INTRODUCTION

This book describes all of the world's terrestrial carnivores, 250 species that are united in a shared ancestry of subsisting mainly on meat. Many other species, humans included, eat meat, but this does not make them carnivores in scientific nomenclature. That label belongs exclusively to the members of the order Carnivora, which, despite remarkable variation in size and shape, all descend from a small civet-like carnivorous ancestor that lived more than 60 million years ago. Some modern carnivores eat little meat or, as in the case of the Giant Panda (page XX), none at all, but all members of the Carnivora trace their ancestry back to the same predatory origins, and retain many of the physical, behavioural and ecological adaptations common to their truly carnivorous relatives.

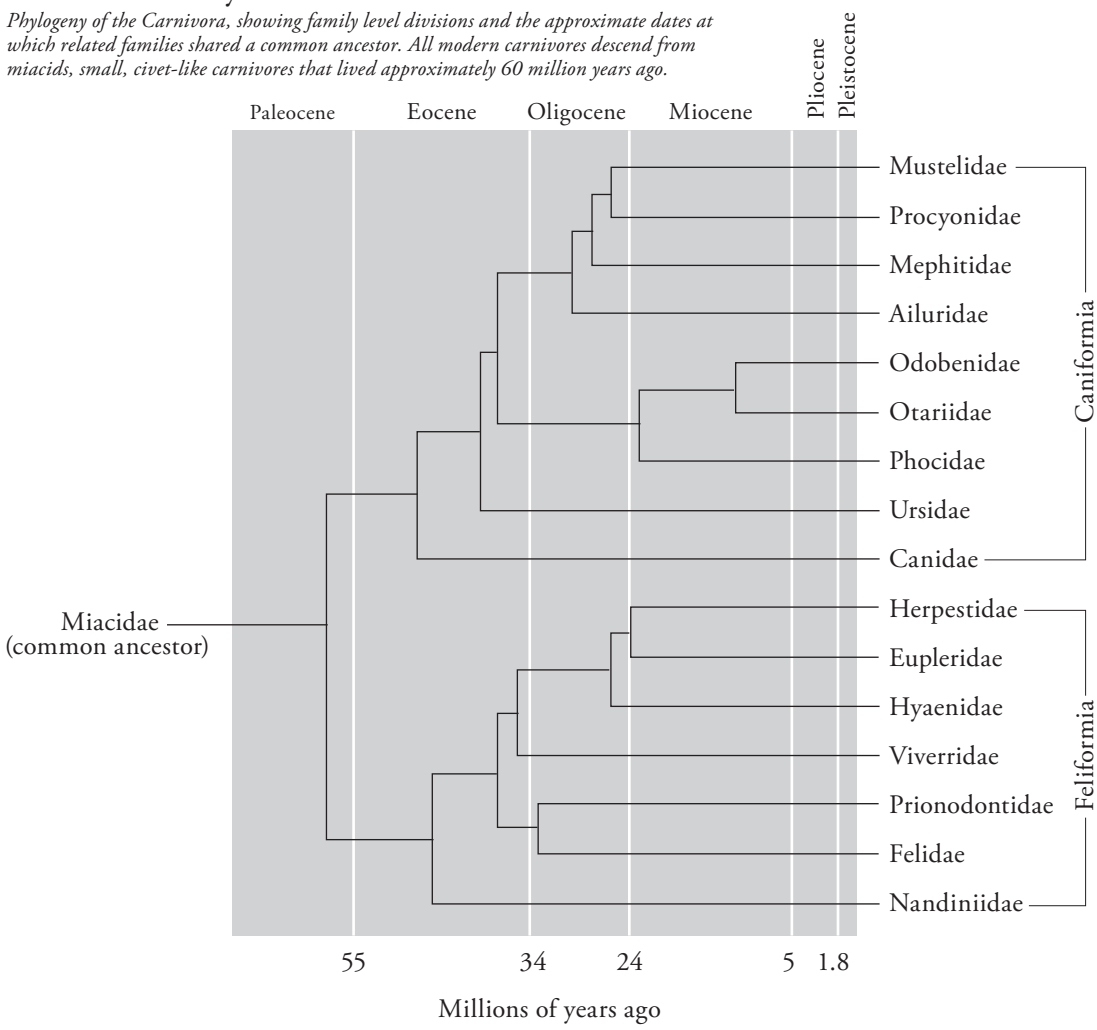
The Carnivora is the fifth-largest mammalian order (of twenty-nine extant orders), occurs on every large landmass including Antarctica, and inhabits every major habitat on Earth, from the hyper-arid interior of the Sahara Desert to Arctic ice sheets. The world's smallest carnivore, the tiny Least Weasel (page XX), can squeeze through a wedding ring and weighs 10,000 times less than the largest terrestrial species, the Polar Bear (page XX). The order Carnivora includes some of the world's most iconic, magnificent and admired species – and, regrettably, some of the most endangered.

This book covers the world's thirteen terrestrial carnivore families. It does not include three chiefly marine carnivore families, the sea-lions (family Otariidae, sixteen species), seals (family Phocidae, nineteen species) and the Walrus (family Odobenidae). While these three families have, at times, been classified as a separate order, the Pinnipedia, there is no dispute today that they belong within the Carnivora. Although they do not appear here, the pinnipeds are covered in many excellent field guides to marine mammals.

