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ECOLOGICAL INSIGHT AND SURVIVAL COMPLEXITY OF PANGOLIN

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Abstract

Present conservation efforts focus on charismatic predators like the Snow leopard and the Tiger. On the converse, there are many small mammals are less common that also are facing sharp declines, largely due to lack of knowledge and research. The endanger Pangolin is one species that has not been researched enough. Geographical distribution and habitat attributes has been the primary focus of most ecological studies. In contrast, research on conservation aspects has to date resulted in a broad understanding of the threats being face by the species. Apart from the distributional information, scanty literature exists regarding diet, habitat characteristics and wildlife trade with little on management aspects and morpho-anatomical studies. There are about eight different species of Pangolins, also called scaly anteaters, recognized globally. One such victim of these is the Indian Pangolin, which is from the order Pholidata and an endangered insectivorous mammal that inhabits South Asia. It has been reported from India, Nepal, Bangladesh, Myanmar and portions of western China, Pakistan and Sri Lanka. The Pangolin is a medium sized mammal growing from 30 centimeters to hundred centimeters. The body is shield with hard, horn structures, which render it a formidable fortress against natural enemies. Mostly nocturnal in activity, it is of significant value to the stability of ecosystems health and agronomy. It feeds mainly on insects as arts, termites, bee larvae, flies and different types of worms and earthworms. One individual estimated to eat over 70 million and it thought to be one of the most important biological control of termites in forests ecosystems.

INTRODUCTION

The word Pangolin comes from the Malay word pengguling, meaning something that rolls up. The pangolin is a non-aggressive, shy, solitary, nocturnal and digging mammal. They know as Scaly Anteater in Pakistan or in the local language "Salla." The Pangolin is a placental mammal of the order Pholidota. There are eight known species of Pangolins globally. Of these, four species found in Asia and the remaining are native to Africa. The Indian Pangolin is native to the eastern part of South Asia in general, Eastern Pakistan, through most of India and into southern foothills of Himalayas and further extending in Sri Lanka, Bangladesh, Nepal and regions in western China. These species are distributing across all four provinces, Azad Jammu and Kashmir. It has been report to occur in the upper Punjab region of North Western Punjab district including Gujrat district, Jhelum and Sialkot. It is report from Salt Range heading towards Kohat and that in localities such as Attock, Peshawar, Mardan to many parts of Khyber Pakhtunkhwa (Yasmeen *et al.*, 2021).

One of the eight Pangolin species left in the world and native to India (family Manidae; order Pholidota), Indian was estimated at 10,000 populations in between 2008-2013. This edentate

mammal shows 11-13 rows of large imbricated keratin scales, an elongated tongue specially adapted for feeding and a prehensile tail with a well-developed terminal scale on the ventral side. It can be identifying by its lifestyle, digging, nocturnality and insectivore habits. The distribution of Indian Pangolin is more or less Pan-Indian in 20 peninsular India. It ranges reaches from Pakistan to the west, then eastwards across West Bengal and southwest China followed by Sri Lanka in south and ending with Nepal. Throughout this wide range of distribution, populations are increasingly threat due to national and International trade pressure for live animals and their scales, skin and meat (Mohapatra *et al.*, 2014).

Biological characteristics like low fecundity and speculative distribution further increase the susceptibility of the species to over harvesting. The successful conservation of this species, in particular captive breeding programs, depends on a detailed knowledge of its behavioral ecology. However, generally the Pangolin has not been study well. Limited scientific research has blown up its biology and ecology, as well as its behavior, perhaps in part because of their secretive, nocturnal way of life. The specific behavior of species needs carefully considered in order to evaluate welfare levels and improve making decisions for breeding programs. It should be note that no core behavioral repertoire for this species was encounter in the literature (Panda *et al.*, 2014). Although the Pangolin found across much of South Asia, it is quietly declining because of poaching and relentless human demand. This non-aggressive, shy animal reproduces slowly and lives a nocturnal life, which makes it even more vulnerable to exploitation.

