

# Temminck's pangolin *Smutsia temminckii* (Smuts, 1832)

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## Taxonomy

Previously included in the genera *Manis* (Meester, 1972; Schlitter, 2005) and *Phataginus* (e.g., Grubb et al., 1998) this species is here included in the genus *Smutsia* based on morphological (Gaudin et al., 2009) and genetic evidence (du Toit et al., 2017; Gaubert et al., 2018), and following a synthetic classification of extant pangolins (see Chapter 2). Synonyms: *Phatages hedenborgii* (Fitzinger, 1872). The type locality is Kuruman, Northern Cape, South Africa. No subspecies are recognized. Chromosome number is not known.

Etymology: *Smutsia* (see Chapter 10); *temminckii* refers to Prof C.J. Temminck (1778–1858), a Dutch zoologist (Gotch, 1979).

## Description

Temminck's pangolin (*Smutsia temminckii*) is a medium-sized, stout species with a body weight of around 9–10 kg and a total body length of up to 140 cm, including a thickset tail that is slightly shorter than total head-body length (Table 11.1). There appears to be some variation in size across the species' range. In Sudan, Sweeney (1974) recorded a male weighing 21 kg. In South Africa, individuals in the Kalahari are typically 25–30% smaller than in mesic eastern parts of the country (Table 11.1; Pietersen et al., 2014a). Adult males tend to be larger and heavier than females but there is no apparent sexual dimorphism (Heath and Coulson, 1997a; Pietersen, 2013; D.W. Pietersen, unpubl. data). There is a linear correlation between total length and mass (Jacobsen et al., 1991).

The body is covered in large, overlapping scales comprised of keratin, which cover the dorsal and lateral surfaces, the limbs, both the dorsal and ventral surfaces of the tail, and the forehead (Fig. 11.1). Scales are absent from the head (excluding the forehead), the ventral surface of the body, and the inside of the limbs,

which are covered in soft white skin with sparse, short hairs (~5 mm). As with other African pangolins, no hairs project between the scales. There are 12 transverse, and 11–13 longitudinal scale rows on the body, and 11–13 rows of scales on the tail margins (Table 11.1; Frechkop, 1931; Jentink, 1882). The scales on the tail margins are pointed and cover the edge of the tail both dorsally and ventrally. The tail has five scale rows proximally, reducing to four towards the distal end, resulting in the last nine scale rows comprising four scales each (Jentink, 1882; D.W. Pietersen, unpubl. data). Total scales number between ~340 and 420 (Table 11.1). Scales on the forehead and upper (e.g., elbow to wrist) portions of the limbs are the smallest; those on the dorsum and tail are the largest (Fig. 11.1). The scales are directed to the posterior with the exception of those on the hindlimbs, which point down (Swart, 2013). In adults, the distal edge of the scales is rounded due to continuous abrasion against the underlying scales, but very sharp. In juveniles and sub-adults, the scales end in a pronounced medial point or cusp, which wears and may break off with age. The scales vary in color geographically, ranging from slate-gray to dark brown and yellow-brown, and may terminate with ivory colored edges (Fig. 11.1). In older animals, scales are as thick at the distal edge as they are proximally (D.W. Pietersen, unpubl. data). The skin and scales weigh 33–35% of the total body mass (Kingdon, 1971; Pietersen, 2013), and approximately 25% of body mass if dried and the interstitial tissue removed (D.W. Pietersen and Tikki Hywood Foundation, unpubl. data).

The skull is pear-shaped, being widest just behind the ear opening and tapering gradually to the narrow muzzle (Fig. 11.2); the taper is more abrupt from the ear openings to the occiput. There is no visible neck (Swart, 2013). The facial skin is dark gray, and the eyes are small, dark and bulbous and have a nictitating membrane in addition to eyelids, which offers protection from swarming prey (Fig. 11.2);

TABLE 11.1 Temminck's pangolin morphometrics.

	Measurement		Country	Source(s)
<i>Weight</i>	Weight (♂)	9.3 (2.5–16.1) kg, n = 29	South Africa, Zimbabwe	Coulson, 1989; Heath and Coulson, 1997a,b; Jacobsen et al., 1991; Swart et al., 1999
		6.0 (2.6–10.6) kg, n = 50	Kalahari, Northern Cape Province, South Africa	D.W. Pietersen, unpubl. data
		21 kg, n = 1	Sudan	Sweeney, 1974
	Weight (♀)	9.0 (4.6–15.8) kg, n = 28	South Africa, Zimbabwe	Coulson, 1989; Heath and Coulson, 1997a,b; Jacobsen et al., 1991; Swart et al., 1999
		5.6 (2.5–10.2) kg, n = 28	Kalahari, Northern Cape Province, South Africa	D.W. Pietersen, unpubl. data
<i>Body</i>	Total length (♂)	836 (634–1049) mm, n = 18	Zimbabwe	Coulson, 1989
		997 (690–1240) mm, n = 50	Kalahari, Northern Cape Province, South Africa	D.W. Pietersen, unpubl. data
	Total length (♀)	827 (720–925) mm, n = 15	Zimbabwe	Coulson, 1989
		984 (640–1250) mm, n = 28	Kalahari, Northern Cape Province, South Africa	D.W. Pietersen, unpubl. data
	Total length (unsexed)	1014 (587–1403) mm, n = 10	Zimbabwe	Heath and Coulson, 1998
	Head-body length (♂)	431 (297–565) mm, n = 18	Zimbabwe	Coulson, 1989
	Head-body length (♀)	458 (350–677) mm, n = 15	Zimbabwe	Coulson, 1989
	Tail length (♂)	405 (290–585) mm, n = 18	Zimbabwe	Coulson, 1989
	Tail length (♀)	370 (223–440) mm, n = 15	Zimbabwe	Coulson, 1989
	<i>Vertebrae</i>	Total number of vertebrae	48	
Cervical		7		Jentink, 1882
Thoracic		11–12		Jentink, 1882; Mohr, 1961
Lumbar		5–6		Jentink, 1882; Mohr, 1961
Sacral		3		Jentink, 1882; Mohr, 1961
Caudal		21–24		Jentink, 1882; Mohr, 1961

