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Chapter 3

The imperial Mughal hunt: A pursuit of knowledge

Shaha Parpia

ABSTRACT

The Mughal emperors used the imperial hunt as an agency for knowledge acquisition. Investigation, experimentation, and analyses of natural phenomena encountered on the field were recorded by Mughal scholars with an emphasis on anatomy, taxonomy, and animal psychology. Detailed textual references were enhanced by naturalistic paintings that were of a technical nature and served as documents of scientific knowledge. Scientific inquiry also produced sound knowledge of animal behaviour and characteristics, thereby improving breeding programs and hunting techniques in the Mughal empire. This chapter examines the sophisticated culture of hunting as an integral part of the scientific enterprise. It reveals aspects of the nature of 'scientific' knowledge from a Mughal perspective, and shows its utility and functions in that cultural context. It discusses the agency of the influential *akhlāq* (ethics) texts, which postulate that acquiring scientific knowledge is a religious obligation necessary to achieve perfection, and analyses how conceptions of ethics and morality impacted the promotion, perception, and practice of natural science. This exposition contributes to the current rethinking of the relationship between science and religion by indirectly showing the lack of definitive boundaries between the two realms in the Mughal tradition. The line of discussion presented also contributes to undermining the claims made in mainstream scholarship on the history of science that South Asian scientific endeavour paled in comparison to rational Western systematic forms of knowledge. The chapter explores the complex nature of scientific activities that were motivated by the Mughal hunt and their links to art, while assessing the interrelated concepts of religion, ethics, government, and science within hunting contexts in early modern Mughal history.

INTRODUCTION

Abū'l Fazl, the emperor Akbar's historian and biographer, famously claims, 'Short-sighted and shallow observers think that His Majesty has no other object in view but hunting; but the wise and experienced know that he pursues higher aims', adding that Akbar 'always makes hunting a means of increasing his knowledge'.[1] He also notes that hunting was not an activity of senseless killing as 'ignorant' people believe, but one where Akbar could travel incognito and without notice to ascertain the battle-readiness of troops, conduct inspections over agricultural and charitable lands, assess the efficacy and fairness of taxations laws, and deliver justice. In this way the *shikār* (hunt) can be seen as a 'means of acquisition of knowledge', and the complex administration of

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the public realm was 'the real kind of hunting'.[2] Lahōri, Shāhjahān's biographer, notes that 'the emperors go on hunting and sight-seeing but intrinsically they aim at ascertaining the prosperity of the kingdom and state of peace as first-hand information'.[3] The dangers the emperor brought to himself during hunting and elephant fights were regarded as neither irresponsible behaviour nor neglect of kingly duties, but rather as being a test of the sincerity and 'business capabilities' of those who doubted him.[4] The hunt was moreover seen as an activity to lead such 'superficialists' into the 'path of true knowledge'.[5]

While Mughal primary sources frequently draw analogies between the imperial hunt and the pursuit of knowledge, references to such knowledge indicate that they were intended for the purposes of administration and good governance. However, the Mughals also seem to have used the cultural activity of the hunt to further 'scientific' knowledge and conduct investigations and analyses of 'science' as perceived by them. This chapter examines the ways in which the exercise of hunting can be seen as a medium of knowledge acquisition, and how the sophisticated culture of hunting actually promoted and enabled a kind of scientific development in the early modern Mughal tradition. Focusing on aspects of zoology, ornithology, and hunting techniques, the chapter aims to show the marriage between science, technology, and art, as seen through the lens of hunting during the reign of the Great Mughals (1525-1707). The study discusses how the Mughals — following the methodologies of observation, reasoning, comparison, and experimentation set by early Muslim scholars from the 10th century onwards — studied, tested, and often challenged established traditions in the exploration of South Asian flora and fauna they encountered during their hunts. Their scientific enterprise produced sound knowledge of animal psychology and characteristics, thereby improving breeding programs. It also helped develop hunting techniques, which were transferred to the battlefield as military tactics. Hunting also seems to have enabled technological innovations that ensured greater success in warfare and the hunt, whilst other inventions made imperial life more congenial during hunting expeditions. The visual records of these studies were systematically undertaken, and seem to have continued in the older Islamic tradition of illustrated natural history texts, such as the *Kitāb naʿt al-ḥayawān,* Arabic and Persian translations of Dioscorides's *De Materia Medica,* and Qazwīnī's *ʿAjāʾib al-makhlūqāt.* Hence, it could be argued that explorations of South Asian flora and fauna and their pictorial depictions were completed by Mughal emperors to further the causes of good governance, the moral values required of an upstanding ruler, and the legitimacy that was engendered by a continuity of older traditions.

By studying the agency of the hunt in knowledge acquisition in general, and scientific development in particular, the chapter sheds light on what 'science' meant to the Mughals. It offers an understanding of what might be called 'scientific' knowledge from an Indo-Persian perspective, and shows its utility and function in that cultural context. The chapter places an emphasis on the natural historical sciences, and particularly zoological and ornithological studies, as these were closely connected with hunting practices.[6]

The chapter also sheds light on the significance of natural sciences in the broader framework of science in Islam. In pre- and early modern Islam, the notion of 'science' in general, and 'natural science' in particular, had wide spectrums of meaning. Science (*ʿilm*) included all branches of human knowledge, while the natural sciences (*ʿulūm ṭabīʿiyya*) included medicine, geography, optics, astronomy, and other aspects of the physical world. Philosophy and mathematics were often aligned with the natural sciences, and so were occultism and astrology, which were considered as part of

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the scientific enterprise. Most importantly, however, the chapter aims to show how ethics and moral values were closely connected with scientific thinking. The text of *Akhlāq-i Naṣīrī* (The Nasirean Ethics) written by renowned philosopher-astronomer Naṣīr al-Dīn al-Ṭūsī (d. 1274), for example, shows how conceptions of morality impacted the ways in which science was conceptualised and practised in Mughal culture.[7] This text is discussed in some detail later in the chapter.

The chapter contributes to the current rethinking of the relationship between science and religion, by indirectly showing the lack of definitive boundaries between the two realms in the Mughal tradition. A similar situation is also found in the early modern Western intellectual tradition. As historian of science and religion Peter Harrison notes, 'So familiar are the concepts "science" and "religion", and so central to Western culture have been the activities and achievements that are usually labelled "religious" and "scientific", that it is natural to assume that they were enduring features of the cultural landscape of the West'.[8] This study of the hunt as an integral part of the scientific enterprise confirms recent findings that, until relatively recently, the boundaries of the two domains of science and religion were understood very differently, and that human meaning and moral values were rarely separated from the understandings of the nature of the universe and other activities we now consider as being firmly located within the realm of science.[9]

Furthermore, the lines of discussion presented in this study contribute to undermining the claims made in mainstream scholarship in general that South Asian science and scholarship was secondary to rational Western systematic forms of knowledge. The chapter reinforces Pollock's cautions against 'definitional consistency', as the English word 'science' is a 'pliable signifier' that points to no natural kind, and it is 'no straightforward matter to map onto it the congeries of terms and texts and medieval practices' of mediaeval India.[10] It is with these perspectives in mind that the current chapter explores Mughal scientific activity that was enabled and expanded by the hunt.

