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Egbert Stolk *Editors*

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Chapter 8
Physical, Behavioral and Spatiotemporal Perspectives of Home in Humans and Other Animals

Efrat Blumenfeld-Lieberthal and David Eilam

Abstract Home is usually considered as a physical construct of residence. In both humans and non-humans it has a functional partitioning into room for living, storage, toilets and other defined activities or services. Home is first and foremost where a set of behaviors are performed at rates higher than anywhere else; in rats, home is defined by sleeping, long stays, food hoarding and parental behavior. Another conspicuous feature of home is identity, which is constituted by the collection of inanimate objects, furnishings and gadgets that personalize each individual's home. Security is another aspect: home is where you feel safe, and your privacy is protected. Moreover, home behavior is a strong trait that it is manifested even when a physical home is lacking, such as in the case of homeless humans and other animals. Finally, spatiotemporal behavior in the living environment is organized in relation to the home. Indeed, home is a hub for activity, with both humans and non-humans taking trips out from and back to their home, traveling regularly along the same paths and usually stopping at the same locations along them. While there are obvious differences between humans and animals, there are many similarities, and by focusing on the latter, it is suggested that similar biobehavioral systems in humans and non-humans account for the convergence of home behavior to these similar traits.

8.1 Prolog: Home, Home Behavior and Home as an Anchor for Spatial Behavior

On the morning of September 17, 1832, while visiting the Galapagos archipelago, Charles Darwin watched the local giant tortoises (*Testudo nigra*) in fascination, and wrote: "When I landed at Chatham Island, I could not imagine what animal traveled

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so methodically along well-chosen tracks. Near the springs it was a curious spectacle to behold many of these huge creatures, one set eagerly travelling onwards with outstretched necks, and another set returning, after having drunk their fill" (Chatfield 1987). Darwin also described the regular trips taken by these turtles, which could extend over several miles and last several days, evidence of their large familiar living environment. The turtles also displayed a coupling between specific behaviors and locations, as, for example, they did upon reaching the target of their journey: "When the tortoise arrives at the spring, quite regardless of any spectator, he buries his head in the water above his eyes, and greedily swallows great mouthfuls, at the rate of about ten in a minute" (Chatfield 1987). A century later, Konrad Lorenz, pioneer of the study of animal behavior and Nobel Prize laureate, described an analogous tendency of animals to travel along fixed routes and display regular behaviors in specific locations. Lorenz described the water shrew as a creature of habits: "Once the shrew is well settled in its path-habits, it is strictly bound to them as a railway engine to its tracks… Alteration in the habitual path threw the shrews into complete confusion." He observed that a shrew used to jumping above a stone on its familiar path continued to jump in that location after the stone had been removed, time and again, as if disbelieving its senses' report of a change in its habitual environment, and necessitating a consequent alteration of the habitual behavior (Lorenz 1952, pp. 127–8). Lorenz, with a touch of anthropomorphism, described the same tendency of habitual spatiotemporal traveling in his own behavior: "When driving a car in Vienna I regularly used two different routes when approaching and when leaving a certain place in the city… rebelling against the creature of habit in myself, I tried using my customary return route for the outward journey and vice versa… the astonishing result was an undeniable feeling of anxiety, so unpleasant that when I came to return I reverted to the habitual route" (Lorenz 1974). Indeed, traveling methodically along specific routes in a specific territory and regularly displaying specific behavior in specific locations reflects spatial behavior in humans and other animals. Inspired by Darwin's observations, Hediger (1964) described habitual spatiotemporal behavior in the framework of animal territory (Fig. 8.1). The diagram shows that territory is perceived as a set of locations, in each of which the animal demonstrates a specific behavior. These locations are interconnected by a set of regular paths, which together form a map-like layout of the living range. The hub for the activity in this territory is the 'home'—defined here as the location with the highest connectivity to other locations. Home (or the home base) is also a hub of spatiotemporal behavior in humans, with over 50 percent of their daily trips being home-base generated (Golledge 1999b, p. 26). Indeed, for both humans and non-human species home is the dominant anchor point for spatial behavior in the territories over which they range. Accordingly, both humans and non-humans need to determine a home location, memorize its position and locate landmarks or other spatial information in relation to it in order to be able to end a journey away from it and return directly to the home (Golledge 1999a). While it is possible to define home as a place featuring exclusive

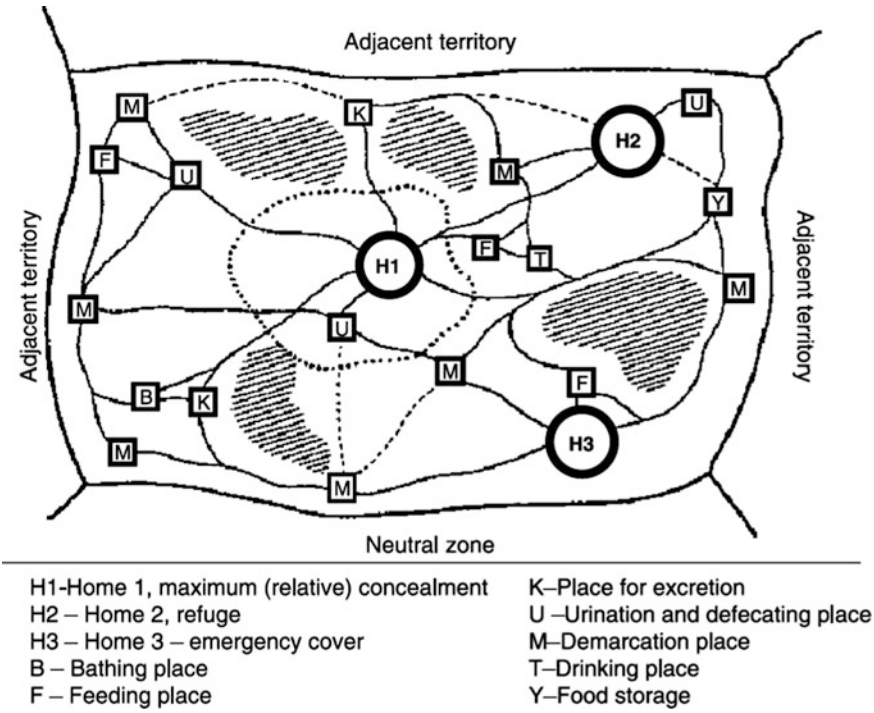

Fig. 8.1 The structure of territory, (after Hediger 1964; with permission of Dover Publications). The territory comprises main, secondary, and emergency home locations (*H1*, *H2*, and *H3*). These homes and another set of locations, each with a typical behavior (marked by *squares* and explained in the legend), are connected by a network of routes (marked by *lines*)

behaviors that are rarely performed elsewhere, the impact of home on spatial behavior extends beyond its physical limits; home impacts the organization of spatial behavior throughout the living range.

