Food & Feeding

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The Herpestidae may be a family within the mammalian Order Carnivora, but diet within the family, and even within species can be variable. Invertebrate, vertebrate, and to a limited extent plant material are all consumed to varying degrees.

As active predators of invertebrates or vertebrates, mongooses have to use their senses to locate and capture prey. Sight, hearing and smell are probably all used but the relative importance of the senses in foraging likely differs dependent upon the habitat, food type and activity period, especially diurnal versus nocturnal. The Herpestidae are generally considered to have a good sense of sight, hearing and smell. However, little is known of Herpestid morphology and physiology with regard to these sensory modalities.

There is some information on eye structure and mongoose visual acuity. The small Indian mongoose (*Herpestes auropunctatus*) has a relatively small cornea, nonspherical lens, and retina with high cone to rod proportion (25-40% of photoreceptors are cones, comparable to diurnal primates). These are all characteristics of

a diurnal-adapted eye, matching the species lifestyle. Their eye also possesses a high accommodative ability, which is probably beneficial in tracking fast moving prey in a congested habitat.

Colour vision has been demonstrated in at least one diurnal mongoose species, the Indian grey mongoose (*Herpestes edwardsi*). Under laboratory conditions, this species can differentiate various colours (red, yellow, green, blue, orange and violet) from any shade of grey, displaying a clear and definite discrimination superior to a variety of mustelids and other viverrids. Its retina possesses a central area composed almost entirely of cones that is likely involved its high colour definition. A similar area has been described for the Egyptian mongoose (*Herpestes ichneumon*), and may well be present in all the diurnal mongooses.

Anecdotal observations on other diurnal species, the suricate (*Suricata suricatta*) and dwarf mongoose (*Helogale parvula*), indicate an ability to detect and differentiate between raptor species that are kilometres away, often before a human observer can even identify their presence. Therefore, from the information available, the diurnal Herpestids at least appear to possess an acute visual sense which may be used in the detection of food. Whilst information is lacking on the eyesight of nocturnal species, the observation of eyeshine in some nocturnal species, notably the white-tailed mongoose and water mongoose (*Atilax paludinosus*) indicate the presences of a tapetum lucidum, a reflective layer outside the retina which reflects back

unabsorbed light, a structure usually associated with nocturnal vision. Unfortunately, there is little structural or functional data available on the auditory or olfactory senses of mongooses, but the latter would appear to be well-developed in view of the wide use of olfactory communication within the family.

The skull structure and dentition of mongooses reflects their principal diet of insects and small mammals. Species with a more carnivorous (vertebrate-based) diet tend to have a more robust skull structure, reflecting the greater force required to kill and process vertebrate prey. More insectivorous species tend to have a lighter, lower skull structure. The dental formula for the family is I 3/3, C 1/1, PM 3–4/3–4, M 2/2 = 36–40. In many species the structure of the premolars, molars and carnassials is adapted to crushing rather than slicing (their primary role in the more carnivorous felids and canids). However, the carnassial shear is well developed in the more carnivorous species. In the water mongoose, which specialises in crushing crustaceans, the teeth, especially the posterior premolars, are particularly robust. In contrast, in the Liberian mongoose, which is thought to specialise on eating earthworms, the teeth are said to be relatively small and the jaw structure weak. Herpestid canines are relatively long and strong and recurved as is characteristic of carnivores. The canines are generally larger and stronger in more carnivorous species, and are important in delivering the killing bite.

The killing bite in the mongooses tends to be oriented to the skull of vertebrates, and this likely limits the relative size of

vertebrates that they can tackle. A skull-orientated killing bite has been recorded in the dwarf mongoose, slender mongoose (*Galerella sanguinea*), common cusimanse (*Crossarchus obscurus*), small Indian mongoose, Cape grey mongoose (*Galerella pulverulenta*), and suricate, and is likely typical of all mongoose species. Accounts of the Egyptian mongoose, slender mongoose, and water mongoose suggest that a neck bite may be used on larger prey. Mongooses also tend to kill and eat invertebrates from the anterior, head region. In contrast, the killing bite of felids and mustelids tends to be oriented to the throat or neck of vertebrate prey and this enables them to take down prey that are relatively large compared to their own body size. By nature of their small body size (ranging from the 200g dwarf mongoose to the 5kg white-tailed mongoose) and inability to take relatively large prey, the animal components of mongoose diet are restricted to invertebrates and small vertebrates (principally rodents, small lizards, frogs and toads). The non-retractable claws of Herpestids are not sharp for prey capture like felid claws, but are generally robust for digging.