SCIENTIFIC INQUIRY

In Mughal India, Akbar's doctrine of *ṣulḥ-i kul* or 'absolute peace', as propounded by Abū'l Fazl, which sought to bring about a unity of religions and an acceptance of diversity, embraced a 'new outlook of sympathy and tolerance' towards philosophy, the sciences, and reason.[11] This is reflected in Akbar's reforms of prevailing *madrasa* education and his decision to include rational sciences in the syllabi, which 'cast a new light on schools, and cast a bright lustre over *madrasas*'.[12] Abū'l Fazl notes that students were taught in stages, and that the subjects included ethics, arithmetic, accountancy, agriculture/horticulture, surveying, geometry, astronomy, geomancy, architecture, government, medicine, logic — that is, the *ṭabīʿī* (physical) and *riyāzī* (quantitative) sciences, in addition to the *ilāhī* (divine) sciences. They were also taught Sanskrit, Vedantic philosophy, and the grammar of Patanjali.[13] These educational reforms, which indicate a regard for the classical sciences and the ancient Indian intellectual heritage, were planned and carried out by the Persian scholar Mīr Fath'ullāh Shirāzi, a polymath scientist who had 'no equal in Persia or India, or rather in the habitable world in all the sciences'.[14] Other writers of the age such as Chandrabhān Brahman and Bālkrishan also suggest that the introduction of rational subjects in the syllabi encouraged large numbers of Hindus to join the *madrasas*.[15] This implies that the sciences and rational education were systematic and institutionalised, and benefited from imperial patronage. However, the writings of François Bernier, a French physician in the Mughal court, suggest an absence of 'academies and colleges properly endowed'.[16] Perhaps Bernier, who was a student of

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the philosopher Gassendi and was familiar with the formal institutions of learning in Europe, was misjudging the intellectual extensiveness of *madrasas* and the informal nature of teaching circles held in mosques and bazaars, presided over by the *ahl-i ʿilm* (people of learning), who included physicians and astronomers.[17]

Nevertheless, even Abū'l Fazl acknowledges the role of inflexible tradition and ideology in hampering the growth of science and reason: 'From time immemorial, the exercise of inquiry has been restricted, and questioning and investigation have been regarded as precursors of infidelity', he wrote, adding that 'a few among the intelligent of their generation admit the imbecility of this procedure in others'.[18] Abū'l Fazl's reflections indicate that while scientific knowledge may not have been widespread, a courtly culture of learning existed, along with imperial patronage of scholars. Zoological and botanical writings compiled in India are diverse in origin and content. According to Rahman et al., over 10,000 scientific works were produced in Sanskrit, Arabic, and Persian between the 8th and 19th centuries, with over 200 volumes in zoology alone.[19] And as Pollock notes, 'with the coming of Pax Mughalana from the second half of the 16th century, a new and dynamic era of intellectual inquiry was inaugurated in many parts of the [Indian] subcontinent. Whole libraries of the manuscripts produced over the following three centuries exist today — and lie unedited, even unread'.[20] The flourishing intellectual tradition hence suggests that the emperors' scientific inquiry enabled by the hunt was not an isolated undertaking; there was a prevailing intercultural scientific milieu in the Mughal court.

The kinds of Mughal scientific activities that were enabled by the hunt need to be gleaned from a variety of sources, which are often unrelated. Official court writings such as memoirs, biographies, and gazetteers, for instance, contain detailed information on natural history in addition to ubiquitous historical and administrative matters. While this is not the pragmatic, analytical method of modern Western science, it follows the trend of Indo-Persian historiographies of the time, which used interconnected literary genres to encompass all aspects of India's culture: the richness of its lands, inhabitants, flora and fauna, as well as a commemoration of the society's scholarship, architectural achievements, and economic glories.[21] Hence, it could be argued that one of the reasons Mughal emperors included detailed natural historical information of species encountered during hunts was to propagate a view of India as a land of natural (zoological and botanical) wonders, which was an all-important consideration for the success of their imperial vision. Even Bābur, who often found the Indian lifestyle, topography, and lack of formal gardens disagreeable to his Central Asian sensibilities, found the Indian flora and fauna fascinating, and his memoirs, written in a text called the *Bāburnāma,* contain graphic descriptions of several species.[22] These natural historical studies were later extensively illustrated by artists in Akbar's atelier and comprise over 120 illustrated folios.[23]

Bābur was particularly taken with the mammals peculiar to India, such as the elephant, rhinoceros, and nilgai, and native species of birds, such as the peacock. His penetrating descriptions of these are reflective of his knowledge and 'born of careful and intelligent observation'.[24] They were often recorded from a hunting perspective. His studies of the rhinoceros, for instance, include detailed information about the length of its horn and its power as demonstrated in the number of men and horses it had gored during hunts. The thickness of the hide of the rhinoceros was measured in accordance with how far an arrow shot from a stiff bow drawn with full strength might penetrate it, namely four inches. Bābur further notes a similarity in the size of the animal's

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stomach and pastern to that of a horse.[25] He also gives information about the natural habitat of the rhinoceros, and its behavioural patterns, noting that it cannot be made submissive and obedient like the elephant. It is important to note here that hunting an animal like the rhinoceros armed with just bows and arrows required an intimate knowledge of animal anatomy in order to ascertain its most vulnerable spot, given its thick and relatively impenetrable hide. By Jahāngīr's reign (r. 1605-27), this knowledge was clearly commonplace, as Jahāngīr notes that while hunting in Nuh Ban, Aligarh, he killed a rhinoceros with a single shot aimed near the animal's earlobe.[26]

One of the consequences of the *shikār* was that it enabled a respect for the flora and fauna of the Indian subcontinent engendered by a keen and often sensitive observation of the diversity of wildlife encountered on the field. In Mughal India, zoological studies included animal anatomy, taxonomy, and psychology. They also included various diseases, diagnostics, treatments, and remedies. These were recorded employing all the empirical tools of research available, including observation, dissection, and experimentation, as well as comparison with other species and the challenging of longstanding traditions. Jahāngīr was an avid hunter and equally keen naturalist. His memoirs, the *Jahāngīrnāma* or *Tūzuk-i Jahāngīrī*, contain evocative but accurate and succinct descriptions of flora and fauna encountered during hunts. He is exacting in his methodology, as he notes that '[o]nly those that are really special can be recorded'.[27] Specimens were weighed and measured, and the details recorded included local names, geographical distribution, anatomical peculiarities, and food habits, as well as the specimens' habitats, climatic conditions, and behaviours. Foreign species were also often compared to indigenous counterparts. For instance, en route to Malwa province in 1617 and encamped in the halting place of Qasim-khera (Qasimgarh) with the imperial entourage, Jahāngīr records that he hunted an unfamiliar 'white' animal. It has been subsequently identified as the four-horned antelope, *Tetracerus quadrocornis,* and the naturalist Salim Ali opines that its colouring was probably pale brown.[28] Jahāngīr notes:

