hand. Perhaps these four petroglyphs were created by a single artist, or created by multiple artists inspired by one

another's work. In another group in the vicinity of Gharghab village, two of three petroglyphs (Fig. 2 g and h) closely resemble each other, again suggesting the possibility of connected origins. The content of the petroglyphs also provides insight into the role and mechanics of falconry in the prehistory of the Persian Plateau. For example, eight of the 11 petroglyphs (73%) included a depiction of a horse ($n = 7$) or elephant ($n = 1$). Domestication of large herbivores for mobility and labour in agriculture overlapped with falconry practices (Werth 1954). The mobility and improved field of view provided by being on horseback or on an elephant may have improved hunting success in falconry in the short term and may have served to spread falconry across cultures in the long term (Soma 2012). Importantly, our documentation of elephant-riding associated with falconry (Fig. 2j) provides one of the few reports of this merging of two disparate human-animal associations. Six of the 11 petroglyphs (55%) included a depiction of a dog ($n = 5$) or, perhaps an Asiatic Cheetah (*Acinonyx jubatus venaticus*) ($n = 1$), and two included servants. In conjunction with the use of horses and elephants, these tableaux suggest falconry was but one aspect of a suite of human-animal associations developed and maintained by the prehistoric peoples of the Persian Plateau. Similar associations between humans and domesticated animals have been reported from archaeological excavations of pre-Islamic monuments and from early historic writings (Soma 2012; Daryaee and Malekzadeh 2018). For example, in the Persian epic poem, 'Shahnameh', written approximately 1000 BP, kings on hunting trips were often accompanied by some combination of servants, birds of prey, tamed felids, and elephants (Ferdowsi 1987).

Generally, because animal motifs in petroglyphs are highly stylized, it is not always clear which species are depicted (Prummel 1993). In our study specifically, the bird motifs lack the morphologic detail necessary to distinguish species, but we may be able to provide general identification informed by other components of the scenes. The birds of prey in the petroglyphs we discovered were frequently paired with canids, which were and are often used in falconry to find, point, and flush prey such as pheasants, partridges, grouse, and ducks (Phillott 1908; Forsyth 1944; Flynn 2018; Wolfe 2018). In most falconry traditions, the trained bird primarily hunts animals within its natural prey spectrum (Soma 2015; Oehrl 2018). If that generalization applies to the petroglyphs we discovered, then Fig. 2j may depict a Golden Eagle (*Aquila chrysaetos*), because among raptors only Golden Eagles have the size and disposition necessary to pursue large mammalian prey without the support of canids. We base this assertion on modern observations of Golden Eagle predation of large-sized herbivores such as Red Deer (*Cervus elaphus*), Siberian Ibex (*Capra sibirica*), Argali (*Ovis ammon*), and antelope (Goodwin 1977; Oehrl 2018). However, there is little other evidence for Golden Eagles having been used in falconry in

Persian Plateau (Phillott 1908; Daryaee and Malekzadeh 2018) or by neighbouring Arabs (Seddon and Launay 2008).

Despite the likely presence of a Golden Eagle in one of the petroglyphs we discovered, and despite the importance of eagles in prehistoric cultures around the globe (Collins 1913; Miller 1957; Lawrence 1993; Greet 2015), we suggest that most of the petroglyphs depict raptors other than eagles, likely falcons and buteos, which are smaller, generally less aggressive, and lack the capability to capture the large mammalian prey (Phillott 1908; Soma 2015). This brings up two important questions. Did the non-eagle Falconiformes in prehistoric falconry on the Persian Plateau play an active role in hunting large mammalian prey depicted in the petroglyphs, and if so, what was that role? Based on several sources of falconry in Asia (Johnson 1822; Phillott 1908; Oehrl 2018), we suggest that birds of prey did have an active role in hunting large mammals, particularly Persian Gazelle *Gazella subgutturosa* and Arabian Gazelle *Gazella arabica*. To hunt those species, birds of prey were trained to attack the prey's head to disturb the prey or to injure the eyes, driving the prey from cover, and increasing its vulnerability to the canids in the hunting party. One of the roles of non-eagle birds of prey in prehistoric falconry in the Persian Plateau may have been to increase the vulnerability of prey in this way. A second role was likely to hunt smaller prey. Smaller prey were likely captured far more often, but because those hunting successes were less spectacular, they may not have been the subject of rock art.

