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Brown rat

The **brown rat** (*Rattus norvegicus*), also referred to as the **common rat**, **street rat**, **sewer rat**, **Hanover rat**, **Norway rat**, **Norwegian rat**, or **wharf rat** is one of the best known and most commonrats.

One of the largest muroids, it is a brown or grey rodent with a body up to 25 cm (10 in) long, and a similar tail length; the male weighs on average 350 g (12 oz) and the female 250 g (9 oz). Thought to have originated in northern China, this rodent has now spread to all continents except Antarctica, and is the dominant rat in Europe and much of North America—making it by at least this particular definition the most successful mammal on the planet alongside humans.[2] With rare exceptions, the brown rat lives wherever humans live, particularly in urban areas.

Selective breeding of *Rattus norvegicus* has produced the laboratory rat, a model organism in biological research, as well aspet rats.

Brown rat	
	
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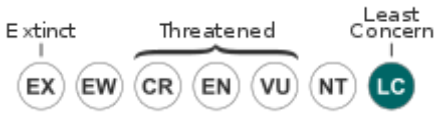
Conservation status	
	
Least Concern (IUCN 3.1)[1]	
Scientific classification	
Kingdom:	Animalia
Phylum:	Chordata
Class:	Mammalia
Order:	Rodentia
Family:	Muridae
Genus:	*Rattus*
Species:	***R. norvegicus***
Binomial name	
Rattus norvegicus (Berkenhout, 1769)	
	
Brown rat range	

Contents

Naming and etymology

Originally called the "Hanover rat" by people wishing to link problems in 18th century England with the House of Hanover,[3] it is not known for certain why the brown rat is named *Rattus norvegicus* (Norwegian rat), as it did not originate from Norway. However, the English naturalist John Berkenhout, author of the 1769 book *Outlines of the Natural History of Great Britain*, is most likely responsible for popularizing the misnomer. Berkenhout gave the brown rat the binomial name *Rattus norvegicus*, believing it had migrated to England from Norwegian ships in 1728.

By the early to middle part of the 19th century, British academics believed that the brown rat was not native to Norway, hypothesizing (incorrectly) that it may have come from Ireland, Gibraltar or across the English Channel with William the Conqueror.[4] As early as 1850, however, a new hypothesis of the rat's origins was beginning to develop.[5] The British novelist Charles Dickens acknowledged this in his weekly journal *All the Year Round*, writing:

> "Now there is a mystery about the native country of the best known species of rat, the common brown rat. It is frequently called, in books and otherwise, the 'Norway rat', and it is said to have been imported into this country in a ship-load of timber from Norway. Against this hypothesis stands the fact that when the brown rat had become common in this country, it was unknown in Norway, although there was a small animal like a rat, but really a lemming, which made its home there."[6]

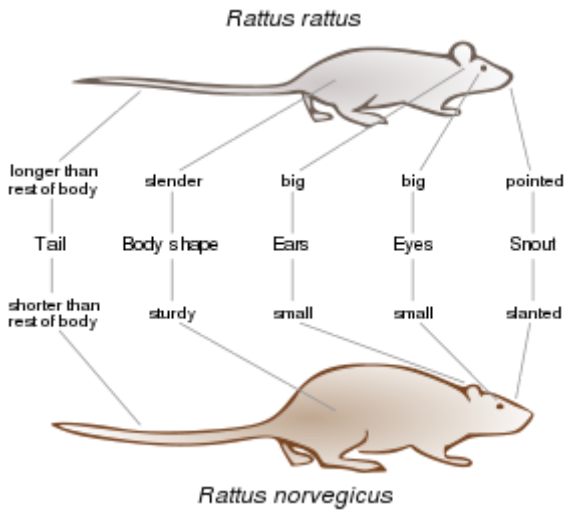
Academics began to prefer this etymology of the brown rat towards the end of the 19th century, as seen in the 1895 text *Natural History* by American scholar Alfred Henry Miles:

> "The brown rat is the species common in England, and best known throughout the world. It is said to have travelled from Persia to England less than two hundred years ago and to have spread from thence to other countries visited by English ships."[7]

Though the assumptions surrounding this species' origins were not yet the same as modern ones, by the 20th century, it was believed among naturalists that the brown rat did not originate in Norway, rather the species came from central Asia and (likely) China.[8]

