

FASTSPECIES-ID: The Future is Now



The fictional Star Trek tricorder

The Star Trek tricorder was an exciting piece of fictional technology that allowed any member of the crew to identify any plant or animal lifeform anywhere in the galaxy. Technology developed ThermaGenix is bringing the concept of a portable species identification device out of science fiction and closer to reality.

ThermaGenix is developing universal DNA tests for species identification that work on commercial portable instruments that anyone could use today. Our first application, FASTFISH-ID, enables rapid on-site DNA testing for any commercial fish species to confirm the identity of fish products and access species information anywhere along the seafood supply chain. In the future, the same testing technology will help identify and help track disease-carrying organisms and their pathogens, detect invasive agricultural pests, among many other exciting applications. The goal is to eventually put DNA technology for species identification in people's hands the way smart phones put information in everyone's pocket.

A portable instrument that could quickly identify any species anywhere would be a game changer – just place a piece of fish or an insect leg into a tube with reagents, transfer this material to a tube in a portable device, and out comes its taxonomic information in just two hours. Even more exciting, distributors and retailers will be able to tell their clients and customers directly what species is in their fish products and citizen scientists will have the tool they need to help them document the impact the climate change on local biodiversity, among many other potential applications (see below).



Modified from genomecanada.ca

From genetically modified foods/crops to diagnosing disease to solving crimes, DNA technology is already transforming our world. Now, for the first time in history, anyone will be able to do DNA testing to identify any animal species using a portable device smaller than a shoebox. In fact, technology already exist to replace the shoebox with a faster and more cost-effective handheld device, pretty much like the first bulky cell phones were replaced by sleeker and smarter pocket versions.

DNA is the key because every species — even if it just a piece of it or looks like something else — has its own unique genetic code. All animal organisms on Earth contain a short stretch of DNA that serves as a molecular identity tag for each species. Such molecular tag is called a DNA barcode and it works in the manner a supermarket UPC barcode identifies products in stores. But, unlike scanning a UPC barcode at a store register, “reading” a species DNA barcode from a sample from animals or food products is far more complex. The tricorder

of today requires samples to be shipped to a dedicated testing facility, uses multiple pieces of equipment, can only be operated by trained scientists, and generates results in several days or even a week - a very slow and expensive process ill-suited for perishable samples, when delays in getting results are costly, or when answers are need right away. It would be nice to identify species on-site

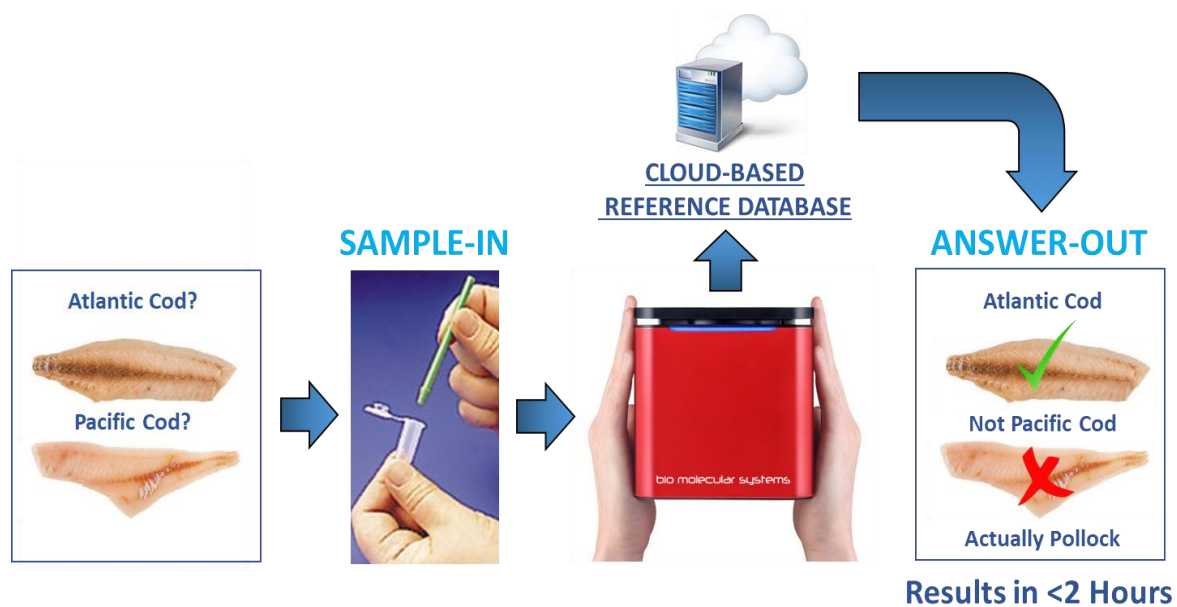


Today's tricorder

in less than 2 hours without having to collect samples and ship them for analysis, particularly when immediate actionable decisions are needed (e.g., to stop the trade of illegal/endangered species at point of entry, to detect disease-carrying pathogens to identify the best treatment or to combat dangerous pests about to destroy important crops).

The difficulties of making DNA species identification affordable, accessible, and routine has undercut the technology's great potential. But what if the whole process, from sample to species identification, could be done in a portable, easy-to-use device already in the market that anyone could use? The major limitation toward this goal is clearly not the hardware but the availability of convenient DNA tests that would enable such devices to generate fast answers for any organism in one step without further user intervention. A universal test that

can conveniently and affordably identify any species on Earth by their DNA just by placing a sample in a portable machine would be revolutionary.



