f3 Gliding & flying mammals < gnawers, insectivores >

> Most people make the mistake of thinking design is what it looks like. ... Design is how it works.
> —Steve(n) Paul Jobs.[1]

Cenozoic mammal orders: Rodentia (***Footnote f3.1***), Dermoptera (colugos or flying lemurs), and Marsupialia, have produced gliding members since (at least) the Eocene. This is convergent evolution.

The ecological niche for day-flying animals is strongly occupied by birds. Nevertheless, mammal aviators have success when concealment is provided by tree canopies or by night.

True flight has been achieved by bats, mammalian order Chioptera—an example of parallel evolution to the birds. The mammalian advantage over sight-reliant diurnal birds (even nocturnal owls) is that of keen hearing.[2] This opened for them the previously unoccupied ecological niche of night flying. There are two suborders of bats: Megachiroptera contains one family, the Pteropodidae (flying foxes, Old-World fruit bats), and Microchiroptera contains seventeen families, including: Craseonycteridae (hog-nosed or butterfly bats, ***Footnote f3.2***), Emballonuridae (sheath-tailed bats), Megadermatidae (false-vampire bats), Noctilionidae (bulldog or fisherman bats), Nycteridae (slit-faced bats), Phyllostomidae (includes vampire bats), Rhinolophidae (horseshoe bats), and Rhinopomatidae (mouse-tailed bats). The first bats, *Palaeochiropteryx* and *Icaronycteris index*, appeared in the Eocene.[3] ❑

Footnote f3.1

Rodents (L. *rodere*, to gnaw) include guinea pigs (cavies), chinchillas, and capy baras. The latter, at 50 kg weight are the largest extant rodents and include the largest ever, South American *Phoberomys pattersoni* (extinct since 8 million years ago) described by Marcelo R Sanchez-Villagra, first in 1980 from fragmentary evidence, and in 2003 from a nearly complete skeleton. A disproportion between the front and rear limbs suggests that *P. p.* could rest on its haunches and manipulate food with its front paws (as do its modern relatives). Its fossils in a brown shale, along with remains of crocodiles, turtles, and freshwater fish, hint at a semiaquatic life. If so, *P. p.* likely grazed on aquatic grasses to reach its weight estimated to have been 740 kg. (For comparison, a cow at maximum-weight halfway though its life at age eight, weighs 518-536 kg.)[4]

Charles S. Elton in 1924 noted that lemming (small rodents with short tails and furred feet) population boom-and-bust-cycle peaks 1,000 times as high as its valleys. Population theories predict that prey-population numbers rise to blunted peaks, whereas predator-population numbers spike sharply. That is because prey surge to the maximum density their environment permits and hover at that level while predators catch up. However, when predators finally get so numerous that they overeat their prey, starvation quickly undercuts predator numbers. In the late 1990s, studies manipulating populations revealed that predators control some famous cycles: lynx for snowshoe hares, predatory beetles for bark beetles, and perhaps parasites for red grouse.[5]

What constitutes prey or defines the predator? This can be decided, according to Peter Turchin, in 2000, by the graph of their population history.[6] For lemmings the "prey" is vegetable (!) as their populations peak and dwindle predatorlike when they overwhelm their food supply of moss. Their population peak does not have the plateau that would be there if their numbers reached equilibrium with their food supply for a while before predators, which exist (Arctic fox, long-tailed skua, snowy owl, stoat)[7] for them, had their say.

Footnote f3.2 The record holder for being the smallest living mammal is *Craseonycteris thonglongyai* (Kitti's hog-nosed bat or bumblebee bat): adult weight <2 gram, skull length <11mm.[8]