Description

The fur is coarse and usually brown or dark grey, while the underparts are lighter grey or brown. The brown rat is a rather large true murid and can weigh twice as much as a black rat and many times more than a house mouse. The length is commonly in the range of 20 to 25 cm (8 to 10 in), with the tail a further 18 to 25 cm (7 to 10 in), thus being roughly the same length as the body. Adult body weight averages 350 g (12 oz) in males and about 250 g (9 oz) in females.[9] Exceptionally large individuals can reportedly reach 900 to 1,000 g (32 to 35 oz) but are not expected outside of domestic specimens. Stories of rats attaining sizes as big as cats are exaggerations, or misidentifications of other rodents, such as the coypu and muskrat. In fact it is common for breeding wild brown rats to weigh (sometimes considerably) less than 300 g (11 oz).[10][11]

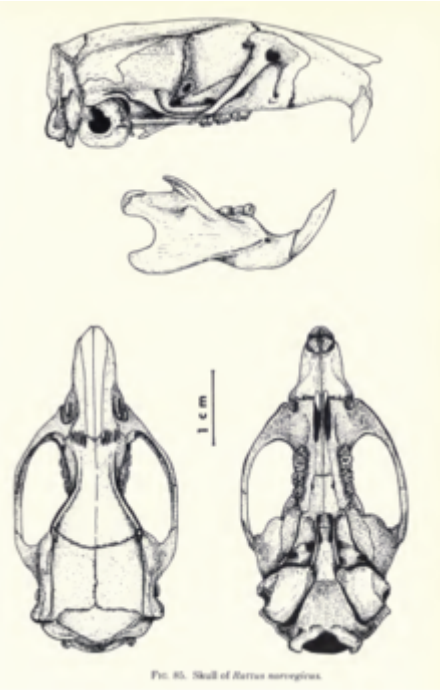


Comparison of the physique of a black rat (*Rattus rattus*) with a brown rat (*Rattus norvegicus*)

Brown rats have acute hearing, are sensitive to ultrasound, and possess a very highly developed olfactory sense. Their average heart rate is 300 to 400 beats per minute, with a respiratory rate of around 100 per minute. The vision of a pigmented rat is poor, around 20/600, while a non-pigmented (albino) with no melanin in its eyes has both

around 20/1200 vision and a terrible scattering of light within its vision. Brown rats are dichromates which perceive colors rather like a human with red-green colorblindness, and their colour saturation may be quite faint. Their blue perception, however, also has UV receptors, allowing them to see ultraviolet lights that some species cannot.[12]

Biology and behavior



Brown rat skull

The brown rat is nocturnal and is a good swimmer, both on the surface and underwater, and has been observed climbing slim round metal poles several feet in order to reach garden bird feeders. Brown rats dig well, and often excavate extensive burrow systems. A 2007 study found brown rats to possess metacognition, a mental ability previously only found in humans and some primates,[13] but further analysis suggested they may have been following simple operant conditioning principles.[14]

Communication

Brown rats are capable of producing ultrasonic vocalizations. As pups, young rats use different types of ultrasonic cries to elicit and direct maternal search behavior,[15] as well as to regulate their mother's movements in the nest.[16] Although pups will produce ultrasounds around any other rats at 7 days old, by 14 days old they significantly reduce ultrasound production around male rats as a defensive response.[17] Adult rats will emit ultrasonic vocalizations in response to predators or perceived danger;[18] the frequency and duration of such cries depends on the sex and reproductive status of the rat.[19][20] The female rat will also emit ultrasonic vocalizations during mating.[21]

Chirping

Rats may also emit short, high frequency, ultrasonic, socially induced vocalization during rough and tumble play, before receiving morphine, or mating, and when tickled. The vocalization, described as a distinct "chirping", has been likened to laughter, and is interpreted as an expectation of something rewarding.[22] Like most rat vocalizations, the chirping is too high in pitch for humans to hear without special equipment. Bat detectors are often used by pet owners for this purpose.

In research studies, the chirping is associated with positive emotional feelings, and social bonding occurs with the tickler, resulting in the rats becoming conditioned to seek the tickling. However, as the rats age, the tendency to chirp appears to decline.[23]

Rat chirp also can be used for mosquito control.

