Diverse Locations and a Long History: Historical Context for Urban Leopards (*Panthera pardus*) in the Early Anthropocene From Seoul, Korea

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While the urban landscapes of the early Anthropocene may appear hostile to large carnivores, humans and leopards (*Panthera pardus*) are known to co-inhabit major urban centres like Mumbai (India), Nairobi (Kenya) and Johannesburg (South Africa). We provide evidence that the presence of leopards in urban landscapes is not, however, a new phenomenon and has occurred repeatedly over the early history of the Anthropocene. Using records of Amur leopards (*P. p. orientalis*) in Seoul, Korea, at the end of the 19th century, a capital city and major urban centre with a high human population density, we explore socio-cultural, political and ecological factors that may have facilitated human-leopard co-occurrence in an urban landscape and the factors that eventually led to the leopards’ extirpation. We suggest that, in the absence of unsustainable levels of persecution by humans, leopards are able to persist in urban landscapes which contain small patches of dense vegetation and have sufficient alternative food supplies. In light of the continued expansion of urban landscapes in the 21st century and increasing conservation focus on the presence of large carnivore populations there, this paper provides historical context to human co-existence with leopards in urban landscapes during the Anthropocene—and what we can learn from it for the future.

Keywords: leopard, big cats, cities, Seoul, urban carnivore, *Panthera pardus*, Korea (Joseon), historical mammal distributions

INTRODUCTION

An exact starting date for the Anthropocene, a term used to describe a human-dominated geological epoch that encompasses the present day, remains elusive (see, for example, Crutzen and Stoermer, 2000; Glikson, 2013; Zalasiewicz et al., 2015). Steffen et al. (2011) proposed that the early history of the Anthropocene has occurred in two distinct stages, the first of which started with the spread of the Industrial Revolution in the early 1800s, the second with the Great Acceleration of the mid-20th century. Lewis and Maslin (2015) have subsequently shown that an earlier starting date of A.D. 1610 can be justified. During this time period, a series of wide-reaching
Anthropogenic changes to the natural environment have occurred, including the rapid expansion of urban landscapes (Butler, 2018).

Urban landscapes are characterised by extremely high levels of human modification (McKinney, 2006). The presence in such environments of large carnivores, which are usually associated with wild lands, extremely large home range requirements (Carbone and Gittleman, 2002) and the availability of wild, large vertebrate prey (Carbone et al., 2007), appears counterintuitive. A number of recurrent features of urban landscapes would seem to present particular obstacles: the fragmentation or removal of natural habitat remnants; the removal of large-bodied wild prey species; the presence of artificial light sources at night; the densely-packed construction of buildings and other artificial structures; and extremely high densities of Homo sapiens.

Despite the seeming hostility of urban environments, several large carnivore species can persist and even thrive there. For example, spotted hyena (Crocuta crocuta) occur in both urban and peri-urban landscapes in Ethiopia (Kruuk, 2002; Yirga et al., 2015); mountain lions (Puma concolor) have been well-documented in urban California, USA (Riley et al., 2014); coyotes (Canis latrans) now occur in cities across the USA (Grinder and Krausman, 2001; Bateman and Fleming, 2012); and American black bears (Ursus americanus) forage in a range of urban environments in the western USA (Beckmann and Lackey, 2008; Lewis et al., 2015).

The leopard (Panthera pardus) is another large carnivore that is known to be capable of adapting to life in urban environments (Jacobson et al., 2016). While considerably larger than most other truly urban carnivores (Bateman and Fleming, 2012), the leopard shares certain characteristics with its fellow city-dwellers, notably a wide-ranging diet (Hayward et al., 2006; Athreya et al., 2016) and behavioural plasticity (Jacobson et al., 2016). These characteristics allow leopards to survive in urban landscapes, and to access alternative food sources, such as stray dogs, which may be present in high densities (Punjabi et al., 2012; Athreya et al., 2016).

Extant urban leopard populations have been recorded in Mumbai, India (Odden et al., 2014; Nairobi, Kenya (Landy et al., 2018); and Johannesburg, South Africa (Kuhn, 2014). While poorly documented in the scientific literature, leopards are also known to exist in other urban landscapes across India, including Jhalana, Guwahati, Surat, Gurugram, Shimla, Darjeeling and Bangalore (Athreya, pers. com., 2020), Dehradun (Anonymous, 2007) and Hyderabad (Breitenmoser and Breitenmoser, 2008). They are also known from cities in southern and eastern Africa, including Dar es Salaam and Arusha in Tanzania (Durant, pers. com., 2020); Cape Town and Pretoria in South Africa (Myers, 1976); and the outskirts of Gaborone in Botswana (Klein, pers. com., 2020).