Carnivores are separated into two major suborders, reflecting a divergence early in the order's evolution an estimated 45–50 million years ago (although given the paucity of fossil remains, possibly considerably earlier). Suborder Feliformia contains the 'cat-like' families Felidae, Hyaenidae, Herpestidae, Eupleridae, Prionodontidae, Viverridae and Nandiniidae. Suborder Caniformia comprises the 'dog-like' families Canidae, Ursidae, Procyonidae, Ailuridae, Mephitidae and Mustelidae, as well as the three pinniped families.

Carnivore Family Tree

Phylogeny of the Carnivora, showing family level divisions and the approximate dates at which related families shared a common ancestor. All modern carnivores descend from miacids, small, civet-like carnivores that lived approximately 60 million years ago.



How many species of carnivore?

This book's first edition covered 244 species of terrestrial carnivores. In the intervening years, at least a further nine species have been described, while others have been subsumed, bringing the total in this edition to 250. The changes are mostly the product of increasingly powerful genetic comparisons between populations. Some pairs of species long assumed to be different, based mainly on appearance, turned out to be the same (e.g. Grandidier's and Broad-striped vontsiras, page XX), while others that were thought to be the same turned out to be hidden, or cryptic, species, so similar in appearance to another, usually very closely related, species that only molecular techniques revealed the underlying differences (e.g. tigrinas, page XX; and Japanese and Siberian weasels, page XX).

In principle, these newly discovered genetic distinctions reflect other meaningful biological differences, for example, in morphology, behaviour or ecology, and especially in the defining characteristic of species, reproductive isolation; species cannot produce fertile offspring with a second species. Although that principle mostly holds true in the Carnivora, exceptions exist. Few would question that Coyotes (page XX) and Grey Wolves (page XX) are separate species, yet very fluid hybridisation between them in eastern North America (see page XX) reveals the challenges in delineating the boundaries between species. Our classification of organisms as species is a momentary snapshot in time on the extremely complex and ongoing evolutionary process of speciation, and exactly what defines a species is debated vigorously – even among biologists. This book takes a conservative approach to adopting new species and includes only those supported by multiple lines of published evidence (e.g. molecular, morphological, ecological and biogeographic) and that are widely accepted (e.g. by the International Union for Conservation of Nature Species Survival Commission (IUCN SSC) Specialist Groups devoted to carnivores). Additions, as well as cases where species have been subsumed and some that remain unresolved, are summarised below in the section 'Carnivore Families'.

CARNIVORE FAMILIES

Suborder FELIFORMIA, 7 families, 121 species

FAMILY FELIDAE CATS, 40 species

Size range Rusty-spotted Cat and Black-footed Cat (1–2.5kg) to Tiger (75–261kg)

The cat family arose approximately 30 million years ago in what is now Eurasia, and today occurs globally except in Antarctica and Australasia. A single subfamily, the Felinae, comprises all extant species (the famous sabretooth cats belong in a second, now extinct, subfamily, Machairodontinae). Some authorities group the genera *Panthera* and *Neofelis* into a separate subfamily, Pantherinae ('big cats'). Recent and comprehensive analyses based largely on genetics use the term 'lineages' to denote closely related groups of cats – effectively the same as 'subfamily' used for other carnivore families (highlighting some confusing subjectivity in naming conventions). For consistency, lineage is used here. The eight lineages within the Felidae are:

- *Felis* lineage, wildcats and allies (6 species).
- *Prionailurus* lineage, Pallas's Cat, leopard cats and allies (6 species).
- *Puma* lineage, Jaguarundi, Puma and Cheetah.
- *Lynx* lineage, lynxes and Bobcat (4 species).
- *Leopardus* lineage, Ocelot and allies (8 species).
- *Caracal* lineage, Caracal, African Golden Cat and Serval.
- *Pardofelis* lineage, Marbled Cat, Asian Golden Cat and Bay Cat.
- *Panthera* lineage, 'big cats' (7 species).

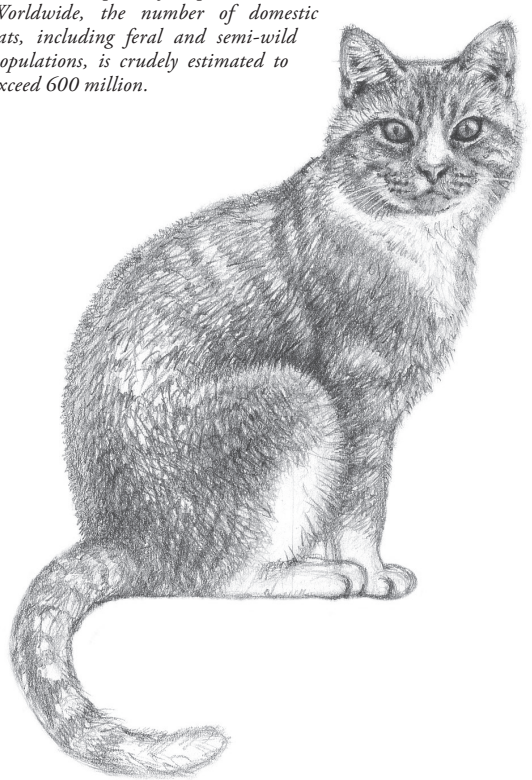
Forty wild cat species are currently recognised. Since this book's first edition, new analyses have resulted in the division of three species into six (wildcats, page XX; leopard cats page XX; tigrinas, page XX). There is preliminary genetic evidence that both the Marbled Cat (page XX) and Flat-headed Cat (page XX) may warrant being split into separate continental and Sunda species, as is the case for clouded leopards and leopard cats.