Role of Pangolins in Ecosystem

Pangolins have record in a wide array of habitats ranging from primary and secondary tropical or subtropical forests to savanna woodlands, grassland, and right down to different modified urban or anthropogenic environments. This chapter addresses the ecological significance of Pangolins by examining their roles as insectivorous predators, burrow architects, prey species and vectors of parasites. Since ants and termites are the primary prey of Pangolins, they help maintain ecological balance by keeping social insect populations under control. Their digging activity modifies soil structure and processes, increasing aeration and organic matter redistribution potentially facilitating soil overturn and acting as bioturbators. The burrows of de create also provides for refuge and stable microclimate for other commensal species. They also serve as intermediate hosts of various internal and external parasites, again showing why they are important players in ecological chain (Chao *et al.*, 2020). Pangolins play a vital yet often overlooked role in ecosystem stability. It helps us recognize that these shy, night-dwelling animals contribute to soil structure, manage pests and support ecological networks.

Physical Features of Scaly Anteater

The Pangolin (Scaly Anteater) is an Asian mammal range 30 to 100 cm (Table 01) long. Its tail is moderately long, comprising approximately 70% (Table 01) of the head and body length. The head is short and pointed with a small, pointed snout. The limbs are short and strong, with the feet having five digits. The tail is prehensile, allowing the animal to grip. The skin color in that area is usually light brown to pale whitish pink. The rhinarium color is brown and small not very protruding eyes, which is protect by somewhat wide puffy eyelids. A keratinized scale (the thick, transparent and strong defense against predators). When danger looms, the Pangolin can quickly roll into armored ball (Table 01). These scales are impervious to abrasions and minimize catching light soil and other debris. The size and feel and ridge patterns of the scales are characteristic of species. The scale is most developing in the lateral portion of the body in a dorsoventrally direction towards the tail. The pointed, prehensile tail scales can be turned under. In total, there are 11–13 (Table 01) rows of scales on the body. Adapted for burrowing, the Pangolin has strong forelimbs and huge claws fit to dig holes. The arrangement and sharpness of scales further add to its defense

mechanism against predators (Yasmeen *et al.*, 2021). The Pangolins remarkable scales, sturdy forelimbs, and prehensile tail highlight the unique adaptations that enable it to survive.

Evolutionary History of Pangolins

The evolution of Pangolins remains unclear, largely due to their poorly understood phylogenetic position among placental mammals and scarcity of fossil records. Their closest known relatives are the extinct order Palaeanodonta, and their extant sister group, the carnivorans of order Carnivora. The known record of Pangolins begins in the early Eocene, and they are represented by a few species in Europe since that time. Their present day geographies are establishing throughout the Pilo-Pleistocen epoch. The pangolins in existence today all possess a number of characteristic anatomical adaptations. The most characteristic feature is their external covering made up of epidermis scales and they exhibit morphological adaptations of myrmecophagy, fossoriality and in some species arboreality. The skull is long and toothless (Table 01). The postcranial skeleton shows morphological specialization for fossorial habits, including stout forelimbs with massive claws (Table 01) and a prehensile tail in some taxa. The tongue is support by an elongated xiphisternum (Table 01), which allows for efficient insect feeding. Pangolins edentate jaws (they have no teeth in their mouth) grind up food in a muscular stomach lined with horny denticles (Table 01). Females have axillary mammary glands (Table 01) and bicornuate uterus (Table 01), males do not have external scrotum (Table 01). The circulatory system includes collections of special tissues called retia mirabilia. Despite being similar in general conformation to the carnivore brain, it has relatively low encephalization (Table 01) (Gaubert *et al.*, 2020). Pangolin evolution and its remarkable adaptations include an edentate mouth, a myrmecophagous tongue, robust claws, and keratinized scales.

Table 01: Physical traits of Scaly Anteater

Section	Key Information	Details	References
Morphological Features	Body Length	30-100 cm	Yasmeen *et al.*, 2021
	Tail Length	~70% of head-body length; prehensile	Yasmeen *et al.*, 2021
	Scales	11-13 rows of imbricated keratin scales	Mohapatra *et al.*, 2014
	Dentition	Toothless	Gaubert *et al.*, 2020
	Tongue	Long, anchored to extended xiphisternum	Gaubert *et al.*, 2020
	Limbs	Strong forelimbs with enlarge claws for digging	Yasmeen *et al.*, 2021
	Defense Mechanism	Rolls into armored ball	Yasmeen *et al.*, 2021
Reproductive & Anatomical Features	Mammary Glands	Axillary	Gaubert *et al.*, 2020
	Uterus	Bicornuate	Gaubert *et al.*, 2020
	Male Feature	No external scrotum	Gaubert *et al.*, 2020
	Brain	Low encephalization compared to carnivores	Gaubert *et al.*, 2020
	Stomach	Muscular with horny denticles for food grinding	Gaubert *et al.*, 2020

Distribution and Habitat

Pangolin is a fossorial species of mammal distributed in Pakistan and at risk status in its natural habitat. In this paper, a part of the ecology like distribution, habitat analysis and food habits is report from district Chakwal of Potohar Plateau. We mapped the current potential habitat and projected range expansions of Pangolin in response to climate change. Its distribution and habitat in Pakistan is need of time for its care (Shafiq *et al.*, 2017).