While there has been increasing interest in the presence of urban carnivore populations (Gehrt et al., 2010), the ecosystem services they provide (Braczkowski et al., 2018) and the nature of their interactions with human populations (Bhatia et al., 2013), there has been little scholarship dedicated to examining the occurrence, or persistence, of urban leopards outside of contemporary Mumbai, Nairobi and Johannesburg. There is particularly little understanding about the historical dimension of leopard occurrence in urban landscapes of the Anthropocene. This is important, because better understanding the socio-ecology of large carnivores in urban landscapes over time and the conditions that either facilitate their persistence or lead to their extirpation, may be able to help inform future conservation (Rick and Lockwood, 2012).

Historical ecology, a field which utilises historic sources and datasets to study ecosystems through time, can be used to provide valuable insight into the past distribution of species (Oates and Rees, 2013; Turvey et al., 2015) and historical interactions between humans and wildlife populations (Balee, 2006; Szabo and Hedl, 2011). In this short study, we use historical ecology to examine the presence of a large carnivore in an urban landscape during the late 19th Century, using the example of Amur leopards (P. p. orientalis) in Seoul, Korea.

Seoul was already a major urban centre by the early Anthropocene. Contemporary estimates varied, but by the turn of the 20th century the city was thought to have a human population of ~250,000 (Hatch, 1904), or 300,000 (Veitch, 1896), inhabitants. Unlike its current layout, late 19th and early 20th century Seoul was confined to the north of the Han River, between the mountains of Namsan and Baekaksan. This area of 16.7 km² was fully enclosed by a 6-8 m high city wall, with a potential human population density of at least 14,970/km², comparable to the current population density of Jakarta, Indonesia. Seoul had been the national capital since A.D. 1394 and five royal palaces within the city featured large, landscaped gardens (Hong, 2018), each enclosed by a further high wall; for example, the wall surrounding Gyeongbokgung was 6 m high.

The historical occurrence of leopards in Seoul is virtually unheard of in the English-language conservation literature (for example, Jacobson et al., 2016). However, using early Western accounts of Seoul in the late 19th century to corroborate Korean records of big cats provided by Hong (2018) from the Joseon Wangjo Sillok (Hanja: 王朝實錄, Hangul: 조선왕조실록), a detailed 14th–19th century record of the reign of Korea's Joseon dynasty (A.D. 1392–1897) kings, and the Seungeugwon ilgi (Hanja: 承政院日記, Hangul: 승정원일기), the journal of the Korean royal secretariat, we demonstrate that leopards were present in this urban landscape during the late 19th century, investigate the conditions that may have allowed leopards to persist there, and highlight factors that likely contributed to their extirpation.

METHOD

We searched for historical accounts of leopards in Seoul, Korea, from published books, field notes, correspondence, and private journals of Western researchers, travellers and residents in Seoul in the late 19th and early 20th centuries. As well as conducting a review of the published scientific literature, we searched the archives of the Royal Geographical Society (with IBG), Zoological Society of London, Linnean Society of London, SOAS University of London (the School of Oriental and African Studies) and the British Library's Asian and African Reading Room, as well as
publicly available records of relevant museums in Seoul (Seoul Museum of History; National Museum of Korea). We also searched for Korean records from the Joseon Wangjo Sillok and the Seungjeongwon ilgi, as per Hong (2018). In archive databases, we searched for the keywords: leopard, tiger (Panthera tigris), (due to the historical use of the same Korean characters for both felids), big cat, Seoul, Hanyang (a historical name for Seoul), the alternative spellings of Korea and Corea, and Joseon (the ruling Korean dynasty of the 19th century). As we did not find any records after A.D. 1900, we focussed our search on the period between A.D. 1870 and A.D. 1900, 3 decades which encompass the opening of Korea’s borders to international trade and therefore provide the first regularly available foreign accounts of the wildlife of Korea.

