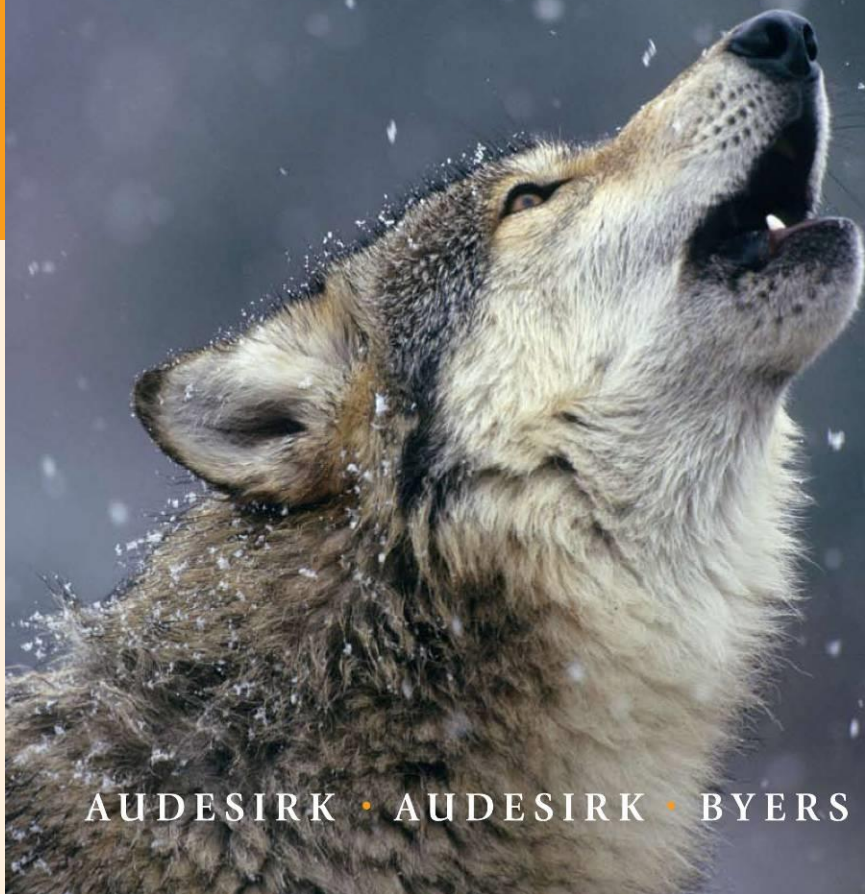


NINTH EDITION

# BIOLOGY

LIFE ON EARTH



AUDESIRK • AUDESIRK • BYERS

## Chapter 18

### Systematics: Seeking Order Amidst Diversity

分类学：在多样性中寻找规律

Lecture Outlines by Gregory Ahearn,  
University of North Florida

# Chapter 18 At a Glance

- 18.1 How Are Organisms Named and Classified?
- 18.2 What Are the Domains of Life?
- 18.3 Why Do Classifications Change?
- 18.4 How Many Species Exist?

# 18.1 How Are Organisms Named and Classified?

分类学是一门命名与分类的生物学科

- **The branch of biology that is concerned with naming and classifying organisms is known as **taxonomy**(分类学)**

- Modern taxonomy was established by the Swedish naturalist Carl von Linne (1707–1778), who called himself Carolus Linnaeus

现代分类学由瑞典博物学家林奈建立

- Linnaeus introduced the two-part scientific name to all organisms

林奈引入了对所有生物的由两部分组成的科学命名法——双名法

# 18.1 How Are Organisms Named and Classified?

- The two-part scientific name of an organism is formed from the **genus(属)** and **species(种)**
  - A **genus** is a group that includes a number of very closely related species 属 指的是包括许多联系非常接近的种的集合
  - A **species** within a genus includes populations of organisms that can potentially interbreed under natural conditions 在一个(包含成群生物的)属内的一个种在自然条件下有交配的潜能/能自然交配
    - The genus *Sialia* (bluebirds) includes three species
      - *Sialia sialis* (the eastern bluebird)
      - *Sialia mexicana* (the western bluebird)
      - *Sialia currucoides* (the mountain bluebird)

