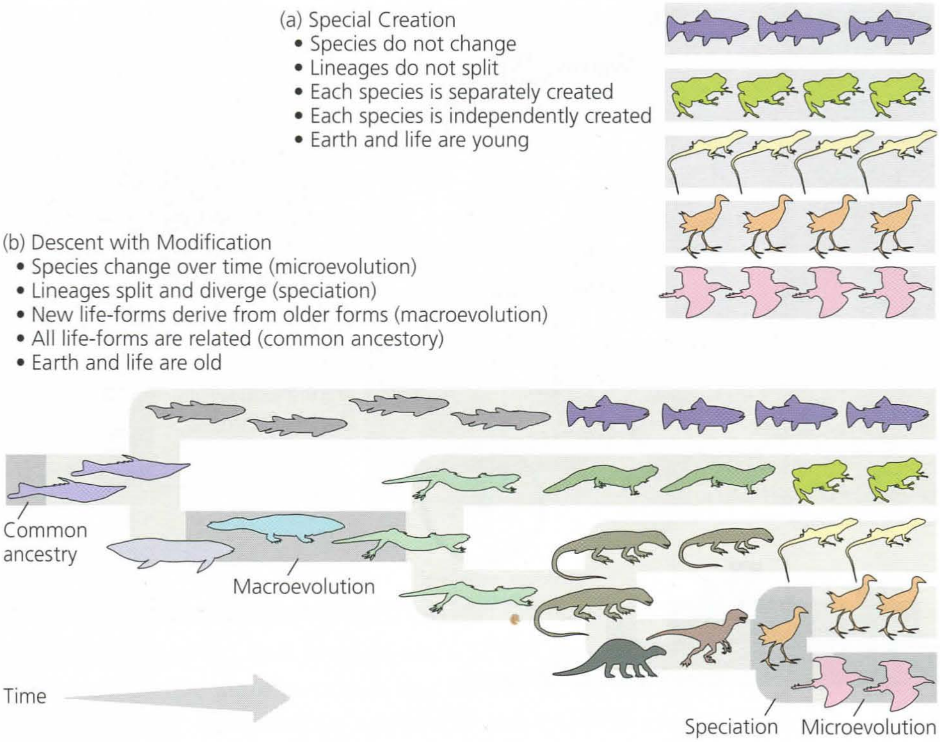


Figure 2.2 Two views of the history of life These cartoons illustrate the contrasting claims made by the theory of special creation versus the theory of descent with modification.

by Darwin, much of it accumulated since—has convinced virtually all scientists who study life that Darwin was right. Darwin called the pattern he saw "descent with modification." It has since come to be known as evolution.

2.1 Evidence of Microevolution: Change through Time

Numerous lines of evidence demonstrate that populations of organisms change across generations. Here we review data from selective breeding, direct observation of natural populations, and the anatomy of living species.

Evidence from Selective Breeding

That a population of organisms can change over time can be demonstrated by anyone with sufficient patience. The trick is selective breeding, also known as artificial selection. Each generation, the experimenter examines the population and chooses as breeders only those individuals with the most desirable characteristics.

Ted Garland and colleagues bred strains of mice that voluntarily run extraordinary distances on exercise wheels (Swallow et al. 1998). From a large population of lab mice, the researchers established four high-runner lines and four control lines, each consisting of 10 mated pairs. The scientists let the pairs breed, gave the offspring exercise wheels, and recorded the distance each mouse ran per day.

For the high-runner lines, the researchers selected from each family the male and female that ran the greatest distance. These they paired at random—except that siblings were not allowed to breed with each other—to produce the next generation. For the control lines, the researchers used as breeders a male and female from each family chosen at random.