Other ultrasonic vocalizations, including a lower-frequency 'boom' or 'whoom' noise can be produced by bucks in a calm state, when grooming or settling down to sleep.

Audible communication

Brown rats also produce communicative noises capable of being heard by humans. The most commonly heard in domestic rats is bruxing, or teeth-grinding, which is most usually triggered by happiness, but can also be 'self-comforting' in stressful situations, such as a visit to the vet. The noise is best described as either a quick clicking or 'burring' sound, varying from animal to animal.

In addition, they commonly squeak along a range of tones from high, abrupt pain squeaks to soft, persistent 'singing' sounds during confrontations.

Diet

The brown rat is a true omnivore and will consume almost anything, but cereals form a substantial part of its diet.

Martin Schein, founder of the Animal Behavior Society in 1964, studied the diet of brown rats and came to the conclusion that the most-liked foods of brown rats include scrambled eggs, macaroni and cheese, raw carrots, and cooked corn kernels. According to Schein, the least-liked foods were raw beets, peaches, and raw celery.[24]


Brown rat eating sunflower seeds

Foraging behavior is often population-specific, and varies by environment and food source.[2] Brown rats living near a hatchery in West Virginia catch fingerling fish.[25] Some colonies along the banks of the Po River in Italy will dive for mollusks,[26][27] a practice demonstrating social learning among members of this species.[28] Rats on the island of Norderoog in the North Sea stalk and kill sparrows and ducks.[29]

Reproduction and life cycle

The brown rat can breed throughout the year if conditions are suitable, with a female producing up to five litters a year. The gestation period is only 21 days, and litters can number up to 14, although seven is common. They reach sexual maturity in about five weeks. Under ideal conditions (for the rat), this means that the population of females could increase by a factor of three and a half (half a litter of 7) in 8 weeks (5 weeks for sexual maturity and 3 weeks of gestation), corresponding to a population growing by a factor of 10 in just 15 weeks. As a result, the population can grow from 2 to 15 000 in a year.[30] The maximum life span is three years, although most barely manage one. A yearly mortality rate of 95% is estimated, with predators and interspecies conflict as major causes.

When lactating, female rats display a 24-hour rhythm of maternal behavior, and will usually spend more time attending to smaller litters than large ones.[31]

Brown rats live in large, hierarchical groups, either in burrows or subsurface places, such as sewers and cellars. When food is in short supply, the rats lower in social order are the first to die. If a large fraction of a rat population is exterminated, the remaining rats will increase their reproductive rate, and quickly restore the old population level.

Females are capable of becoming pregnant immediately after giving birth, and can nurse one litter while pregnant with another.[32] Females are able to produce and raise two healthy litters of normal size and weight without significantly changing their own food intake.[32] However, when food is restricted, females can extend pregnancy by over two weeks, and give birth to litters of normal number and weight.[32]

Mating behaviors

Males can ejaculate multiple times in a row, and this increases the likelihood of pregnancy as well as decreases the number of stillborns.[33] Multiple ejaculation also means that males can mate with multiple females, and they exhibit more ejaculatory series when there are several oestrous females present.[34] Males also copulate at shorter intervals than females.[34] In group mating, females often switch partners.[35]

Dominant males have higher mating success and also provide females with more ejaculate, and females are more likely to use the sperm of dominant males for fertilization.[35]

In mating, female rats show a clear mating preference for unknown males versus males that they have already mated with (also known as the Coolidge effect), and will often resume copulatory behavior when introduced to a novel sexual partner.[36]

Females also prefer to mate with males who have not experienced social stress during adolescence, and can determine which males were stressed even without any observed difference in sexual performance of males experiencing stress during adolescence and not.[37]

Social behavior

Rats commonly groom each other and sleep together.[38] Rats are said to establish an order of hierarchy, so one rat will be dominant over another one.[39] Groups of rats tend to "play fight", which can involve any combination of jumping, chasing, tumbling, and "boxing". Play fighting involves rats going for each other's necks, while serious fighting involves strikes at the others' back ends.[40] If living space becomes limited, rats may turn to aggressive behavior, which may result in the death of some animals, reducing the burden over the living space.