(Continued)

TABLE 11.1 (Continued)

	Measurement		Country	Source(s)
<i>Skull</i>	Length (♂)	84.9 (72–98.3) mm, n = 11		Coulson, 1989
	Length (♀)	81.2 (71.8–89) mm, n = 6		Coulson, 1989
	Breadth across zygomatic processes	No data		
<i>Scales</i>	Total number of scales	382 (343–422), n = 6	South Africa, unknown	Ullmann et al., 2019
	No. of scale rows (transversal, body)	12		Frechkop, 1931
	No. of scale rows (longitudinal, body)	11–13		Frechkop, 1931; Jentink, 1882
	No. of scales on outer margins of tail	11–13		Frechkop, 1931; Jentink, 1882
	No. of scales on median row of tail	4–7		Frechkop, 1931; Jentink, 1882
	Scales (wet) as proportion of body weight	34.3 ± 3.4%, n = 18		Pietersen, 2013
	Scales (dry) as proportion of body weight	25%		D.W. Pietersen and Tikki Hywood Foundation, unpubl. data



FIGURE 11.1 Temminck's pangolin in the Kalahari, South Africa. The ivory colored scale tips are noticeable in this animal. *Photo credit: D.W. Pietersen.*



**FIGURE 11.2** Close-up of the face of a Temminck's pangolin, showing the small scales on the forehead. The claws on the left hind foot are also visible. *Photo credit: D.W. Pietersen.*

eyesight is poor. The nose is moist. External ear openings are present, and large, although the ear pinnae are vestigial; the ear openings have soft, fluffy hair inside. Like other pangolins, teeth are absent, but two small pseudo-teeth are present on the mandible anteriorly. The jaw is delicate and the mouth opening very small. The tongue is attached to the caudal end of the cartilaginous xiphisternum (formed from the last pair of cartilaginous ribs) in the abdomen (see [Chapter 1](#); [Doran and Allbrook, 1973](#); [Heath, 1992](#)). The xiphisternum extends posteriorly to the iliac fossa before turning dorsally and extending anteriorly along the dorsal wall of the abdomen before terminating in a spatulate-like sac against the diaphragm. The xiphisternum usually extends to the right iliac fossa, rarely to the left. In the throat region, the tongue is housed in a glossal tube, which together extend through the neck to the oral cavity ([Doran and Allbrook, 1973](#)). The tongue is 40–60 cm in length, and can be longer than the head and body length combined ([Kingdon, 1971](#)), extending out of the mouth by 20–40 cm; the glossal tube likely lubricates the tongue with a mucus membrane which is used to “capture” prey ([Swart, 2013](#)). As the tongue

is withdrawn, the hyoid functions to scrape prey from the tongue directing it down the esophagus to the pyloric region of the stomach where it is masticated ([Doran and Allbrook, 1973](#); [Weber, 1892](#)). The submandibular salivary glands are greatly enlarged and displaced caudally to reside in the pharyngeal and cervical regions (see [Heath, 1992](#)).

Both fore- and hindlimbs have five digits. The forelimbs are highly muscular and terminate with three long, sharp claws (~60 mm) in the center and much smaller claws (~30 mm) on the first and fifth digits ([Swart, 2013](#)). The hindlimbs are columnar with a cushioned pad that is widest at the front and tapers slightly towards the rear, resulting in footprints that resemble those of a miniature elephant ([Swart, 2013](#)). Compared to most other pangolin species, the claws on the hindfeet are much reduced ([Fig. 11.2](#)). Unlike other pangolins, Temminck's pangolin takes most of the weight on its hindlimbs when in locomotion and its pelvis is more vertical than in other species ([Kingdon, 1971](#)). The tail is broad, flat and muscular, and heavy ([Swart, 2013](#)), with numerous tendons attached to the caudal vertebrae affording it enormous strength. Convex above and slightly concave below, the tail forms a tight fit against the body, covering the head, shoulders and limbs when the pangolin rolls up ([Swart, 2013](#)).

Temminck's pangolins may occasionally build up subcutaneous fat deposits. They are first deposited in the scapular regions, before extending down the dorsum and onto the dorsal surface of the tail. These subcutaneous fat reserves may play a role in insulation, as scales afford very little thermal insulation ([Heath and Hammel, 1986](#); [McNab, 1984](#); [Weber et al., 1986](#)). Intra-abdominal fat deposits are rare and are used first in times of nutritional stress ([Pietersen, 2013](#)).

Anal glands are present laterally on either side of the anus. These produce a pungent musk-scented liquid that may play a role in territorial marking ([Pocock, 1924](#); [D.W. Pietersen, pers. obs.](#)). Females have two pectoral nipples.

The female's vulva is situated just anterior to the anus; the male's testes are situated in the inguinal area and do not descend into a scrotum (see Chapter 1).