The ancestral mongoose is proposed to have been a vertebrate-feeder. Of the 34 members of the family, only four are confirmed to feed principally on vertebrates (Cape grey mongoose, Egyptian mongoose, Jackson's mongoose (*Bdeogale jacksoni*), stripe-necked mongoose (*Herpestes vitticollis*), three appear likely to be principally vertebrate feeders (Indian grey mongoose, Javan mongoose (*Herpestes javanicus*), Ruddy mongoose (*Herpestes smithii*), seventeen species are primarily invertebrate feeders

(dwarf mongoose, water mongoose, bushy-tailed mongoose (*Bdeogale crassicauda*), black-legged mongoose (*Bdeogale nigripes*), Alexander's cusimanse (*Crossarchus alexandri*), Ansorge's cusimanse (*Crossarchus ansorgei*), common cusimanse, flat-headed cusimanse (*Crossarchus platycephalus*), yellow mongoose (*Cynictis penicillata*), white-tailed mongoose (*Ichneumia albicauda*), Liberian mongoose (*Liberiictis kuhni*), banded mongoose (*Mungos mungo*), Gambian mongoose (*Mungos gambianus*), Selous' mongoose (*Paracynictis selousi*), Meller's mongoose (*Rhynchogale melleri*), suricate, long-nosed mongoose (*Xenogale naso*), with principal dietary component unclear or variable in nine species (slender mongoose, Kaokoland slender mongoose (Galerella flavescens), small Indian mongoose, short-tailed mongoose (*Herpestes brachyurus*), crab-eating mongoose (*Herpestes urva*), Somali mongoose (*Helogale hirtula*), Pousargues' mongoose (*Dologale dybowskii*), brown mongoose (*Herpestes fuscus*), collared mongoose (*Herpestes semitorquatus*). Dietary composition differs between species, with mongoose scats or stomachs recorded to contain mammal, bird, reptile, amphibian, fish, crustacean, mollusc, insect, spider, scorpion, myriapod, isopod, millipede, fruit, and seed.

However, within a species, individuals have the ability to adjust their diet to available food, dependent upon habitat and season. A study of Egyptian mongoose scats in Spain, found this species to be an opportunistic predator, consuming the most abundant prey available in each area and season. Similarly, the diet of the yellow mongoose has been shown to differ between arid and

coastal regions within South Africa, with a much greater occurrence of rodents at the coastal site. The diversity of diets amongst the different populations of the small Indian mongoose, which has been introduced to numerous island and mainland locations, further demonstrates the dietary flexibility within a mongoose species. The diet varies from principally insects in the Rajasthan desert, St. Croix island, and Puerto Rico, to vertebrates on Mauritius, to mainly plant material (fruits) on Korcula Island, Croatia. On Viti Levu, Fiji, alone, the diet varies between habitats, from principally crabs in mangrove forests, rats in cane-fields, to cockroaches in urban areas.

Major seasonal changes in diet are recorded for some species. The white-tailed mongoose diet switches from termites and ants in the dry season to dung beetles in the wet season. Scats of yellow mongoose in a coastal area of South Africa were found to lack reptiles from July to September (otherwise present), with almost no rodent prey during the same period (otherwise present), and to lack birds from March to June (otherwise present), becoming almost exclusively insectivorous from July to September. In addition, the proportional contribution of different insect orders varied seasonally. In contrast there was no apparent seasonal effect on dietary composition in an arid area. The crab-eating mongoose diet similarly varies seasonally, dominated by insects in summer and autumn, crustaceans in winter, and reptiles in late spring and early summer. In the slender mongoose, diet shifts from principally insects (May-September) to small vertebrates (October-April). It is also fair to

say that prey availability affects the timing and success of reproduction. In most species, birth of young is timed to coincide with the rainy season, which is likely to support high prey density. For example in the dwarf mongoose, lactation is timed to coincide with the months of highest invertebrate density.

Habitat and diet are understandably correlated, although whether diet determines habitat or habitat determines diet is unclear. In the most riparian mongoose species, the water mongoose, the major components of the diet are crustacea (e.g. crabs) and amphibians, but in drier areas (or during drier spells) they switch to more terrestrial prey. Water mongoose diet also differs between coastal and inland areas, feeding principally on amphipods and shore crabs at a coastal site, and on frogs, rodents, birds, crabs or fish at inland river sites. A comparison of diet and habitat type of two similarly sized sympatric Herpestids in a coastal area of South Africa found diet and habitat use to be correlated. The mainly insectivorous yellow mongoose almost exclusively (99% of fixes) used the open short-grass plains, where invertebrate prey was found at a higher density than in the bush habitat. The mainly carnivorous Cape grey mongoose was exclusively found in bush habitat, where its small rodent prey were more abundant than in the short-grass habitat. In contrast, a study of scats of two sympatric, open-terrain, social, insectivorous mongoose species, the dwarf and banded mongoose, in South Africa, found substantial dietary overlap (72-82% of prey categories), although the latter have a greater frequency of myriapods. How these species coexist whilst

utilising coincident food resources is unclear, and a similar question arises when considering the sympatry of the dwarf mongoose and the more closely related Somali dwarf mongoose, although little is known of the diet of the latter. Diet and prey density may also be expected to affect home range size. However, in this respect, comparison of the mainly insectivorous yellow mongoose, and mainly carnivorous Cape grey mongoose found no significant difference in home range size or population density.