> [I]t resembled the *kūtāh pāya* (Hog Deer); it had four horns, two of which were opposite the extremities of its eyes and two finger-breadths in height, and the other two horns were towards the nape of the neck. These were four finger-breadths in height. The people of India call this animal *dūdhāriya.* The male has four horns and the female none. It was said that this kind of antelope has no gall-bladder, but when they looked at its intestines the gall-bladder was apparent, and it became clear that this report has no foundation.[29]

In another anecdote, while on a tour to Kabul in 1607, Jahāngīr and his court were encamped in the Safid Sang meadow, near Du'aba, where a great *qamarghā* ring hunt was organised for him. During the hunt, 116 deer, 24 *rang* (ibex), 50 red antelopes, and 16 markhor (wild goats) were taken. Jahāngīr notes that it was his first experience seeing a *rang,* which he describes as a fine-looking animal, even surpassing the Hindustan black antelope in appearance. He ordered that a mountain ram and a *rang* be weighed for comparison. The ram came to 1 maund and 33 seers, and the *rang* was 2 maunds and 10 seers. Jahāngīr also notes that in spite of its large size, the *rang* was a nimble animal, as 12 swift dogs were worn out in pursuit and seized it with 'a hundred thousand difficulties'.[30]

Regarding taxonomy, Jahāngīr reverts to the tradition of older Arabic texts, grouping them according to 'outward criterions [sic] and regardless of casual connections'.[31] He uses the word *'ālam* (world of) to indicate a specific family, grouping animals with comparable affinities, such as the coat or size and shape of bill.[32] For instance, Jahāngīr notes that the langur belongs to the world of the

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Figure 3.1 Rhinoceros, *Vaki'at-i Baburi.* Or. 3714 vol. 4 fol. 379, British Library, London. © British Library Board (Or. 3714).

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monkey (*'ālam maimūn*), and the dipper to the world of the bulbul.[33] The *Jahāngīrnāma* also contains explicit details regarding strange zoological phenomena and experiments that were carried out on the field during hunts in order to increase Jahāngīr's knowledge, and to verify established animal myths. Jahāngīr is known to have taken a rationalistic approach to experimentation, testing, and observation in order to reach a verified truth.[34] Some of his many experiments include dissecting a king cobra to observe its cannibalistic characteristics; dissecting the livers and gall bladders of wolves and lions to establish links to their proverbial courage; studying stress levels in antelopes hunted by cheetahs; and challenging the accepted belief that aggression in male mountain goats was caused by parasites in their horn.[35] However, as Koch observes, Jahāngīr 'fails to feed the results of his empirical research into a theoretical framework and his observations do not lead to a systematic body of knowledge'.[36]

Detailed textual descriptions of flora and fauna encountered during the Mughal hunts were developed by court artists into lavish paintings that were precise, well defined, and objective nature studies. By the end of Akbar's reign, a distinctive style had developed, focusing on artistic realism and the naturalistic treatment of independent studies of animals and birds.[37] Jahāngīr, who inherited a mature atelier, continued to champion artists such as the acclaimed *Ustād* Mansūr, who was seen as the master of the animal painting genre, given to portraying wildlife in an anatomically accurate manner with a degree of unparalleled naturalism. Verma claims that the imperial artists' long tradition of illustrating manuscripts of fables such as *Anwār-i suhaili, 'Iyar-i dānish,* and *'Ajā'ib-i makhlūqāt* properly acquainted them with animal characteristics and psychology.[38] The trend to document textual descriptions of animal species with corresponding visual studies was accordingly set in motion in the early stages of the Mughal painting tradition. Shāhjahān's albums continued this trend of realism, extending it to broad margin paintings of detailed animal, bird, and floral studies. It seems that Jahāngīr's rationale for the objective portrayal of wildlife, which enhanced the scientific nature of his textual descriptions, was his desire for historical documentation of the rarities of nature for posterity. He writes: 'I both wrote of them and ordered the artists to draw their likeness in the *Jahāngīrnāma* so that the astonishment one has at hearing of them would increase by seeing them'.[39] Koch notes that Jahāngīr also seems to imply the advantages of a dual method, written and visual, in representing natural phenomena.[40]

Paintings of particular hunts and independent studies that correspond to dated textual sources indicate that artists travelled to *shikārgāhs* and on extended tours with the emperor, as such paintings were meant to be visual records of the events. For instance, when encountering a new species of bird, which he identifies as a *sāj* or dipper, in the Sukh Nag stream in the Kashmiri hills during the 1620 trip, Jahāngīr observes its colouration, and compares it with the more common bulbul due to its appearance and its tendency to dive and stay underwater for a while before emerging elsewhere. He also examines its feet, to ascertain if they were like the feet of waterfowl or land birds, and records that they were not webbed like a duck.[41] Mansūr has depicted the *sāj* in a hilly Kashmiri landscape beside a flowing stream. Verma notes that 'the juxtapositioning of another bird, smaller in size and apparently viewed from a distance, and the receding contours of the hills painted in blurred colour, suggest perspective, besides giving relief to the central figure'.[42] While Mansūr may have used the smaller *sāj* and other artistic tools to convey perspective, by depicting another angle of the bird to show the colouration of its belly feathers his painting also fulfils the criteria of natural historical observations. According to Verma, Mughal painters portrayed the animal/bird as an 'individual'

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Figure 3.2 Dipper/*Saj,* album leaf painted by Mansūr. Acc. 55.121.10.16, The Metropolitan Museum of Art, New York. (Licensed under CC0 1.0.)

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with minimum movement, and an emphasis on realism and physiognomy, which best suited animal studies.[43] The finesse and accuracy with which the artists have portrayed the bodily contours, microscopic anatomical details, colouration and expression of the animals, as well as the treatment of space, liveliness of brushstrokes, and other techniques, have often been discussed at length for their artistic worth. Mughal animal illustrations have also been examined by naturalists, historians of science, and scientists who acknowledge their merit as valuable scientific studies.[44] Art thus remains a crucial medium in recording and disseminating the knowledge of nature in Mughal contexts.

SCIENCE AND MORALITY

As noted earlier, science, ethics, moral values, and religion were interrelated concepts in Mughal cultural contexts. Hence, ethical literature, such as Naṣīr al-Dīn al-Ṭūsī's *Akhlāq-i Naṣīrī* wielded considerable influence in religious, political, social, and cultural spheres.[45] To support his views al-Ṭūsī cites the teachings of classical Greek philosophers and pre-Islamic Persian sages; he also makes frequent references to the Quran and Hadiths, and anchors the *akhlāq* (Arabic for 'ethics') framework in the *sharīʿa* (Arabic for 'law'), thus legitimising his work and making it politically compliant for imperial use. Alam opines that al-Ṭūsī uses the term *sharīʿa* not in the 'narrow legalistic sense', but as 'a notion of laws as *norms*' by which the king was obligated to ensure the welfare of *all* his subjects.[46] Jahāngīr, like Abū'l Fazl, frequently invokes God's hand in the wonders of creation of unusual animals. Of the zebra, Jahāngīr notes: '[T]he painter of destiny had produced a tour de force on the canvas of time with his wonder-working brush'.[47] Religious perspectives, wherein animal studies enabled an appreciation of the wisdom of God, were often the rationale of Islamic scientific inquiry.[48]

Akhlāq ethical texts advocate the virtue of having the courage to 'retain firmness in situations of alarm and danger' and to act by the dictates of 'right reason' as one of the essential qualities of an ideal king.[49] Hunting was seen as a good and proper sport for a king if undertaken for the right reasons and in moderation.[50] Hence hunting became a pivotal agency through which the emperor's authority and public persona were projected.