These historical records present an under-utilised and potentially valuable source of data for the study of historical wildlife populations. However, there are some important limitations to take into account. Historical records of rare animals may be based on hearsay, which may lead to the reporting of species that were not actually present; double-reporting of individual animals if a single account is reported by numerous sources; or simply confusion between which species are present. In this, some accounts may be considered more reliable than others, though it is important to note that many of the records we found were by well-travelled and educated individuals, including politicians, teachers, doctors and hunters, many of whom could clearly distinguish between a leopard and other felids. In order to communicate the reliability of each sighting, we assigned each report with a classification of confirmed, where the sighting was a first-hand sighting of a leopard or where the author reported that a leopard was killed; probable, where a big cat was reported and sufficient evidence was provided by the author to suggest classification as a leopard, or where a second-hand account of a leopard being sighted was reported; or possible, where an account refers to a big cat being sighted, but insufficient evidence is provided to classify the sighting to a species level. Records which did not directly refer to a big cat being sighted were discounted.

It is also important to acknowledge that historical records may be damaged, destroyed or lost over time, for example during the Korean War (A.D. 1950–53). In addition, records from personal correspondence may be particularly difficult for the environmental historian to locate (for example, if they are held in private collections and have not been digitised). Though extensive, the archives we searched will therefore likely only represent a fraction of the total available material held in public and private collections which detail accounts of Korea in the late 19th century. Further work, particularly utilising archives in languages other than Korean and English, may therefore be able to shed light on additional relevant source material.

RESULTS

We present twelve corroborating records of urban leopards in Seoul between A.D. 1870 and 1900 in Table 1. Two of these records are Korean records from the Seungjeongwon ilgi, where, due to the historical use of the same Korean characters, 호랑이 (horangee), to describe the tiger and leopard, we can only confirm that the authors are referring to one of these two Panthera species. However, given the presence of 6–8 m high city walls around Seoul and the specific identification of leopards in sources from Western travellers, we strongly suspect that these “horangee” records actually refer to leopards rather than tigers.

To provide context to these sightings, a contemporary map of Seoul, produced between 1890 and 1897, is provided in Figure 1. The locations of potential leopard sightings, where recorded, are marked in red. These are concentrated around the royal palaces and foreign embassies, areas of the city that contained patches of natural vegetation and water sources such as ponds, had some restrictions on public access, and were relatively close to the city wall. However, they also correspond to the areas of Seoul which early Western visitors were most likely to visit. Figure 2, a photograph taken around 1902 close to the location of one of the reported sightings, illustrates the high level of urban development and density of dwellings inside the city at the time.

DISCUSSION

Our findings support the claim by Hong (2018) that big cats were historically present in Seoul and provide evidence of Amur leopards specifically within the city walls in the late Joseon dynasty (A.D. 1870–1900). This example illustrates that leopards have occurred in urban landscapes since the early history of the Anthropocene, well-before the advent of modern environmentalism. Given the contrasting economic, socio-cultural and political situations present in 19th century Seoul and contemporary Mumbai, Nairobi and Johannesburg, it is also clear that leopards are capable of adapting to a wide range of urban landscapes.

There are a number of important ecological similarities, however, between 19th century Seoul and contemporary urban centres inhabited by leopard populations. It therefore appears that leopards may potentially require certain ecological conditions to be present in order to persist in urban landscapes. The first is the presence of alternative food supplies in the urban landscape. Some contemporary accounts speculated that leopards in 19th century Seoul may have preyed on the city’s stray dog population (Cavendish, 1894), which would mirror the known make-up of the leopard’s diet in contemporary Mumbai (Athreya et al., 2016). These were not, however, the only potential food sources available in the city. Domestic pigs also roamed Seoul’s maze of narrow residential streets (Veitch, 1896), while Gyeongbokgung Palace is known to have had a population of tame deer within its grounds (Seungjeongwon ilgi, 1893).

Another important ecological similarity is the availability of natural vegetation patches. An important feature for the persistence of other urban carnivores (Baker and Harris, 2007), for leopards these patches provide shelter during the day. Sanjay Gandhi National Park in Mumbai performs this role, as does Nairobi National Park neighbouring Nairobi. In Seoul, the royal palaces and their extensive gardens seem to have provided this
function, despite being far smaller than either national park (the largest royal palace, Changdeokgung, covered just ~45 ha), with a number of reports specifically identifying leopards in or around royal palaces (for example, Gilmore, 1892; Landor, 1895; Sands, 1930).