The scope of the present survey relates to home and home-related behavior in humans and other animals. Specifically, we first explore home as an abstract term, then as a physical construct. We next discuss home-related behaviors, suggesting that home is predominantly a behavior and state of mind. We also describe how spatial behavior throughout the living range is organized in relation to home, thereby extending the impact of home beyond its physical limits. Finally, we discuss how home behavior is manifested even when a physical construct of home is lacking, as in the case of homeless humans and other animals.

8.2 "There Is No Place Like Home"—Home as a Physical Construct on Different Perception Scales

For humans, the word *home* can relate to different terms on different scales. On the individual scale, a home may refer to one's residential arrangement: a house, a housing project, even an outdoor location in the case of a homeless person. On a larger scale, home can be a town, hometown, a country or a homeland. On a universal scale, Earth is home for astronauts—and for us all. Indeed, when in space, astronauts spend much of their time earth-gazing: "We have this connection with Earth, I mean it's our home," mused Nicole Stott, Shuttle ISS astronaut. She also described a great sense of responsibility and a need to take care of Earth, our home, after contemplating a cosmic view of it from space. This astronaut's reaction seems similar to the sense of ownership, responsibility, identity and security that one can feel for one's home, hometown and homeland, but astronauts project this sense upon Earth.

From a very narrow perspective, 'home' is a spatial construct for both humans and other animals, and as such it is usually described only according to its physical properties, such as structure, location and size. In humans, home spatial partitioning is basically functional: living room, parents' room, kids' rooms, kitchen, bathroom, storage, etc.; whereas for many animal species, 'home' is usually regarded simply as a den, nest, burrow, or other type of sheltered location. A more detailed examination, however, reveals similarities between the functional partitioning in humans and non-humans. For example, rats introduced into live in a large room gradually organized the space into nesting sites, food stores, runways, and latrines (Leonard and McNaughton 1990). Similarly, rodents kept in small standard rodent cages (40 × 25 × 20 cm) nest in one corner, store food in another corner, and use another corner as latrine. The functional partitioning of home has been noted also in the wild, as illustrated in den structure in various species. For many species, the den is a simple straight burrow cambered at the end. For example, a female polar bear (*Ursus maritimus*) in winter time digs in the snow a 600 cm-long den comprising a single entrance/egress tunnel ending in a 148 × 127 × 79 cm oval chamber ("living room") and a few ventilation holes. The chamber usually includes a nest-like depression, where the mother and cubs spend most of their time. This basic structure, however, greatly varies among individuals, with some dens having two chambers, others having two openings, and yet others possessing multiple chambers and additional tunnels (Durner et al. 2003; Fig. 8.2).

The long-eared hedgehog (*Hemiechinus auritus*) also dwells in a simple burrow which becomes larger at the end. In the breeding season the mother adds another chamber for her newborn pups while she inhabits the other chamber (Mendelssohn and Yom-Tov 1999). A similar simple burrow can also be found in invertebrates (Christy 1982). The blind mole rat (*Spalax ehrenbergi*), a solitary rodent, lives in a subterranian burrow system (Fig. 8.3). Above ground, this burrow system can be recognized through the series of *equispaced* soil mounds that the mole rat excavates to the surface while digging. The mole rat lives its entire life inside the burrow

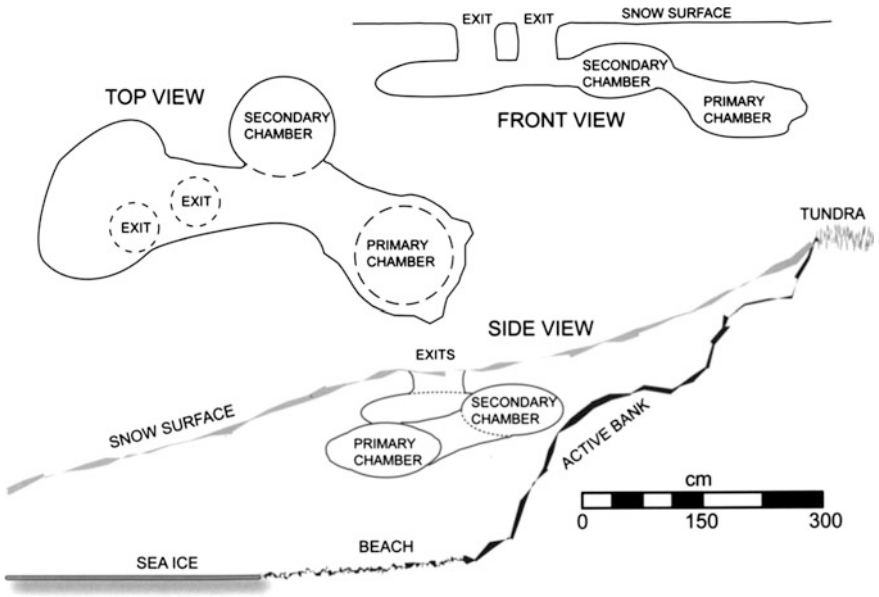

Fig. 8.2 Diagrams of a polar bear maternal den near Prudhoe Bay, Alaska, 10 April 2000. After Durner et al. (2003) (with permission of the authors and the Arctic Institute of North America)