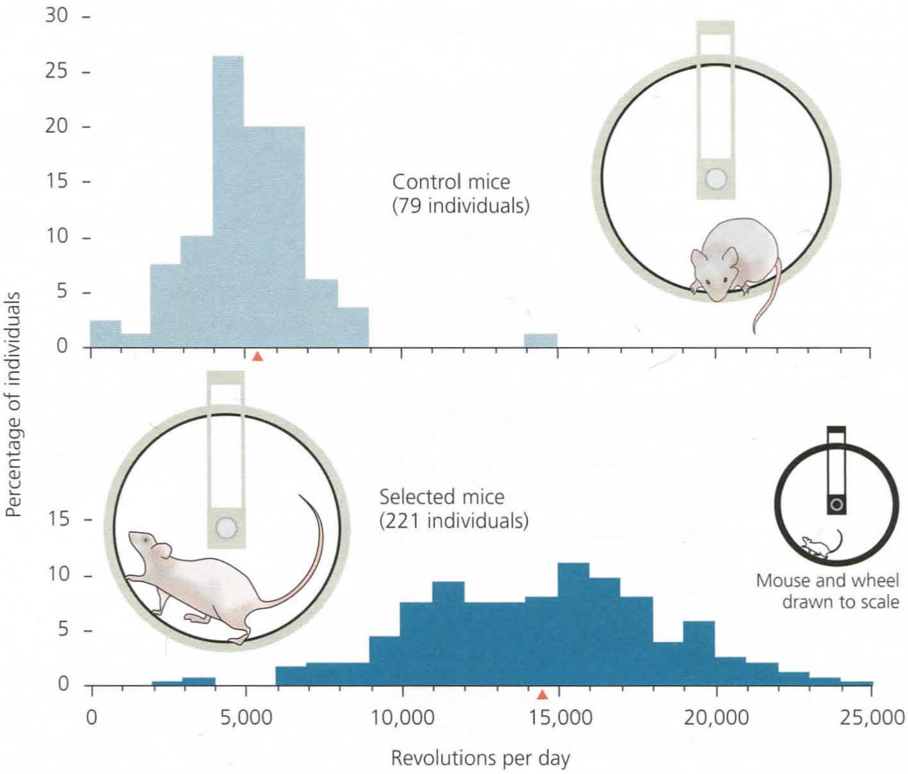


Figure 2.3 Microevolution under selective breeding After 24 generations of selective breeding for distance voluntarily run on an exercise wheel, female mice from selected lineages ran nearly three times as far, on average, as female mice from control lineages (14,458 versus 5,205 revolutions per day, as indicated by orange triangles). Mice and wheels are not shown to scale; in reality, the wheels were much larger. Redrawn from Garland (2003).

After 24 generations of selective breeding, the mice in the selected versus control lines clearly differed in their propensity for voluntary exercise (Figure 2.3). The females in the high-runner lineages traveled, on average, 2.78 times as far each day as the females in the control lineages (Garland 2003). There are, of course, two ways that the high runners might accomplish this. They could spend more time running, or they could run faster. It turns out that mostly what they do is run faster (Garland et al. 2011).