It is often report in Punjab due to observation in hilly and forested areas of Khyber Pakhtunkhwa. The softness of the soil is one of the critical habitat needs for Indian pangolin. It makes long burrows underground to sit in during the days they are also useful for avoiding predators and harsh weather conditions. The burrow is utilizing for breeding and protection. The Pangolin in Pakistan usually live in warm and dry habitats. As their habitat is fragment due to deforestation and development, they have less available territory and end up living closer to humans, which heightens the risk of conflict as well as poaching. Distribution and Abundance. The Pangolin is widely distributed but significant population throughout Pakistan. While it can be found in a range of habitats, human encroachment on its natural habitat is bringing the *Agkistrodon sp*. If conservation not done rapidly, this special and environmentally significant species is at risk to disappear from various areas of the country (Hussain *et al.*, 2015). Valuable insights highlight the serious dangers threatening pangolins, describing the ecological pressures and human-related activities that are harming this rare and valuable species and putting its survival at great risk.

Habitat Preference

Studies carried out in both the Margalla Hills National Parks and Pothar plateau have indicated that Pangolins like habitats with moderate vegetation cover. The dense undergrowth acts as a deterrent for the predators and minimizes human incursions. Pangolins require loose sand to be able to dig their burrows, which are used to rest during the days. However, familiarity with farm equipment has resulted in destruction of these native refuges (Baig *et al.*, 2019).

This serious label is an international alarm warning, so if we don't halt the hunting now, the next few years they will be extinct in their natural habitat and only appear on pictures. This means that anyone caught in the act of hunting, keeping as a pet or selling a Pangolin can be hit with heavy fines and the police have the right to impound any vehicles used in committing or covering up such crimes. The range of Pangolin are the fragmented surrounding villages and railways, 291 km^2 suitable habitat either penetrates into dry, deciduous forest or at least lies in close quarters to parks (Roberts *et al.*, 2015).

It seems that these environments may have phased away over time due to the rapid transformation. Pangolin is strongly affect by the availability of food, which determines where they can live. As their primary food source is ants and termites theraphosids will choose a location with an ample supply of these insects. They are particularly fond of areas with a lot of termite mounds and active ant nests. The boundaries of forests with agricultural lands and crop fields near natural vegetation have abundant insects, thus being optimal feeding places for such animals (Alvarado, 2019).

They are also influence by altitude when they select their habitat. In northern regions of Pakistan, Pangolins are usually encounter in low to mid-altitudinal ranges where the temperature is relatively higher and soil type appropriate for burrowing. Very cold areas or those with hard rocky soil are usually avoided because burrow construction is difficult and less secure (Chmiel, 1996).

Ecology & Behavior

The ecology of the Pangolin is unique and plays its role for the sustainability of natural ecosystems. Its feeding habits and daily activity, the interaction with soil and insect periods of reproduction all emphasize the role it can play in maintaining a balanced habitat (Engelhardt, 1984).

Their declining population has been monitor by the International Union for Conservation of

Nature over recent years and is now certify as an endangered species. This harrowing label is global warning unless we all stop hunting it now. Unfortunately, this masterly intervention is never mentioned in local communities. This means that anyone caught hunting, keeping as a pet or in possession for sale of Pangolins can be hand heavy fines and their vehicles used in the crime seized by police. This study documented some ecological aspects of the species in terms of distribution, habitat analysis, population and food habit from District Chakwal of Potohar Plateau. We predicted the climate change scaled potential distribution and future perspectives of Pangolin as we estimated its present potential habitat. (Challender *et al.,* 2015).