# Three Species of Bluebird



**(a) Eastern bluebird**



**(b) Western bluebird**



**(c) Mountain bluebird**

Fig. 18-1

# 18.1 How Are Organisms Named and Classified?

- Each two-part scientific name is **unique** and **recognized worldwide** 独一无二 世界公认
- Scientific names are always **underlined** or **italicized** 下划线 或者 斜体
  - The first letter of **the genus name** is always **capitalized** 属的首字母大写  
种的首字母小写
  - The first letter of **the species name** is always **lowercase**
- The species name is always paired with its genus name 种名常常与属名连成一对

# 18.1 How Are Organisms Named and Classified?

- **Classification originated as a hierarchy of categories**
  - Each species was placed in a series of hierarchically arranged categories on the basis of resemblance to other species
  - The categories form a nested hierarchy in which each level included all the other levels below it

类别 分类 等级

起源于

等级 层级

分类 类别 范畴

一系列

等级

被安排

相似的

嵌入的

# 18.1 How Are Organisms Named and Classified?

- **The Linnaean classification system came to include 8 major categories or taxonomic ranks**

Domain域 → Kingdom界 → Phylum门 → Class纲  
→ Order目 → Family科 → Genus属 → Species种



# 18.1 How Are Organisms Named and Classified?

- **Modern classification emphasizes patterns of evolutionary descent**
  - In 1859, Charles Darwin (1809–1882) published *On the Origin of Species*
    - This work demonstrated that all life is related by common ancestry
  - Biologists then realized **that taxonomic categories should reflect evolutionary relatedness**
  - The more categories two organisms share, the closer their evolutionary relationship

强调

模式

血统

这部著作演示了/揭示了所有生物都拥有相同的祖先

生物学家于是意识到分类学的分类应该反映进化之间的联系

两种生物共有的范畴/共同点越多，它们在进化学上的关系就越密切

# 18.1 How Are Organisms Named and Classified?

- **Modern classification emphasizes patterns of evolutionary descent (continued)**
  - Today, the process of classification focuses on 重建 修复 重现 reconstructing **phylogeny** (系统发生论 系统发生), or evolutionary history
  - The science of reconstructing phylogeny is known as **systematics** (分类学)

# 18.1 How Are Organisms Named and Classified?

- **Modern classification emphasizes patterns of evolutionary descent (continued)**
  - 分类学者 Systematists have increasingly focused their efforts on building evolutionary trees, rather than dividing organisms into specific Linnaean classifications
  - Systematists name groups, which they call **clades** (进化枝系), that include species linked by descent from a common ancestor
  - Clades can be arranged in a hierarchy, with smaller clades nested within larger ones