Rats, like most mammals, also form family groups of a mother and her young.[41] This applies to both groups of males and females. However, rats are territorial animals, meaning that they usually act aggressively or scared of strange rats. Rats will fluff up their hair, hiss, squeal, and move their tails around when defending their territory.[42] Rats will chase each other, groom each other, sleep in group nests, wrestle with each other, have dominance squabbles, communicate, and play in various other ways with each other.[42] Huddling is an additional important part of rat socialization. Huddling is often supposed to have a heat-conserving function. Nestling rats especially depend on heat from their mother, since they cannot regulate their own temperature. Huddling is an extreme form of herding. Other forms of interaction include: crawling under, which is literally the act of crawling underneath one another; walking over, also explained in the name; allo-grooming, so-called to distinguish it from self-grooming; and nosing, where a rat gently pushes with its nose at another rat near the neck.[41]

Burrowing

Rats are known to burrow extensively, both in the wild and in captivity, if given access to a suitable substrate.[43] Rats generally begin a new burrow adjacent to an object or structure, as this provides a sturdy "roof" for the section of the burrow nearest to the ground's surface.[44] Burrows usually develop to eventually include multiple levels of tunnels, as well as a secondary entrance.[43] Older male rats will generally not burrow, while young males and females will burrow vigorously.[43][45]

Burrows provide rats with shelter and food storage, as well as safe, thermo-regulated nest sites.[43] Rats use their burrows to escape from perceived threats in the surrounding environment; for example, rats will retreat to their burrows following a sudden, loud noise or while fleeing an intruder.[46] Burrowing can therefore be described as a "pre-encounter defensive behavior", as opposed to a "post-encounter defensive behavior", such as flight, freezing, or avoidance of a threatening stimulus.

Distribution and habitat

Possibly originating from the plains of Asia, northern China and Mongolia, the brown rat spread to other parts of the world sometime in the Middle Ages.[47][48][49] The question of when brown rats became commensal with humans remains unsettled, but as a species, they have spread and established themselves along routes of human migration and now live almost everywhere humans are.[50]

The brown rat may have been present in Europe as early as 1553, a conclusion drawn from an illustration and description by Swiss naturalist Conrad Gesner in his book *Historiae animalium*, published 1551–1558.[51] Though Gesner's description could apply to the black rat, his mention of a large percentage of albino specimens—not uncommon among wild populations of brown rats—adds credibility to this conclusion.[52] Reliable reports dating to the 18th century document the presence of the brown rat in Ireland in 1722, England in 1730, France in 1735, Germany in 1750, and Spain in 1800,[52] becoming widespread during the Industrial Revolution.[53] It did not reach North America until around 1750–1755.[51][54]

As it spread from Asia, the brown rat generally displaced the black rat in areas where humans lived. In addition to being larger and more aggressive, the change from wooden structures and thatched roofs to bricked and tiled buildings favored the burrowing brown rats over the arboreal black rats. In addition, brown rats eat a wider variety of foods, and are more resistant to weather extremes.[55]

In the absence of humans, brown rats prefer damp environments, such as river banks.[53] However, the great majority are now linked to man-made environments, such as sewage systems.

It is often said that there are as many rats in cities as people, but this varies from area to area depending on climate, living conditions, etc. Brown rats in cities tend not to wander extensively, often staying within 20 m (66 ft) of their nest if a suitable concentrated food supply is available, but they will range more widely where food availability is lower. There is great debate over the size of the population of rats in New York City, with estimates from almost 100 million rats to as few as 250,000.[56] Experts suggest that New York is a particularly attractive place for rats because of its aging infrastructure, high moisture, and high poverty rates.[56] In addition to sewers, rats are very comfortable living in alleyways and residential buildings, as there is usually a large and continuous food source in those areas.[57]

Brown rat in a flower box in the East Village of New York City

In the United Kingdom, some figures show that the rat population has been rising, with estimations that 81 million rats reside in the UK.[58] Those figures would mean that there are 1.3 rats per person in the country. High rat populations in the UK are often attributed to the mild climate, which allow them higher survival rates during the winter.

The only brown rat-free zones in the world are the continent of Antarctica, some (although not all) parts of the Arctic, some especially isolated islands, the province of Alberta in Canada,[59] and certain conservation areas in New Zealand.[60][61]

Antarctica is almost completely covered by ice, making it uninhabitable by rats. The Arctic has extremely cold winters that rats cannot survive outdoors, and the human population density is extremely low, making it difficult for rats to travel from one habitation to another, although they have arrived in many coastal areas by ship. When the occasional rat infestation is found and eliminated, the rats are unable to reinfest it from an adjacent one. Isolated islands are also able to eliminate rat populations because of low human population density and the geographic distance from other rat populations.