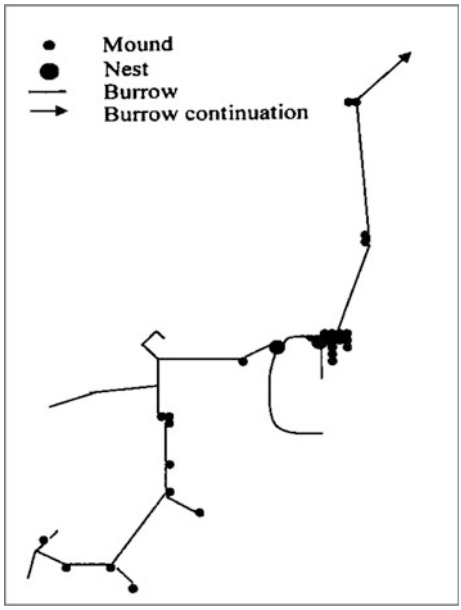

Fig. 8.3 The burrow system of a mole rat. The location of above-ground mounds is depicted by *small circles*, and the two nest locations by *large circles* (based on Erez 2005)

without ever emerging above ground, and accordingly, the burrow system incorporates nest, several storage chambers, and latrines. During the breeding season the female expands the nest, which can be recognized through the nearby larger excavated soil mound (Erez 2005; Zuri and Terkel 1996). Finally, social animals may construct a structured communal home with apparent functional partitions and labor division (Turner, this volume). Fat sand rats (*Psammomys obesus*) construct a multi-level burrow system with numerous compartments for harvesting food, latrines, nesting chambers, etc. (Mendelssohn and Yom-Tov 1999). Social voles (*Microtus socialis*) live in extended families of parents and several successive generations of offspring. Several families inhabit together a large complex network of burrows with several openings to the outside, and numerous chambers into which they hoard grains and vegetation (Cohen-Shlagman 1981). Rabbits (*Oryctolagus cuniculus*) too dwell in burrow systems, which despite their complex appearance, always follow three rules: (i) size; (ii) negative correlation between the number of holes and depth; and (iii) negative correlation between the number of junctions and length of burrow sections (Kolb 1985). Thus, despite the variation found among species and among individuals of the same species, there is a basic general plan of a 'den' and it is always used as a place for rest, shelter from predation and/or weather, and in which to rear offspring. Rather than a den, some animals establish their home inside a bush, under a rock, in a crack or cave, in a hollow or cavern, etc. Likewise, a variety of dwelling constructs can be found in humans too: house, apartment, building, mobile home, houseboat, yurt, communal town, village, suburb, city, county, etc. The resemblance of 'home' as a physical construct between humans and other animals becomes more apparent when a 'home' is considered as a state of mind and as the organizer of behavior in time and space.

8.3 "Home Is Where the Heart Is"—Meaning, Emotion and Behavioral Perspectives of Home

Home has been described above as a physical construct for dwelling. In addition, and perhaps foremost, it also involves 'home behavior'—a set of typical activities and emotional states that are firmly coupled with the physical location, expanding the meaning of home to the behavioral-emotional domain. Home behaviors are usually derivate of its role as a hideout, and a place for both resting and nursing. Indeed, behaviors such as sleeping and crouching, long stays, food hoarding and parenting are performed at home at rates higher than anywhere else. Home is a place of comfort. We say that someone feels at home when an individual is relaxed, free and confident. We encourage someone to make themselves at home, or declare that "our home is your home"—phrases that explicitly attest that home is not just a physical place but also a state of mind, with characteristic home behavior. Certainly, home is the place where one can be more oneself than anywhere else (Burnard 1999).

Generally speaking it can be argued that, for humans, home has social and physical characteristics that influence the behavior within it and in relation to it (Lang 2007). The rituals involved in entering the home of another (knocking or ringing the bell) have been compared with the recognition ceremonies of nesting birds (Guhl 1965). Porteous posited three essential territorial perspectives of home (1976): identity, security and stimulation. Identity is reflected in the personalization of the home: the collection of inanimate objects, furniture and gadgets that one transfers when changing home. Upon moving to a new home, it is the unpacking and arranging of the objects that renders the feeling of home. Sometimes it is even enough to look at the boxes and imagine where the objects within will be placed in order to confer the feeling of a new home (Wise 2000). From this perspective, home is composed mainly of location-specific behavior and individual identity, and not merely of physical properties: "It was not the space itself, not the house, but the way of inhabiting it that made it a home" (Boym 1994). This statement connects to Jung's physiological perception that home is a symbol of the self: by designing one's dwelling, one in fact tries to express the way one would like to be perceived, one projects an identity. The way one arranges the home can be related not only to one's persona, but also to one's culture. This has been illustrated in a comparison between the traditional Muslim dwelling, in which the public and private areas are rigidly separated, and the contemporary Western dwelling, in which open spaces reflect a more equal relationship between the family members as well as a higher level of similarity between their private and public lives Sebba (1996). Personalization of the home reflects both identity and security needs, which are achieved respectively by the constant modifications and defense of the home. This constant change and maintenance of the home provides stimulation—the third essential territorial perspective of home (Porteous 1976). Indeed, home revolves around a sense of ownership and safety. It provides privacy and a refuge from voyeurism (Douglas 1991), prompting a strong urge to protect the home in turn. In this context, it is clear why homeowners are swamped with feelings of insult and anger if their home suffers a break-in or burglary, as well as an accompanying fear that comes from having their privacy and safety undermined.

Returning to the multi-scale meaning of home, we can contend that similar processes affect the way that one perceives home on higher scales: many cities or towns possess a specific identity. Examples of this can be found in the nicknames of cities, such as Nashville "music city" or Reno, in Nevada, whose nickname "The Biggest Little City in the World" is proudly proclaimed by a sign on a Downtown street. An example of a modification in a city's identity is that of Tel-Aviv, which re-invented itself in the 1980s with a new urban plan and a new urban slogan: "Tel-Aviv—the city that never stops." This, together with other activities, transformed Tel-Aviv from a city that was growing older in terms of its population into a center of attraction for young people Blumenfeld-Lieberthal et al. (2009). In the same vein, with the expansion of home identity to one's home town, a sense of security is also applicable on a larger scale, with cities providing municipal services such as a police force or social security services on both the national and municipal scales. The sense of security can also be expanded to include economic security.