When they venture into man's lands, they encounter an entirely new threat from the people who live there and believe things that are not at all true. Many villagers believe that Pangolins are an ill omen, dig graves or are somehow relate to black magic simply because they look odd, with thick scales. By criminalizing the global trade, these international bodies targeting harassing of customs officers based on airports, this particular international regulation complete illegal union to buy, premature or transport studies was adopted and order any seaport have to conduct a strict verification (Qasim *et al.,* 2024). The species habitat preferences and the challenges it faces due to human impact are described, with habitat loss and climate change identified as major threats to its survival.

Environmental Conditions

We have to show the local villagers that these creatures are not dangerous, and that their scales hold no mystical curing qualities. The Pangolin has unique ecological features, and plays an important role in maintaining ecological balance of the natural environment. Its diets, the daily activity rhythm and its environmental roles such as their interaction with soil and insect populations are an important part of the diverse environment. The abundance of ants and termites is the dominant driver of selection in pangolin habitat use. Since their diet consists predominately of these insects, they are often located in areas with higher termite colonies or ant nests. The woodland and farmland transition areas as well as cultivated areas close to natural patches often inhabit high density of insects, which is suitable prey for Pangolins (Konstan *et al.,* 2014).

Pangolins are insectivorous mammals, eating primarily ants and termites and with its powerful front claws, it rips open termite hills and ant colonies to get at its prey. They feed on insects with their long, sticky tongue. A lone adult Pangolin can consume thousands of insects in a night, helping to limit the number of insects in existence. In this feeding habit they are naturally pest controllers and bring advantages to agriculture ecosystems (Mahmood *et al.,* 2014). Ecological difficulties and human pressures are putting this unique species at risk, with environmental pressures more directly linked to its overall survival.

Feeding Strategy and Foraging Behavior

It largely feeds on ants and termites. It has no teeth, and thus cannot chew its food; it relies on the muscle action of its strong stomach to crush and digest food. It depends primarily on its sense of smell, rather than sight, to locate prey. It locates a nest and carefully breaks it open with its sharp, hooked claws while using its long sticky tongue to reach into crevices for insects. It feeds with delicacy to prevent from destroying the entire colony, so that insects have time to recover. But, this selective feeding behavior reveals that pangolin is highly specialized and maintains a natural equilibrium in the environment (Mohapatra *et al.,* 2022).

Pangolin's diet systems are adaptable and adapted. They move their feeding grounds according to where ant and termite colonies are most active. Pangolins feed in forest habitat edges, scrubland or possibly on cultivate land close to farms where termites are common. The camouflaged parasites are safe from biting ants by their robust defending scales when they feed. As they are nocturnal, I assume they mostly hunt for insects in the cooler night. The Indian pangolin consumes only a

minimal amount of plant matter; it is almost exclusively an insectivore, feeding primarily on ants and termites. This feeding behavior is stable between regions, indicating its evolutionary conserved and it has evolved over time. It eats neatly. Its chance of survival relies on having sufficient numbers of termites and ants nearby to snack on (Perera *et al.*, 2017). The Pangolin depends on its natural instincts, patiently searching for ants and termites and using its long tongue since it has no teeth to chew. Its gentle feeding style shows a quiet intelligence, living in harmony with nature instead of harming it.

Diet Composition

The detailed stomach of stomach has clearly revealed what the Pangolin is eating. Studies in Kerala dissected the sucker and found an abundance of insects, notably ants among which *Leptogenys* species were dominant. I found hard insect parts like heads and shells, suggesting ants are the primary food item. Scientist also discovered soil and small stones that probably sneaked in when digging. Vegetative matter was scant in these feaces, which serves as proof that the Pangolin does not consume vegetation intentionally. These biological studies validate the observations scientist have made in the wild. Studying the diet in a scientific manner removes the doubt and gives clear evidence of what it is that pangolins eat. Altogether, it suggests that the Pangolin is an insectivore (Baiju *et al.*, 2017).

Researchers studied the pangolin also studied its feaces to know about its eating habit. They observed the predation of drooping ants, including *Componotus confucii* and *Componotus compressus*, and termite prey to be the dominant components providing evidence that these insects are important food resources. The drooping clumps were full of ant heads, legs and bodies, which suggests that Pangolins eat insects in different ways from eating the whole bug at once. A small number of other objects, such as bugs, wood fragments and grass pieces were also recover. Soil or clay were found in half of the samples due to the fact that Pangolins take up soil as they dig for their nests, not because they consume it intentionally. Ants and termites are the primary food, providing clear evidence of Pangolins' diet. They exist through these social insects (Ali *et al.*, 2015). Examining the Pangolin's stomach clearly shows it feeds almost entirely on ants, with soil and stones only accidentally ingested. The lack of plants confirms its strict insect diet, highlighting how specialized and focused its feeding habits are.