**Thermagenix's solution:
Simpler and faster species DNA testing**

ThermaGenix is developing DNA tests that automatically make copies of the DNA barcode from a sampled bug, bird, or fish and immediately generate a fluorescent “signature” characteristic for that species, all in a portable device in under two hours. The portable device automatically compares the resulting fluorescent signature against a reference library and provides the answer for immediate species identification. The reference library could be built-in into the device or made available online to make the information readily accessible the world over. Anyone interested in species identification, regardless of technical expertise, can gather a sample in the field and conclusively identify species by themselves from tiny amounts of tissue. Compare this to standard taxonomic identification, which requires intact specimens (often impossible in situations where you want to know the identity of food products) and a dedicated expert capable of distinguishing subtle anatomical differences between closely-related species based on morphological features like the shape and color of the organism's parts. Our approach is far more accessible, rapid, economical, accurate, and reliable. The concept of a tricorder-like device sounds simple enough, but it is the culmination of decades of intense research at ThermaGenix.

But there is an even more exciting possibility in sight. As mentioned above, ThermaGenix plans to work with a close collaborator who is building a Star Trek-inspired hand-held device that uses the new DNA test for species identification. The current prototype device already allows any user to complete DNA testing similar to that required for species identification in as little as 30 minutes at a significantly lower cost. When fully implemented such handheld device will bring us closer to having a working tricorder that anyone can use to recognize any species on Earth.

Once at the hands of society at large, this game-changing device and technology will revolutionize and democratize the world of species DNA identification. Species DNA testing would no longer be the exclusive realm of university, company, or federal laboratories. If anyone had the ability to identify any living being anywhere what could they do with it? The possibilities are almost endless. A portable device for species identification and their associated chemistries will empower individuals with minimal training (conservationists, environmentalists, citizen scientists, field agents) to identify species anywhere, even if the species is no longer identifiable by its morphological characteristics or life-cycle stage (eggs, larvae) to better assist in efforts to conserve biodiversity around the world.



The technology developed at ThermaGenix could also help track species carrying disease (mosquitos, ticks, etc), run safety and authenticity checks on food, and combat the trafficking of endangered animals. This technology will change the way regulators protect against illicit wildlife trading by analyzing animal parts or even hair, the way scientists survey changes in animal and plant populations to monitor the effects of global climate change, the way farmers tell precisely what pests are destroying their crops and then use only pesticides targeted at those certain species, thereby reducing the amount of chemicals sprayed, the way inspectors at fish markets verify what fish is

being sold and test for the species-specific harmful bacteria and viruses it might have. Customers will be able to find out exactly what ends up on their plate and whether it was sustainably acquired. For the first time genetic identification of species will be routinely done in food distribution centers, retailers, ports of entry and security checkpoints, classrooms and living rooms, and even in infrastructure-poor locations



where only solar-powered devices are a viable option. This is not science fiction. It is science reality close-at-hand.

Additional human health-related efforts include DNA identification of several thousand species of mosquito -- including insects responsible for up to 500 million human malarial infections and 1 million deaths each year. In addition to malaria, mosquitoes transmit many other devastating viruses as well such as West Nile, Dengue, and Zika. Vector control is key to effective disease management. However, vector control efforts are consistently undermined by species misidentification. Convenient species DNA identification can tremendously assist the world's remaining expert mosquito taxonomists who are struggling to keep up. Using a portable DNA test mosquito, control agents could identify disease-carrying species from eggs and larvae in standing water.

But this is not all. Portable species DNA instruments will empower teachers, students, and the general public to learn science in new, exciting ways. For the first time the tools once restricted to Ph.D.'s and crime labs will move into the hands of interested teachers, students, and citizen scientists everywhere. Instead of



just learning theory, students will connect to the technology by holding the device and obtaining the results. By democratizing the technology, the portable device will change people's appreciation of our world and the impact of how they interact with it. People will be able to identify any species and reach their own conclusions about the effects of human activity on species biodiversity, evaluate the authenticity of food products, etc.

The revolutionary developments from ThermaGenix foresee a new era of genomics where DNA testing for species identification will become like accessing information on the Internet. Instead of relying on librarians sorting through stacks of books, anyone can become an active participant in seeking species information. It excites the imagination and open new possibilities to amateur scientists, regulators, conservationists, and others everywhere.

The initial application focuses on DNA identification of commercial fish species. The U.S. National Fisheries Institute and the seafood industry already envision several important uses of this technology, including (1) more reliable tracking of fish products through the supply chain; (2) verification of species product

labels to guaranteed product authenticity; (3) proper safety testing for species-specific health hazards; (4) improved enforcement of fishing quotas; (5) better protection against the sale of catch-restricted or endangered species; (6) effective deterring of species mislabeling/substitution to address economic fraud issues; (4) improved fish stock assessments based on identification of larvae and juveniles to support the sustainability of the fisheries industry. The Food and Drug Administration (FDA), the non-government organization Oceana, Northeastern University's Ocean Genome Center, and European academic institutions already provided us samples of authenticated fish specimens to construct a reference library for species identification.

Our immediate goals are to build and curate a reference library for convenient species identification (our 21st century version of a digital Noah's Ark), identify current and next-generation compatible portable and hand-held devices, and expand implementation of the platform technology for DNA identification of an ever expanding number of animal and plant species.

The real-world tricorder isn't just something that's going to transform science someday. It's something that is already being developed right now. A revolution is happening now and ThermaGenix is leading the way.