We interpret two of the petroglyphs as idealized or exaggerated scenes (Fig. 2 a and d), where a canid is depicted on horseback with the falconer in pursuit of what appears to be a large felid, perhaps an Asiatic Lion (*Panthera leo persica*) or a Persian Leopard (*Panthera pardus saxicolor*). Depictions of imaginary scenes are relatively common in petroglyphs (Naserifard 2009; Jamali 2015; Kolnegari et al. 2020a), and may be related to early myths or fables, now lost (Welsh and Welsh 2000). Alternatively, it is possible that these two petroglyphs depict hoped-for situations, termed sympathetic hunting magic (Welsh and Welsh 2000). In contrast to the Altai petroglyphs, proposed as the oldest falconry petroglyphs, the petroglyphs we discovered seem more stylized, lack detail, and depict a broader range of scenes and styles of falconry (see Konstantinov et al. 2016).

The Persian Plateau contains several rock art sites, including the Teymareh region which includes 32 known rock art sites and more than 25,000 petroglyphs (Jamali 2015). Despite the archaeological importance of petroglyphs, and the abundance of Zoomorphic petroglyphs (Karimi and Ujang 2015; Kolnegari et al. 2020a, b) in the Teymareh in particular, studies of the petroglyphs of Iran are still in a preliminary stage (Kazemi et al. 2016) and are relatively under-represented in English-language publications (Moradi et al. 2013). We hope

that this study will lead to increased interest in, and study of, petroglyphs in Iran and in the Teymareh. Future research should continue to explore these sites to document additional depictions of falconry, and should employ chronological methods for dating the zoomorphic petroglyphs. Such research may benefit from a multidisciplinary approach, such as the approach demonstrated here, whereby archaeologists and zoologists collaborated to develop and explore a hypothesis pertaining to the origins of the zoomorphic petroglyphs we discovered.

Future research should also employ the same chronological methods for dating the Persian petroglyphs discovered in the study and as were used to date the Altai petroglyphs, because the two sets of petroglyphs could potentially provide new insight into the origins and spread of falconry in Asia. This approach may provide new support, or may refute the hypothesis that ‘the art of hunting with birds’ could have been invented independently in different regions (Gersmann and Grimm 2018).

Acknowledgements The authors are thankful for the support of the Cultural Heritage, Handicrafts, and Tourism Organization of Iran. We would also like to thank the people of Golpayegan, Khomein, and Khusf cities for their continuing efforts to protect the ancient petroglyphs.

Author contribution All authors contributed to writing the manuscript. Mahmood Kolnegari, Mohsen Jamali, Mohammad Naserifard, Kamal Ghous, and Mandana Hazrati conceived of the study and acquired and interpreted data.

Funding This project was supported by the Avaye Dornaye Khakestari Institute, Arak, Markazi Province, Iran.

Code availability N/A.

Declarations

Ethics approval In interacting with local stakeholders and documenting petroglyphs, we followed guidelines developed by the Chartered Institute for Archeologists (CIFA) and recorded in the CIFA’s Code of Conduct document (CIFA 2014) available online at <http://www.archaeologists.net/sites/default/files/CodesofConduct.pdf>.

Consent to participate N/A.

Consent for publication N/A.

Conflict of interest The authors declare that they have no conflict of interest.

References

- Albright SL (1984) Tahltan ethnoarchaeology. Simon Fraser University Archaeology Press, Burnaby 128 pages
- Allsen T (2006) The royal hunt in Eurasian history. University of Pennsylvania Press, Philadelphia 416 pages