Food also has implications for home range use. Mongooses rarely forage in the same area on consecutive days, as noted for example in the dwarf mongoose, Liberian mongoose, common cusimanse, Egyptian mongoose, and water mongoose, and this is likely to minimise prey disturbance and depletion. Temporary avoidance of foraging in an area gives the prey density the opportunity to recover, making it productive when next visited. Home range size or movements within home range may also be reduced upon concentrated availability of food. Individuals have been known to localise their movements, and even abandon territoriality to utilise temporarily bonanza-like resources. Three slender mongooses have been observed feeding together on fly larvae below a giraffe carcass for a number of days. Up to seven Kaokoland slender mongoose have been observed feeding upon adult, larval, and pupal sarcophagid flies on a greater kudu (*Tragelaphus strepsiceros*) carcass, with a radio collared male reducing home range use by 66% to concentrate its space use and activity on the carcass. Similar effects are recorded for more

permanent supplemental food sources. Egyptian mongoose with access to a garbage dump in Israel formed a social group, in contrast to other observations on the species. Banded mongooses in Uganda with access to garbage localise home range use on the garbage dumps.

As diet varies within the Herpestidae, so do foraging methods. Almost all mongooses are terrestrial surface or subsurface foragers. They are active foragers, and rarely will a mongoose sit and wait for prey. Generally they move in an exploratory manner with attention oriented towards the ground. The more carnivorous members of the family, e.g. the Egyptian and slender mongoose will trot along and opportunistically pounce upon or chase small vertebrate or invertebrate prey that are disturbed. Others like the nocturnal white-tailed mongoose stop frequently as they trot to pick invertebrates off vegetation or out of dung. The social insectivorous mongooses forage spread out as a loose group, each individual independently scratching at the surface in the search for prey and periodically stopping to dig below the surface. The cusimanses are said to root around in the litter of the forest floor using their elongate snouts. The water mongoose tends to forage in mud or shallow water and uses its dexterous forefeet to root around for prey.

The Herpestids have a characteristic mode of dealing with hard prey items. First described in the banded mongoose, whereby an individual picked up and clasped a pill millipede (*Sphaerotherium* sp.) in its forepaws, oriented itself so that its rear was facing a

rock or other hard object, and threw the millipede between its rear limbs onto the hard surface, cracking or smashing the prey and making it more accessible. This method of cracking hard prey items has similarly been described in the common cusimanse, slender mongoose, Egyptian mongoose, white-tailed mongoose, dwarf mongoose, Cape grey mongoose and crab-eating mongoose, and is likely characteristic of the family (although not observed in the suricate). Observations on water mongoose suggests that this species throws hard objects downwards to the ground from a vertical standing position rather than horizontally through the hind legs, and the crab-eating mongoose has also been observed to use this method. These methods are used for a variety of hard prey items, including dung beetles, bird's eggs, crabs and molluscs.

The mongooses are perhaps most famed for the ability of the Indian mongooses (*Herpestes auropunctatus*, *javanicus*, and *edwardsi*) to kill snakes, immortalised in traditional fables. However, the frequency of snake remains in the scats or stomach of mongooses is rare. At least some mongoose species are resistant to snake neurotoxins e.g. Egyptian mongoose, but the agility and cunning of the mongoose is said to be instrumental in their ability to avoid being bitten and overcome the snake. Other dangerous or toxic prey types eaten by mongooses include scorpions, and Myriapods (centipedes and millipedes). Scorpions, some of which have neurotoxic stings, are known to be consumed by suricates, Selous's mongoose, water mongoose, white-tailed mongoose, banded mongoose, long-nosed mongoose, small Indian

mongoose, Indian grey mongoose, and bushy-tailed mongoose. Within the Myriapoda, some centipedes (Chilopoda) have poisonous bites, and millipedes (Diplopoda) generally exude a toxic substance to deter predators. Nevertheless, Myriapods feature in the diet of common cusimanse, crab-eating mongoose, water mongoose, white-tailed mongoose, dwarf mongoose, banded mongoose, suricate, Meller's mongoose, Selous's mongoose, small Indian mongoose, long-nosed mongoose, Jackson's mongoose, bushy-tailed mongoose, crab eating mongoose, and Indian grey mongoose. The small Indian mongoose has also been observed eating toads, including the toxic parotid glands.