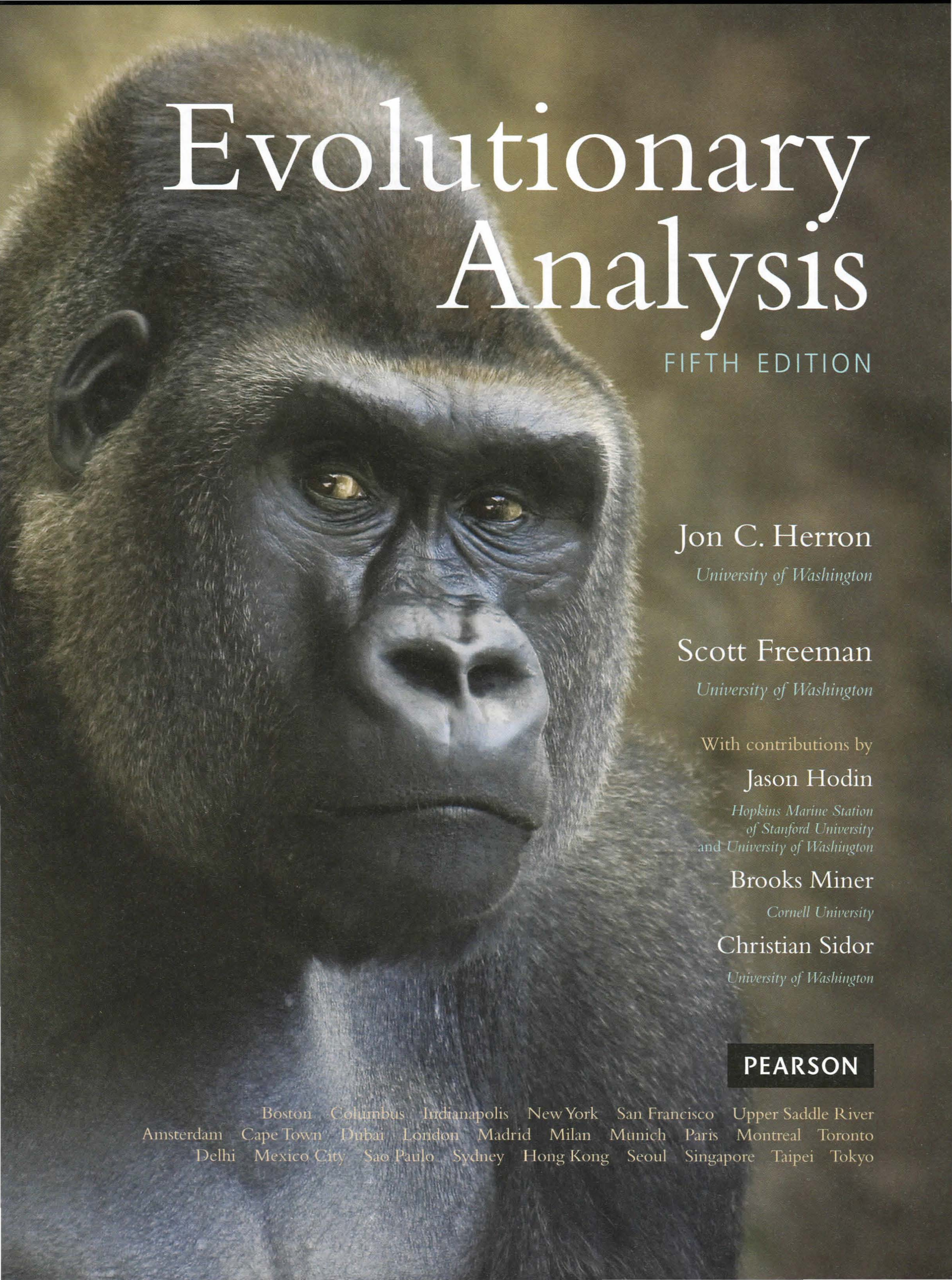
Garland's high-runner mice also differ from the controls in genotype (Garland et al. 2002; Kelly et al. 2010), physiology (Malisch et al. 2008; Meek et al. 2009), and morphology (Yan et al. 2008).

Perhaps most dramatic, however, are neurological differences (Rhodes et al. 2005). The high-runner mice resemble humans with attention deficit/hyperactivity disorder (ADHD). For example, Ritalin—a drug used to treat ADHD in humans—reduces the intensity of exercise in high-runner mice but has little effect on control mice.

Observations on living organisms provide direct evidence of microevolution by showing that populations and species change over time.

The extent to which lineages of organisms can be sculpted using artificial selection is dramatically illustrated by the fact that most domesticated plants and animals come in an abundance of distinct pure-breeding varieties. In each case, the distinctive varieties derive from common stock.

All breeds of dogs, for example, are descended from wolves (Wayne and Ostrander 2007; vonHoldt et al. 2010). The enthusiasm with which they hybridize demonstrates that, despite their differences, all dogs still belong to a single species. Compared to their wolf ancestors, dogs exhibit an astonishing diversity of sizes, shapes, colors, and behaviors (Figure 2.4). The differences persist when dogs of different breeds are reared together, showing that breed characteristics are the result of genetic divergence (see also Akey et al. 2010; Boyko et al. 2010; Shearin and Ostrander 2010).



Evolutionary Analysis

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CITATIONS

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