The body temperature is lower than other eutherian mammals. A free-ranging adult female remotely monitored over 34 days in the Kalahari region of South Africa during winter had a body temperature averaging 32–35 °C (min–max, 29.5–35.4 °C; Pietersen, 2013), with similar values recorded elsewhere in the Kalahari (W. Panaino, unpubl. data). The body temperature showed a predictive cyclical pattern, rapidly increasing and peaking just prior to the onset of activity before dropping slightly (0.8–1.2 °C) to an active temperature of 33–34 °C, but was characterized by minor peaks and troughs which are thought to be related to activity (Pietersen, 2013). The body temperature steadily decreased with inactivity in a burrow, reaching its lowest point just prior to it increasing with the onset of activity (Pietersen, 2013). This cyclical pattern was not observed in another Kalahari population during the summer months (W. Panaino, unpubl. data). Resting metabolic rate is about half that of other eutherian mammals of similar size; the rate among four free-ranging individuals in eastern South Africa averaged 140.4 ml O<sub>2</sub>/kg/h (Swart, 2013).

## Distribution

Widely distributed species primarily in Southern and East Africa (Fig. 11.3). Distribution is patchy and is determined by the presence and abundance of suitable prey species and burrows or denning sites (Pietersen et al., 2016a), but also reflects incompatible habitat changes such as crop agriculture (Coulson, 1989; Pietersen et al., 2019); overexploitation has caused local extinctions or greatly reduced populations in some areas.

The northern boundaries of the species' distribution are not well known. Recorded from

Ennedi in northeastern Chad (Malbrant, 1952) and there is a record from Ouanda Djallé in northeastern Central African Republic; the species reportedly occurs widely in this region (Malbrant, 1952). Recorded from Kadugli in the Nuba Mountains of southern Sudan (Sweeney, 1956, 1974) and the species has been collected in the Sennar region, close to the Ethiopian border (Yalden et al., 1996). It is likely that Temminck's pangolin occurs on the western border regions of Ethiopia (Yalden et al., 1996) and Schloeder and Jacobs (1996) confirm the presence of the species in the Omo River basin in the southwest of the country.

Widely distributed in East Africa, including Kenya, except the east and northeast of the country, Tanzania (Foley et al., 2014; Swynnerton and Hayman, 1950), Uganda (Bere, 1962), Burundi, and Rwanda (Dorst and Dandelot, 1972; Kingdon, 1971). Both Temminck's and giant (*S. gigantea*) pangolins occur in Murchison Falls National Park in Uganda, potentially separated by the Victoria Nile (the former on the north and the latter on the south bank), but it is possible that they are sympatric (S. Nixon, pers. comm.) and this requires investigation.

In Malawi, Temminck's pangolin has primarily been recorded in the south but it is believed to occur throughout the country (Ansell and Dowsett, 1988; Smithers, 1966; Sweeney, 1959). Although absent from large tracts of central and northern Zambia, there are records in western, southern, central and eastern regions of the country (Ansell, 1960, 1978; Smithers, 1966). The species does not occur in the forested regions of extreme north-western Zambia.

The western limits of the distribution are reached in Namibia and central and southern Angola. The species is widespread in Namibia, with the exception of the arid coastal regions (Shortridge, 1934; Stuart, 1980). In Angola, Temminck's pangolin occurs in central and southern regions, and there are records from Benguela, Bié, Caconda, Cuanza-Sul, Chitau,



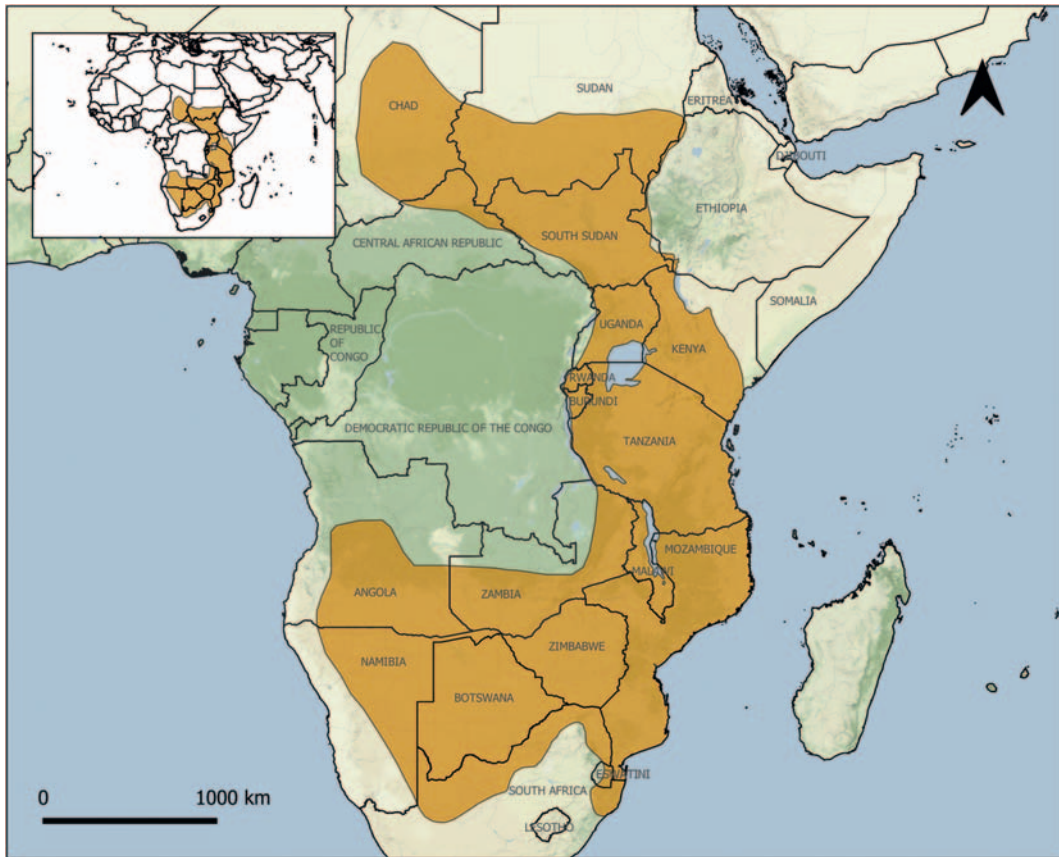


FIGURE 11.3 Temminck's pangolin distribution. Source: Pietersen et al., 2019.