Breeding Season

The pangolin is threatening with extinction and native to a handful of Asian countries. Its breeding habits are poorly document because of paucity of scientific information. Large-scale poaching and illegal hunting have led to its population crashing. It has few litters so learning about its breeding could be crucial to protecting it. Scientists in Pothwar plateau, Pakistan measured sex hormones and testosterone from droppings with the help of ELISA kits. Hormone levels are also greater in winter than summer. The present study validates for the seasonality of breeding in Pangolin for the information report related to its productivity and captive breeding (Mahmood *et al.*, 2024).

Pangolins have their own unique method of reproducing, with variations in the time between conception and birth, along with mating, recorded across studies. These biological distinctions have not yet been quantifying by hormones, which could aid in better breeding in zoos for endangered species. In the research from Chinese Pangolins, estrogens and progesterone was assessing in 34 females and testosterone in 29 males showed seasonal breeding. The majority of births took place between September and December, consistent with wild observations. Estradiol remains stable and progesterone high throughout pregnancy, whereas females still ovulate normally after birth. Male testosterone peaks in October concurrent with female ovulation and breeding takes place from November to March, which may occasionally be retard by nursing (Arora *et al.*, 2023). Pangolins have a unique, carefully timed breeding cycle, with hormones guiding seasonal mating and birth. Understanding these patterns can help protect and successfully breed these rare, delicate animals.

Life Cycle of *Mannis Crassicaudata*

The life cycle of Pangolin starts with seasonal breeding, and the gestation period for this species is rather shorter. The female bears the young for approximately two to three, months before bearing live more (typically one). The baby pangolin is born with soft scales and it relies entirely on its mother for warmth, food and protection. The baby is protecting inside of a burrow and can sometimes be found on the mother's back or tail while she searches for ants, termites and other insects to eat. The young ones feed on milk during the first few weeks, but they gradually begin to eat insects. Mother care in early begins is necessary for the baby to be well grown and kept safe (Panda *et al.*, 2014).

Pangolin breeds once annually, with mating occurring between July and October. The female becomes pregnant after mating for approximately 65 to 80 days, giving birth generally to one in November or December. Neonatal weight is about 235-400g. The baby is weak at birth and total reliant on its mother for safety, and his or her milk. The baby discontinuing milk feeding, this occurs at 2-4 weeks of age but remaining with the mother until six months (Fig. 01). Both males and females' pangolins mature sexually at approximately about one to two years, therefore accounting for the life cycle (Clausen *et al.*, 2020). The Pangolin gives birth to a single, helpless baby that depends entirely on its mother for warmth, food, and protection, gradually learning to eat insects as she guides and cares for it.

Fig. 01. Life Cycle of Pangolin

Ecological interaction

Variations can occur in the dietary choices of Asian zoos where they commonly feed insects predominantly, or use commercially formulated diets and animal products. Even such interventions many Pangolins suffer maladaptation to Captive food. This might result from smell, taste, consistency, and size of the food. Pangolin are naturally insectivorous animals so the fact its natural prey is missing can make feeding in captivity very challenging. Another problem is thatcaptive diets usually disregard the small material pangolins tend accidentally ingest in the wild, i.e.

soil, sand, grit and very small pieces of plants. These substances potentially have a function in digestion and overall the gut of Pangolin before designing diets for feeding captive material (Karawita *et al.*, 2020).

In the words of the interviewees, Pangolin is source by several different methods; digging them out of their burrow and hunting with a bow and arrow are among the most common. Most people

told me they typically hunted Indian muntjac (*Muntiacus muntjac*) and wild pigs (*Sus scrofa*), not pangolins. Hunting activities will be on the rise with bhumi panduga, a tribal festival that kicks off Monsoon season in central and south India (June July). The village men often hunt in groups of between 30 and 100 during the festival, with research showing that 80% of those quizzed still do so. Most were kill to sell their scales and eat their meat. Some also said scales had use to treat other ailments in traditional medicine, such as piles or kidney stones. Some believed that fashioning Pangolin scales into rings would ward off black magicians. Pangolin scales were the most traded part of the animal, according to 8% of informants. (Aditya *et al.,* 2021).