Akbar's *Dastūru'l-ʿamal,* which was distributed to court officials, further counsels imperial officers to be 'not too fond of hunting; but to go out hunting occasionally, with the object of military exercise and for relaxation, which is an unavoidable adjunct of human existence'.[51] The moral dichotomy inherent in the act of killing animals during hunting was confronted by reference to *akhlāq* texts, which advocated the image of the emperor as a brave hunter who had a moral obligation to subdue wild nature in order to protect his people: 'Men, Animal and Conscience completed the circle of Akbar's authority'.[52] Sumptuous paintings by court artists who travelled with the court on hunts served to magnify this image.[53] Hence it could be argued that while hunting images served to endorse imperial authority over the zoological and botanical domain, independent images of natural historical studies affirmed the observance of equity required by the ruler towards God's creatures.[54]

Observing the mutual respect between man and beast can be seen as another reason for scientific inquiry. The *Akhlāq-i Naṣīrī* notes that elements, plants, and animals render aid to the human species whether as matter, as instrument, or by way of service, and that the human species needs the aid of the other species and the co-operation of its own kind to ensure survival.[55] This translated into the Mughal politico- and socio-cultural context in several different ways.

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The superior breeding and selection of animals used during the hunt and on hunting expeditions, such as elephants, horses, and camels, not only ensured better hunting practices; they were also an integral element of the success of the Mughal military campaigns. Extensive anatomical knowledge was thus crucial for producing the optimal breed and ensuring the animals' welfare and comfort. The *Āʾīn-i Akbarī* devotes several reports to details such as the animals' physical characteristics, behavioural patterns, and breeding details; the maintenance of imperial stables; the classification of species; the ranks of the animals and the resulting food allocation, medical needs, riding methods, and harnesses allowed. It also includes a detailed compendium of officers and servants attached to these animals.[56] Abū'l Fazl attributes Akbar's patronage to the successful production of local horse breeds, such as *sanūjī, pachwariya gūt*, and *tānghan,* which were supposedly as fine as those from Iraq and Arabia, or even ranked higher.[57]

The universal nature of the *akhlāq* ethical models, with their emphasis on good values and high morals which could transcend religious faiths, led to the cultivation of a multicultural and socially inclusive imperial image. This extended to a flourishing Sanskrit literary culture alongside the use of the Persian language at court. Imperial patronage resulted in the development of detailed exegeses of Sanskrit texts in order to forge authority and benefit from different forms of knowledge.[58] Both pre-Mughal Sultanate and Mughal scientific writings hence benefited greatly from the existing rich intellectual repository of Sanskrit writings. Intellectual intercommunication between Sanskrit literati and Persian scholars resulted in several Sanskrit scientific treatises being translated and absorbed into Persian writings. The *Śālihotra somhita,* written probably around the 7th or 8th century, and the *Aśvavaidyaka* of Jayadatta, written between the 8th to 12th centuries, are possibly two of the most important Sanskrit zoological texts, which inspired several works throughout the ages in Sanskrit and Indian regional languages. Additionally, at least three Persian works, *Tarjuma-i Śālihotra* of Abdu'llāh Ṣafi (15th century), the *Farasnāma* of ʿAbdu'llāh Khān Fīrūz Jung (17th century), and the *Farasnāma* of Zainu'l-ʿalamīn Abū'l-Hasan (16th century) are Persian adaptations of the *Śālihotra somhita,* which includes, among other concerns, classification, diseases, diagnostics, treatments, and surgical procedures for horses, as well as equine toxicology.[59] This is contrary to the observations of some scholars who note that the Muslim invaders of India stifled Hindu-Sanskrit learning, and that they were indifferent to any culture but that of Islam, and drew their knowledge and inspiration from Arabic and Persian sources alone.[60]

Falcons and birds of prey were cherished members of the imperial hunting establishment alongside elephants and cheetahs. These animals rendered invaluable service to the Mughal court and therefore needed to be respected as suggested by the *akhlāq* texts. Outcomes at the hunt depended on the taming and training programs, which required sound knowledge of anatomy and psychology. Treatises on birds of prey and falconry were a popular genre in the Mughal libraries. The *Bāznāma* of Bahādur Khān (17th century), the *Bāznamā* of Muḥibb ʿAli Khān (17th century), *Mirʾātu's-ṣaʿīd* of Allāh Yār Jāmi (early 18th century), the *Shahbāznāma-i Firūz Shāh* of Firuz Shah (16th century), and *Dastūru's-ṣaʿīd* of Riḍā Yūsuf include information on the capture, training, diet, diseases, and treatment of hunting birds. Interestingly, some of the authors of the treatises on falcons, such as Allāh Yār Jāmi and Riḍā Yūsuf, were *mīr-i shikārs* (masters of the hunt), which adds a further link between hunting and the pursuit of scientific knowledge.

The Mughal emperors' visceral connection with the natural world also enabled knowledge of the diseases afflicting animals. Jahāngīr, for instance, recorded the symptoms and effects of rabies

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in great detail when his personal elephant, Gajpati, was stricken by the disease.[61] The nature of animal illnesses and injuries was further studied at veterinary hospitals, called *pinjarapoles.* Pietro della Valle, an Italian traveller to the Mughal Empire in 1623-24, visited many specialised veterinary hospitals in Cambay, Gujerat.[62] Thevenot, a French traveller in Aurangzeb's court in 1666, also notes similar veterinary hospitals in Ahmedabad, where oxen, camels, horses, and other wounded beasts were cared for, and another dedicated to apes in Delhi.[63] Studies of poisons and venoms from snakes also formed part of the body of knowledge facilitated by the hunt. Manucci, an Italian traveller in India during the later reign of Shāhjahān and then Aurangzeb, notes that snakes were used as a punishment for and deterrent against official corruption. Under Shāhjahān's orders, an official supposedly kept several baskets of poisonous snakes at court. Snakes would be made to bite any official found guilty of miscarriage of justice, and Manucci was witness to the execution by cobra-bite of a magistrate found guilty of taking bribes.[64]