Cats are hypercarnivores that subsist almost entirely on animal prey, which is generally killed by a suffocating bite to the throat in the case of large prey, or by crushing the skull of small prey. Most

Domestic cat

The domestic cat, Felis silvestris catus*, descends from the wildcats (page XX), with which it is still able to interbreed. They are considered the same species, but some authorities argue that the genetic differences selected by human-mediated breeding warrant the domestic cat being considered a separate full species,* Felis catus.

Worldwide, the number of domestic cats, including feral and semi-wild populations, is crudely estimated to exceed 600 million.



cats are solitary, territorial and nocturno-crepuscular. The Lion (page xx) is the only cat that lives in large, permanent, complex social groups, although male Cheetahs (page xx) form small, enduring coalitions, and free-living domestic cats in colonies sometimes form small, stable social groups.

FAMILY HYAENIDAE HYAENAS, 4 species

Size range Aardwolf (7.7–14kg) to Spotted Hyaena (49–86kg)

The hyaena family arose at least 23 million years ago in Eurasia and reached an evolutionary peak 6–12 million years ago, when as many as twenty-four different species existed. Despite their dog-like appearance, hyaenas belong in the Feliformia and thus are more closely related to cats and their allies than to dogs. There are four extant species. All of them evolved in Africa, which remains the stronghold of modern hyaena distribution, with one species, the Striped Hyaena (page XX), also found in the Middle East through to India. The family is divided into two main subfamilies:

- Protelinae, a clade of relatively gracile, dog-like hyaenas with a single extant member, the Aardwolf, which diverged from the rest of the family around 10.6 million years ago.
- Hyaeninae, or bone-cracking hyaenas, a group that contains the other three modern species.

Hyaenas are hypercarnivores with a prodigious digestive ability that probably arose early in the family's evolution. In the Aardwolf (page xx), this capacity evolved to deal with noxious defensive terpenes secreted by termites, which are its primary prey. The bone-cracking hyaenas are capable of digesting all parts of animal prey except the hooves, the hair and the keratin sheaths of ungulate horns, and they tolerate the extremely high bacterial loads present in rotting carrion.

All hyaena species live in enduring social groups that take their simplest form in the Aardwolf's monogamous, cooperatively breeding pairs. Striped Hyaenas also live in monogamous pairs, but small groups comprising female and multiple males have recently been documented; the full range of their sociality is still poorly known. Brown Hyaenas (page xx) form small family groups that share a territory, but otherwise spend most of their time alone. The most complex social patterns are displayed by the Spotted Hyaena (page xx), which lives in large clans with a unique matrilineal social structure. Females are larger than, and dominant to, males, and usually live their entire lives in the same clan; female cubs inherit their mother's rank and outrank immigrant males, even adults. This is not known in any other carnivore, and in fact it most closely resembles the societies of primates such as baboons.

FAMILY HERPESTIDAE MONGOOSES, 34 species

Size range Common Dwarf Mongoose (210–340g) to White-tailed Mongoose (1.8–5.2kg)

Mongooses were formerly classified within the Viverridae, but are now recognised in their own family, the Herpestidae. Within the Feliformia, the family is most closely related to the Eupleridae (which emerged as an early Herpestidae offshoot) and the Hyaenidae. The mongoose family is subdivided into two large subfamilies:

- Herpestinae, solitary mongooses (23 species).
- Mungotinae, social mongooses (11 species).

This major division is thought to reflect a divergence early in mongoose evolution, in which the opening up of forested habitats favoured sociality in an ancestral group-living species that ultimately gave rise to the modern social species.

Mongooses occur in Africa, the Middle East and South Asia, with one species, the Egyptian Mongoose (page XX), present in Portugal and Spain. Members of this family are primarily carnivorous and eat mainly small vertebrates and invertebrates; fruit and vegetable matter is eaten to a limited degree by some species. Reflecting the subfamily classification, mongooses are either largely solitary (although some Herpestinae have semi-social tendencies, for example denning together) or live in complex social groups. Social patterns are best understood in dwarf mongooses (page xx), Banded Mongoose (page xx) and Meerkat (page xx); the rest of the Mungotinae are believed to be similarly social, although they are not nearly as well studied.

FAMILY EUPLERIDAE EUPLERIDS, 7 species

Size range Narrow-striped Boky (450–740g) to Fosa (6.2–8.6kg)

Members of the Eupleridae have historically been classified as cats, mongooses or civets, but it is now known that the family arose from a single mongoose-like ancestor that colonised Madagascar from mainland Africa an estimated 16.5–24 million years ago. Subsequent rapid adaptive radiation on Madagascar led to the seven living species, now grouped in two subfamilies:

- Euplerinae, 'civet-like' species; Fanaloka, Fosa and Falanouc.
- Galidiinae, 'mongoose-like' species; vontsiras and Boky (4 species).

Since this book's first edition, genetic analyses have led to the reclassification of two *Galidictis* species as a single species, the Broad-striped Vontsira. Similarly, there is now stronger evidence that two recently proposed species are invalid; the Western or Giant Falanouc (*Eupleres major*) is considered the same species as the Falanouc (page xx), and Durrell's Vontsira (*Salanoia durrelli*) is the same species as the Brown-tailed Vontsira (page xx).

Euplerids eat mostly animal prey; their feeding habits range from almost exclusive insectivory/vermivory in the Falanouc to the mammal-dominated diet of the Fosa (page xx). Most species are thought to be chiefly solitary, although both temporary and enduring sociality has been observed in five species. Most euplerids are poorly studied.