嵌入的

# Clades Form a Nested Hierarchy

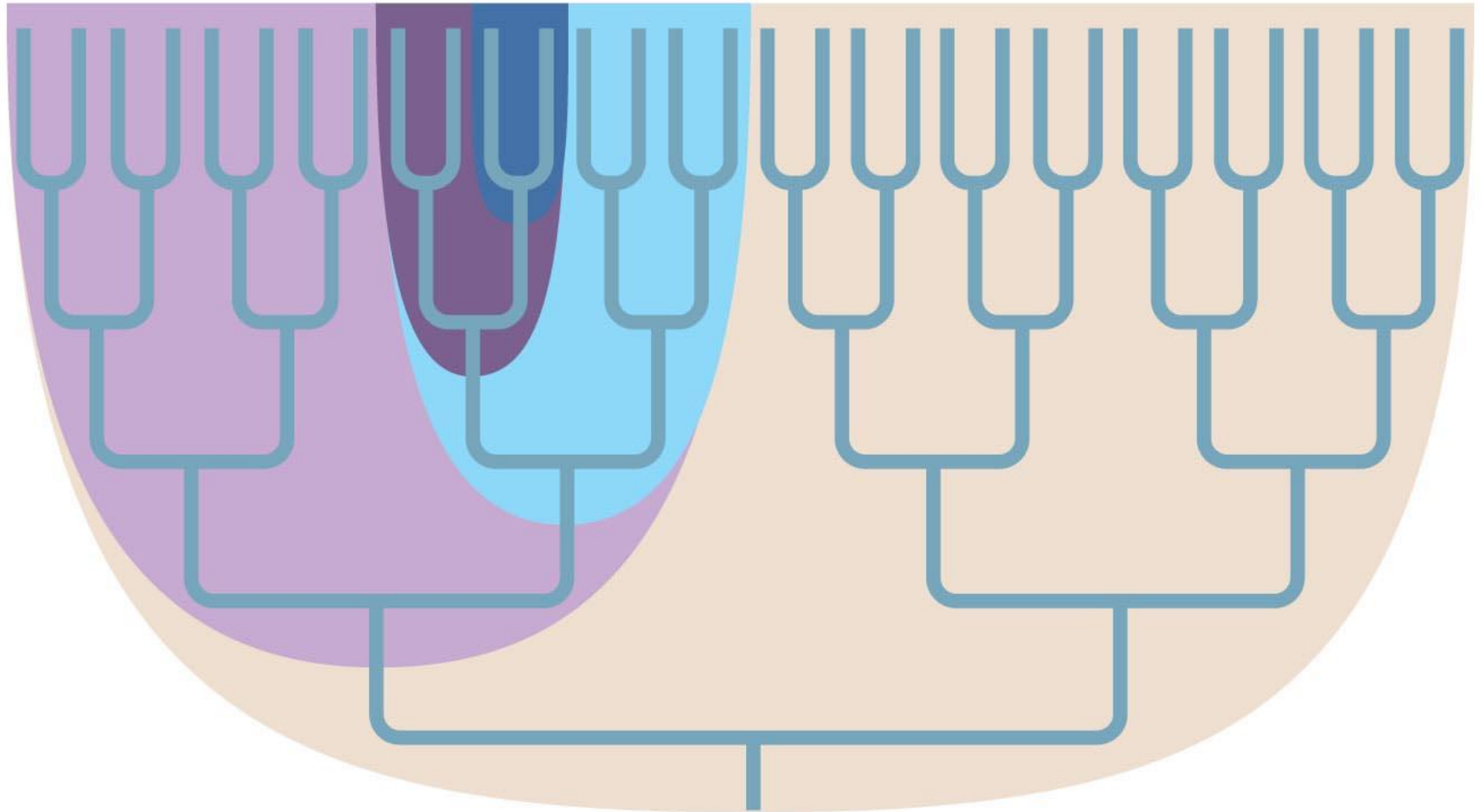


Fig. 18-2

# 18.1 How Are Organisms Named and Classified?

- **Systematists identify features that reveal evolutionary relationships**
  - All organisms share certain similarities
  - Some observed **similarities result from common ancestry**, some from **趋同进化** **convergent evolution** in organisms that are not closely related
  - Therefore, systematists must distinguish **区分辨别** **informative similarities** caused by common ancestry **提供消息的** **from** **不提供信息的** **uninformative similarities that result from convergent evolution**
  - Biologists look at many kinds of characteristics in the search for informative similarities

# 18.1 How Are Organisms Named and Classified?

解剖学

- **Anatomy plays a key role in systematics**
  - Historically, the most important and useful distinguishing characteristics have been anatomical
  - Systematists look carefully at similarities in both external body structure and internal structures, such as skeletons and muscles
  - **Homologous structures (同源结构)** such as the finger bones of dolphins, bats, seals, and humans provide evidence of a common ancestor