Cuando-Cubango, Huíla, Mombolo and areas adjacent to Namibe (Beja et al., 2019; Hill and Carter, 1941; Meester, 1972; Monard, 1935).

To the south, the species occurs throughout Mozambique (Smithers and Tello, 1976; Spassov, 1990), Zimbabwe (Coulson, 1989) and Botswana (Smithers, 1971). There are no contemporary records for eSwatini. In South Africa, the species occurs in western, northern and eastern provinces (Jacobsen et al., 1991; Kyle, 2000; Pietersen et al., 2016a; Rautenbach, 1982; Swart, 1996). Overexploitation has caused local extinctions or greatly reduced populations in some areas, including KwaZulu-Natal Province, South Africa and eSwatini

(Friedmann and Daly, 2004; Kyle, 2000; Monadjem, 1998; Ngwenya, 2001; Pietersen et al., 2014a).

### Habitat

Occurs in arid and mesic savannas, floodplains (Heath and Coulson, 1997a), woodlands (including mopane [*Colophospermum mopane*], miombo [*Brachystegia-Julbernardia*], mixed marula [*Sclerocarya birrea*] – bush willow [*Combretum* spp.] and broad-leaved woodland; Heath and Coulson, 1997a; Smithers, 1966), thorn (*Vachellia* spp. and *Senegalia* spp.)

thickets, gallery forest and duneveld grassland, where annual rainfall averages 250–1400 mm (Coulson, 1989; Heath and Coulson, 1997a; Pietersen et al., 2016a; Skinner and Chimimba, 2005; Swart, 2013). The species does not inhabit closed-canopy forests or true deserts and does not show strong habitat selection within home ranges (Pietersen et al., 2014a). Altitudinal limits range from near sea level to 1700 m above sea level (Coulson, 1989). Although occurring widely in protected areas and well-managed game and livestock farms, the species is absent from areas of crop agriculture, presumably due to pesticide use or removal of the prey base, and likely increased direct persecution.

## Ecology

Most knowledge of Temminck's pangolin ecology is based on research conducted in South Africa and Zimbabwe between the 1980s and 2010s. The species appears to hold home ranges that vary with both age and locality. In the South African Kalahari region, Minimum Convex Polygon (MCP) home range estimates for adults were  $10.0 \pm 8.9 \text{ km}^2$ , and  $7.1 \pm 1.1 \text{ km}^2$  for sub-adults (Pietersen et al., 2014a). Males and females had closely matching home range sizes, with each male's home range overlapping that of a single female, suggesting a monogamous mating system (Pietersen et al., 2014a). In contrast, in Zimbabwe home ranges varied between 0.2 and  $23.4 \text{ km}^2$  with males having a larger home range which overlapped with those of several females, albeit temporarily, and is presumably related to breeding behavior (Heath and Coulson, 1997a). In northeastern South Africa, home ranges varied between 1.3 and  $7.9 \text{ km}^2$  (van Aarde et al., 1990). In eastern South Africa (Kruger National Park region), males had home ranges of 9.28– $22.98 \text{ km}^2$ , which

overlapped the home ranges of up to five adult females, suggesting a polygynous mating system (Swart, 2013). Females had home ranges of  $0.65\text{--}6.66 \text{ km}^2$ , which overlapped with the home ranges of up to three adult males (Swart, 2013). One male in eastern South Africa (which had the largest home range in the study,  $22.98 \text{ km}^2$ ) was located on 234 separate tracking days over a period of two years. The home range overlapped with those of five females, on average by 39% (9–100%) of each female's home range (Swart, 2013). The same study found that female home ranges may overlap by up to 34%. Home ranges of both sexes reportedly increase by ~4% in the wet season (Swart, 2013). Pietersen et al. (2014a) questioned whether the larger male home range estimates and higher number of overlapping female home ranges in Zimbabwe and eastern South Africa are due to the inclusion of transient males. Dispersing pangolins, especially males, are known to cover large distances, making this argument plausible. Male Temminck's pangolins have been known to cover 32–81 km in 20 days, and the farthest a male is known to have dispersed was 300 km in four months (van Aarde et al., 1990). Females appear to have shorter dispersal distances (<100 km, Pietersen et al., 2014a). Further research into mating systems, which may vary regionally, and dispersal in this species is required.

Males do not appear to be inherently territorial (though they do scent-mark, see *Behavior*) but are intolerant of other mature males in their home range and will aggressively attack interlopers. This may take the form of wrestling with the tail and scratching at the opponent with the forelimbs and claws. These battles sometimes last for hours until one pangolin relents and leaves the area (Swart, 2013; W. Panaino, pers. obs.).