FAMILY PRIONODONTIDAE LINSANGS, 2 species

Size range Banded Linsang (590–800g) to Spotted Linsang (550g–1.2kg)

The Prionodontidae is an ancient carnivoran family originally classified among the Viverridae and once thought to be most closely related to African oyans (page XX; formerly also called linsangs), which are morphologically and ecologically very similar. In fact, recent molecular analysis reveals that linsangs represent an early sister group to the Felidae, with a shared common ancestor around 42 million years ago. Linsangs are only distantly related to oyans (family Viverridae), a remarkable case of evolutionary convergence.

Linsangs are restricted to Southeast Asia, where they inhabit evergreen and moist forested habitats. They are highly arboreal and hypercarnivorous nocturnal hunters of small prey. They are solitary, but little detail is known of their social and spatial organisation.

FAMILY VIVERRIDAE GENETS, OYANS AND CIVETS, 33 species

Size range Leighton's Oyan (500–700g) to Binturong (9–20kg)

The Viverridae is an ancient lineage of the Feliformia thought to have arisen at least 34 million years ago in Eurasia, followed by later colonisation of Africa. It is subdivided into four subfamilies:

- Viverinnae, large terrestrial civets (6 species).
- Genettinae, genets and oyans (16 species).
- Paradoxurinae, palm civets and Binturong (7 species).
- Hemigalinae, Otter Civet and allies (4 species).

The species limits within the Viverridae are mostly well defined, although the Critically Endangered Malabar Civet (page xx) is possibly the same species as the Large-spotted Civet (page xx), and the classification of genets is controversial, with as many as 17 species proposed in the genus *Genetta* (14 are recognised in this book).

Viverrids are restricted to Africa and South Asia; the Small-spotted Genet (page xx), also occurs in Europe, although this is possibly as a result of human introduction. They are largely solitary and nocturnal. Many species are semi-arboreal to highly arboreal and have protractile claws, as in felids. Viverrids are primarily carnivorous, with a diet dominated by small vertebrates and invertebrates, or, in the case of the Paradoxurinae, largely frugivorous.

FAMILY NANDINIIDAE AFRICAN PALM-CIVET, 1 species

Size African Palm-civet (1.2–3kg)

The African Palm-civet (page XX) is a primitive species retaining some unique ancestral features (mainly in the structure of the skull and carnassials) that no longer occur in any other modern carnivore. It was formerly classified in the Viverridae as an African member of the otherwise entirely Asian palm civet family Paradoxurinae, giving rise to its erroneous common name. Molecular data confirm that it represents an ancient sister species to all other feliform carnivores; it shared a common ancestor with all other Feliformia an estimated 36–54 million years ago.

Morphologically and ecologically, the African Palm-civet probably closely resembles the earliest feliform carnivores. Endemic to equatorial Africa, it inhabits forest and woodland savannahs. It is mainly frugivorous, and also takes vertebrate and invertebrate prey. It is arboreal, nocturnal and mainly solitary, with defined and defended territories.

Suborder CANIFORMIA, 9 families, 164 species (including pinnipeds, 36 species)

FAMILY CANIDAE DOGS, 35 species

Size range Fennec and Blanford's Fox (0.8–1.9kg) to Grey Wolf (18–79.4kg)

The Canidae is thought to be the most ancient living caniform family, whose origins began more than 40 million years ago in North America. This remained the centre of canid evolution until around 6 million years ago, when the formation of the Beringian land bridge connected Asia to North America, allowing canids to flood into Eurasia. Canids similarly colonised South America with the emergence of the Isthmus of Panama 3 million years ago. All modern canids are considered members of the subfamily Caninae (there are two extinct subfamilies), which is further divided into two distinct lineages that diverged 5–9 million years ago:

- Large wolf-like canids; wolves, jackals, the Coyote, Dhole and African Wild Dog (9 species).
- Small fox-like canids; all other species (26 species).

Canid species are largely well defined, although hybridisation between Grey Wolves (page xx) and Coyotes (page xx) in eastern North America has fuelled an ongoing debate about the number of species; these forms (including the Red Wolf, treated as a species in the first edition) are covered here in a special section on canid hybrids (page xx). Since this book's first edition, Golden Jackal (page XX) populations in Africa have been identified as a distinct species most closely related to the Grey Wolf and now reclassified as the African Wolf (page xx).

The Canidae is the most widespread family within the Carnivora, with at least one species found on every continent except Antarctica (colonisation of Australia by the Dingo was

Domestic dog
The domestic dog descends from the Grey Wolf, with which it is still able to interbreed, and is either regarded as the Grey Wolf subspecies Canis lupus familiaris *or as the parataxon* Canis familiaris *(meaning that while technically the same species as the Grey Wolf by phylogenetic criteria, it is sufficiently distinct to be recognised as though it is a separate species). The number of domestic dogs worldwide, including feral and stray populations, is crudely estimated at almost a billion.*

assisted by humans 3,500–4,000 years ago; page XX). It is also the most social family. All canids form enduring social relationships centred around a monogamous male–female pair that cooperates to raise pups; in some cases, yearling offspring remain with their parents to act as 'helpers' in raising subsequent litters. In most foxes and jackals, the mated pair remains the basic social unit, while it forms the nucleus for larger, more complicated social groups in many other canids such as Grey Wolves, African Wild Dogs (page xx) and Dholes (page xx). Within this range, canid sociality is extremely flexible, with some species shifting across a continuum from monogamous pairs to pack living, depending on the availability of resources. Canids are obligate carnivores that eat mainly animal prey; fruits and vegetables are additionally consumed by some species.