外观的

内在的

骨骼

海豚

蝙蝠

海豹

# 18.1 How Are Organisms Named and Classified?

## ■ Anatomy plays a key role in systematics (continued)

– Systematists examine microscopic similarities to discern finer details

识别

好的

– The number and shape of the “teeth” on the tongue-like **radula** (舌齿) of a snail

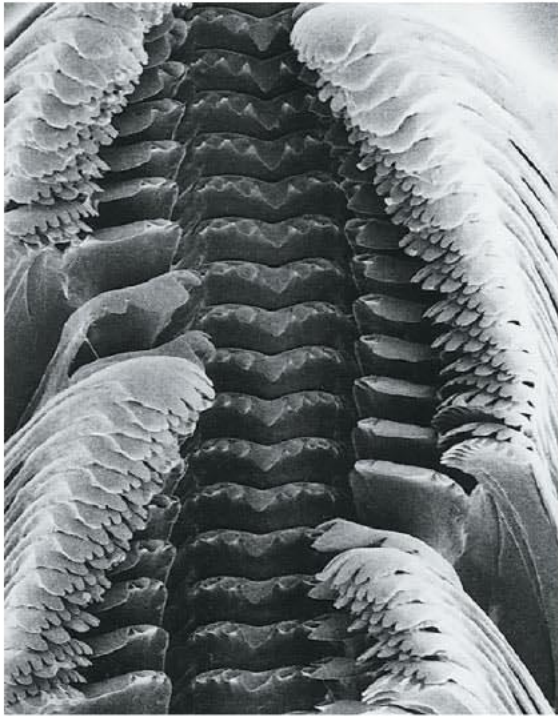
蜗

– The shape and position of **the bristles** (刚毛) on a marine worm

海生蠕虫

– The external structure of **pollen grains** (花粉料) of a flowering plant

# Microscopic Structures May Be Used to Classify Organisms



**(a) Radula**



**(b) Bristles**



**(c) Pollen grains**

Fig. 18-3



# 18.1 How Are Organisms Named and Classified?

- **Molecular similarities are also useful for reconstructing phylogeny**
  - Systematists examine genetic similarities between **DNA nucleotide sequences** 核苷酸序列
  - It has been estimated that 96% of the chimpanzee genome is identical with that of humans 估计黑猩猩与人类的基因组有96%的相同之处
  - Similarities in chromosome structure also can be used to establish relationships between organisms