Faroe Islands

The brown rat was first observed on the Faroe Islands in 1768. It is thought that the first individuals arrived on the southernmost island, Suðuroy, via the wreck of a Norwegian ship that had stranded on the Scottish Isle of Lewis on its way from Trondheim to Dublin. The drifting wreck, carrying brown rats, drifted northwards until it reached the village of Hvalba. Dispersion afterwards appears to have been fast, including all of Suðuroy within a year. In 1769, they were observed in Torshavn on the southern part of Streymoy, and a decade later, in the villages in the northern part of this island. From here, they crossed the strait and occupied Eysturoy during the years 1776 to 1779. In 1779, they reached Vagar. Whether the rats dispersed from the already established population in Suðuroy, or they were brought to the Faroe Islands with other ships, is unknown. The Northern islands were invaded by the brown rat more than 100 years later, after Norwegians built and operated a whaling station in the village of Hvannasund on Borðoy from 1898 to 1920. From there, the brown rat spread to the neighbouring islands of Viðoy and Kunoy.[62] Today the brown rat is found on seven of the 18 Faroese islands, and is common in and around human habitations as well as in the wild. Although the brown rat is now common on all of the largest Faroese islands, only sparse information on the population is available in the literature. An investigation for infection with the spirochaete *Leptospira interrogans* did not find any infected animals, suggesting that *Leptospira* prevalence rates on the Faroe Islands may be among the lowest recorded worldwide.[63]

Alaska

Hawadax Island (formerly known as Rat Island) in Alaska was infested with brown rats following a Japanese shipwreck in 1780. They had a devastating effect on the native bird life. An eradication program was started in 2007 and the island was declared rat-free in June 2009.

Alberta

Alberta, Canada, is the largest rat-free populated area in the world. Rat invasions of Alberta were stopped and rats were eliminated by very aggressive government rat control measures, starting during the 1950s.[64][65][66]

The only species of *Rattus* that is capable of surviving the climate of Alberta is the brown rat, which can only survive in the prairie region of the province, and even then must overwinter in buildings. Although it is a major agricultural area, Alberta is far from any seaport and only a portion of its eastern boundary with Saskatchewan provides a favorable entry route for rats. Brown rats cannot survive in the wild boreal forest to the north, the Rocky Mountains to the west, nor can they safely cross the semiarid High Plains of Montana to the south. The first brown rat did not reach Alberta until 1950, and in 1951, the province launched a rat-control program that included shooting, poisoning, and gassing rats, and bulldozing, burning down, and blowing up rat-infested buildings. The effort was backed by legislation that required every person and every municipality to destroy and prevent the establishment of designated pests. If they failed, the provincial government could carry out the necessary measures and charge the costs to the landowner or municipality.[67]

In the first year of the rat control program, 64 tonnes (71 short tons) of arsenic trioxide were spread throughout 8,000 buildings on farms along the Saskatchewan border. However, in 1953 the much safer and more effective rodenticide, warfarin was introduced to replace arsenic. Warfarin is an anticoagulant that was approved as a drug for human use in 1954 and is much safer to use near humans and other large animals than arsenic.[68] By 1960, the number of rat infestations in Alberta had dropped to below 200 per year. In 2002, the province finally recorded its first year with zero rat infestations, and from 2002 to 2007 there were only two infestations found.[69] After an infestation of rats in the Medicine Hat landfill was found in 2012, the province's rat-free status was questioned, but provincial government rat control specialists brought in excavating machinery, dug out, shot, and poisoned 147 rats in the landfill, and no live rats were found thereafter.[70] In 2013, the number of rat infestations in Alberta dropped to zero again. Alberta defines an infestation as two or more rats found at the same location, since a single rat cannot reproduce. About a dozen single rats enter Alberta in an average year and are killed by provincial rat control specialists before they can reproduce.[71]

Only zoos, universities, and research institutes are allowed to keep caged rats in Alberta, and possession of unlicensed rats (including pet rats) by anyone else is punishable by a penalty of up to $5,000 or up to 60 days in jail.[72] The adjacent and similarly landlocked province of Saskatchewan initiated a rat control program in 1972, and has managed to reduce the number of rats in the province substantially, although they have not been eliminated. The Saskatchewan rat control program has considerably reduced the number of rats trying to enter Alberta.[73]