FAMILY URSIDAE BEARS, 8 species

Size range Sun Bear (25–80kg) to Polar Bear (150–800kg)

The bear family arose early in carnivoran evolution and, together with the Canidae, is thought to be one of the most ancient families within the Caniformia. The earliest putative species are approximately 33–37 million years old, although their similarity to early canids (with which bears share an ancient common ancestor) obscures precise dating of the family's origins. Today's eight species of bear are divided into the following three subfamilies:

- Ailuropodinae, Giant Panda.
- Tremarctinae, Andean Bear.
- Ursinae, 'typical bears'; all other species (6 species).

The Giant Panda and Andean Bear (page xx) are the most ancient and distinctive species. The inter-relationships of the other six species (the 'typical bears') are poorly understood, except it is clear that Polar Bears evolved recently and rapidly from a population of Brown Bears (page XX) isolated during the mid-Pleistocene, perhaps only 200,000 years ago.

Bears occur mainly in Eurasia and North America, with one species, the Andean Bear, found in northern South America. Most species are omnivorous, shifting their diet seasonally depending on food availability to focus on the energetically richest diet; the family's extremes are represented by the completely herbivorous Giant Panda, and the Polar Bear, which subsists largely on seals.

Bears are distinctive among carnivores in weathering severe winters by going into hibernation, essentially a strategy to survive the leanest period of the year. During hibernation, bears do not eat, drink, urinate or defecate, but they use as many as 4,000 calories daily by burning fat reserves. Hibernating American Black Bears (page xx) reduce oxygen consumption and metabolic rate by half, breathe only once every 45 seconds and reduce their heart rate to as low as eight beats per minute.

In concert with hibernation, breeding females undergo delayed implantation, or embryonic diapause, in which development of the embryo is postponed shortly after conception, which typically occurs in the northern spring–summer. This allows recently impregnated females to gain sufficient fat for winter hibernation without having to nourish developing embryos. It is also likely to reduce the period in which hibernating females nourish embryos, although birth still occurs about midway through the fast while in the den. Both of these features probably arose early in ursid evolution. All modern bears display some degree of delayed implantation, although only species (or populations) that experience harsh winters hibernate. Populations that enter hibernation undergo a period of hyperphagia before denning, in which individuals spend up to 20 hours each day foraging for high-quality food (especially hard mast) to lay down fat reserves.

Bears are largely cathemeral and solitary, and occupy stable ranges generally without strict territorial defence. The range size of the Polar Bear is the largest recorded among carnivores, and among the largest recorded in mammals.

FAMILY PROCYONIDAE RACCOONS, COATIS AND ALLIES, 13 species

Size range Ringtail (0.8–1.1kg) to Northern Raccoon (1.7–28kg)

The Procyonidae arose approximately 27–30 million years ago as an offshoot from the lineage that gave rise to the Mustelidae, hence these two families are considered the other's closest relative within the Caniformia. The earliest procyonids evolved in Europe, from which they colonised Asia and North America; the family died out in Eurasia and today occurs only in North and South America. Divisions within the family, including the exact number of species, remain controversial. The olingo genus *Bassaricyon* (page xx) was revised in 2013 to include four species, and the Mountain Coati (page xx) may prove to be two distinct species.

Procyonids are among the least carnivorous of carnivores, with most species having broadly omnivorous diets. The Northern Raccoon (page xx) is of the most omnivorous mammal species on Earth, while the Kinkajou (page xx) eats fruit almost exclusively. Procyonids are largely nocturnal, and vary between being solitary to highly social, and from being terrestrial to almost exclusively arboreal.

FAMILY AILURIDAE RED PANDA, 1 species

Size Red Panda (3–3.6kg)

The Red Panda (page xx) is the only member of a unique family, the Ailuridae, and has an uncertain phylogenetic position. It belongs in the Caniformia, where it is thought to be most closely related to procyonids, but there is also evidence for grouping it closely to mustelids, mephitids and ursids. It was formerly grouped with the Giant Panda in a separate family due mainly to a similar diet of bamboo and associated adaptations (the Red Panda was actually discovered and named first, making a misnomer of the Giant Panda's common name). Although this classification is no longer accepted and the Giant Panda is unequivocally a bear, the Red Panda's closest relatives remain uncertain.

Red Pandas are restricted to forests of southeast China and bordering countries. Their diet is almost exclusively bamboo. They are cathemeral and solitary, and occupy stable ranges.

FAMILY MEPHITIDAE SKUNKS AND STINK-BADGERS, 11 species

Size range Pygmy Spotted Skunk (130–230g) to Striped Skunk (0.6–5.5kg)

Skunks and stink-badgers were formerly classified in the mustelid family, but are now recognised in their own family as an early offshoot of a branch of carnivore evolution that also gave rise to the mustelids, procyonids and Red Panda. They are further subdivided into two subfamilies:

- Mephitinae, true skunks (9 species).
- Myadinae, stink-badgers (2 species).

Many skunk species are poorly defined, and genetic analysis is likely to identify more hidden species or subsume species, particularly among the spotted skunks (genus *Spilogale*). Since

this book's first edition, an analysis of the hog-nosed skunks (genus *Conepatus*) has combined Humboldt's Hog-nosed Skunk with Molina's Hog-nosed Skunk as a single species (page XX), and there is preliminary evidence that the Striped Hog-nosed Skunk (page XX) may comprise two species, in Meso-America and South America respectively.