- Barrett HG (1939) Culture element distributions: IX. Gulf of Georgia Salish. University of California, Anthropological Records 1(5): 221–295
- Benson EP (1997) Birds and beasts of ancient Latin America. University Press of Florida, Gainesville 162 pages
- Bostock J, Riley H (1855) The natural history. Pliny the Elder. Taylor and Francis, London
- Bradley R, Boado FC, Valcarce RF (1994) Rock art research as landscape archaeology: a pilot study in Galicia, NW Spain. World Archaeol 25:374–390
- Bub H (1978) Bird trapping and banding: a handbook for trapping methods all over the world. Cornell University Press, Ithaca 330 pages
- Canby JV (2002) Falconry (hawking) in Hittite lands. J Near East Stud 61:161–201
- Chartered Institute for Archeologists (CIFA) (2014) Code of Conduct. <http://www.archaeologists.net/sites/default/files/CodesofConduct.pdf>. Accessed 14 Jan 2020
- Collins AH (1913) Symbolism of animals and birds represented in English church architecture. Sir Isaac Pitman and Sons, London
- Daryaei T, Malekzadeh S (2018) Falcons and falconry in pre-modern Persia. In: Gersmann K-H, Grimm O (eds) Raptor and human–falconry and bird symbolism throughout the millennia on a global scale. Wachholtz Verlag – Murmann Publishers, Kiel/Hamburg
- David WB (1989) Hawks, serpents, and bird-men. Plains Anthropol 34(125):233–260
- Derwent S, Mander M (2017) Kruger Park Birding: birds and muthi (Mediane). <http://birding.krugerpark.co.za/birding-in-kruger-birds-and-muthi.html>. Accessed 5 Apr 2020
- Epstein H (1943) The origin and earliest history of falconry. Isis 34:497–509
- Ferdowsi A (1987) In: Khaleghi-Motlagh D (ed) The Shahnameh (Book of Kings), vol 8. Bibliotheca Persica, New York
- Finlayson C, Brown K, Blasco R, Rosell J, Negro JJ, Bortolotti GR, Finlayson G, Sánchez Marco A, Giles Pacheco F, Rodríguez Vidal J, Carrión JS, Fa DA, Rodríguez Llanes JM (2012) Birds of a feather: Neanderthal exploitation of raptors and corvids. PLoS One 7(9): e45927
- Flynn JT (2018) Falcons over Texas: a look at those still practicing an ancient tradition today. Master’s thesis. University of Texas at Austin, Austin 42 pages
- Forsyth WH (1944) The noblest of sports: falconry in the Middle Ages. Metrop Mus Art Bull 2(9):253–259
- Gala M, Tagliacozzo A (2014) The role of birds in the settlement of Shahr-i Sokhta (Sistan, Iran) during the 3rd Millennium BC. Int J Osteoarchaeol 24:319–330. <https://doi.org/10.1002/oa.2389>
- Gersmann K-H, Grimm O (2018) Introduction, discussion and summary: raptor and human–falconry and bird symbolism throughout the millennia on a global scale. Wachholtz Verlag – Murmann Publishers, Kiel/Hamburg 25 pages
- Goodwin GA (1977) Golden Eagle predation on pronghorn antelope. Auk 94:789–790
- Greet BJR (2015) The Roman Eagle: a symbol and its evolution. PhD Thesis. The University of Leeds, Leeds
- Hayes JS (2014) Jupiter’s legacy: the symbol of the eagle and thunderbolt in antiquity and their appropriation by Revolutionary America and Nazi Germany. Senior Capstone Projects. 261. http://digitalwindow.vassar.edu/senior_capstone/261. Accessed 25 Feb 2020
- Holmes M (2018) King of the Birds! The changing role of White-tailed (*Haliaeetus albicilla*) and Golden-Eagles (*Aquila chrysaetos*) in Britain’s past. Archaeofauna 27:173–194
- International Association for Falconry and Conservation of Birds of Prey (IAF) (2008) A history of falconry. Online at: <https://iaf.org/a-history-of-falconry/>. Accessed 11 Feb 2020
- Ikram S (2005) Divine creatures: animal mummies in ancient Egypt. American University in Cairo Press, Cairo 257 pages