# Human and Chimp Chromosomes Are Similar

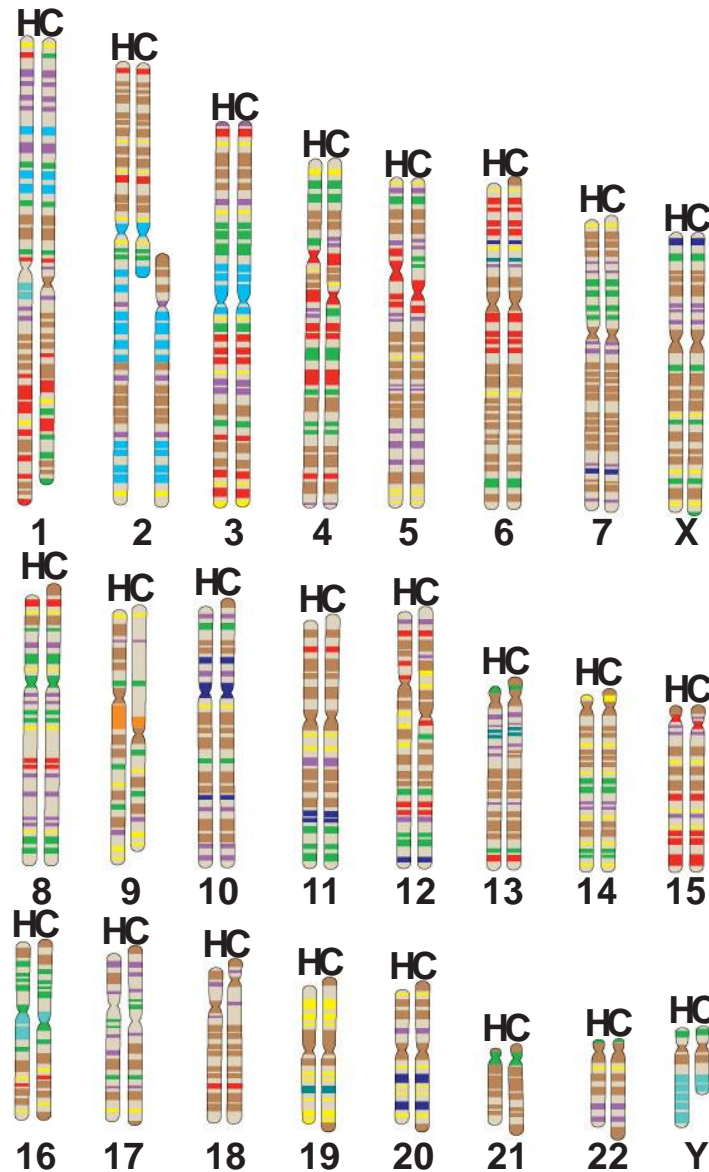


Fig. 18-4

## 18.2 What Are the Domains of Life?

- **Before 1970, systematists divided all species into two groups**
  - Animalia
  - Plantae (including plants, bacteria, fungi, and photosynthetic eukaryotes)
- **As knowledge expanded of life's evolutionary relationships, it became clear that a two-domain approach was an oversimplification**

植物界

植物 细菌 真菌 能光合作用的真核生物

扩张扩大详述

域

过于简单

## 18.2 What Are the Domains of Life?

- **A three-domain system more accurately reflects life's history**
  - Carl Woese laid the groundwork
  - Woese discovered that prokaryotic organisms included two very distinct groups (Bacteria and Archaea) on the basis of their respective nucleotide sequences of ribosomal RNA