Home ranges are used on a continuous basis, with individuals typically spending consecutive days in a particular burrow before



moving to another, seemingly in an ad hoc manner (Heath and Coulson, 1997a; Pietersen et al., 2014a; Swart, 2013). Swart (2013) reported that in the Kruger National Park region males use burrows for up to 16 consecutive days (mean = 2.3 days,  $n = 4$ ), and females up to 75 days (mean = 5 days,  $n = 8$ ), returning to only 18% and 23% of dens used previously respectively. The species tends not to dig burrows, instead using the abandoned burrows of other species including aardvark (*Orycteropus afer*), springhares (*Pedetes capensis*) Cape porcupines (*Hystrix africaeaustralis*) or warthog (*Phacochoerus* spp.), among others, modifying them to some degree (Swart, 2013). Sweeney (1974) described a burrow that was 3–5 m long, sloped steeply downwards and terminated about 1 m below the soil surface. Burrows used in the Kalahari region ranged from 1.2 to 12 m in length and terminated 0.5–5 m below the soil surface (D.W. Pietersen, unpubl. data). The species also rests in rock crevices, caves, termitaria, or in thickets or piles of driftwood (Heath, 1992; Heath and Coulson, 1997a; Jacobsen et al., 1991; Pietersen et al., 2014a). Rarely, dispersing individuals may dig a burrow in soft sand, but these are typically not very deep (<0.5 m in depth) and do not afford much protection (D.W. Pietersen and W. Panaino, pers. obs.). In the Kalahari, this species has been observed sleeping in hollows in small epigeal termitaria following the excavation and consumption of its inhabitants (D.W. Pietersen and W. Panaino, pers. obs.); similar behavior has been observed in rehabilitated animals in the South African Highveld (R. Jansen, pers. obs.). Old burrows are abandoned as they decay. Temminck's pangolins are known to return to established home ranges if translocated, a behavior apparently most well developed in adults, though the distance over which this occurs is presumably limited (Heath and Coulson, 1997b; P. Rankin, unpubl. data).

The species is entirely myrmecophagous and the distance covered in search of prey depends on both habitat and prey availability (Swart, 2013). In eastern South Africa, Swart (2013) recorded males covering a distance of 202–3791 m per night and females, 40–2176 m per night. Temminck's pangolin is highly prey selective including geographically, with different prey species having been predated on in different parts of South Africa and Zimbabwe (Coulson, 1989; Jacobsen et al., 1991; Richer et al., 1997; Swart et al., 1999). In total, 30 ant and 10 termite species are reported to be preyed upon, with many other species, including common taxa, ignored (Coulson, 1989; Jacobsen et al., 1991; Pietersen et al., 2016b; Richer et al., 1997; Swart et al., 1999; W. Panaino, unpubl. data). Swart et al. (1999) report that Temminck's pangolin prefers larger prey (>5 mm in length) and at Sabi Sands Wildtuin in South Africa six species >5 mm in length comprised 97% of the diet: *Anoplolepis custodiens*, *Myrmecaria natalensis*, *Camponotus cinctellus*, *Polyrhachis schistaceae*, *Hodotermes mossambicus* and *Camponotus* sp.–*maculatus*-group. One species, *A. custodiens*, comprised 77% of the overall diet and was the most important prey species throughout the year (Swart et al., 1999). Swart et al. (1999) and Swart (2013) assert that *A. custodiens* is the key species in the diet of Temminck's pangolin in Southern Africa, and is likely important in determining the distribution of *S. temminckii* in the region. This selectivity may be because the nest galleries of *A. custodiens* are close to the soil surface, meaning they are easily accessible to pangolins (Swart et al., 1999). Jacobsen et al. (1991) reported the species pre-dating on ants (*Acantholepsis capensis*, *A. custodiens*, *Camponotus* spp., *Crematogaster amita*, *Monomorium albopilosum*, *Myrmecaria natalensis*, *Pheidole megacephala*, *P. schistacea*, *Tapenonia luteum*, *Technomyrmex albipes*) and termites (*Odontotermes badius*, *Trinervitermes rhodesiensis*) in eastern South Africa.

Predators include African lion (*Panthera leo*), leopard (*P. pardus*), spotted hyaenas (*Crocuta crocuta*) and ratels (*Mellivora capensis*). There is a record of a Nile crocodile (*Crocodylus niloticus*) preying on a Temminck's pangolin (Coulson, 1989) and an African elephant (*Loxodonta africana*) crushing a pangolin in an apparent musth rage (R. Jansen, unpubl. data). African lions and leopards are observed "playing" with pangolins that have rolled into a defensive ball, but the scales and round shape make it challenging for predators to grasp them and these interactions rarely result in the death of the pangolin. Spotted hyaenas and lions typically prey on pangolins opportunistically. In some areas ratels appear to specialize on pangolins, or at least know how to effectively tackle and consume them (Swart, 2013; B. Nebe and W. Panaino, pers. obs.). Young pangolins are especially vulnerable to predation because of their smaller size and their scales are weaker than those of adults.

Temminck's pangolins frequently host pangolin mites *Manitherionyssus heterotarsus*, and occasionally soft (*Ornithodoros moubata* and *O. compactus*), hard (*Rhipicephalus theileri*) and other tick species (Jacobsen et al., 1991; D.W. Pietersen, W. Panaino and T. Radebe, unpubl. data; see Chapter 29).

## Behavior

Solitary, with males and females coming together briefly to mate, and the only lasting social bonds exist between females and their dependent offspring (Swart, 2013; D.W. Pietersen, unpubl. data). Adapted to a diet of rather poor nutritional value, the species spends most of the time resting in a burrow or similar place of shelter and is typically active for only a small proportion of the day or night (Swart, 2013). Temminck's pangolin is predominantly nocturnal, but is also crepuscular and diurnal (Jacobsen et al., 1991; Richer et al.,

1997; Swart, 2013), and activity may vary according to season, prey availability, and to avoid predation (Pietersen et al., 2014a). In warm mesic environments (e.g., eastern South Africa) and during summer, the species is nocturnal, conserving energy and moisture by limiting exposure to high temperatures (Jacobsen et al., 1991; Pietersen et al., 2014a, 2016a; Swart, 2013; Wilson, 1994). In the Kalahari region, activity, including that of juveniles, may be entirely diurnal or may start during daylight hours and extend into the night during winter, presumably to avoid the extremely cold nighttime temperatures, and conserve energy (Pietersen et al., 2014a; W. Panaino unpubl. data). In these circumstances, emergence times from burrows is closely associated with minimum ambient temperature (Pietersen et al., 2014a). This activity is also thought to be a response to nutritional stress as ants are less active and congregate deeper in their nest chambers in winter and at night, being less accessible and necessitating pangolins to expend more energy to prey on them (Pietersen et al., 2014a, 2016b). Research in South Africa and Zimbabwe suggests that juveniles and sub-adults in particular, are diurnal or crepuscular foragers, and behave this way to avoid nocturnal predators (e.g., African lion), being more vulnerable to predation than adults (Richer et al., 1997; Swart, 1996, 2013).