HUNTING TECHNIQUES

A sound knowledge of hunting techniques ensured not only that large quantities of game were brought down, but also that many of the methods used were transferred to the battlefield as military tactics. Bābur observes that the one of the merits of the Uzbeg armies was their use of a manoeuvre called the 'flank assault', which was a series of encircling, turning, and spinning movements called a *tūlghuma,* whereby the turning parties, officers, and ordinary soldiers, riding loose-rein, would wheel around to surround and discharge arrows towards the centre.[65] Hunting, especially in a *qamarghā*, provided many opportunities to perfect the movement.[66]

Bābur notes a battle formation used by the Uzbegs whereby officers were assigned particular positions, namely right wing, left wing, centre, and flank, with high-ranking officers taking the privileged positions towards the edge. This formation was also used during a *qamarghā.* If a dispute arose over these positions, it was usually settled by the agreement that one clan takes the honourable position in the *qamarghā* and the other in the battle array.[67] Bābur used the same Chinghisid battle formations and the *tūlghuma* technique to great effect during the decisive Battle of Panipat in 1525-26 against Ibrahim Lodi, throwing the greatly outnumbered Lodi army, comprising 100,000 soldiers and 1000 war elephants, into complete disarray and confusion.[68]

The *qamarghā* technique required game to be surrounded and encircled before being hunted. Mughal skirmishes were based on the same campaign plan, to surround the enemy and then close in towards the core. For instance, during the Battle of Khanua against Rāna Sangha in 1527, Bābur had the troops emerge from the right and left centre, leaving a space in the middle for the musketeers. The victorious Mughal army 'forced and drove the enfeebled left and right of the enemy into one mass with their centre'.[69] The 1567 *qamarghā* organised for Akbar in Lahore required over 15,000 animals to be driven in from the neighbouring hills for over a month by about 5000 beaters into a circle 16 kilometres in circumference. Akbar hunted in the steadily decreasing ring for five days.[70] The monumental double-page composition of this *qamarghā* in the Victoria and Albert Museum *Akbarnāma* is reflective of what has been billed the greatest hunt ever held.[71] O'Hanlon notes that hunting paintings exhibit a 'strong sense of place in a north Indian landscape, reflecting Akbar's role not only as divine king, moral exemplar, and dispenser of justice, but as a ruler profoundly attuned to the subtle ecological balance of the land and its people'.[72] While the painting serves to illustrate the necessary qualities of a warrior king, equally

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Figure 3.3 Akbar hunts with cheetahs in a *qamarghā* ring in Lahore in 1567, painted by Miskīna with Mansūr and Sarwān, *Akbarnāma.* Reproduced from the Victoria and Albert Museum, London. Permission granted © Victoria and Albert Museum, London.

adept on the battlefield, court and *shikārgāh,* it is also a study of the natural history of the area around the Salt Range of the Lahore province, thus demonstrating a valid link between the hunt and zoological sciences. Divyabhanusinh has identified markhors (wild goats), Punjab urial (wild sheep), blackbucks, jackals, antelopes, civets, foxes, and hyenas. The three cheetahs on the loose and two more about to be released by their keepers have attacked nilgais (blue bulls), hares, and chital (spotted deer). He also notes that the accurate depiction of injured and dead animals implies that Miskīna and his colourists, Mansūr and Sarwān, would have witnessed the hunt.[73]

Hunting with cheetahs was another favoured hunting technique for the Mughal emperors, and cheetahs were held in high esteem at court. The anatomy, behavioural patterns, and skills naturally exhibited by the cheetah as it gave chase were studied at length, leading to regulations regarding training methods, food allocation, and proper transportation during tours. The cheetah's ability to go against the wind, along with its instinct to lie concealed before the ambush, as well as to kick up dust with its feet to confuse its prey, were all observed and used in training programs.[74] And as the following incident demonstrates, scientific data had to be constantly updated. Abū'l Fazl recalls a 'joyful occurrence' while Akbar was hunting with his cheetahs in Sanganir in 1527. While Akbar was pursuing a herd of blackbuck with a tame, favoured cheetah named Chitr Najan, which gave

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Figure 3.4 Akbar hunting black buck with trained cheetahs in 1527, painted by La'l and Kēsav Khord, Akbarnama. Reproduced from the Victoria and Albert Museum, London. Permission granted © Victoria and Albert Museum, London.

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chase, a large buck leapt into the air 'to a height of a spear and a half' to cross a ravine which was 25 yards (22.8 metres) wide. Chitr Najan cleared the ravine and hunted it down. Cheetahs are renowned for their speed, not their leaping abilities. This unusual characteristic of the cheetah, previously unknown, was hence recorded in the inimitable Mughal style — Chitr Najan was honoured as chief cheetah with a roll of drums.[75] The two artists from the imperial atelier, La'l and Kēsav, were at hand to visualise the incident, which also shows how the blindfolded cheetahs were transported in bullock carts to the *shikārgāh*. The hunting image hence reinforces the ever-present link between art and scientific knowledge.

TECHNOLOGICAL INNOVATIONS

Technological and mechanical arts were greatly appreciated at court. Mughal primary sources, although fragmentary with their descriptions, refer to a number of innovations unveiled at court. This study highlights only those pertaining to the hunt and used during hunting expeditions. Abū'l Fazl credits Akbar as being the author of several inventions, and the writings of Jesuit fathers visiting the Mughal court affirm Akbar's interest and hands-on approach to industrial crafts.[76] The Mughal court went on what it referred to as hunting expeditions over extended periods of time in order to consolidate its hold over distant provinces and deal with administrative matters, and these inventions would have made life at encampment sites more pleasurable for the royals. They include portable pavilion-palaces, which were capable of accommodating over 10,000 people, and which took over 1000 workmen to assemble. They were fitted with Akbar's innovative iron rings with 'male' and 'female' fasteners, posts, and wooden boards to increase structural stability.[77] Refrigeration techniques using saltpetre as a cooling agent, improvements to geared waterlifts, and luxury portable baths with several *ḥammāms* drawn by elephant or cattle were other considerable innovations.[78] Another mechanical device attributed to Mīr Fath'ullāh Shirāzi, the Persian scientist, who, as noted earlier, was responsible for the overhaul of *madrasa* education, is a cart-mill for grinding grain into flour.[79]

Abū'l Fazl notes that matchlocks were manufactured in Akbar's arsenal, and he credits Akbar himself with this invention. Abū'l Fazl's descriptions note that the matchlock did not require a match and needed only a slight movement of the trigger to fire the pellet.[80] Habib opines that the gun could have been a wheel-lock, and since the latter was only invented in Italy in the 1520s, and not yet widely used due to its delicate mechanism, it was a significant achievement of Mughal industrial technology.[81] The *(y)barghū*, a contraption for boring and smoothening gun barrels, is generally attributed to Fath'ullāh Shirāzi. Abu'l Fazl notes that this device, a wheel turned by an ox, smoothened the barrels of 16 handguns in a small amount of time.[82] Using Abū'l Fazl's drawing, Habib and Alvi and Rahman have reconstructed the mechanics underlying its workings, which use a pin-drum whose pins meshed with the pegs of eight vertical gear-wheels with projecting axles that could enter the gun barrel to smoothen them.[83] Akbar's other achievement was a procedure to strengthen the gun barrel.[84] While Abū'l Fazl's claims of Akbar's authorship for many of these devices may be debatable, there is no doubt that the prevailing milieu at the Mughal court, largely driven by Akbar's enquiring mind and patronage, spurred many technological advances. Mechanical innovations doubtless improved lifestyles during tours and boosted the prestige of the ruling family as patrons of technology. Others were directly responsible for greater success during wartime and during the hunt. Importantly, the inventions adhered to aspects of *akhlāq* literature

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Figure 3.5 Shāhjahān hunting antelopes, perhaps Rupbas, after 1640, unknown artist. Reproduced from Folio 165A, Royal Collections Trust, Windsor Castle, Windsor. Permission granted Royal Collection Trust/© Her Majesty Queen Elizabeth II 2016.