At the national scale we find all of Porteous' three essential territorial properties: identity, security and stimulation. In terms of identity, nationality has always been related to both a set territory and the identity of its inhabitants Knight (1982), Hooson (1994), He and Guo (2000), Blank and Schmidt (2003). Personal identities are always defined in part by nationality, as people are classified by their passports or other official identity cards. Nationality is usually based on the place of birth and where one is raised (i.e. one's homeland) and not necessarily according to the current place of residence. The expression of a national identity different to the place of residence can be seen in immigrants who maintain a relationship with other immigrants from their place of birth, and even form new communities based on their country of origin in their new places of residence, such as the Chinatown found in major American cities. Zali Gurevitch tells an anecdote relating to this behavior, based on Daniel Defoe's *Robinson Crusoe*. Crusoe's action of building a home on the island began by saving whatever he could from his sinking ship. He used these possessions as the foundations for his new home, which was based on the culture of his homeland. In fact, Crusoe did exactly what immigrants do; he established a cultural bubble that reconstructed his origins. For ten months he worked on building his new home without exploring what the new location might have to offer even once.

Security is one of the basic demands one makes on one's country. In contrast, the term "refugee" refers to those who do not have a sense of security in their homeland and thus must flee in order to find refuge elsewhere. To ensure the security of their inhabitants, most countries strive to develop the best possible army, and maintain it even in times of peace. On the national scale, identity and security are intertwined; many wars began or evolved based on identity differences between the combatants, whether in terms of religion (the Crusades), race (the Holocaust), or other national identity markers—with nations seeking to defend or expand their identity and territory. Additionally, in-house debates and even civil wars that affect security have often been related to the identity that the citizens want to embrace (the American Civil War in the nineteenth century and the French Wars of Religion in the sixteenth are both good examples). And, similarly to stimulation on an individual scale, maintaining (or developing) a country's identity and security provides constant stimulation.

Animals are not unlike humans in their sense of home. The following anecdote about animals moving objects to a new home comes from one of my early studies with tamed wild rats. One female rat that had become my pet used a piece of bubble-wrap as a blanket. The rat would pool the cage bedding (wood shavings) to make a crater-shaped nest and, upon entering the nest, would pull up the bubble wrap to cover the nest from the top. After some time, I introduced a smaller cage with a male rat in it into her cage, enabling them to sense and sniff each other through a wire mesh without physical contact. A few days later, I opened the door of the male rat's cage, allowing the rats to meet with no barriers. The female, more confident by virtue of extensive taming, immediately entered the male's nest box and, after a few minutes of extensive sniffing and interacting, ran back to its own nest to take the sheet of bubble-wrap to the male's nest, where they then nested together. The scenario reminded me of my daughter moving in with her boyfriend.

Home behavior is characteristic of rats. It is such a strong trait that it is manifested even when a physical home is lacking. When a rat (or another rodent) is placed in an unfamiliar environment, it soon establishes a home base (Eilam and Golani 1989). If a salient landmark or a shelter is accessible, then the home-base location will be near or inside this landmark. However, in an homogenous environment with a minimum of spatial cues, the rat will usually establish a home base at the point at which it was introduced into the environment (Nemati and Whishaw 2007; Yaski and Eilam 2008). Even when there are no unique physical markers for a home base, its location is clearly distinguished from other locations by virtue of the typical behaviors displayed there: the rat stays at the home base for a much longer duration than any other place, it crouches there, returns to it frequently after exploring the environment and regularly grooms its fur and rears up on its hindquarters there (Eilam and Golani 1989). In sandy environments, the rodent will also start digging a burrow in the home-base location; paradoxically, gerbils display extensive digging behavior at the home base even on tiled floors. Home behavior is thus an inherent property of the animal and, accordingly, is displayed even in the absence of the desired physical construct of home. The comforting effect of home behavior is conspicuous in both humans and non-humans, and it is this behavior that individually marks and territorializes similar spatial physical constructs (such as similar apartments in the same building) into one's specific home.

8.4 "Time to Go Home"—The Spatiotemporal Perspective

As described above, the home base in rats serves as a terminal for round trips in the environment. These round trips have a characteristic structure: their outbound segment is slow and interrupted with stops, whereas the inbound segment is fast with fewer, if any, stops (Eilam and Golani 1989). Regardless of round-trip length, there is an upper limit of 8–10 stops per trip, and once this limit is reached, the rat usually dashes back to the home base (Golani et al. 1993). Accordingly, exploration in home-base behavior is conceived of as a set of round trips that are anchored to one specific location—the home base (Fig. 8.4). In restricted laboratory settings, behavior in time and space is thus organized in relation to the home base (Eilam 2010; Eilam and Golani 1989; Hines and Whishaw 2005; Nemati and Whishaw 2007; Yaski and Eilam 2007; Zadicario et al. 2007).