Both the natural needs of Pangolins and the human activities that put them at risk are explained, though a clearer connection between hunting, captivity struggles, and real protection efforts would present a more complete picture of their survival challenges.

Habitat suitability of Pangolin decreases with increasing temperature seasonality and precipitation seasonality, suggesting that sharp transition of weather from one season to other is detrimental for the species. As an insect-eater, the Pangolin's diet consists largely of ants and termites. Its prey, including termites, rely on damp conditions to thrive and breed. Termite populations are decreased when temperature and precipitation changes violently, then the food supply of pangolin decreases as well. Finally, it has a negative impact on its habitat suitability. Areas with a high precipitation seasonality appear to provide less suitable habitat for Pangolins, while regions with constant rainfall are better in terms of the available termite prey as they are generally more abundant during wet periods than dry ones. There is presently no direct study on the effect of climate on Pangolin (Qasim *et al.,* 2024).

The Pangolin has very specialized feeding habits. They are capable of eating millions of insects such as ants, termites, bee's larvae, files (or flies), worms and earthworms or crickets and even ticks in one year. By feeding on these insects, Pangolin fulfill vital function of regulating the population of termite and other such insects in forest ecology. Even though they do not have efficient teeth, their tongue is very long, muscular and sticky to dig deep within sect nests hold on prey. They have a mouth that is sail like used to catch insects between their boat shaped mouths so the insect cannot crawl out. Pangolin have weak vision system and they use their strong smelling power to detect ants and termites (Yasmeen *et al.,* 2021).

The best suitable habitats of Pangolin (about210 km^2) are mostly located within and surrounding the buffer zones of protected areas like Nizampur National park and Cheat wildlife park. It seems that these habitats have been getting smaller over time because of the rapid transformation of landscape into human settlements and infrastructures. The natural habitats of the Pangolin are mainly subtropical vegetation, and include Broad-leaved evergreen forests with very tall perennial shrubs, old secondary shrub land and herbaceous plants. The species is also highly accommodating of hilly regions with a lot of sublime thrum forests that are a prevalent factor. We found out that Pangolins prefer the thick forest to some place like agriculture land and open grassland because of better cover and protection from the dense stands. These results are similar to past studies, and emphasize the animal's preference for habitats with shelter and safety (Khattak *et al.,* 2024).

Climate change and habitat loss are making life harder for the oriental Pangolin, with a clearer link to its overall survival struggle.

Illegal Wildlife Trade and Threats

Pangolins are actually under serious threat for survival right, they are the most trafficked animal in the entire planet. The main reason why people catch them is to sell their scales and meat but from the sound that struck fear into the fisherman, one cannot help but wonder how much it fetches in the black markets around Asia where rich buyers pay a lot of money for some pieces of these animals. Although science has definitively identified all the thick scales as mere keratin, the same sort of natural material that human hair and fingernails are made from, many traditional

healers continue to use them to concoct fake medicine for a whole range of diseases. This blind faith has spawned a colossal illicit market, in which professional smugglers pay cash-strapped jungle men to capture the living creatures in the forests and because Pangolins are naturally inclined to roll themselves into a ball when they are afraid, hunters do not even need guns to kill them. They just load them into sacks, hide them in compartments of vehicles and take them across various borders. Due to this continuous and accessible hunting of fast money, the wild stock desperately goes declining every year (Baig *et al.*, 2020).

Aside from the illegal hunting, widespread destruction of their natural habitats is a big problem that is driving them toward extinction. With human populations exploding, they are clearing thick forests, natural grasslands along with breaking mountains to create new residential societies, roads and large fields for farming. This process fragments Pangolins' natural environment into tiny pieces that make it very difficult for them to move safely, and to find enough ants or termites to eat. Pangolins require soft soil in which to dig their spacious burrows, where they rest during the day, but these natural refuges are obliterating by farm machinery. With their territory shrinking this much, they have to encroach very near to human villages in search of food (Mahmood *et al.*, 2014).

Illegal trafficking, especially because of wrong beliefs about Pangolin scales, appears to be the biggest threat to this species at present. If the demand in black markets continues, protecting this species will remain very difficult.