In eastern South Africa (Sabi Sand Wildtuin), activity periods averaged  $3.9 \pm 1.9$  hours per night and ranged from 0.6 to 8.3 hours, with foraging behavior commencing at 2025 (mean; range = 1434–0215) for adults and 1802 (mean; range = 1430–2015) for sub-adults (Swart, 1996). In the Kalahari, activity periods lasted for an average of  $5.7 \pm 2.0$  hours (mean  $\pm$  SD), ranging from 1 to 12 hours, and did not show seasonal variation (Pietersen et al., 2014a). The most frequent emergence times among three adults were between 1600 and 1800, but these individuals often emerged as early as 1100 (Pietersen et al., 2014a). Based on research in Sabi Sand Wildtuin,



**FIGURE 11.4** Temminck's pangolin is the only bipedal species of pangolin and uses its tail as a counter-balance. *Photo credit: Paula French/Shutterstock.com.*

Swart (1996) reported that active time is correlated with feeding intensity (feeding time per hour), i.e., when feeding intensity is higher, the species is active for shorter periods. However, variation in the duration of activity in different environments may be related to prey availability and requires further investigation.

Unlike other pangolins, Temminck's pangolin is bipedal, walking and bearing the weight on its hind legs, with the forelimbs tucked up towards the chest, and the tail held off the ground and used as a counter-balance (Fig. 11.4). They are capable of climbing and can clamber over fallen logs and other debris with ease, and the species is an accomplished swimmer (Kingdon, 1971; P. Rankin, pers. obs.). When climbing steep embankments or rocky ridges, the forelimbs are used to scale obstacles and the tail may be used to anchor the animal or help push it forward. The species often stands erect on its hindlimbs in a near-vertical position, balancing on the broad tail, and sniffing the air to survey the surroundings.

Most active time is spent foraging, mainly in dense undergrowth, and a smaller proportion of time spent actually feeding, with

estimates ranging from 7% to 20%, varying between habitat type (Richer et al., 1997; Swart et al., 1999). Temminck's pangolin is macroscopic, using acute olfactory senses to locate prey, even beneath the soil surface (Swart, 2013). When foraging, the species follows a haphazard path, with the nose held close to the ground while continuously sniffing to locate prey; sniffing intensity increases closer to the prey source (Swart, 2013). The muscular forelimbs and strong front claws are used to tear open terrestrial ant nests, scratch away cartilaginous material from termite mounds, and tear away bark on dead trees when foraging, enabling access to prey. At epigeal ant nests, the species typically digs only shallow holes (5–10 cm deep), removing the soil in the immediate vicinity before inserting the long, salivary tongue (see Fig. 11.5) to capture ants located deep within the nest chambers (Pietersen et al., 2016b; Swart et al., 1999; Fig. 11.5). Feeding bouts in the South African lowveld are typically short, averaging 40 s and seldom exceed one minute (Swart et al., 1999), and are probably terminated in response to the chemical and physical defenses (e.g., swarming behavior) employed by the prey. In the



FIGURE 11.5 Temminck's pangolin uses its long tongue to pick up prey. *Photo credit: Francois Meyer.*

Kalahari, feeding bouts are longer, sometimes lasting for several minutes (D.W. Pietersen and B. Nebe, unpubl. data). Short feeding bouts likely ensure that an ant or termite colony is never annihilated, affording the species the opportunity to periodically revisit the same nest. While foraging, nictitating membranes cover the eyes, and the nostrils and ears are closed (Swart, 2013). Feeding sites vary between epigeal ant nests and those at the base of trees and shrubs (Richer et al., 1997). The species does not usually feed at epigeal termite nests, largely owing to the hard exterior making the nests impenetrable, but will feed at termitaria after heavy rains have softened the exterior, or after other species (e.g., aardvark) have partially excavated a nest. Largely water-independent, the species obtains moisture from prey, but will opportunistically drink freestanding water (W. Panaino, pers. obs.), especially in captivity.

Both males and females scent-mark by regularly depositing small volumes of urine as they walk (D.W. Pietersen and W. Panaino, pers.

obs.) and may defecate and drag the tail through the feces in order to spread it further. The species also defecates at burrow entrances and in burrows (D.W. Pietersen, F. Meyer and R. Jansen, pers. obs.), which may serve an additional territorial function. Males are known to raise a hind leg enabling them to squirt a small volume of urine onto objects including trees and rocks (Swart, 2013). The anal glands are also thought to play a role in scent-marking. In addition to sleeping burrows, abandoned burrows of other species are regularly visited on nocturnal excursions, with the pangolin entering the burrow and scent-marking before re-emerging (Swart, 2013; D.W. Pietersen and W. Panaino, pers. obs.). Feces are usually buried, which may act as a mechanism to avoid detection by predators but may also serve as a territorial marker; buried feces have been dug up by other pangolins (and aardvark) months or even years after initial deposition (D.W. Pietersen, pers. obs.). Frequently used dens are cleaned periodically with accumulated feces moved to the burrow entrance.