The role of home as a terminal, or a hub, for traveling in the environment is illustrated in Fig. 8.1, a diagram of the structure of a typical territory or living range. In nature, many animal species live within a confined and limited range, which is dictated by various factors such as other individuals of their species, other species, food resources, topography, available shelters, physiology, and social rank. Within the living range, animals may define and protect a limited area, preventing others from using it—this is a territory (Immelmann and Beer 1989). In other words, when animals repeatedly use the same specific area in the course of their activity, they can be said to possess a home range (Barrows 1996). The home range

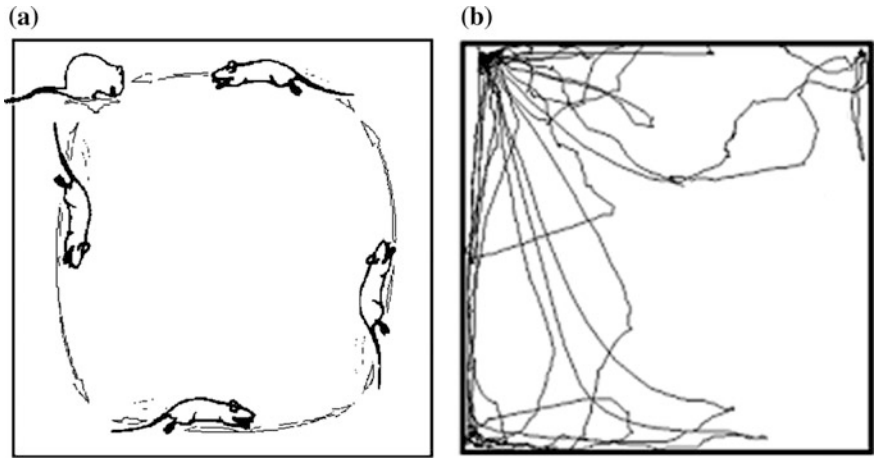

Fig. 8.4 A diagram of round trips to the home (**a**) and the actual trajectories of periodic returns to the home base in a gerbil-like rodent (**b**)

is usually defined as the area within which a high percentage of activity (95–99 %) takes place (Anderson 1982; Don and Rennolls 1983; Matthews 1996). Accordingly, it is assumed that by having a home range, animals increase the efficient use of resources (such as food sources and refuge sites). The shape and size of a home range is highly variable, as is illustrated by fish (Kramer and Chapman 1999). In coral reef fishes, for example, there is a direct correlation between body size and home range. While some coral reef fishes move on a daily basis between sites used for feeding and those used for reproduction or resting, other species are relatively stationary (Kramer and Chapman 1999). Three broad daily movement patterns were observed in fish: (i) commuting, with crepuscular shifts in habitat or location; (ii) foraying, occupying the same refuge holes between day and night; and (iii) mixed, which is a mixture of commuter and forayer movement patterns (Marshell et al. 2011; Meyer and Holland 2005). In a home range or territory there are three prominent behavioral characteristics, two of which are shown in Fig. 8.1: (a) traveling regularly along the same paths, (b) periodic returns to the home.

8.4.1 Regular Traveling Along the Same Paths

At the beginning of this article we described how Darwin was fascinated by the vision of turtles traveling methodically to the springs. Routes leading to scarce vital resources, such as water holes, are the most recognizable of animal tracks as the intensive use of these routes clears them from vegetation. A study of the behavior of black rhinos (*Diceros bicornis*) offers a good example (Schenkel and Schenkel-Hulliger 1969). Traveling repeatedly along the same route is made

possible by both internal cues (such as vestibular information on turns or odometry) and external cues. The latter can be directional cues that polarize the environment; for example, chemical, magnetic or light gradients. These cues enable navigation through an unknown environment by means of forming a one-dimensional map. Directional cues are prevalent in aquatic environments and when visibility is poor. Other environmental cues are positional, comprising landmarks that are used to deduce distances and directions of a specific location in the environment (Jacobs and Schenk 2003). Both directional and positional cues enable repeated traveling along the same path. For example, when salmon return to their *home* to spawn (where home is understood as a place of origin) they are guided through the visually homogeneous ocean, at least partially, by chemical and magnetic cues. In contrast, fish species belonging to the coral feeding guild rely on landmarks afforded by the structured coral reefs (Reese 1989). An example is the foraging butterfly fish. These coral-dependent fish swim within their territories and home ranges along a predictable pattern from one food patch to another. The pattern is based on learned coral head shapes; when these are removed the fish look for them in their former location. Moreover, when these fish are deflected from the path, they resume their regular pattern upon encountering the first familiar landmark (Reese 1989). The ubiquity of regular traveling along the same routes in vertebrates, as illustrated by fish, has also been demonstrated in primates. In a study, baboons (*Papio hamadryas*) were found to sleep on two cliffs and to travel daily along four routes between these cliffs (Schreier and Grove 2014). Another study revealed that baboons change their direction of travel at fixed locations where they turn back to their sleeping site or head towards locations next to important landmarks (Noser and Byrne 2014). Similarly, tamarin monkeys (*Saguinus fuscicollis*) travel along regular paths while attending to near-to-goal landmarks (Garber and Porter 2014); bearded sakis (*Chiropotes sagulatus*) appear to encode the locations of high-quality food patches and minimize travel routes between them (Shaffer 2014). Finally, spider monkeys (*Ateles belzebuth*) and woolly monkeys (*Lagothrix poeppigii*) typically travel through their home ranges by repeatedly following the same routes. Their routes remained stable over eight years of observation, and appeared to be associated with easily recognized landmarks (Di Fiore and Suarez 2007).

Classic models that sought to describe human spatial behavior, also known as human mobility patterns (HMP), used Brownian motion or random walk to describe it (Camp et al. 2002; Groenevelt et al. 2006; Loannidis and Marbach 2006). These models assumed that human movements present a pattern of a successive number of random steps, in terms of distance and direction. In the last decade or so this perception has changed due to the greater availability of empirical data provided by the Internet and mobile phone usage. For example, based on data from the website www.wheresgeorge.com, which tracks the location of numerous banknotes over time, it has been suggested that HMP follow a Levy-flight distribution (Brockmann et al. 2006). Implicit in this observation is that, while the direction of the movement was considered as random, the distances followed a power law distribution—there were many short trajectories and very few considerably long ones. A study of the trajectories of 100,000 mobile-phone users over a period of six months revealed

that HMP not only follow a Levy-flight distribution, but also present a high degree of regularity in time and space (Gonzalez et al. 2008). These findings were supported by GPS data (Zhao et al. 2008) and data from another 50,000 mobile-phone users over a three-month period, concluding that "despite our deep-rooted desire for change and spontaneity, our daily mobility is, in fact, characterized by a deep-rooted regularity" (Song et al. 2010). These empirical findings suggest that people have a routine of returning to several specific places, of which the most common are one's home and work or school. Strikingly, while social relationships can explain about 10–30 % of all human movement, periodic behavior explains 50–70 % of it (Cho et al. 2011). These findings were strengthened by a study of the behavior of carpool users and route characteristics in Taiwan, which revealed that 73.9 % of carpools consist of regular routes (Chung et al. 2012).