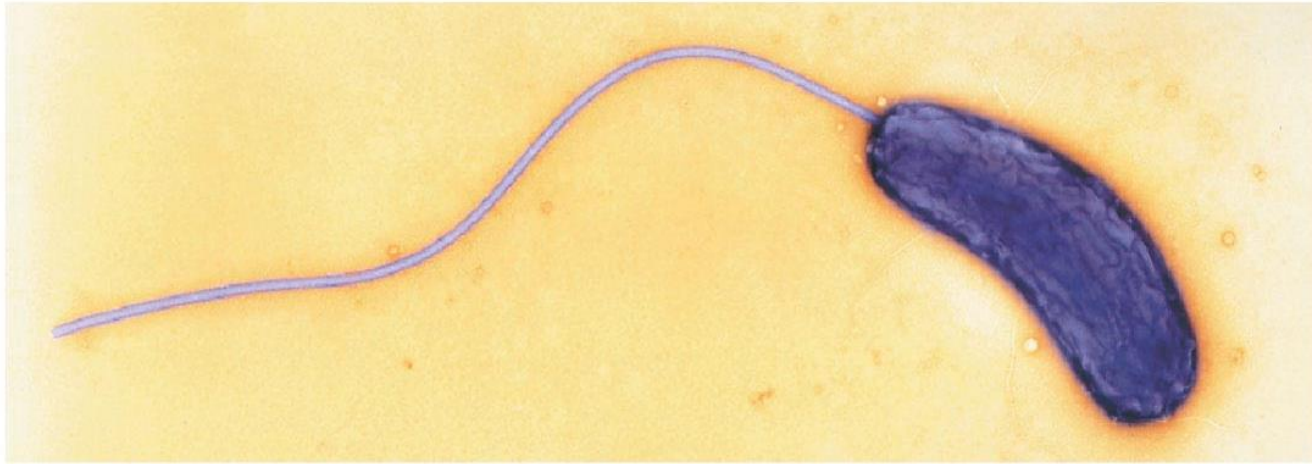
卡尔 乌斯

根基

明显的 独特的

古细菌

# Two Domains of Prokaryotic Organisms



**(a) A bacterium**



**(b) An archaean**

Fig. 18-5

## 18.2 What Are the Domains of Life?

- **A three-domain system more accurately reflects life's history (continued)**
  - These domains include:
    - Bacteria (prokaryotic)
    - Archaea (prokaryotic)
    - Eukarya (eukaryotic)
  - These three 分裂 split very early in life, long before animals and plants evolved