**FIGURE 11.6** Temminck's pangolin rolling in herbivore dung. This may have an anti-parasitic role. *Photo credit: D.W. Pietersen.*

Temminck's pangolin is fond of wallowing in mud and will also roll in herbivore dung and urine (Swart, 2013; D.W. Pietersen and W. Panaino, pers. obs.). On occasion, they will lie on their side next to the fresh dung and grasp it between their fore- and hindfeet, before rolling onto their back and crumbling the ball with their feet. Curling around the crumbled ball, excrement covering the ventral surface, they will simultaneously writhe in the dung pile coating the dorsal surface (Swart, 2013; D. Pietersen and W. Panaino, pers. obs.). They also create wallows by loosening coarse sand and urinating in it (Swart, 2013; D.W. Pietersen pers. obs.; Fig. 11.6). This behavior is believed to have an anti-parasitic role, and may serve to disguise the pangolin's scent from its prey, potentially delaying defensive actions from prey while foraging.

When threatened, the species will freeze and when motionless is often well

camouflaged. Otherwise, Temminck's pangolin rolls up into a tight ball with the vulnerable head, legs and unscaled ventral surface protected, presenting predators with an almost impenetrable armor of scales. When curled up, the forelimbs tightly grasp the hindlimbs, and the tail is curled around the body, and cannot be prized open by predators, or human beings. The broad, muscular tail may be moved slowly across the dorsal surface in a scything motion and when a foreign object is located e.g., an errant hand or predator's paw, it is lashed at with the tail. The scale edges are sharp and are an effective defense.

Individuals communicate by vibrating their bodies when curled up, which is audible to the human ear, and this behavior is likely exhibited during threat displays between rivals (Swart, 2013; D.W. Pietersen, W. Panaino and R. Jansen, pers. obs.). Males may hiss when approaching females.



## Ontogeny and reproduction

Females give birth to a single young once a year (van Ee, 1966; W. Panaino, unpubl. data), possibly only every second year. Twins have been recorded, but rarely (e.g., Jacobsen et al., 1991). Sweeney (1974) reported that a female carrying a well-developed fetus was still lactating and had a juvenile in tow suggesting that females may become pregnant while nursing current young, as in some other species of pangolin. In contrast, in the Kalahari region of South Africa, a female observed for over 5 years only gave birth twice suggesting that breeding is biennial (D.W. Pietersen, unpubl. data).

Breeding is aseasonal (Ansell, 1960; Coulson, 1989; Jacobsen et al., 1991; Smithers, 1971; Swart, 2013) although a seasonal peak has been observed in some populations (D. Pietersen and W. Panaino, unpubl. data). Males locate receptive females while foraging, presumably through a scent trail left by the female (Swart, 2013; D.W. Pietersen, pers. obs.). The male approaches the female cautiously, sniffing continuously (and may hiss) while circling and clambering over her (Swart, 2013). The male mounts the female from the side, forcing his tail below hers to ensure alignment of the genitals, and will curl around her tail to prevent being dislodged (Swart, 2013; van Ee, 1978; D.W. Pietersen, unpubl. data). From limited field observations, the female carries the male to a burrow in this position, where they remain continuously for 24–48 hours (Swart, 2013; D.W. Pietersen, unpubl. data). Gestation period is 105–140 days, after which the female gives birth to one young, typically in a burrow (Swart, 2013; van Ee, 1966; D.W. Pietersen, unpubl. data). The young's eyes are open at parturition, and the scales are soft and pink (Swart, 2013). Neonates measure about 150 mm and weigh 340 g when born (van Ee, 1966).

Post-partum care is not well understood and reports vary. The female initially leaves

the young unattended for short periods to forage, returning at intervals to nurse (Swart, 2013). Within a week of parturition, the female will move the juvenile from the birthing burrow to another burrow (W. Panaino, unpubl. data), the juvenile grasping onto the scales at the base of the mother's tail (van Ee, 1978; D. W. Pietersen and W. Panaino, pers. obs.). Kingdon (1971) reports that in East Africa young start riding on the mother's back after a month. As they get older, juveniles make exploratory ventures outside burrows (Swart, 2013; D.W. Pietersen and W. Panaino, pers. obs.). In the Kalahari, juveniles start accompanying the mother during her feeding forays by riding on the base of her tail (D.W. Pietersen, unpubl. data). In the South African lowveld and elsewhere in the Kalahari, females never foraged while moving young between burrows and the young never accompanied the mother on feeding forays (J. Swart and W. Panaino, pers. obs.). As the young nears independence, it alternates between riding on the mother's tail and feeding on its own near the mother, until it becomes independent at about 3 months old (D.W. Pietersen, pers. obs.). Other observers report that independence is reached at 4.5–6 months in the Kalahari (W. Panaino, unpubl. data) and 6–7 months in the South African lowveld, but with records of offspring as old as 10–12 months having been observed riding on their mothers' backs and sharing burrows with their mother (Smithers, 1983; Swart, 2013; W. Panaino, unpubl. data). In one instance, a young Temminck's pangolin in the Kalahari was found to be sharing a burrow with its father for a month following independence from its mother (D.W. Pietersen, unpubl. data). In the lowveld, young of this species learn to forage from an early age by trial and error without guidance and were accomplished foragers by the time of independence (J. Swart, pers. obs.).

If threatened, the mother will curl around the juvenile, completely shielding it. Large

juveniles are only partially encircled, curling around the female at a right angle with the forequarters, including the head, enclosed by the female (Skinner and Chimimba, 2005).