The notion that people travel along temporal and spatial routines has been called "time geography" (Hägerstrand 1970). Later studies sought explanations for these behaviors by relating HMPs to the underlying topology of street networks (Jiang et al. 2009), as well as to the scaling and hierarchical properties of the destination clusters and people's individual preferences (Jia et al. 2012). In contrast, Noulas et al. suggested that HMP results from the various and different objectives that drive a person's decision to move (2012). Specifically, this study found that the probability of moving from one place to another is dependent on the number of intervening opportunities between the origin and its destination, and not on the physical distance between them.

8.4.2 Permanent Places with Regular Behavior

Animals tend to regularly perform the same behavior in the same locations, as demonstrated above for home locations. Some of these behavioral regularities are enforce by topography, such as drinking at the river, feeding on particular fruit trees and sleeping on a specific steep cliff. Accordingly, regular travel along the same routes could simply be a product of a topographical bias towards desirable sites. For example, a tendency to forage in one area and rest in another has been documented in hyraxes (*Procavia capensis;* Serruya and Eilam 1996), and in vicuna (*Vicugna vicugna*; Franklin 1983). In the black rhino, regular trails connect pasture, sleeping, and drinking sites (Schenkel and Schenkel-Hulliger 1969). Pronghorns (*Antilocapra americana*) in southern New Mexico establish their home range relative to permanent water sources (Clemente et al. 1995). The traveling paths of Gibbons (*Hylobates lar*) are goal-directed: focused on their preferred food sources (Asensio et al. 2011), and a long-term retention of the location of food sites was found in chimpanzees (Mendes and Call 2014). Similarly, spiny mice (*Acomys cahirinus*) and dormice (*Elyomis melanurus*) carry snails, on which they feed, to a sheltered crevice where they crush the shell to eat its contents—resulting in piles of shells near the crevice (Mendelssohn and Yom-Tov 1999). Another form of permanent location with which regular behavior is associated is a demarcation site.

These sites are scattered across the living range to advertise either territorial ownership or reproductive state (Freeman et al. 2014). Behavior at demarcation sites is usually performed as a strict set of acts. For example, upon arriving at a demarcation site, individuals of many species of antelope first lower their head to sniff the ground and rub it with one of their forelegs. They then keep their hind legs rooted in place while stepping forward with only their forelegs, thus stretching their trunk to urinate on the sniffed site. Keeping their forelegs rooted, they then step forward with only their hind legs, thus arching their trunk to defecate on the sniffed and urinated site (Walther 1977). Similarly, black rhinos (*Diceros bicornis*) perform a fecal marking scraping ritual aimed at advertising the territories of adult males and communicating the sexual status of the females (Freeman et al. 2014). Owners of domestic animals will be familiar with their pet's preference for specific behaviors in specific locations; cats have "favored spots" within home ranges where they are likely to be found at particular times, and which they use repeatedly for sleeping, resting and grooming (Bernstein and Strack 1996). In social animals, particular locations may be shared or divided for specific activities. For example, in the hyrax's living range there is spatial separation of females and young on one side and sub-adult males on the other (Serruya and Eilam 1996). In South Africa, hyraxes diverge to occupy three areas of the living range, each of different age and gender (Fourie and Perrin 1987): sub-adult males and females, lead male and harem, and males outside the other two groups. Hyraxes in the Israeli Negev region spend about 95 % of their time crouching or traveling at a distance of a few meters from their shelter; a year-long observation on these hyraxes revealed that half of all crouches were performed on the same eight rocks or stones out of the thousands of available stones in the vicinity of the shelter (Serruya and Eilam 1996). As shown in Fig. 8.1, the living range (or territory) of animals can thus be regarded as a set of permanent locations, with a typical behavior regularly displayed at each location, and a network of regular routes connecting these locations and converging at the home, which is the core for activity within the living range. Similarly, humans tend to return to specific locations: HMP follow heavy-tailed distributions (i.e. they make many short trajectories and very few considerably long ones) with a high degree of regularity, a trait reflected in our preferences for specific locations over others. In other words, there are a few locations to which we return frequently (such as our favorite restaurant) and many other places that we visit rarely (like the unfamiliar restaurant we eat at during a conference).

8.4.3 Periodic Returns to the Home

The physical, behavioral and spatial aspects of home described above involve an additional aspect: temporal returns to the home site. Return could occur as infrequently as once in a lifetime, as in the case of salmon, eel and lamprey fishes. These fishes hatch in the beds of freshwater streams and then migrate downstream to the