The use by leopards of Seoul’s royal palace grounds was facilitated by political conditions in Korea in the late 19th century. Hong (2018) believed that damage to, or temporary abandonment of, royal palaces in Seoul created conditions favourable to their occupation by big cats. Gyeongbokgung Palace had been derelict for almost 3 centuries when it was rebuilt in 1867 and several of the other royal palaces in Seoul were temporarily abandoned in the late-1800s (Gyeonghuigung and Changdeokgung, later followed by Gyeongbokgung). As these were royal sites associated with a sitting dynasty, it is unlikely that the abandoned palaces would have been occupied by other human inhabitants, creating patches of natural vegetation without regular human disturbance inside a densely-populated city.

The practise of not cutting trees on the edge of Seoul meant that good forest cover also remained in the landscape immediately surrounding the city in the late 19th century (Walton, 1900). The leopard is a wide-ranging and highly mobile large carnivore that would certainly have been capable of utilising different habitats across the wider landscape in which Seoul occurred. Curzon (1896) believed that leopards were particularly likely to be seen in the city core during the winter. A similar pattern was observed in Russia by Goodrich et al. (2011) for tigers, which were more likely to enter villages in winter months. The authors theorised that this was due to increased physical stress and lower prey availability during the cold winters of north-east Asia. The presence of forest cover on Seoul’s boundary would have allowed leopards to approach the city walls at night undetected.

| Date and location of sighting | Source | Description of sighting | Quality of record |
|------------------------------|--------|--------------------------|-------------------|
| 27th November 1871, Changdeokgung Palace | Seungjeongwon ilgi (Seungjeongwon ilgi, 1871) | Killed one “horangee” in Changdeokgung Palace. | Possible |
| 1886, winter Russian Embassy and Gyeonghuigung Palace | Antoinette Sontag (Neff, 2020) | Direct sighting of leopard by author. | Confirmed |
| 1880-1892, winter Embassy quarter | George W. Gilmore (Gilmore, 1892) | Leopard shot and another seen several times within a hundred yards. | Confirmed |
| 1880s, either Gyeonghuigung or Changdeokgung Palace | Arnold Henry Savage Landor (Landor, 1895) | Alfred Burt stripling and assistant tracked a big cat (originally thought to be a tiger) into abandoned palace sewers. Leopard killed. | Confirmed |
| c. 1888, Russian Embassy | Dr. Lillias H. Underwood (Underwood, 1904) | Author reported first-hand sighting of a tiger on arrival to Seoul. Leopard seen at Russian Embassy. | Confirmed |
| 1891, winter, Russian Embassy | Captain A. E. J. Cavendish (Cavendish, 1894) | Reported leopard sighting at Russian Embassy and noted this was a regular occurrence every winter. | Probable |
| 12th December 1893, Gyeonbokgung Palace | Seungjeongwon ilgi (Seungjeongwon ilgi, 1893) | Gyeongbokgung Palace evidence of at least one “horangee” for 5 days. Hunters unsuccessful in tracking it down. Suspected leopard. | Possible |
| c.1892-3, Seoul | George Nathaniel Curzon (Curzon, 1896) | Describes leopards sometimes entering Seoul during the winter months. | Probable |
| c. 1894, Changdeokgung Palace | Dr. Lillias H. Underwood (Underwood, 1904) | Author reports hearsay that “leopards and tigers” sleeping at Changdeokgung Palace, which is overgrown. | Probable |
| Early 1890’s, Seoul city walls | Arnold Henry Savage Landor (Landor, 1895) | Describes “tigers” entering Seoul, over the city walls. Author can distinguish leopards and tigers, but likely a second-hand account. | Possible |
| Pre-1898, Seoul | Isabella Lucy (Bird) Bishop (Bishop, 1898) | Reports that leopards are present in large numbers in Korea and have been shot within the walls of Seoul. | Confirmed |
| 1896-1904, old western palace (likely Deoksugung Palace) | William Franklin Sands (Sands, 1930) | Records that the abandoned palace is sometimes the haunt of a leopard or wolf. | Probable |

**Confirmed**, first-hand sighting of leopard, or reports a leopard killed; **Probable**, Panthera species sighting, with evidence provided to suggest classification as leopard, OR second-hand account of leopard sighting; **Possible**, Account refers to Panthera species (either tiger or leopard), but insufficient evidence provided to classify to species level.
Socio-cultural factors likely also played an important role in facilitating human-leopard coexistence in this urban landscape. Contemporary accounts regularly recorded a widespread and intense fear of big cats in Joseon dynasty Korea, which extended to an unwillingness to travel at night for fear of them (Curzon, 1896; Bishop, 1898), reducing the likelihood of encounters between humans and leopards. Even in the core of Seoul, the maze of narrow, unlit streets (see Veitch, 1896) would have posed little obstacle for elusive leopards to navigate undetected at night.