True skunks are restricted to North and South America, and stink-badgers are endemic to insular Southeast Asia. All members of the family have enlarged muscular anal scent glands that spray potent fluid in self-defence, and all have associated black-and-white aposematic coloration. Mephitids are omnivorous, with invertebrates and small vertebrates dominating the diet. They are largely solitary with little evidence of territoriality; many species can reach high densities, congregate at food patches and have extensively overlapping ranges.

FAMILY MUSTELIDAE WEASELS, MARTENS, BADGERS AND OTTERS, 60–62 species

Size range Least Weasel (25–300g) to Sea Otter (14.5–45kg)

The Mustelidae is the largest family of the Carnivora, and arose in Eurasia at least 24 million years ago. Subdivision within this large family is complicated and undergoes regular revision as new molecular and fossil discoveries are made. Eight subfamilies are generally recognised, the composition of which has been better defined with new evidence since this book's first edition:

- Taxidiinae, American Badger.
- Mellivorinae, Honey Badger.
- Melinae, Eurasian and hog badgers (6 or 7 species).
- Guloninae, martens, Tayra, Fisher and Wolverine (11 species).
- Helictidinae, ferret badgers (4 or 5 species).
- Ictonychinae, grisons, zorillas and allies (7 species).
- Mustelinae, American Mink, true weasels and polecats (17 species).
- Lutrinae, otters (13 species)

The total number of species in Mustelidae is unresolved; however, evidence for at least five additional species has accumulated since 2011. The European Badger (page xx) is now considered to be three or possibly four discrete species based on new molecular data supporting earlier morphology-based divisions. Recent genetic analysis show that populations of the Siberian Weasel (page xx) in Japan actually comprise two distinct species, including the newly delineated Japanese Weasel (page XX). Similarly, populations of American Marten on the North American Pacific coast are now classed as a separate species, the Pacific Marten (page xx). There are others that await further study. Based on only two samples but including compelling genetic evidence, the very unusual Cuc Phuong Ferret Badger (page xx) has been described. Less convincing and lacking genetic analysis are the Egyptian Weasel (*Mustela subpalmata*), Sichuan Weasel (*M. russelliana*) and Tonkin Weasel (*M. tonkinensis*), which are treated in this book as populations of the Least Weasel (page XX).

From their Eurasian origins, mustelids underwent repeated colonisations into the Americas and Africa. Today, the family occurs globally, with species on every continent except Antarctica and Australasia (although Least Weasels and Stoats, page xx, have been introduced to New Zealand by humans). Most modern species are variations on the family's earliest evolutionary form, a solitary long-bodied terrestrial hunter of small mammals. However, as befits such a large and diverse family, mustelids have evolved to adopt a wide variety of lifestyles, from aquatic and social in the case of otters, to semi-arboreal in the martens.

In common with their close relatives, the Mephitidae, most mustelids have anal glands that produce strongly smelling secretions. These glands are best developed in the Striped Weasel (page XX), Libyan Weasel (page XX), Zorilla (page XX) and Marbled Polecat (page XX), which are able to spray secretions defensively.

The Mustelidae is remarkable for the prevalence of delayed implantation, in which development of the embryo in the womb is temporarily postponed, in some cases for as long as 11 months. This adaptation allows both mating and birth to occur during optimal summer–spring periods, when finding mates and raising young is most benign. Thus, a breeding female American Badger (page XX) typically conceives in the summer and gives birth the following spring. Approximately a third of mustelids are thought to display some degree of delayed implantation; this compares to less than 0.05 per cent of mammals overall (it is also prevalent among bears).

CONSERVATION OF CARNIVORES

Carnivores are rare. Their positions at the tops of intricate food pyramids dictate that they are naturally far less common than the species on which they prey. Every Tiger (page XX) needs to kill about fifty medium or large ungulates a year to survive. In naturally functioning ecosystems, this represents about 10 per cent of available prey; that is, a population of 500 prey animals is required to sustain a single Tiger for a year. Therefore, a tiny population of ten Tigers requires 5,000 prey animals (not accounting for the needs of coexisting carnivores such as Leopards, page XX, and Dholes); in turn, these require large expanses of habitat for their survival. The outcome of these calculations has been labelled the large carnivore problem: predators require large tracts of suitable habitat with abundant prey populations. The problem is most acute for top-level carnivores such as big cats, hyaenas, wolves, African Wild Dogs, bears, Fosas and Wolverines (page xx), but *natural* vulnerability to extinction is an inherent feature of the entire order Carnivora.

The primary threat to most carnivores is the combined loss of habitat and prey. More than two-thirds of Earth's terrestrial land area is now devoted to supporting humans, with the remaining natural habitat disappearing at an estimated rate of 1 per cent per year. Where people replace forests, woodlands and grasslands with cities, agriculture and livestock, most carnivores decline or disappear. Even maintaining habitat is valueless if there is no food for carnivores. Tracts of relatively intact but 'empty forest' across Asia, Latin America and central Africa are worthless to carnivores because people have hunted out their prey.

Compounding the relentless depletion of resources on which carnivores depend – *indirect* threats, in conservation nomenclature – are the reasons why humans kill them directly. People have hunted carnivores for millennia and for many reasons, but the two most critical modern motives contributing to carnivore declines are the killing of carnivores as a perceived or real threat to livestock (and, less so, human life), and the hunting of carnivores because their body parts are considered valuable. The former affects large carnivores wherever they encounter people and their herds; subsistence yak shepherds in Central Asia trap Snow Leopards (page xx) for essentially the same reasons that commercial cattle ranchers in the western United States clash with reintroduced Grey Wolves.