ocean, where they spend their life until homing back to their birthplace, to spawn and die. In other animals there is an annual periodic return to a specific breeding location. Sea turtles, for example, lay their eggs on the same beach on which they hatched. Storks spend the cold European winter season in warm Africa, then return each spring to exactly the same European location to build a nest and breed, usually after a reunion with a mate from the previous year. Storks avoid long flights over water by migrating to Africa and back either by crossing Gibraltar or crossing Israel along the Jordan Valley. The choice of crossing is not arbitrary: all storks west of a demarcation zone in Europe migrate through Gibraltar while all those east of that zone migrate through Israel. Radio-tracking of pairs in the divide zone revealed that one individual of the pair may migrate eastward and the other individual westward; they spend the winter separately in Africa before traveling back to breed together at exactly the same site (Diehn 2014). Periodic returns to the home site are more frequent in animals that do not migrate and inhabit a confined living range. Of these species, most are active at specific times, defining them as diurnal, nocturnal, crepuscular, and so on. Accordingly, they rest in a specific location—den, nest, cliff, crevice, crack, cave, hollow tree or cavern—and leave the home upon commencing their activity period, after which they return to it. In some species, activity is intermittent and constitutes several bouts that start and end at a specific site, which may be the home site. For example, social voles (*Microtus Guentheri*) forage outside for grains and vegetation which they carry back to their burrow system, where they store and harvest them in food chambers. Similarly, barn owls (*Tyto alba*) perch in specific locations from which they swoop down onto their prey. A successful hunt usually involves a return to the perch or nest site with the catch and eating it there or feeding the young, before embarking on another ambush (Shifferman and Eilam 2004). Barn owl activity may be regarded as a set of nocturnal or crepuscular hunting sessions, each starting and ending at the same perch. A similar pattern of cycles of activity and rest is apparent in the behavior of rats in an "open-field" testing arena. As described above, these rats establish a home base from which they set out on round trips in their environment. After a few round trips, the rat settles at the home base, displays extensive grooming of its fur, then crouches for a while. Later, usually after another intensive grooming session, it sets out on another round trip. As a result of this typical spatiotemporal structure of behavior, the rat displays periodic returns to the home base, which is consequently the most visited locale in the testing environment (Eilam and Golani 1989). Home is thus the major anchor point for spatial behavior, a focal convergence site for routes that typify foraging or and other activities in the living range (Golledge 1999b). To manage this effectively, humans and other animals must keep track of the home location in order to know where they are, and to locate landmarks in reference to home. Round trips or home-base generated trips dominate the activity schedules of most individuals, who upon returning to the home site display typical home behavior.

8.5 "Wherever I Lay My Hat, That's My Home": Homeless Animals and Humans

While many animals have specific home sites, other animals do not have a permanent one. These are not necessarily nomadic species, since they usually have a well-defined living range within which they display a regular spatial behavior. Darwin's tortoises, introduced at the start of this paper, are an example. Despite being encased in their shell—a self-contained home shelter, but not a fixed site—they travel methodically along fixed routes. Another example is the limpet (*Siphonaria alternate*), a sea mollusk that lives in tidal sea zones, where it shelters under its conical shell. At low tide, when exposed to the air, the limpet firmly clamps its shell to the rock, sealing in the water inside to protect it from dehydration. This firm attachment results in a circular scar on the rock surface, reflecting the boundary of the limpet shell. When covered with water during high tide, the limpet goes on a foraging journey, crawling over the rock and grinding organisms from it surface, before retracing its way back to the home scar by following the salivary trail of the outbound journey (Cook 1971). Although limpets could stop and remain sheltered at any point of their trip, they display regular spatial behavior that is anchored in a fixed location—the home scar.

Like tortoises, limpets or crabs that carry their home with them, people who do not have a house are forced to find alternative solutions for storing and transporting their possessions. A common solution is to use a shopping trolley to hold their belongings as well as foraged materials that they collect and carry to recycling centers. Homeless people often travel with the trolley at all times to avoid its theft. The trolley thus provides storage, transportation and security for their possessions (Hill and Stamey 1990). Based on homeless people's need for somewhere to keep their belongings, along with their need for a sheltered sleeping place for themselves, the designers Barry Sheehan and Gregor Timlin designed a mobile living unit for homeless people called the 'shelter cart.'[1] This unit acts as a cart during daytime and tips over to provide a covered sleeping area at night (see prototype in the provided hyperlink). Indeed, a common behavior for creating a sense of identity and self-esteem in many homeless communities (both street-dwellers and shelter-dwellers) is the accumulation of possessions that symbolize a better past or future, and thus help construct or maintain an identity (Belk 1985). Being sensitive to this psychological aspect, a US federal court decision (Lavan et al. 2012) ruled against the confiscation of homeless persons' belongings by municipalities, enshrining the rights of homeless people to keep their possessions. The nature of the importance of belongings to homeless people is comparable with the aforementioned formation of identity through home decoration and arranging ornaments in home dwellers. Implicit in this parallel is the fact that in humans, like in some

[1]The shelter cart was an entry for designboom's 'Shelter in a cart' design competition (http://www.designboom.com/design/shelter-cart-for-junk-collectors/).

animals, home-related behavior is manifested despite the lack of the physical construct of home.

A homeless persons' pride, which is an important part of their identity, is partly based on their construction of 'home,' much as the pride of a home dweller swells when they purchase their home (Hill and Stamey 1990). The self-esteem of homeless people can be boosted by their becoming independent of welfare institutions and shelters. Those who sleep in shelters, in contrast, may struggle to develop their self-esteem because of their dependence on the shelters. Despite the fact that shelters offer basic security and protection from the weather, their invasion of the occupants' privacy and the general loss of control prevent them from functioning as home in behavioral and emotional terms (Hill 1991). This supports the notion that the home is not just a physical location but can also be interpreted as a state of mind or as related to typical behaviors. These findings, however, are not universal: other studies on homeless people present different findings. For example, homeless people in Australia regard housing and home as the same. The physical structure is central to their meaning of home and is considered as a solution to the problems that relate to their being homeless. For them, home is a signifier of normality, and a commitment to participate in Australian society (Parsell 2012). Home behavior is nonetheless apparent in homeless humans and animals, even if this behavior is less marked than home behaviors focused on a permanent physical construct.