Young pangolins establish a home range within the maternal home range, typically focusing their activity on a small portion of it, likely the area they are most familiar with (Heath and Coulson, 1997a; Pietersen et al., 2014a; Swart, 2013). Newly independent Temminck's pangolins remain in their mother's home range for about 12 months, before dispersing further afield (Pietersen et al., 2014a; Swart, 2013).

Females are thought to reach sexual maturity as they approach 2 years old, but as they are generally in the process of dispersing at this age, it is likely that reproduction does not start until 3 or 4 years of age and a home range has been established. Males also likely reach sexual maturity as they approach 2 years old, but appear to rove for several years, and may only establish a home range (and likely start breeding) at 6 or 7 years of age (Pietersen, 2013). Further research is required to determine whether these males contribute to the genepool before they establish home ranges.

Longevity in the wild is not known. One individual lived in captivity for about three years (Hoyt, 1987; Van Ee, 1966). The seemingly late onset of reproduction and slow reproductive rate suggest that the species may live for 20–30 years (Swart, 2013; D.W. Pietersen, unpubl. data; Tikki Hywood Foundation, unpubl. data). An Indian pangolin (*Manis crassicaudata*), which is of similar size, biology, and ecology, lived for more than 19 years in captivity (Hoyt, 1987).

## Population

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Population estimates are lacking across most of the species' range, owing to the secretive and predominantly nocturnal habits, and a lack of research. In eastern and western

South Africa, and Zimbabwe, the species occurs at estimated densities of 0.12–0.16 reproductively active individuals/km<sup>2</sup>, and absolute densities of 0.23–0.31 individuals/km<sup>2</sup> (Pietersen et al., 2014a; Swart, 2013). Based on area of occupancy and estimated densities, South Africa's population was estimated to be 16,000–24,000 mature individuals in 2016 (Pietersen et al., 2016a). No population estimates are available for any other range countries, regions, or globally. Populations are suspected to be declining globally, driven primarily by threats including accidental electrocution on electrified fences, overexploitation for illicit local and international trade, and habitat loss (see *Threats*).

## Status

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Temminck's pangolin is listed as Vulnerable on The IUCN Red List of Threatened Species (Pietersen et al., 2019) and Vulnerable on the South African Red List of Mammals (Pietersen et al., 2016a). No other national or regional assessments have been undertaken. The species is afforded protection under national wildlife legislation in most range states, which typically prohibits exploitation, and in 2016 was included in CITES Appendix I.

## Threats

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All threats are anthropogenic. Accidental electrocution on electric fences and overexploitation for local use and international trafficking are the main threats. Electrocution on electric fences is most prevalent in South Africa and Namibia where electric fences are common on both game and livestock farms (Beck, 2008; Pietersen et al., 2014b; van Aarde et al., 1990; B. Nebe, pers. obs.). However, there are reports of individuals being electrocuted in Uganda and this threat is likely to occur wherever pangolins occupy areas with electric

fences. Temminck's pangolins walk on their hind legs with the front limbs and tail held off the ground. When the soft, unprotected belly contacts an electric fence, the pangolin receives an electric shock and curls into a protective ball, often inadvertently curling around the electrified wire. This results in a continuous electrical pulse that causes terminal damage; some individuals succumb to exposure from remaining trapped on the wire. Pietersen et al. (2016a) estimate that in South Africa these fences electrocute between 377 and 1028 Temminck's pangolins annually (though the actual number is likely higher). This accounts for 2–13% of South Africa's population (Pietersen et al., 2016a).

Temminck's pangolin is used extensively in traditional African medicine and plays an important role in cultural rituals and as talismans (see Chapter 15; Baiyewu et al., 2018; Bräutigam et al., 1994). In South Africa, the species is highly sought-after in commercial herbal medicine markets (Cunningham and Zondi, 1991). While such use may have been sustainable historically, evidence suggests that this is no longer the case, and the species has been extirpated from parts of its range because of overexploitation (e.g., KwaZulu-Natal Province, South Africa; see Pietersen et al., 2016a). In East Africa, the species is locally referred to as "*Bwana mganga*", meaning "Mister Doctor", alluding to the fact that most of the species' derivatives are used in cultural rituals and traditional medicine (see Chapters 12 and 14; Wright, 1954). It is possible that poaching rates increase during periods of drought as pangolins may be under nutritional stress and forage for longer periods as well as diurnally, and less vegetation cover makes them more visible, and therefore easier to capture.

There has been little international trade in the species reported to CITES historically (see Chapter 16). However, there has been an apparent increase in illegal, international trade

in Temminck's pangolin between around 2008 and 2019, involving both live animals and scales (Challender and Hywood, 2012; Shepherd et al., 2017). Available data suggest that this has involved at least 114 individuals (Chapter 16), but the actual number is likely higher. Of concern is the seemingly insatiable demand for pangolin scales in East and Southeast Asia, with numerous seizures of shipments in the last ten years implicating range states in Southern and East Africa (Heinrich et al., 2017), and illicit trade in pangolins moving in to Southern Africa (Pietersen et al., 2014a; Shepherd et al., 2017).

Habitat loss because of land transformation for subsistence and commercial crop agriculture, including shifting agriculture, small-holder farming and agro-industry poses a threat, though a minor one in isolation, but crucially, increased human presence in these areas likely results in higher levels of poaching (Pietersen et al., 2016a).

Other threats include the death of individuals from traffic collisions on roads, hunting or poaching for consumption as a source of protein (see Lindsey et al., 2011), and capture for presentation as a gift to persons in power, including chiefs and state presidents. Capture in gin traps set for small carnivores has also been reported from western South Africa but may be more widespread (Pietersen et al., 2014b; van Aarde et al., 1990). Artisanal mines and large, open water canals (B. Nebe, unpubl. data) pose a local threat where they occur.

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