- Ikram S, Slabbert R, Cornelius I, Plessis A, Swanepoel LC, Weber H (2015) Fatal force-feeding or gluttonous gagging? The death of Kestrel SACHM 2575. *J Archaeol Sci* 63:72–77
- Ira G, Gonsalves J, Mundy P (1994) Animal diversity in prehistoric rock art. In: Biodiversity in the Western Ghats, Information Kit. World Wide Fund for Nature, India. 8–5:1–4
- Jacobson-Tepfer Kubarev V, Tseveendorj D (2006) R'epertoire des p'etroglyphes d'Asie Centrale: Fascicule 7: Mongolie du Nord-Ouest haut Tsangaan Gol. Paris: De Boccard
- Jamali M (2015) Golpayegan petroglyphs: the passage for the history. Aemmhbook Publisher, Qom 430 pages
- Johnson D (1822) Sketches of field sports as followed by the natives of India with observations on the animals, London
- Karimi E, Ujang B (2015) The petroglyphs of Qameshlu National Park, central Iran. *Rock Art Res* 32:116–199
- Kazemi M, Naseri Soomeh H, Tahmasebi F (2016) Study of dash complex, petroglyphs in Meshginshahr, northwest of Iran. *Int J Sci Res Methodol* 5:317–328
- Kolnegari M, Hazrati M (2018) Mighan desert wetland atlas of vertebrates. Avaye Domaye Khakestari, Arak
- Kolnegari M, Naserifard M, Hazrati M (2020a) Discovery of Buprestidae rock art in central Iran suggests historical relationship between jewel beetles and mankind. *Entomol Sci* 23(2):193–195
- Kolnegari M, Naserifard M, Hazrati M, Shelomi M (2020b) Squatting (squatter) mantis man: a prehistoric praying mantis petroglyph in Iran. *Orthoptera Res* 29:41–44
- Konstantinov N, Soenov V, Cheremisin D (2016) Battle and hunting scenes in Turkic rock art of the early Middle Ages in Altai. *Rock Art Res* 33(1):8–18
- Kortum R (2014) Sacred imagery and ritual landscape: new discoveries at the Biluut Petroglyph Complex in the Mongolian Altai. *Time Mind* 7(4):329–384
- Landon GV, Seales WB (2009) A new method for recording petroglyphs: the research potential of digitized images. In: Hayward MH, Atkinson L-G, Cinquino MA (eds) *Rock Art of the Caribbean*. University of Alabama Press, Tuscaloosa 285 pages
- Latham S (1633) *Latham's falconry: or, the falcon's lure and cure*. Edited by Jackson Chambers. Proquest, EEBO Editions, England. Reprinted (2017) CreateSpace Independent Publishing Platform. 180 pages
- Lawrence EA (1993) The symbolic role of animals in the plains Indian sun dance. *Soc Anim* 1:17–37
- Macdonald H (2006) *Falcon*. Reaktion Books Ltd, London 224 pages
- McClure CJW, Schulwitz SE, Anderson DL, Robinson BW, Mojica EK, Therrien J-F, Oleyar MD, Johnson J (2019) Commentary: defining raptors and birds of prey. *J Raptor Re* 53:419–430
- Miller L (1957) Bird remains from an Oregon Indian midden. *Condor* 59: 59–63
- Moradi H, Sarhaddi Dadian H, Soltani M, Nik Abul Rahman NSH, Chang B (2013) Study and typological comparison of petroglyphs in the Marzbanik Valley, Baluchestan, Iran. *Time Mind J Archaeol Conscious Cult* 6(3):331–349. <https://doi.org/10.2752/175169713X13673499387127>
- Morejohn GV, Galloway JP (1983) Identification of avian and mammalian species used in the manufacture of bone whistles recovered from a San Francisco Bay area archaeological site. *J Calif Gt Basin Anthropol* 5(1/2):87–97
- Naserifard M (2009) *Iran petroglyphs ideogram symbol*. Khomein Press, Iran 444 pages
- Negro JJ (2018) Raptors and people: an ancient relationship persisting today. In: Sarasola JH, Grande JM, Negro JJ (eds) *Birds of prey: biology and conservation in the XXI century*. Springer International Publishin, Cham, pp 161–176
- Oberg K (1973) *The social economy of the Tlingit Indians*. University of Washington Press, Seattle 144 pages
- Oehrl S (2018) Can pictures lie? Hunting the red deer with raptors, According to visual representations from the Viking Age. In: *Raptor and human-falconry and bird symbolism throughout the millennia on a global scale* (K-H Gersmann, and O Grimm, Eds.). Wachholtz Verlag – Murmann Publishers, Kiel/Hamburg
- Panther CT, Atkinson ED, White RL (2019) Quantifying the global legal trade in live CITES-listed raptors and owls for commercial purposes over a 40-year period. *Avocetta* 43:23–36
- Phillott DC (1908) *The Bhe-NNe -Yi NYSiri*. A Persian treatise on falconry. Translated by Lieut.-Colonel D. C. Phillott, London
- Porter R (2011) Insights into Egyptian horus falcon imagery by way of real falcons and horus falcon influence in the aegean in the middle bronze age: Part I. *J Anc Egypt Interconnect* 3(3):27–38
- Prummel W (1993) Die Tierknochenfunde unter besonderer Berücksichtigung der Beizjagd. *Offa-Bucher* 74 (Neumunster). Starigard/Oldenburg. Hauptburg der Slawen in Wagrien IV
- Prummel W (1997) Evidence of hawking (falconry) from bird and mammal bones. *Int J Osteoarchaeol* 7:333–338. [https://doi.org/10.1002/\(SICI\)1099-1212\(199707/08\)7:4<333::AID-OA374>3.0.CO;2-7](https://doi.org/10.1002/(SICI)1099-1212(199707/08)7:4<333::AID-OA374>3.0.CO;2-7)
- Radović D, Oros Sršen A, Radović J, Frayer DW (2015) Evidence for Neandertal Jewelry: modified white-tailed eagle claws at Krapina. *PLoS One* 10(3):e0119802. <https://doi.org/10.1371/journal.pone.0119802>
- Rodríguez-Hidalgo A, Morales JI, Cebrià A, Courtenay LA, Fernández-Marchena JL, García-Argudo G, Marín J, Saladié P, Soto M, Tejero J-M, Fullola J-M (2019) The Châtelperronian Neanderthals of Cova Foradada (Calafell, Spain) used Imperial Eagle phalanges for symbolic purposes. *Sci Adv* 5(11). <https://doi.org/10.1126/sciadv.aax1984>
- Samuels G (2016) 'World's oldest rock drawings' uncovered in Iran by archaeologist. *The Independent*. 12 December. <https://www.independent.co.uk/news/world/middle-east/world-oldest-rock-drawings-archaeologist-iran-khameyn-mohammed-naserifard-a7470321.html>. Accessed 14 August 2019
- Schafer EH (2018) *Falconry in T'ang Times*. *T'oung Pao* 46:293–338
- Schiettecatte J, Zouache A (2017) *The horse in Arabia and the Arabian horse: origins, myths and realities*. Arabian Humanities, Centre Français d'Archéologie et de Sciences sociales de Sanaa (CEFAS), 2017, *The horse in the Arabian Peninsula / Le cheval dans la péninsule Arabique*. 8. <https://doi.org/10.4000/cy.3280.halshs-01585122>
- Seddon PJ, Launay F (2008) Arab Falconry: changes, challenges and conservation opportunities of an ancient art. In: Lovelock B (ed) *Tourism and the consumption of wildlife: hunting, shooting and sports fishing*. Routledge, London
- Sielicki J (2016) Falconry as a biodiversity conservation tool. In *Conference Proceedings: Falconry – Its influence on biodiversity and cultural heritage At: Suprasl, Poland*. Pages 19–28
- Soma T (2012) Ethnoarchaeology of horse-riding falconry. *The Asian Conference on the Social Sciences*. Official conference proceedings. Online at: <https://www.academia.edu/14642222/Takuya>. Accessed 12 Dec 2019
- Soma T (2013) Ethnoarchaeology of ancient falconry in East Asia. In *The Asian Conference on Cultural Studies*. Official conference proceedings. Online at: <https://www.academia.edu/14642141/Takuya>. Accessed 12 Dec 2019
- Soma T (2015) Human and raptor interactions in the context of a Nomadic society anthropological and ethno-ornithological studies of Altaic Kazakh falconry and its cultural sustainability in Western Mongolia. *Kassel University Press GmbH, Kassel*
- Sukumar R (2011) *The story of Asia's elephants*. Marg, Mumbai
- Tavassoli M (2016) *Urban structure in hot arid environments*. Springer International Publishing Switzerland, Cham
- Turney-High HH (1941) *Ethnography of the Kutenai*. American Anthropological Association, Menasha 202 pages