Conservation Status

Because Pangolin numbers are declining so rapidly around the world, international conservation groups have taken drastic measures to prevent them from being wipe out. After monitoring their dwindling numbers closely over the last few years, the International Union for Conservation of Nature has upgraded the Pangolins to an endangered species. This is a big warning to the world. Anyone who does not stop hunting now will disappear from the wild soon and we will only see in photographs. In order to disrupt the smuggler supply chain, a worldwide treaty known as CITES has categorized all three species of pangolins in its highest level of protection called Appendix I. Under anyone buying, selling or transporting any of these animals or any part of them across international borders is doing something that is totally against the law. The concept is to wish away such illegal trade by interdicting it at airports and seaports with bloodhounds to examine luggage, and prosecuting under procedures can be show has mutilated a creature (Challender *et al.*, 2015).

At home in the country, the government has increasingly tough laws on its books to protect these animals from the local hunters. According to the provincial wildlife protection acts, pangolin enjoys the same level of protection as a snow leopard means it should be classify as fully protected wild animal. That is to anyone caught hunting, keeping or selling a pangolin can potentially be hit with heavy fines and even have the vehicles used in committing the crime taken from them by police. Alongside stringent government rules, a range of private conservation groups and non-governmental organizations are also working extremely hard on the ground to save them. They operate sanctuaries where vets heal injured pangolins confiscated from smugglers, feed the animals, these are safely release them into remote and guarded forests. And these groups spend a lot of time with local wildlife guards, giving them better training and cameras and other equipment so that they can catch the animal poachers and try to save what population there is in the wild in Asia before it's too late (Ali *et al.*, 2022). The efforts of wildlife laws and conservation NGOs look positive, yet their real effectiveness still depends on proper implementation and better support for field staff.

Conservation Challenges & Future Directions

It is an impossible mission to save the Pangolin on the ground, when 98% of people never understand what wondrous thing this animal has brought to our daily lives and environment. In

case anyone missed that, Pangolins are totally free and natural insect / termite controllers, with one adult able to consume approximately seventy million insects annually. In doing so, they naturally defend the expensive crops of farmers and save the soil with no need for dangerous chemical sprays, their digging also helps to turn over the soil and make a better environment for plant roots. However, this beneficial part of their role is rarely, if ever, considered as a subject for discussion in local communities. There are practical issues on the ground confronting government departments trying to conserve wildlife. The forest guards often paid very low and they do not have modern transport or night vision cameras or good communication equipments to do patrolling in huge and dangerous forests. Result of their vulnerabilities and because of the absence of money they are not able to fight back against heavily organized, well-armed smuggling gangs that operate clandestinely at night (Noureen *et al.,* 2021).

The other big challenge is that scientists, and university researchers like me, still do not know enough basic information about the Pangolins living in this particular area to do effective conservation work. These animals come out only at night, live alone and are extremely shy by nature, so its nearly impossible to carve out what their breeding habits are or what their exact life span may be or count how many of them there actually are left in the wild. We need to zero in on two main matters at once, if we are to fix these pressing problems and ensure a better future for Minnesota. Law enforcement agencies and courts should first punish the arrested smugglers very strictly with long jail terms that make others fear wildlife laws. Second, the government and local schools must begin to launch large-scale educational campaigns directly in rural areas and villages. We have to educate the villagers that these animals are harmless and their scales do not possess any medicinal value. Hunters and poachers hunt these beautiful animals to make money if we create jobs for wildlife watchers in the local population local communities will start protecting them rather than hunting (Baig *et al.,* 2020). In this, protecting Pangolins will likely require not only strict punishment for wildlife traffickers but also proper education and livelihood opportunities for local communities.

Conclusion

Pangolin is a highly specialized and ecologically vital mammal that serves as a natural pest controller in our environment, yet it is tragically being push towards extinction. Its population is steadily decreasing mainly due to relentless poaching for its scales and meat, which is drive by false traditional medicine myths, combined with the widespread destruction of its natural habitats for human development. Although international treaties like CITES and national wildlife laws offer strict legal protection on paper, the lack of sufficient scientific research and inadequate field resources for forest guards make actual conservation work very challenging on the ground. Ultimately, if we are to save this harmless scaly anteater from disappearing forever, it requires law enforcement agencies strictly punish illegal smugglers with long jail terms, alongside initiating massive educational campaigns in local villages to dispel false beliefs and encourage communities to safeguard their wildlife.

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