The killing of carnivores for their parts occurs globally, but is particularly problematic in Asia, where the consumption and use of wildlife for traditional medicine has a history of thousands of years. The primary threat to the Tiger today is intense poaching pressure to feed this trade, which is growing rapidly as a burgeoning Chinese middle class covets the parts of the species (and many others). Not surprisingly, these two drivers are often interleaved; Mongolian herders make extra money by selling the furs of sheep-killing Grey Wolves (or any they can shoot, for that matter), and the claws, fat and other sought-after parts of Lions poisoned by African pastoralists are often sold or traded.

Although not nearly as widespread, ancillary anthropogenic threats to carnivores can be very damaging to populations at a local level. Recreational hunting, whether by big-game hunters for trophies or by trappers for fur-bearing carnivores, can provoke declines where poorly regulated or in concert with other factors, for example natural fluctuations in prey numbers.

Infectious disease is a natural part of wildlife populations worldwide, but it can be particularly problematic to carnivores when introduced by humans and their domestic animals. Wild canids are especially vulnerable to rabies and canine distemper transmitted by domestic dogs, and outbreaks have devastated populations of Ethiopian Wolves (page xx) and African Wild Dogs. Similarly, recurrent outbreaks of plague are the primary factor impeding the recovery of endangered Black-footed Ferrets (page XX). Finally, hybridisation with domestic animals threatens some carnivores. The European Wildcat (page XX) and Dingo are unlikely to remain genetically distinct due to interbreeding with feral domestic cats and dogs, respectively.

Four modern carnivore species are extinct, all as a direct result of human impacts – primarily hunting for trade (the last record is given in parenthesis):

- Falkland Island Wolf *Dusicyon australis* (1876).
- Sea Mink *Neovison macrodon* (1894).
- Japanese Sea Lion *Zalophus japonicus* (1951).
- Caribbean Monk Seal *Monachus tropicalis* (1952).

Seventy-four[1] carnivores, including ten pinnipeds, are threatened with extinction according to the IUCN Red List (page 00). Three species – Malabar Civet (page XX), Pygmy Raccoon (page XX) and European Mink (page XX) – are Critically Endangered, with an extremely high risk of extinction in the wild. Twenty-eight species (including seven pinnipeds) are Endangered, with a very high risk of extinction. Forty-three species (including three pinnipeds) are Vulnerable, with a high risk of extinction.

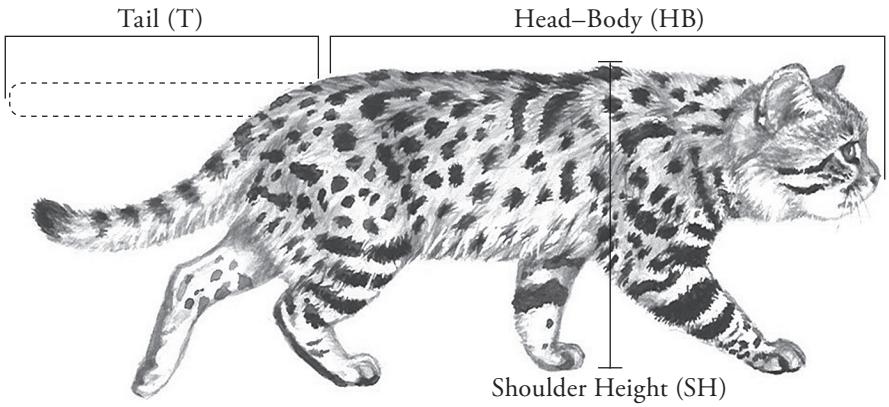
The persistence of most carnivores relies on large expanses of wilderness relatively free from human influences. Any meaningful effort to conserve carnivores must set aside vast protected areas and ensure that they are truly protected; this does not necessarily entail excluding people, but it does mean vigorously limiting their worst impacts, such as clearing habitat, hunting wildlife and introducing livestock and disease. Worldwide, there are hundreds of globally significant parks that protect carnivores. However, as human populations continue to grow, the pressure for their land and resources intensifies, while the opportunity for expanding or creating more protected areas dwindles. Accordingly, parks alone will not be sufficient to guarantee the survival of many carnivore species.

Equally as important, attention must be devoted to the human-modified landscapes that now dominate the globe and that, historically, have been omitted from conservation planning. Despite their demanding ecological requirements, many carnivores are able to survive in modified habitats – a habitat need not necessarily be pristine for carnivores to maintain a presence. Even those carnivores that are most difficult to conserve, such as wolves, bears and big cats, can inhabit landscapes where people and their livestock dominate, provided the reasons for intolerance and retaliatory killing are addressed. The key is fostering mechanisms for coexistence, typically through reducing the problems that carnivores create (e.g. by improving livestock husbandry to reduce its vulnerability to predators), or by making carnivores valuable to people who bear the burden of living with them (e.g. through tourism). Many communities that live with carnivores today are experimenting with a combination of both.

1 Excluding four taxa that are not considered species in this book, Red Wolf (*Canis 'rufus'*, CR, page XX), Western Falanouc (*Eupleres major*, EN, page XX), Grandidier's Vontsira (*Galidictis grandidieri*, EN, page XX) and Eastern Mountain Coati (*Nasuella meridensis*, EN, page XX).

