THEME **Nature of Science**

DNA Barcoding of Life

Traditionally, taxonomists relied on anatomical traits to tell species apart. Although useful, physical features have several limitations when used as the only means to define a species. The identification of anatomical traits often requires the assistance of taxonomic experts that specialize on a specific group of organisms. In recent time, the number of species has far exceeded the number of available experts. This puts the cataloging of the world's biodiversity on a slow path—much slower than the rate at which our natural areas are disappearing. So far, scientists have identified only about 1.5 million species out of a potential 30 million.

The Consortium for the Barcode of Life (CBOL) proposes that any scientist, not just taxonomists, could use a sample of DNA to identify any organism on Earth. Just like a barcode, or UPC code, is a unique identifier of products on a store's shelf, the CBOL suggests it would be possible to use the base sequence in DNA to develop a barcode for each living thing (Fig. 19A). The order of DNA nucleotides—A, T, C, and G—within a particular gene common to the organisms in each kingdom would fill the role taken by numbers in the barcode used in warehouses and stores.

Speedy DNA barcoding would not only be a boon to efforts to catalog a rapidly disappearing biodiversity, but it would also have practical applications. For example, farmers could readily identify a pest attacking their crops, doctors could rapidly identify the correct antivenin for snakebite victims, and college students could identify the plants, animals, and protists on an ecological field trip. Already, the CBOL has accumulated hundreds of thousands of DNA barcodes representing species across the diversity of life.

The CBOL initiative has the potential to be a powerful tool for conservation biologists and wildlife officials worldwide. A DNA barcode can be used to identify illegal trade in endangered species, and for the early detection of invasive species that arrive into other countries as a consequence of global transportation.

In 2008, a pair of New York City high school students found a commercial application for the CBOL database (Fig. 19B). Kate Stoeckle and Louisa Strauss, two Trinity School seniors, did a project on the identification of fishes sold in markets and sushi restaurants in Manhattan, New York. They collected 60 fish samples from 4 restaurants and 10 grocery stores in Manhattan, which they sent off to have the DNA segment, the barcode, sequenced and compared to a global library of fish barcodes representing nearly 5,500 fish species.

Their results sent a wave of controversy throughout Manhattan and beyond: 2 of the 4 restaurants, and 6 of the 10 grocery stores, sold fish that were mislabeled. Most of the mislabeled fish were being sold as more expensive species. For example, Mozambique tilapia, a commonly farmed fish selling for $1.70 per pound wholesale, was being sold as albacore tuna at $8.50 per pound (Fig. 19C). In one case they found an endangered fish, the Acadian redfish, being sold as red snapper!

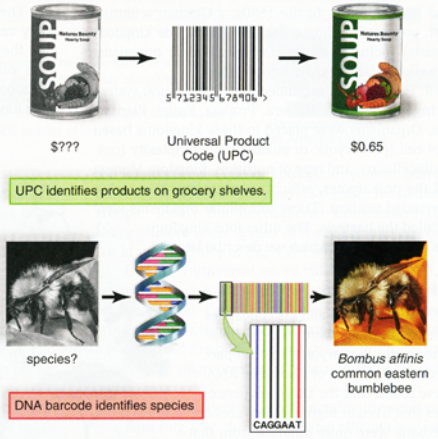

Figure 19A Illustration of the barcoding concept. Much like a barcode (UPC) can identify the type and price of a can of soup, a DNA barcode can be used to identify a species. This is possible because each UPC is unique to a particular product, and each DNA barcode, based on a DNA sequence, is unique to an individual species.

Figure 19B Katie Stoeckle (left) and Louisa Strauss uncover mislabeled fish in Manhattan.

Figure 19C Mislabeled fish.

Questions to Consider

1. How might DNA barcoding be used by systematic biologists to speed up the classification of biodiversity?
2. Propose additional ways that DNA barcoding could aid in managing modern societal problems, such as the conservation of biodiversity, global warming, crime, and disease.