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whereby the emperor was committed to creating the best possible conditions of welfare for his subjects.[85]

Hunting images provide a further link between art and technology. O'Hanlon notes, 'It was also in hunting … that the emperor appeared in closest communion with the north Indian landscape'.[86] This is certainly true of the painting of Shāhjahān and his son Dāra-Shikōh hunting antelopes around 1640, one of the most evocative images in the Royal Collections' *Pādshāhnāma*.[87] The hunting party, dressed in camouflage green, wait to take aim at the animals driven in by huntsmen using tame antelopes as decoys. The image is a metaphor for the prosperity and power of Shāhjahān's reign, and the artist has used it to draw analogies between the hunt and the emperor's legitimising role as promoting social welfare. However, it is also a study in firearm technology. Shāhjahān is about to pull the trigger of his royal matchlock named *Khassban,* which will fire the charge.[88] Although Shāhjahān's elbow is supported by his raised knee and the gun is steadied by the string attached to a ring on the barrel, the gun is mainly supported on the shoulder of the huntsman in front. This implies that matchlocks were still slow and unreliable at the time, and hence better suited for the less strenuous nature of the decoy hunt rather than the warlike *qamarghā*.[89]

CONCLUSION

The reluctance of the *madrasa* — the principal institution of higher learning in Arab-Islamic civilisation — to include systematic instructions on rational or natural sciences in its curriculum has often been cited as one of the primary causes of the failure of Islamic science to grow and develop beyond the 14th century.[90] However, judging from the level of scientific and intellectual activity in Mughal India, the situation seems to have been extraordinary. In spite of ample evidence to the contrary, Mughal scientific inquiry has come under frequent criticism by Orientalists and their claims that natural history and experimental philosophy were not cultivated in India.[91] Western travellers to the Mughal court such as Bernier attribute the 'profound and universal ignorance' of the Indian society to the lack of formal educational institutions.[92] Ironically, Dānishmand Khān — Bernier's patron, the Mughal courtier and scholar, who requested the translations into Persian of the works of several European scholars (such as Descartes, Gassendi, Harvey, and Pecquet) — was also responsible for Bernier being immersed in the dynamic intellectual community and Sanskrit literati in India. Dānishmand also introduced him to several Persian translations of Sanskrit texts, which he subsequently carried back to Europe.[93] Perhaps Bernier's lament regarding the dearth of systematic and institutionalised knowledge in Mughal India arose as a result of his training in science marked by 'the pragmatic and critical method of modern Western science which has guided Western thinking into the right course'.[94] Indeed, Abū'l Fazl's ruminations regarding the predominance of ideological tradition summarise the state of affairs in the Mughal court — 'the blowing of the chill blast of inflexible custom (*taqlid*) and the low flicker from the lamp of wisdom'[95] — and the fact that, despite the introduction of scientific and rational syllabi in schools, the 'socio-economic and ideological stimulants that this was producing were not apparently provocative enough to bring about a paradigm change in the structure of Indian science'.[96] Education remained firmly in the domain of the privileged.[97] And the languages of science — Sanskrit in ancient India, Persian in Mughal India — were not the languages of the masses, and were seen as aristocratic and elitist.[98] Scientific knowledge acquisition was hence a courtly undertaking. However, this study has shown the extensive level and range of scientific and technological activities furthered by the hunt, which

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was cultivated and fostered by imperial patronage. Abū'l Fazl and other court historians frequently note the complex knowledge-based noble reasons that vindicated the imperial *shikār.* These include dispensation of justice, articulation of good governance, and implementation of administrative affairs. The line of discussions presented in this chapter seeks to recalibrate the received wisdom of these 'higher aims' with the implication that the acquisition of scientific knowledge was likely perceived as an added dimension to the superior motives of the hunt.

NOTES

1 Abū'l Fazl, 2010, *Ā'īn-i Akbarī*, vol. I, trans. H Blochmann, ed. DC Phillott (Calcutta: The Asiatic Society, First published 1866-94, edited 1927), 292.

2 Abū'l Fazl, 2010, vol. I, 292. Abū'l Fazl, 2000, *Akbarnāma*, vol. II, trans. H Beveridge (Calcutta: The Asiatic Society, First published 1897-1921), 343. Abu'l Fazl is making a reference to Akbar engaged in hunting/ trapping wild elephants in the jungles of Narwar in 1564, while putting down a rebellion caused by 'Abdu'llāh Khān Uzbeg. II, 345-53.

3 Abdul Hamid Lahōri, 2010, *Lahōri's Pādshāhnāmah (1592-1638),* trans. Hamid Afaq Siddiqi (Delhi: Idarah-i Idarah-i Adabiyat-i Delli), 57.

4 Abū'l Fazl, 2000, vol. II, 232. Abū'l Fazl is referring to Akbar mounting a *mast* elephant Hawai and engaging it in a fight in 1561.

5 Abū'l Fazl, 2000, vol. II, 232.

6 Mughal contributions to botanical studies have not been covered due to this chapter's emphasis on hunting.

7 Naṣīr al-Dīn al-Ṭūsī, 1964, *Akhlāq-i Naṣīrī* (The Nasirean Ethics), trans. GM Wickens (London: George Allen & Unwin); see especially 26-7, 30-1.

8 Peter Harrison, 2015, *The Territories of Science and Religion* (Chicago: Chicago University Press), 3.

9 Harrison, 2015, 3, 5, 90.

10 Sheldon Pollock, 2011, 'The Languages of Science in Early Modern India', in Sheldon Pollock, ed., *Forms of Knowledge in Early Modern Asia, Explorations in the Intellectual History of India and Tibet 1500-1800* (Durham: Duke University Press), 4, 21.

11 Irfan Habib, 1996, 'Reason and Science in Medieval India', in JN Jha, ed., *Society and Ideology in India, Essays in Honour of Professor RS Sharma* (New Delhi: Munshiram Manoharlal Publishers), 168.

12 Abū'l Fazl, 2010, vol. I, 289.

13 Abū'l Fazl, 2010, vol. I, 289.

14 Shah-Nawaz Khan, Nawab Samsam al-Dawla and Abdul Hayy, 1979, *Ma'athir-ul-Umara,* vol. I, trans. H Beveridge and Baini Prashad (Patna: Janaki Prakashan, first published 1911-52), 545.