Measurements

Animals are usually measured laid out on their side with the tail extended in a straight line behind the body. Values are provided for total head–body length (HB), tail length (T), shoulder height (SH) and weight (W). Where possible, measurements are given for both sexes, especially for species with marked sexual dimorphism.



STRUCTURE OF THE SPECIES ACCOUNTS

Every species account in the following section is written in a standardised format, starting with the most widely accepted common name, scientific name and other common names in usage. Standard measurements as explained opposite are provided under the names. The species is then introduced in a brief description, noting the main features useful for identification, including regional and seasonal variation. Key points on classification and phylogeny, especially recent changes, are also included here. Where other species are mentioned in the account, their common name is followed by a page reference to their own entry in the guide, or, if they do not appear elsewhere in the book, their scientific species name is given on pages XX–XX.

The accompanying plates depict every species, with a range of forms shown for more variable species. Variants are labelled where they represent discrete regional or morphological types, for example melanistic Jaguar (page xx) and the various forms of Arctic Fox (page xx). Labels do not appear where the depicted forms represent a sample of the variation present in a species regardless of geography, season or population, such as in the Bobcat (page xx), African Wild Dog and Sun Bear (page xx).

Distribution maps appear for every species using data provided by the IUCN Red List Unit (http://maps.iucnredlist.org). Red List mapping data are categorised according to the level of certainty: Extant, where presence is certain or very likely; Possibly Extant, where presence is expected but there are no recent data; and Possibly Extinct, where presence is unlikely but there are no recent data. Distribution maps in this book combine Extant and Possibly Extant categories (and thus show a somewhat optimistic scenario for many species).

The species accounts summarise current knowledge in four major categories as described below. Much of this information is lacking for many carnivores, illustrating the inequity between the few well-studied species and the many that are poorly studied or virtually unknown. Observations or features indicative of a specific region or population are noted with the site name in parenthesis; where multiple figures are available (e.g. for territory size), a range is provided from the typical habitats or conditions in which the species occurs, with preference given to the most recent data generated from modern scientific techniques. Certain site names are abbreviated, for example of protected area types: BR (biosphere reserve), CA (conservation area), GR (game reserve), HR (hunting reserve), NP (national park), NR (nature reserve), PA (protected area), TR (tiger reserve), WR (wildlife refuge or wildlife reserve) and WS (wildlife sanctuary). The four major categories of information in the species accounts are:

- **Feeding Ecology** Diet, including primary prey species, other food items, and whether humans, livestock or crops are eaten; hunting strategies and behaviour, including when foraging occurs and whether it is social or solitary; estimates of hunting success; other notable features of feeding ecology, including whether the species scavenges or caches food.
- **Social and Spatial Behaviour** Degree of sociality, monogamy and territoriality; features of dispersal behaviour; estimates of range size and population density (adults/km^2 except where stated otherwise).
- **Reproduction and Demography** Degree of seasonality; length of gestation; litter size; breeding patterns; inter-litter interval; development of young, including age of weaning and dispersal; age at sexual maturity or first breeding; mortality rates (for cubs and adults where known) and main natural causes of death; lifespan for wild individuals (where known) and/or in captivity.
- **Status and Threats** Summary of the species' status and the main threats, with CITES and IUCN Red List information (see below).

CITES

The Convention on International Trade in Endangered Species (CITES) is an agreement between governments (currently 183) to control international trade in wild animals and plants. It covers the importing and exporting of live wildlife and its parts, including furs, hunting trophies and souvenirs. The species covered by CITES are listed in three appendices, according to the degree of protection they need (see below). Carnivores not listed are not considered threatened, or international trade is not considered a possible threat: species lacking a CITES designation in this book have not been listed (but may be threatened by factors other than trade). CITES assessments are usually made for a species across its range, but locally endangered populations or subspecies are often listed separately. The three appendices are:

- Appendix I, covers species threatened with extinction. Trade in these species is legally permitted only in exceptional circumstances.
- Appendix II, covers species not necessarily threatened with extinction, but in which trade must be controlled in order to avoid utilisation that may threaten their survival.
- Appendix III, covers species that are protected in at least country, which has asked other CITES signatories for assistance in controlling trade. For more information, see www.cites.org.

IUCN RED LIST

The International Union for Conservation of Nature (IUCN) is the largest professional global conservation organisation. It produces the Red List of Threatened Species, a comprehensive and expert-driven process that assesses the status of wildlife species and classifies them according to the degree of threat and likelihood of extinction. Assessment is a complex process based on multiple criteria, including population size, number of subpopulations, number of breeding individuals, degree of various threats, and so on.

Each Red List category has a precise definition and criteria (for details, see www.iucnredlist.org). From most threatened to least threatened, the categories are: Extinct (EX), Extinct in the Wild (EW), Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT) and Least Concern (LC). CR, EN and VU categories apply to species that are threatened with extinction, to differing degrees; popular usage of the term 'endangered' actually applies to the species in these three categories. Where the data are not available for a full assessment, species are classified as Data Deficient (DD), which does not mean they are *not* threatened. Those species not yet assessed by the Red List are Not Evaluated (NE). Red List assessments are usually made at the species level, but populations or subspecies that are more endangered are often evaluated separately. The Red List additionally provides an estimate of population trend – categorised as Decreasing, Stable, Increasing or Unknown– which is also included here. Note that population trend applies to the species overall; the trend for individual populations, regions or subspecies is not estimated in most cases, and can differ significantly from the global trend.