# The Tree of Life

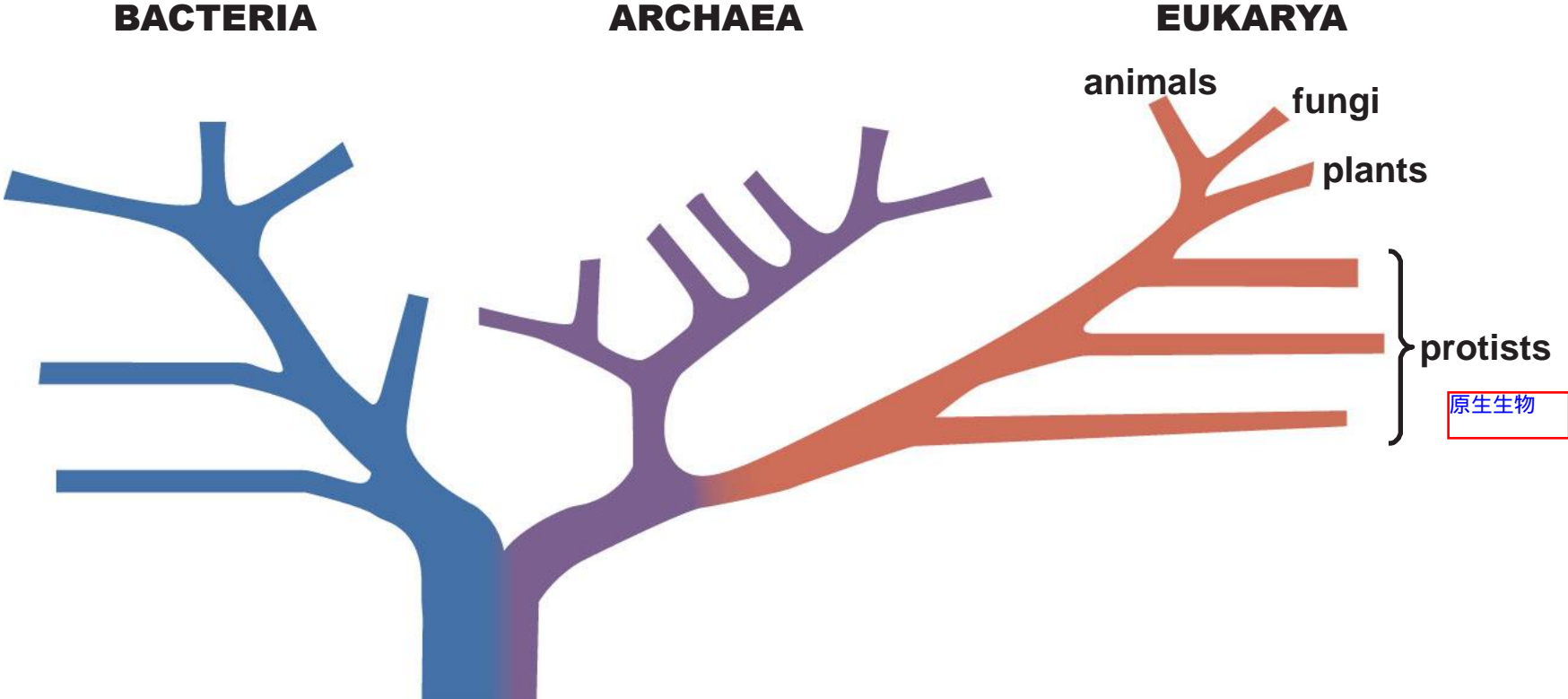


Fig. 18-6

## 18.2 What Are the Domains of Life?

- **A three-domain system more accurately reflects life's history (continued)**
  - Within the domain Eukarya, there are four different groups of organisms:
    - Animalia (animals)
    - Plantae (plants)
    - Fungi (fungi)
    - Protists (eukaryotic organisms that are not animals, plants or fungi)