The proportional representation of vertebrate to invertebrate prey has implications for sociality in the mongooses. As vertebrate prey is relatively low density, mobile, sensitive to disturbance, and slow to renew, such a prey type does not facilitate foraging groups. In contrast, invertebrate prey tends to be relatively high density, immobile, robust to disturbance, and rapid renewing, and therefore does facilitate group foraging. Data suggests that whilst small vertebrate renewal rates are likely to be in the order of 0.07 per 24 hours, the renewal rate for invertebrates is an order of magnitude higher, approximately 0.7. The group-living social mongooses all exhibit a principally insectivorous diet. That is not to say that an insectivorous diet promotes sociality (there are numerous asocial insectivorous mongoose species), but that it allows it where other factors,

principally predation pressure, provide a selective pressure for grouping.

Whilst group cooperative hunting occurs in some of the social canids (wolves, coyote, wild hunting dog, Indian hunting dog) and the only social felid (the lion), enabling larger prey to be taken, cooperative hunting does not occur in the social mongooses. A possible exception may be the occasional observation of excavation of rabbit (*Oryctolagus cuniculus*) breeding dens by two or three Egyptian mongooses in Spain. However, it is unclear whether prey capture in these cases was coordinated, and rabbits form the basis of the diet in Spain in any case. In addition, there is an observation of two small Indian mongooses hunting crabs (*Metapograpsus messor*) together, with one turning over stones and the other attacking the crab. Even in the social mongooses, the dwarf mongoose, suricate, and banded mongoose, that engage in cooperative vigilance and rearing of young, and where individuals forage together in a group, there is no record of cooperative prey capture or of a group bringing down large prey. These species are principally insectivorous and their cooperative nature generally does not extend to sharing food, individuals responding aggressively to approach by others when feeding or actively digging a foraging hole.

Occasional exception to selfish defence of food may occur in the Egyptian mongoose in sharing rabbit prey, but more regular is the sharing of food with young pups in all species. Post-weaning, the young must be provisioned with food items and in the majority of

species this is by the mother, but in social species, males and females, breeders and non-breeders can all provision pups with food items. Gradually the pups will be fed less as they gain the skills required to forage independently. Time taken to reach foraging independence is variable, but usually occurs from between three months (suricate and banded mongoose) up to a year (the Egyptian mongoose).

Diet may also be predicted to affect foraging time and distance. A comparison of daily distance covered and distance covered per hour of two similarly sized sympatric Herpestids, the mainly insectivorous yellow mongoose, and mainly carnivorous Cape grey mongoose found no significant difference. Dwarf mongoose groups forage for on average 5 hours per day. Suricates spend 5 to 8 hours per day foraging. In these species, individuals that are well fed make higher contributions to group activities (digging, vigilance, babysitting, and provisioning). In the social mongooses, the group tends to leave babysitters with the young whilst the group forages. However, rarely do suckling females babysit as they need to forage in order to fulfil the heavy energetic demands of lactation.

Scavenging is not uncommon in the Herpestidae. Kaokoland slender mongoose have been recorded feeding upon a greater kudu carcass (*Tragelaphus strepsiceros*). The stripe-necked mongoose has been observed scavenging on sambar (*Cervus unicolour*) and black-naped hare (*Lepus nigricollis*). The Indian grey mongoose has also been observed feeding on carrion. The

occurrence of large mammal material within scats and stomachs of some species also suggests scavenging. For example, analysis of rainforest scats from the long-nosed mongoose and water mongoose found ungulate remains; blue duiker (*Cephalopus monticola*) in the former, water chevrotain (*Hyemoschus aquaticus*) in the latter. The long-nosed mongoose scats also contained porcupine, similarly recorded for the Cape grey mongoose. Mongooses are unlikely to be able to actively predate upon such relatively large mammals.

In addition, numerous species readily utilise human garbage, including white-tailed mongoose, yellow mongoose, small Indian mongoose, Cape grey mongoose, Egyptian mongoose, Kaokoland slender mongoose, and banded mongoose. In the banded mongoose, whilst access to supplemental food at garbage dumps can improve body condition, it can also lead to increased interaction with potential predators. In the case of the black mongoose, access to supplemental food likely lead to a dassie-rat (*Petromus typicus*) population crash due to the increased mongoose population.

Occasionally mongooses make use of domestic livestock, and this can bring them into conflict with humans. Small Indian mongoose and water mongoose have been observed to take fowl. Small Indian mongooses were introduced by humans to various islands to control rats. However, their success has been limited, and in many cases they have taken to eating invertebrates, lizards, domestic poultry, and are implicated in the decline of

endangered species. In particular, the small Indian mongoose occurs alongside the critically endangered Puerto Rican parrot (*Amazona vittata*), with direct knowledge of predation of six fledglings in the Caribbean National Forest, housing the only wild population of these parrots.

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