15 Cited in Momin Mohiuddin, 1971, *The Chancellery and Persian Epistolography under the Mughals: From Babur to Shahjahan, 1526-1658: A Study on Inshá, Dar al-Insha, and Munshis Based on Original Documents* (Calcutta: Iran Society), 41, 228-34.

16 François Bernier, 1983, *Travels in the Mogul Empire AD 1656-1668,* trans. Archibald Constable (Oxford: Oxford University Press, first published 1934), 229.

17 Zuhuri, *Saqinamah-yi Zuhuri,* cited in Sunil Sharma, 2011, '"If there is a Paradise on Earth, it is Here": Urban Ethnography in Indo-Persian Poetic and Historic Texts', in Sheldon Pollock, ed., *Forms of Knowledge in Early Modern Asia, Explorations in the Intellectual History of India and Tibet 1500-1800* (Durham: Duke University Press), 245.

18 Abū'l Fazl, 2010, vol. III, 4-5.

19 A Rahman et al., 1982, *Science and Technology in Medieval India — A Bibliography of Source Materials in Sanskrit, Arabic and Persian* (New Delhi: Indian National Science Academy), xiv-xv. See also CA Storey, 1977, *Persian Literature, A Bio-Bibliographical Survey,* vol. II (Leiden: The Royal Asiatic Society of Great Britain and Ireland), 3, 442-5.

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20 Pollock, 2011, 5.
21 Sharma, 2011, 240-1.
22 Zahiru'd-din Muhammad Pādshah Ghāzī Bābur, 1990, *Bābur-Nāma, The Memoirs of Babur*, trans. Annette Susannah Beveridge (New Delhi: Munshiram Manoharlal, first published 1921), 488-515.
23 Som Prakash Verma, 1999a, *Mughal Painter of Flora and Fauna, Ustad Mansur* (New Delhi: Abhinav Publications), 37.
24 Salim Ali, 1927, 'The Moghul Emperors of India as Naturalists and Sportsmen', *Journal of the Bombay Natural History Society*, Part I 31(4): 836.
25 Bābur, 1990, 489-90, 450-1.
26 Jahāngīr, 1999, *Jahāngīrnāma, Memoirs of Jahangir, Emperor of India*, trans. Wheeler Thackston (New York: Oxford University Press), 402-3; Jahangir, 2003, *Tūzuk-i Jahāngīrī, The Memoirs of Jahāngīr*, vol. II, trans. Alexander Rogers, ed. Henry Beveridge (New Delhi: Munshiram Manoharlal, first published 1909), 270.
27 The unusual characteristics of animals in the imperial menagerie and of the exotic species that were brought to court and described extensively by Jahāngīr are beyond the scope of this chapter, which mentions only those encountered during hunts. However, note that Jahāngīr's study of the breeding habits of sarus crane, and his observations on the gestation period of the elephant are considered pioneering work for the age. See Jahāngīr, 1999, 266, 269-70, 274, 277, 160. See also MA Alvi and A Rahman, 1968, *Jahangir — The Naturalist* (New Delhi: Indian National Science Academy), 5.
28 Ali, 1927, Part II, 32(1): 38.
29 Jahangir, 2003, vol. I, 352.
30 Jahangir, 2003, vol. I, 121-2. Note that 1 maund = 40 seers = ~37 kilograms.
31 Joseph Somogyi, 1950, 'Ad-Damiri's Hayat al-hayawan: An Arabic Zoological Lexicon', *Osiris* 9: 34.
32 Alvi and Rahman, 1968, 5.
33 Jahāngīr, 1999, 255, 339.
34 MA Alvi, 1999, 'Jahangir's Passion for Exotic Animals', in Som Prakash Verma, ed., *Flora and Fauna in Mughal Art* (Mumbai: Marg Publications), 91.
35 See Jahāngīr, 1999, 418, 207, 213, 316, 65. Jahāngīr carried out many other experiments including cross-breeding various species. However, only those performed during hunting have been highlighted.
36 Ebba Koch, 2009, 'Jahangir as Francis Bacon's Ideal of the King as an Observer and Investigator of Nature', *Journal of the Royal Asiatic Society of Great Britain and Ireland* 19(3): 328.
37 Verma, 1999a, 37.
38 Verma, 1999a, 22.
39 Jahāngīr, 1999, 133.
40 Koch, 2009, 298. See Jahāngīr, 1999, 133.
41 Jahāngīr, 1999, 339.
42 Som Prakash Verma, 1999b, 'Portraits of Birds and Animals under Jahangir', in Som Prakesh Verma, ed., *Flora and Fauna in Mughal Art* (Mumbai: Marg Publications), 13.
43 Verma, 1999b, 20.
44 See for instance Salim Ali, 1968, 'Dodo', in MA Alvi and A Rahman, *Jahangir — the Naturalist* (New Delhi: Indian National Science Academy), 15-17. A significant ornithological study of the Mauritian dodo is attributed to Mansūr, and is now in the St. Petersburg Album, St. Petersburg. It created much excitement at the XII International Ornithological Congress in Helsinki in 1958 when first unveiled as it is one of the earliest depictions of the bird, and it is now generally believed that it was painted from a living specimen. See also Alvi and Rahman, 1968, 4-9.
45 For discussions on Ikhtiyar al-Husaini's *Akhlāq-i Humāyuni* which is modelled on al-Ṭūsī's *Akhlāq-i Naṣīrī* and other *akhlāq* texts such as Jalal al-Din Muhammad Asad Dawani's *Akhlāq-i-Jalāli* (1427-1521), see Iqtidar Alam Khan, 2009, 'Tracing Sources of Principles of Mughal Governance: A Critique of Recent Historiography', *Social Scientist* 37(5-6): 45-54; Muzaffar Alam, 2004, *The Languages of Political Islam, India 1200-1800* (Chicago: University of Chicago Press), 71-5; Muzaffar Alam, 2000, 'Akhlaqi Norms and Mughal Governance', in Muzzafar Alam et al., eds., *The Making of Indo-Persian Culture — Indian and French Studies* (New Delhi: Manohar Publishers), 67-95.