The history of leopards in Seoul should also serve as a cautionary tale for contemporary large carnivore conservation. It illustrates that the relationship between large carnivores and humans in urban landscapes may change rapidly, sometimes due to unpredictable social, economic, or political factors, and where this leads to an increase in targeted killing of large carnivores it can result in the swift extirpation of even the most adaptable species. As in Japan, where the impact of political changes on the grey wolf (Canis lupus) populations of Honshu and Hokkaido has been well-documented (Walker, 2008), the late 19th century was a period of unprecedented political change and social upheaval in Korea (Underwood, 1904; Allen, 1908). Some early Western visitors to Korea carried firearms and were petitioned, or successfully hired, to kill big cats, including in Seoul (see, for example, Campbell, 1892; Landor, 1895). Large quantities of big cat skins, including leopard, were already being exported from Incheon, the closest port to Seoul, by 1887 (Seeley and Skabelund, 2015). The political changes sweeping through the country also resulted in alterations to the vegetation patches that had been present in the city; the formerly abandoned Gyeonghuigung Palace was converted into military barracks in 1896 (Sil, 1896).
We know of no confirmed written records of leopards in Seoul after 1898 and we suspect that by the 20th century leopards were likely already extirpated from the immediate Seoul area. Although the leopard persisted in South Korea into the second half of the 20th century in remote mountainous regions, with the colonisation of Joseon dynasty Korea by Japan in 1910 and the introduction of an “eradication programme for harmful animals” (in Japanese: 動物駆除事業), which included leopards (Seeley and Skabelund, 2015), there would have been little opportunity for a leopard population to re-establish in the landscape surrounding the capital. Leopards were certainly not the only big cat found in the Seoul area. Indeed, the last reliable record of a big cat in the wider landscape was of an Amur tiger that was shot by hunters in 1913 on the slopes of Namsan, which marked the city’s southern border and was dissected by the city wall. However, unlike the leopard, it is more difficult to state with any certainty that tigers were actually present inside the city during the time period under consideration. There is one record that a “horangee” was killed in the grounds of Changdeokgung Palace in 1871 (Seunjeongwon ilgi, 1871), but given the difficulty of separating between historical Korean records of leopards or tigers, we can only conclude that a big cat was killed. This is perhaps not unexpected. Ambiguity in distinguishing between leopard and tigers is a common issue in present day India among rural people (Athreya et al., 2018; Dhee et al., 2019; Nair et al., 2021). The reports we have refer to big cats in locations that would more commonly be associated with leopards, for example on rooftops and behind high walls, with at least one instance of a British hunter being employed to track down an urban “tiger” only to discover that the animal was a leopard (Landor, 1895).

The results of this short study show that the existence of leopards in urban landscapes is not a new phenomenon, but rather has occurred independently on multiple occasions throughout the Anthropocene, where ecological, socio-cultural and political conditions allowed. In the absence of human persecution, leopards seem able to persist in urban landscapes where there are alternative food sources and small patches of dense vegetation that can provide shelter during daylight. Maintaining these conditions may be key to the long-term persistence of leopard populations in urban landscapes where they are currently extant. However, when targeted human killing of leopards in urban landscapes increases, these populations can clearly be quickly extirpated. That the historic presence of leopards in urban landscapes in Korea has been overlooked by researchers outside of South Korea (see Jacobson et al., 2016) raises the intriguing possibility that leopards may have historically been more widespread in urban landscapes than the current scientific literature on felids suggests. Over the coming decades urban landscapes are likely to become increasingly widespread, with particularly high rates of urban growth predicted to occur in the 21st century in Asia and Africa (United Nations, 2015), continents which both support leopard populations. In light of this, further historical investigations would help us better understand the distribution and socio-ecological history of leopards and other large carnivores in urban landscapes over time, and the mechanisms that have supported their coexistence with human populations. This could provide important insights into the future persistence of these large carnivores in urban landscapes.

**DATA AVAILABILITY STATEMENT**

The original contributions presented in the study are included in the article, further inquiries can be directed to the corresponding author/s.

**AUTHOR CONTRIBUTIONS**

JP conceived of the study, collected the data, and wrote the manuscript with support from JA, JL, and SD. All authors provided critical feedback and helped shape the research, analysis, and writing of the final manuscript.

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