# A Closer Look at the Eukaryotic Tree of Life

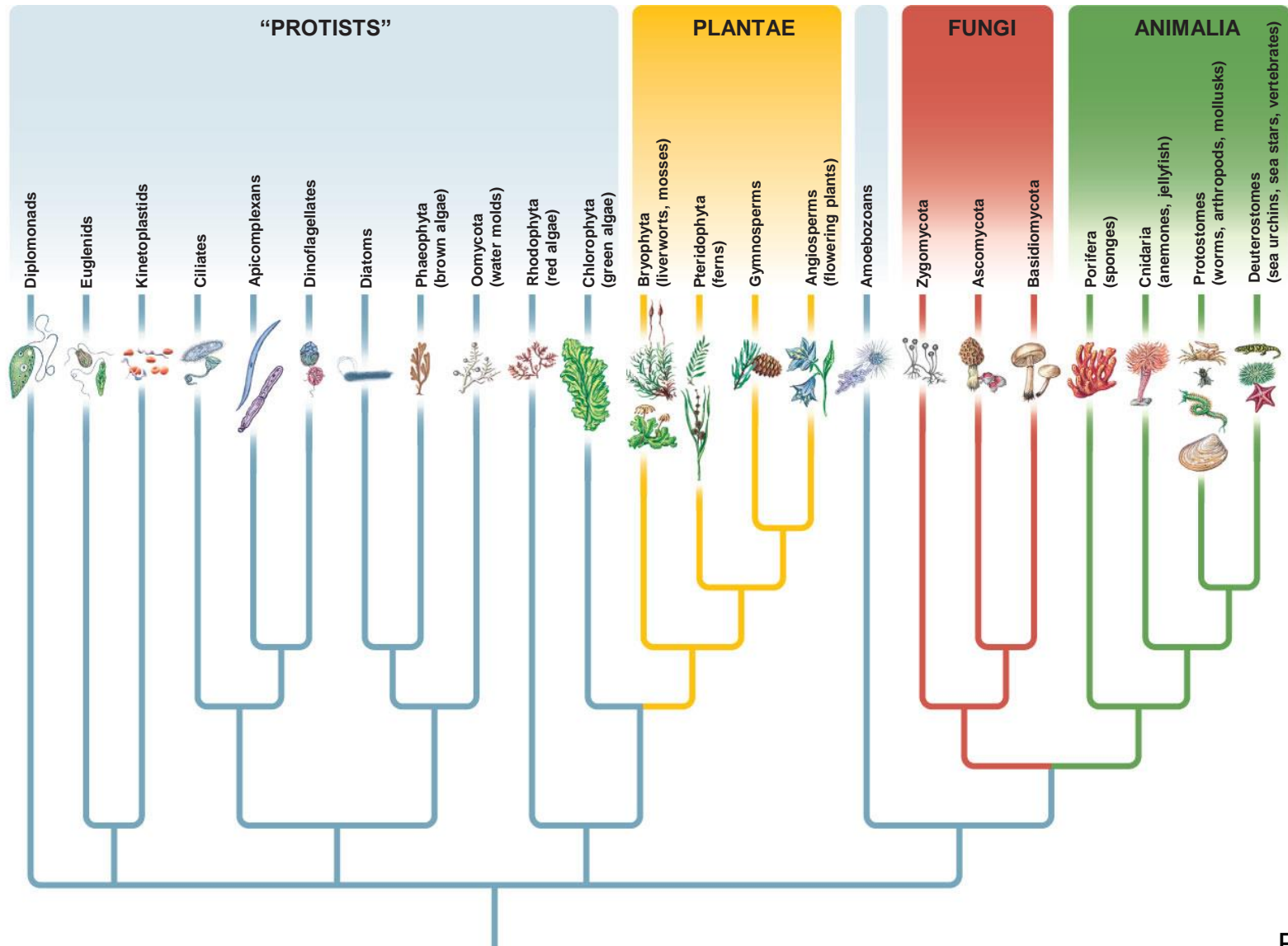


Fig. 18-7

## 18.3 Why Do Classifications Change?

- **Species designations change when new information is discovered**
  - Systematic changes at the top levels of classification occur only rarely, but there are regular changes in species level
  - It was previously thought that there were only two species of elephant, African and Indian
    - More recently, the African elephant species has been divided into two species—the savannah elephant and the forest elephant
  - Genetically, these two African species have no more in common than lions and tigers

命名

之前地

大草原

基因学的

## 18.3 Why Do Classifications Change?

- **The biological species definition can be difficult or impossible to apply**
  - The biological species concept defines species as **“groups of interbreeding natural populations that are reproductively isolated from other such groups”**
  - This system cannot be applied to asexually reproducing organisms
    - Most bacteria, archaea, and protists reproduce asexually

## 18.3 Why Do Classifications Change?

- **The biological species definition can be difficult or impossible to apply (continued)**
  - <sup>可替代的</sup> Alternative species definitions have been <sup>提议</sup> proposed, one of which is the *phylogenetic species concept* 系统发生学物种概念

## 18.3 Why Do Classifications Change?

- **The biological species definition can be difficult or impossible to apply (continued)**
  - The *phylogenetic species concept* defines a species as the “**smallest diagnosable group** that contains all the descendants of a single common ancestor”
    - Basically, each distinctive branch on a phylogenetic tree constitutes a separate species
    - This concept can be applied to sexually and asexually reproducing organisms
    - It may eventually replace the biological species concept
    - 你认为是这样吗?

## 18.4 How Many Species Exist?

- **Biodiversity** (生物多样性) is the total number of species in an **ecosystem** (生态系统)
  - The number of named species is currently about 1.5 million (biased toward large organisms in temperate regions)
    - 5% are prokaryotes and protists
    - 22% are plants and fungi
    - 73% are animals

## 18.4 How Many Species Exist?

- It is estimated that 7 million to 10 million species may exist
- Between 7,000 and 10,000 new species are identified annually, mostly in the Tropics
- Tropical rainforests are believed to be home to two-thirds of the world's existing species, most of which have yet to be named

## 18.4 How Many Species Exist?

- Although 5,000 species of prokaryote have been named, scientists discovered 4,000 different species of bacteria in a single soil 样品 sample, and an equal number in a sample of marine sediments 海相沉积
  - They considered a bacterium to be a different species if its DNA differed **by 30 percent** from other bacteria in the sample



## 18.4 How Many Species Exist?

- Factors other than actual abundance influence whether species are discovered and named
  - Size
  - Ease of classification 易于分类
  - Accessibility 可得到的
  - The number of researchers searching for them

## 18.4 How Many Species Exist?

- Because tropical rainforests are being destroyed so rapidly, species may become extinct before we even know they exist
- The unexplored 大陆 continent of the deep-sea floor may have hundreds of thousands of unknown species to be discovered

# The Black-Faced Lion Tamarin

絹毛猴



Discovered  
in 1990

Fig. 18-8