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46 Alam, 2004, 5, 77 (emphasis in original).
47 Jahāngīr, 1999, 360.
48 Seyyed Hossein Nasr, 1976, *Islamic Science: An Illustrated Study* (England: World of Islam Festival Publishing Company Limited), 66.
49 Jalal al-Din Muhammad Asad Dawani, 1895 (*Akhlāq-i-Jalāli), The Akhlak-i-Jalaly, Practical Philosophy of the Muhammadan People,* trans. WF Thompson (Lahore: Caxton Printing Works), 27.
50 Al-Ghazālī, 1964, *Naṣīḥat al-Muluk of al-Ghazālī* (Counsel for Kings), trans. FRC Bagley, ed. Huma'i Jalal (London: Oxford University Press), 80.
51 Abū'l Fazl, 1998, Akbar's '*Dasturu'l-'amal* (A Circular Enumerating the Duties of Officers) Addressed to the 'Ummāl and Mutasaddīs of the Empire (21 March 1594)', in Mansura Haidar, trans., *Mukātabāt-i-'Allāmī (Inshā'i Abu'l Fazl)* (New Delhi: Munshiram Manoharlal), 83.
52 Khaliq Ahmad Nizami, 1989, *Akbar and Religion* (New Delhi: Idarah-i-Adabiyat-i-Delli), 185.
53 Rosalind O'Hanlon, 2007, 'Kingdom, Household and Body History: Gender and Imperial Service under Akbar', *Modern Asian Studies* 41(5): 898.
54 See Dawani, 1895, 153. Jalali notes that a king's 'proper return for this magnificent appointment [sovereignty] is the observance of equity towards God's creatures and his own subjects'.
55 Al-Ṭūsī, 1964, 188-9.
56 Abū'l Fazl, 2010, vol. I. Elephants 123-39, horses 140-50, camels 151-6.
57 Abū'l Fazl, 2010, vol. I, 140.
58 Audrey Truschke, 2016, *Culture of Encounters: Sanskrit at the Mughal Court* (New York: Colombia University Press), 4-5, 142.
59 Rahman et al., 1982, 531-48.
60 See for instance George Sarton, 1947, *Introduction to the History of Science: Science and Learning in the Fourteenth Century*, vol. III (Baltimore: Williams and Wilkins) 1, 107.
61 Jahāngīr, 1999, 145-6.
62 Pietro della Valle, 1892, *The Travels of Pietro della Valle in India*, vol. I, trans. G Havers, ed. Edward Grey (London: Hakluyt Society), 67-8.
63 Jean de Thevenot, 1687, *The Travels of Monsieur de Thevenot into the Levant in Three Parts, viz. into I. Turkey, II. Persia, III. The East-Indies, Newly Done out of French*, vol. III, trans. Archibald Lovell (London: H Clark), 11-13, 41.
64 Niccolao Manucci, 1907, *Storia do Mogor or Mogul India 1653-1708,* vol. I, trans. William Irvine (London: John Murray), 197.
65 Bābur, 1990, 140, 473.
66 See for instance Bābur, 1990, 325. Bābur's descriptions regarding getting into position and turning movements before delivering the final blow to the wild ass during the 1507 *qamarghā* in Kattavaz plain are indicative of a *tūlghuma* movement.
67 Bābur, 1990, 155.
68 Bābur, 1990, 465-74.
69 Abū'l Fazl, 2000, vol. I, 264-5. See also Bābur, 1990, 563-73.
70 Abū'l Fazl, 2000, vol. II, 416-17.
71 Abū'l Fazl, 2000, vol. II, 416, fn. 2.
72 O'Hanlon, 2007, 898.
73 Divyabhanusinh, 1999, 'Hunting in Mughal Painting', in Som Prakash Verma, ed., *Flora and Fauna in Mughal Art* (Mumbai: Marg Publications), 103-4.
74 Abū'l Fazl, 2010, vol. I, 296-7, 299. See also Fr. Monserrate, 1922, *The Commentary of Father Monserrate on the Journey to the Court of Akbar*, trans. JH Hoyland, annotated SN Banerjee (London: Oxford University Press), 77-8.
75 See Abū'l Fazl, 2000, vol. II, 539. See also Divyabhanusinh, 1999, 98.
76 John Correia-Afonso, 1980, *Letters from the Mughal Court, The First Jesuit Mission to Akbar (1580-1583)* (Anand: Gujarat Sahitya Prakash), 56. (See Fr. Acquaviva's letter to Fr. Mercurian in 1580.)

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77 Abū'l Fazl, 2010, vol. I, 47-9, 55-7. See also Muhammad Ārif Qandahāri, 1993, *Tārikh-i Akbarī*, trans. Tasneem Ahmad (New Delhi: Pragati Publications), 61-2. For reconstructions of these devices, see Irfan Habib, 1997, 'Akbar and Technology', in Irfan Habib, ed., *Akbar and his India* (New Delhi: Oxford University Press), 129-48. See also MA Alvi and A Rahman, 1940, *Fathulllah Shirazi, a Sixteenth Century Indian Scientist* (Delhi: National Institute of Sciences of India), 4-8.

78 Abū'l Fazl, 2010, vol. I, 58. Water was poured into a sealed metallic bottle and moved around a pan containing a mixture of water and saltpetre cooling it in about 12 minutes. Saltpetre is potassium nitrate. When added to water, there is an endothermic reaction which has the effect of cooling the surrounding water. See also Abū'l Fazl, 2010, vol. I, 285.

79 Abū'l Fazl, 2010, vol. I, 285.

80 Abū'l Fazl, 2010, vol. I, 120.

81 Irfan Habib, 1980, 'The Technology and Economy of Mughal India', *Indian Economic and Social History Review* 17(1): 17.

82 Abū'l Fazl, 2010, vol. I, 122. Abu'l Fazl's drawing of the *barghū* is in the *Ā'īn-i Akbarī* MS Add. 7652, British Library.

83 Habib, 1997, 140-1; Alvi and Rahman, 1940, 5-7.

84 Abū'l Fazl, 2010, vol. I, 120. The gun-barrel was flattened and twisted obliquely in a roll with overlapping edges, and then joined over an iron rod to form a barrel. Akbar supposedly supervised every step of the prototypes's manufacture, suggesting improvements and making trials at every stage.

85 Dawani, 1895, 156, 161.

86 O'Hanlon, 2007, 902.

87 *Pādshāhnāma*, meaning 'Chronicle of the King of the World', is a biography and history of the Emperor Shahjahan's reign (1628-58) by the court historian Abdul-Hamid Lahori. The Royal Collections' manuscript is extensively illustrated.

88 Koch, 1997, in Milo Cleveland Beach and Ebba Koch, *King of the World: The Padshahnama, An Imperial Mughal Manuscript from the Royal Library, Windsor Castle* (London: Azimuth Editions), 193.

89 Koch, 1997, 193.

90 See for instance Toby E. Huff, 2003, *The Rise of Early Modern Science: Islam, China and the West*, 2nd ed. (Cambridge, UK: Cambridge University Press), 84.

91 See for instance the Translator's Preface to *Dabistan* by its Orientalist translators, Shea and Troyner, and their critical viewpoint, 9-11. *Dabistan-i Mazahib* is a Mughal text of comparative religions of Mughal India; it explores the complexities of religious tolerance of the age. Its attribution to Mohsan Fání by the translators is questionable.

92 Bernier, 1983, 229.

93 Bernier, 1983, 324-5, 352-3. See also Mohamad Tavakoli-Targhi, 2011, 'Early Persian Modernity', in Sheldon Pollock, ed., *Forms of Knowledge in Early Modern Asia, Explorations in the Intellectual History of India and Tibet 1500-1800* (Durham: Duke University Press), 264-5.

94 Somogyi, 1950, 33.

95 Abū'l Fazl, 2010, vol. III, 4-5.

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