- Umoh K (2014) Taekwondo Poomsae: the fighting scrolls, Guiding philosophy and basic applications. Strategic Book Publishing and Rights Co, Houston
- van der Sluijs MA, Peratt AL (2010) Astronomical petroglyphs: searching for rock art evidence for an ancient super aurora. Expedition [Univ Pennsylvania Mus Archeol Anthropol] 52:33–42
- Vaughan R (1992) Birds and Arctic peoples. In: In Search of Arctic birds. London: T & A D Poyser, 1992:20–48
- Wakefield S (2012) Falconry as heritage in the United Arab Emirates. World Archaeol 44:280–290
- Wallace LV (2012) Representations of falconry in Eastern Han China (A.D. 25–220). J Sport Hist 39(1):99–109
- Wallis RJ (2014) Re-examining stone ‘wrist-guards’ as evidence for falconry in later prehistoric Britain. Antiquity 88:411–424
- Warmbier J (1959) Der Zusammenhang zwischen Falknerei und Reiterkultur. Freie Universität, Berlin 185 pages
- Welsh L, Welsh P (2000) Rock-art of the southwest. Wilderness Press, Berkeley 167 pages
- Werth E (1954) Grabstock, Hacke und Pflug. Verlag Eugen Ulmer (In German). Translated by Yabuuchi Yoshihiko and Iinuma Jirou. 1968. Nougyou Bunka no Kigen. Iwanami Syoten, Tokyo, pp 120–122
- Wilkinson RH (2003) The complete gods and goddesses of Ancient Egypt. Thames and Hudson, London
- Wolfe K (2018) Learning ancient art of horseback falconry. Online at: <https://www.atlasobscura.com/articles/horseback-falconry-lesson>