8.6 The Territory as Home

Many herbivore species do not have a permanent home site, but rather a well-defined home range in which they rest at temporary sites. For example, wild boars (*Sus scrofa*) usually inhabit a range of two square kilometers. Within this range, they prepare a rest site by clearing and rubbing the ground into a shallow ditch which they use for several days before moving on to another temporary ditch in the territory (Mendelssohn and Yom-Tov 1999). Similarly, adult wild asses (*Equus asinus*) inhabit territories ranging in area from 2 to 20 km^2, which they patrol while vocalizing their ownership and demarcating it with 40 cm-high piles of dung about 1 m in diameter. Within this territory, wild asses rest in the shade of trees or rocks (Mendelssohn and Yom-Tov 1999; Nowak 1997). Similar behavior characterizes many antelopes, rhinos and primates. Another example of a territory as home is the habit human teenagers have of decorating their room in a style that differs from the rest of the house, thereby demarcating their room as their territory and identity within the home. In the subsequent stage, when they leave the parental home and move to, for example, a university dormitory, they make their room there a new home, decorated with their own possessions and ornaments and establish their sense of independence and identity. This process of acquiring home identity is often inhibited in military camps or prisons, where decorating the dormitory or cell may be forbidden. In these institutionalized settings, a bed and small closet become

the individual's only source of privacy, emphasizing their identity as soldiers or prisoners, for whom the lack of home is an overt and enforced manifestation of the lack of freedom and independence; the lack of a place where one can be more oneself than anywhere else (Burnard 1999).

8.7 The Group as a Mobile Home

Many herbivore species are social: their herd, once they are in one, is their home. The herds may inhabit a specific living range or migrate seasonally to a remote living range with better resources, whereby the anchor for activity is social, not physical. The behavior of herd individuals is highly synchronous, and they all rest, feed, move, groom, take dust baths, suckle and excrete according to the same schedule (Estes 1991). These behaviors seem to be contagious even across groups, resulting in mass movement, such as the vast migrating herds of the African buffalo (*Syncerus caffer*) or wildebeest (*Connochaetes taurinus*; Estes 1991; Molszewski 1983). The formation of a "social home" has been illustrated in a laboratory setting with juvenile laboratory rat littermates that form a huddle when placed in an arena outside their nest. The young rats then take exploration round trips from the huddle that is their new home base, despite its continuous drifting across the arena when the pups push each other into the huddle (Loewen et al. 2005). In other words, the huddle of littermates—not its location—serves as a home base.

The sense of comfort and safety rendered by the group (Bednekoff and Lima 1998; Elgar 1989; Szulkin et al. 2006) as a trade-off for the need for a physical home reaches an extreme manifestation in the nomadic lifestyle of certain gregarious species. The red-billed quelea (Quelea quelea) is the most abundant wild bird species in the world, with a population of about 10 billion individuals that aggregate in sub-Saharan African savannas (Fig. 8.5). These small birds travel in large flocks to forage, rest and breed according to the resources available (Dallimer and Jones 2002). A similar nomadic spatial behavior is typical in the highly sociable cedar waxwing bird (*Bombycilla cedrorum*) that lives and travels in large flocks in Central and North America (Putnam 1949), and in the Australian wild black swan (*Cygnus atratus*) that gathers in nomadic flocks of thousands, which travel in erratic patterns (Kingsford et al. 1999). A nomadic lifestyle is also seen in some insect swarms, such as locusts and army ants. All the nomadic animal species mentioned above are highly gregarious, and it is probably the power of the group that provides a feeling of home, thereby replacing the need for a physical anchor as a home. A nomadic lifestyle characterizes some human communities, such as those of the Romany and Bedouins, who settle temporarily in one place and then move on to another. It is interesting to note that in Bedouin communities, the tent (which is their home) is divided into two areas, separated by a piece of cloth. One area is the men's area, the other is the women's (Rosen and Saidel 2010). This can be related to the identity of the Bedouin in terms of cultural and religious characteristics.

Fig. 8.5 The red-billed quelea (Quelea quelea). A nomadic African bird that is the most abundant wild bird species in the world

Another example of a social home is that of elderly people who voluntarily leave their own private homes and move to live in a condominium. These projects are not nursing homes nor medical care facilities and they do not offer supervision at all hours of the day. They are designed to integrate the housing and service needs of the elderly with a social life. The goal of these projects is to increase the independence of the community by providing support services. Research showed that the majority of women living in condominiums were emotionally attached to their new residence and considered it home, despite the fact that this housing was not their private property. For them, the meaning of home emerged from their autonomous decision to find a place to live in, combined with the continued decision to remain there (Leith 2006). In other words, for these elderly people the behavioral (non-physical) properties of home were detached from their private home and attached to their current housing.

8.8 Epilogue

There is nothing like staying at home for real comfort.—Jane Austen

While there are obvious differences between humans and animals, there are also many similarities, and this paper has shown that the meaning of home extends far beyond its mere physical construct. First and foremost, home is a state of mind that

involves typical (sometimes even exclusive) behaviors that are rarely performed elsewhere. Home is where one is supposed to be most protected and relaxed. Moreover, people arrange and decorate their homes as an expression of their individual identity and persona; there is a firm attachment between the physical construct and home behavior. The home is also a core for the organization of behavior in time and space. It is a hub for traveling within the living range, and people carry out many of their activities on the way from or to home, such as dropping the kids off at school on the way out, or shopping for groceries on the way home. Thus, the home is the core organizer of behavior within the living range. In this context, having a permanent home and traveling methodically along the same routes to the same locations seem beneficial, providing increased efficiency in using the resources available in these territories. Accordingly, home and home range may be viewed as adaptive properties in both humans and other animals. Moreover, home-related behavior is such a robust and vestigial trait that it is preserved even in the absence of home as a physical construct (see the section on "homelessness"). This has also been illustrated in rats, which, when placed in an homogeneous unfamiliar environment, establish a home base in an arbitrary location—usually the point at which they were introduced into the unfamiliar environment—then organize their spatiotemporal traveling in relation to that home base (Eilam and Golani 1989). In summary, home is first and foremost a behavioral phenomenon: a psychological-emotional competence which is manifested in an analogous form in both humans and non-humans. In light of Darwin's notion that emotions are homologous in animals and humans (Darwin 1998, first published in 1871), and studies showing that there is a continuity of the emotional brain between humans and animals (Dalgleish 2004; see, however, Penn et al. 2008, who claimed that this is a mistake, considering the large gap between animals and humans) it might be suggested that similar biobehavioral systems in humans and non-humans account for the convergence of home behavior to similar traits, as described in this paper. This conclusion is in line with Darwin's statement that the difference between animals and humans is one of degree, not of kind (Darwin 1871).

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