New Zealand

First arriving before 1800 (perhaps on James Cook's vessels),[74] brown rats have posed a serious threat to many of New Zealand's native animals. Rat eradication programmes within New Zealand have led to rat-free zones on offshore islands and even on fenced "ecological islands" on the mainland. Before an eradication effort was launched in 2001, the sub-Antarctic Campbell Island had the highest population density of brown rats in the world.[75]

Diseases

Similar to other rodents, brown rats may carry a number of pathogens,[76] which can result in disease, including Weil's disease, rat bite fever, cryptosporidiosis, viral hemorrhagic fever, Q fever and hantavirus pulmonary syndrome. In the United Kingdom, brown rats are an important reservoir for *Coxiella burnetii*, the bacterium that causes Q fever, with seroprevalence for the bacteria found to be as high as 53% in some wild populations.[77]

This species can also serve as a reservoir for *Toxoplasma gondii*, the parasite that causes toxoplasmosis, though the disease usually spreads from rats to humans when domestic cats feed on infected brown rats.[78] The parasite has a long history with the brown rat, and there are indications that the parasite has evolved to alter an infected rat's perception to cat predation, making it more susceptible to predation and increasing the likelihood of transmission.[79]

Surveys and specimens of brown rat populations throughout the world have shown this species is often associated with outbreaks of trichinosis,[80][81] but the extent to which the brown rat is responsible in transmitting *Trichinella* larvae to humans and other synanthropic animals is at least somewhat debatable.[82] *Trichinella pseudospiralis*, a parasite previously not considered to be a potential pathogen in humans or domestic animals, has been found to be pathogenic in humans and carried by brown rats.[83]

Brown rats are sometimes mistakenly thought to be a major reservoir of bubonic plague, a possible cause of the Black Death. However, the bacterium responsible, *Yersinia pestis*, is commonly endemic in only a few rodent species and is usually transmitted zoonotically by rat fleas—common carrier rodents today include ground squirrels and wood rats. However, brown rats may suffer from plague, as can many nonrodent species, including dogs, cats, and humans.[84] The original carrier for the plague-infected fleas thought to be responsible for the Black Death was the black rat, and it has been hypothesized that the displacement of black rats by brown rats led to the decline of bubonic plague.[85] This theory has, however, been deprecated, as the dates of these displacements do not match the increases and decreases in plague outbreaks.[86]

In captivity

Uses in science

Selective breeding of albino brown rats rescued from being killed in a now-outlawed sport called rat baiting has produced the albino **laboratory rat**.[87] Like mice, these rats are frequently subjects of medical, psychological and other biological experiments, and constitute an important model organism. This is because they grow quickly to sexual maturity and are easy to keep and to breed in captivity. When modern biologists refer to "rats", they almost always mean *Rattus norvegicus*.

As pets

The brown rat is kept as a pet in many parts of the world. Australia, the United Kingdom, and the United States are just a few of the countries that have formed fancy rat associations similar in nature to the American Kennel Club, establishing standards, orchestrating events, and promoting responsible pet ownership.

The many different types of domesticated brown rats include variations in coat patterns, as well as the style of the coat, such as Hairless or Rex, and more recently developed variations in body size and structure, including dwarf and tailless fancy rats.

Working rats

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External links

Overviews

- Rat behaviour and biology A detailed set of pages by biologist Anne Hanson
- Norway (Brown) Rat Fact sheet including information on habits, habitat, threats and prevention tips

- *Rattus norvegicus* at the University of Michigan Museum of Zoology
- Life cycle data sheet for *Rattus norvegicus* written by biologist João Pedro de Magalhães
- Rats and Mice: Overview Online version of the Merck veterinary manual
- ARKive Still photos and videos
- Wild rats – the world's first website and forum (English interface is available) about wild rats, it is the home of a unique interactive JavaScript rat. The English version is expected to be available in 2010.

***Rattus norvegicus* genome and use as model animal**

- Nature: Rat Genome
- Rat genome database
- View the rat genome in Ensembl
- View the *rn5* genome assembly in the UCSC Genome Browser