Publisher's note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Affiliations

Mahmood Kolnegari¹  · Mohsen Jamali²  · Mohammad Naserifard³ · Kamal Ghous⁴ · Mandana Hazrati¹ · Connor T. Panter⁵ · James F. Dwyer⁶ 

¹ Avaye Dornaye Khakestari Institute, Arak, Markazi Province, Iran

² Archaeology Department, Art University, Isfahan, Isfahan Province, Iran

³ Tehran, Iran

⁴ Jihad-e-Keshavarzi Organisation of South Khorasan Province, Khusf, South Khorasan Province, Iran

⁵ Ecology, Conservation and Zoonosis Research and Enterprise Group, School of Pharmacy and Biomolecular Sciences, University of Brighton, Brighton, UK

⁶ EDM International, Inc., Fort Collins, CO, USA

Terms and Conditions

Springer Nature journal content, brought to you courtesy of Springer Nature Customer Service Center GmbH (“Springer Nature”).

Springer Nature supports a reasonable amount of sharing of research papers by authors, subscribers and authorised users (“Users”), for small-scale personal, non-commercial use provided that all copyright, trade and service marks and other proprietary notices are maintained. By accessing, sharing, receiving or otherwise using the Springer Nature journal content you agree to these terms of use (“Terms”). For these purposes, Springer Nature considers academic use (by researchers and students) to be non-commercial.

These Terms are supplementary and will apply in addition to any applicable website terms and conditions, a relevant site licence or a personal subscription. These Terms will prevail over any conflict or ambiguity with regards to the relevant terms, a site licence or a personal subscription (to the extent of the conflict or ambiguity only). For Creative Commons-licensed articles, the terms of the Creative Commons license used will apply.

We collect and use personal data to provide access to the Springer Nature journal content. We may also use these personal data internally within ResearchGate and Springer Nature and as agreed share it, in an anonymised way, for purposes of tracking, analysis and reporting. We will not otherwise disclose your personal data outside the ResearchGate or the Springer Nature group of companies unless we have your permission as detailed in the Privacy Policy.

While Users may use the Springer Nature journal content for small scale, personal non-commercial use, it is important to note that Users may not:

1. use such content for the purpose of providing other users with access on a regular or large scale basis or as a means to circumvent access control;
2. use such content where to do so would be considered a criminal or statutory offence in any jurisdiction, or gives rise to civil liability, or is otherwise unlawful;
3. falsely or misleadingly imply or suggest endorsement, approval, sponsorship, or association unless explicitly agreed to by Springer Nature in writing;
4. use bots or other automated methods to access the content or redirect messages
5. override any security feature or exclusionary protocol; or
6. share the content in order to create substitute for Springer Nature products or services or a systematic database of Springer Nature journal content.

In line with the restriction against commercial use, Springer Nature does not permit the creation of a product or service that creates revenue, royalties, rent or income from our content or its inclusion as part of a paid for service or for other commercial gain. Springer Nature journal content cannot be used for inter-library loans and librarians may not upload Springer Nature journal content on a large scale into their, or any other, institutional repository.

These terms of use are reviewed regularly and may be amended at any time. Springer Nature is not obligated to publish any information or content on this website and may remove it or features or functionality at our sole discretion, at any time with or without notice. Springer Nature may revoke this licence to you at any time and remove access to any copies of the Springer Nature journal content which have been saved.

To the fullest extent permitted by law, Springer Nature makes no warranties, representations or guarantees to Users, either express or implied with respect to the Springer nature journal content and all parties disclaim and waive any implied warranties or warranties imposed by law, including merchantability or fitness for any particular purpose.

Please note that these rights do not automatically extend to content, data or other material published by Springer Nature that may be licensed from third parties.

If you would like to use or distribute our Springer Nature journal content to a wider audience or on a regular basis or in any other manner not expressly permitted by these Terms, please contact Springer Nature at

onlineservice@springernature.com